Residents' Perception on the Impact of Urban Development on Water Quality in Kabul City, Afghanistan

Safiullah Zahid, M. Zainora Asmawi and Muhammad Faris Abdullah

Department of Urban & Regional Planning, Kulliyyah of Architecture & Environmental Design (KAED), International Islamic University of Malaysia (IIUM), 53100, Selangor, Malaysia.
Email: zainora@iium.edu.my

Abstract
Kabul, as one of the biggest cities and capital of Afghanistan, has been severely affected by the past few decades of war in the country. The Kabul city population has significantly increased after 2001, which resulted in the fastest urban development of the city. About 70% of the Kabul city residents living in the informal settlement, nearly two-thirds of its population do not have access to the city water supply network, and the Kabul city drinking water is mainly being supplied through shallow wells. Proper sanitation system also does not exist in the city. This resulted in the decline of water quality. Indeed, groundwater analyses display a continued reduction in water quality due to increases in pollution. Thus, the main purpose of this research is to analyse the effects of urban development on water quality of groundwater through resident's perception. Therefore, a survey questionnaire was circulated among 429 persons, which shows that about half of the respondents were not satisfied with their home drinking water quality. Besides, the analyses of data also revealed that rapid urbanisation has a significant impact on water quality and that the rapid population growth, stormwater, water pollution, colour of water, septic tank, drainage, and pit latrine are the main elements that contribute to the impact of urban development on water quality of the city.
Keywords: Urban Development, Population Growth, Water Quality, Residents Perception, Groundwater

Introduction
Afghanistan has an old history of urban settlement, which dates back to 3000BC and counting as one of the oldest centres of civilisation in central Asia (Habib & Kidokoro, 2015). However, bypassing nearly two decades of wars Afghanistan become one of the poorest countries in the world, more than five million people emigrated to the neighbouring countries, until the new government came into existence in 2001 (Beall & Schütte, 2006). Hence, the major cities of

the country show rapid population growth due to the returning of emigrant and internal displacement (Majidi, 2011). Even though Kabul as one of the biggest city and capital of Afghanistan has significantly affected, the Kabul city population has rapidly increased from 1.5million in 2001 to about 4.9million people in 2015 which resulted the Kabul city become the fifth rapidly growing city in the world due to fastest urbanisation and population growth, where about 70% of the people are currently living in an informal settlement in Kabul city (Ahmadi & Kajita, 2017). Besides, the residents of the city are suffering from different types of environmental challenges such as air pollution, weak solid waste management, absence of water sanitation, safe drinking water and green areas (Afghanistan's Environment, 2008).

It was discovered that nearly 27.5% of the Kabul city residents have access to the water supply network (Zaryab et al., 2017). The Kabul city drinking water is mainly being supplied by privately or community-owned shallow wells of groundwater, with a depth of normally less than 30m (Mack, Chornack, & Taher, 2013). The groundwater level decreased by 1.7m/year during the years 2008 – 2016 due to rapid increase in the population growth and using the shallow well as the main source of drinking water (Zaryab et al., 2017). Besides, a research carried out in 2009 for the development of Kabul city master plan displayed, a required water demand of 123.4million m^3/year for the Kabul city. However, the Kabul city groundwater storage was estimated nearly 44million m^3/year, so if daily consumption of 50lit/day per capita were to be considered, then it would only supply water for 2million people (JICA, 2009). Therefore, to solve the water decline issue in Kabul, the government started the aquifer recharge project in early 2017. This project aims to store the water discharging from snow melting or rainfall to further recharge the local aquifer layer ("Kabul Managed Aquifer Recharge Project Preparation," 2017). The feasibility study for the construction of *Shahtoot* dam located in the southwest of Kabul city on the Kabul river was completed in 2010, and the estimated capacity of the water supply after completion for this dam is an average of 87.2 million m^3/year (Zaryab et al., 2017). Collectively, the dam and groundwater can solve the water supply issues of Kabul city. In spite of this, in 2018, the Ministry of Energy and Water had announced that the government will soon start the implementation of the *Shahtoot* dam after they resolve the land acquisition issue and environmental impact study by the Ministry of Urban Development and Land (Omid, 2018). Hence, until the construction of this dam, the groundwater can be counted as the main source of drinking water.

Additionally, the appropriate system for wastewater treatment does not exist in Kabul city and the groundwater pollution associated infection also increased in the citizen, which shows the negative path of the groundwater due to increases of the pollution (Zaryab et al., 2017). Excluding the Microryan area, which is the only area in Kabul city that has the sewerage system and treatment plant (JICA, 2011). Further, the absence of public sewerage system resulted that some of the people make septic tank; while others build a simple latrine and that caused to mix the sewerage with underground water and increasing the groundwater pollution (Constable, 2017). Therefore, the main reasons for decreasing the level of water quality noticed; quick population growth, which became tripled in a few decades, fastest urbanisation and industrial development, and economic growth (Akhtar, 2017).

Furthermore, previous studies show the GIS-based assessment of the Kabul city water quality shows, that the water quality in Kabul City is not suitable for drinking purpose due to increased level of lead, arsenic, with coli and E-coli, while the level of alkalinity and bicarbonate are also higher close to the city (Shah, 2011). Besides, the chemical analysis of the water quality in Kabul city revealed that the water quality in Kabul city is much more polluted and has a serious risk due to the high level of magnesium, boron, manganese, and

sodium (Sundem, 2014). Additionally, the analysed of about 227 water well samples for toxic elements of the water quality in Kabul city resulted that, three toxic elements among all ten tested have exceeded from the World Health Organization (WHO) guideline which is: chromium in 0.9%, uranium in 19.4% and arsenic in 7% of the samples, that represent the groundwater pollution of the Kabul city (Kato et al., 2016). Moreover, the analysed of nearly 450 samples for biological characteristics of water from water supply network of Kabul city resulted in the existence of Fecal Coliform bacteria by 9.6% and Total Coliform bacteria by 12.9% on the total water sample tested, which also shows the groundwater pollution of the city (Zahid, Asmawi & Abdullah, 2019).

Thus, the main purpose of this study is to identify the resident's perception about water quality and to analyse the impact of urban development on groundwater quality in the Kabul city. However, many authors have analysed the groundwater quality of Kabul city. While, the significance of this study is that it covers the resident's perceptions about water quality and the impact of urban development on it. Though, to achieve the objectives of this study, a survey questionnaire has been developed and circulated among the residents of the city.

Methods
The study area of Kabul city, the capital of Afghanistan is located in the north-eastern part of the country. The city is surrounded by mountains and situated at 1,800 meter above sea level. Besides, Kabul city consists of 22 municipality districts (JICA, 2011). The research method used for this study consisted of both qualitative and quantitative methods. The trend of Kabul urban development has been analysed using the qualitative research method. Hence, the resident's perception about water quality and the impact of urban development have been analysed using the quantitative method of the research. The questionnaire survey has been circulated among the residents of Kabul city through the internet using the google form and as a hard copy between the city dwellers to know about their perception in regards to the water quality and the impact of the urban development on the groundwater quality. As a result, 429 persons have filled the survey questionnaire form and responded to all the questions stipulated in the questionnaire. The survey questionnaire was consisting of three parts, first demographic information of the respondent, second the questions related to the water quality, and the third part of the survey questionnaire was about the urban development impact on the water quality.

Data Analysis and Discussion
The analysis of demographic data achieved through the questionnaire survey shows that nearly 60% of the total respondents were male and the remaining about 40% female. It also illustrates the age variation of the respondents, which is within the range of 18 years old to above 55 years. The educational level of the respondents was also varied; most of them (53.1%) had completed a bachelor's degree. Besides, most of the respondents (35.4%) have a monthly income of ranged between $201 and $500 (Table -1).

Table 1
Demographic Information

Information	Group	Percentage	Number of Respondents
Gender	Male	59.7	256
	Female	40.3	173
Age	18-24	67.1	288
	25-34	24.7	106
	35-44	5.8	25
	45-54	1.6	7
	Above 55	0.7	3
Education	Lower than High School	1.4	6
	Graduate from High School	29.1	125
	Graduate from Technical Institute	3.5	15
	Bachelor's Degree	53.1	228
	Post Graduate Degree	12.8	55
Income	Less than $200	25.9	111
	$201 - $500	35.4	152
	$501 - $1000	19.3	83
	$1001 - $1500	8.2	35
	$1501 and Above	11.2	48

However, the analysis of data illustrated in Figure 1 below shows that the majority of the respondents (53.6%) were using the well as the main source of drinking water, following by 41.7% have access to the water supply network. While the main source for water supply network is also the groundwater. Additionally, the data stipulated in Table- 2 below describes that the mean value for most of the items related to water quality was more than the moderate level and nearly reached to the scaled level of good except the value for safe to drink, which is close to the medium level. Besides, Figure 2 below demonstrates that more than half of the respondents agreed about their home drinking water contamination.
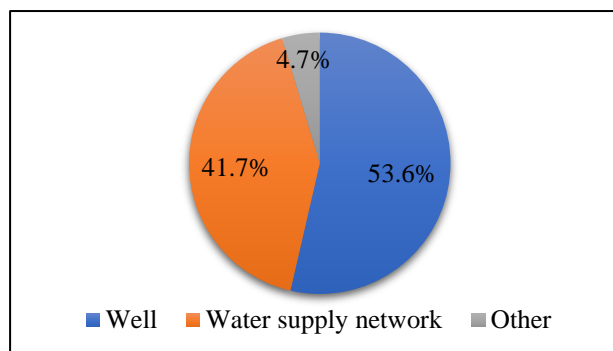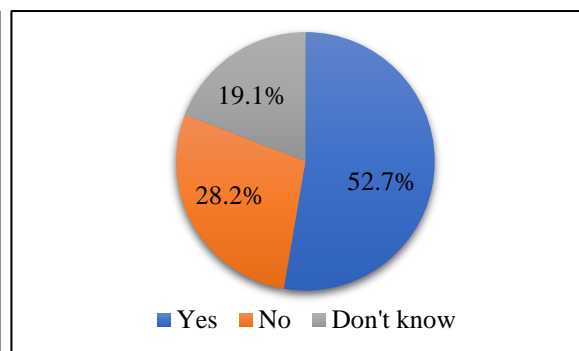
Figure 1: Sources of Drinking Water

Figure 2: Residents Perception about their Home

Table 2 Residents Perception on Drinking Water Quality

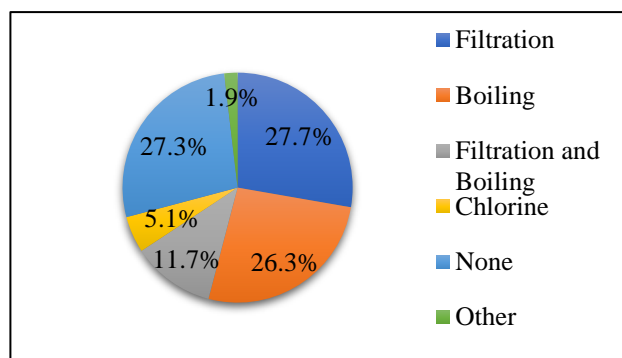| Descriptive Statistics					
	N	Min	Max	Mean	SD
Colour	429	1	5	3.76	0.974
Taste	429	1	5	3.45	1.198
Odour	429	1	5	3.68	1.039
Clearness	429	1	5	3.60	1.095
Safe to drink	429	1	5	3.09	1.245
Valid N (listwise)	429				
Standard Deviation (SD), 1=Very Poor, 5=Very Good					

Figure 3: Water Quality Improvement Method **Using**

The high amount of dissatisfaction among the residents about the groundwater quality is due to contamination of groundwater with a different type of pollutants. As stated above, many authors have also analysed the groundwater quality of the Kabul city and revealed that the Kabul city groundwater had been polluted with different types of chemical and biological elements. Besides, Figure 3 above shows that 27.7% of the respondents are using the filtration system in their houses to improve their drinking water quality; where about 26.3% are boiling the water. Moreover, nearly 11.7% are using both filtration system and boiling. While the chlorine is used by 5.1% of the respondents and 27.3% are drinking tap water without using any improvement method. However, about 1.9% of the respondents indicated other types, such as buying bottled water. Additionally, the respondents were also asked to provide their opinion about some of the urban development factors' impact on water quality (Table 3).

Table 3
Residents' perception about the negative impact of urban development factors on the water quality

Descriptive Statistics					
	N	Min	Max	Mean	Std. Deviation

Rapid Population growth	429	1	5	4.29	1.049
Rapid Urbanization growth	429	1	5	4.00	1.150
Stormwater	429	1	5	3.14	1.403
Urban Wastewater	429	1	5	4.35	1.061
Septic tank	429	1	5	4.17	1.110
Pit Latrine	429	1	5	4.26	1.030
Industrial Pollution	429	1	5	4.03	1.169
Solid waste dump irregularly	429	1	5	4.15	1.064
Limited access to water supply	429	1	5	4.11	1.131
Inadequate transportation	429	1	5	3.62	1.256
Valid N (listwise)	429				

1=No impact, 5=High impact

Table 3 above shows that rapid urbanisation growth has a significance impact on water quality. Furthermore, the regression analysis has been conducted among different variables stipulated in the survey questionnaire, such as physical characteristics of water quality, water pollution, sources of pollution, population growth, and urban development. Therefore, the result for the best fit model achieved is described in Table 4 below.

Table 4
Regression Model for the Impact of Urban Development on the Water Quality

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.543[a]	.294	.283	.974
a. Predictors: (Constant), Pit Latrine, Colour, Stormwater, Septic Tank, Water Pollution, Rapid population growth, Drainage				

Table 4 above shows the regression model for assessing the impact of urban development on the water quality, the R^2 value for the above model is 0.294 which mean the rapid population growth, stormwater, water pollution, the colour of water, septic tank, drainage and pit latrine as independent variables have about 29.4% of the variance with the dependent variable of rapid urbanisation growth. The R^2 value for this model is not much more, but the independent variables are highly significantly correlated with the dependent variables (see Table 5). Therefore, this model is the best fit model.

Table 5

Regression Coefficients for the Impact of Urban Development on the Water Quality

Coefficients[a]						
Model		Unstandardised Coefficients		Standardised Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	0.591	0.325		1.816	0.070
	Rapid population growth	0.437	0.049	0.399	8.958	0.000
	Stormwater	0.104	0.035	0.126	2.993	0.003
	Water Pollution	0.103	0.045	0.102	2.302	0.022
	Colour	0.085	0.049	0.072	1.716	0.087
	Septic Tank	0.132	0.058	0.115	2.266	0.024
	Drainage	-0.116	0.056	-0.106	-2.069	0.039
	Pit Latrine	0.106	0.049	0.095	2.137	0.033
a. Dependent Variable: Rapid urbanisation growth						

Table 5 above describes the coefficients for the impact of urban development on water quality. Thus, the regression equation based on these coefficients described above in Table- 5 is drawn as follow:

$$Y = 0.591 + 0.437X1 + 0.104X2 + 0.103X3 + 0.085X4 + 0.132X5 - 0.116X6 + 0.106X7$$

Where, Y= Impact of rapid urban development on the water quality, X1=rapid population growth, X2=stormwater, X3=water pollution, X4=colour of water, X5=septic tank, X6=drainage, and X7=pit latrine. Consequently, the above equation shows that all the independents' variables have a significant positive relationship with the dependent variables except the drainage, which has a negative correlation. Besides, it has been concluded from the above regression analysis that the rapid urbanisation will impact the groundwater quality through producing different kinds of pollution, which can affect the water quality. In this relation, the rapid population growth is contributing the most important roles in the urban development impact on the water quality and drainage provide the less important. However, the water pollution, septic tank, pit latrine, colour of water, and stormwater were also influencing the impact of urbanisation on water quality.

Conclusion

The review of the Kabul city urban development trend shows that Kabul city has faced rapid urbanisation growth after 2001, which is due to the fastest increase of the population and

non-implementation of the city master plan, which resulted in nearly 70% of the residents living in the informal settlement. That caused to limit the residents' access to the most important urban services. The estimation shows that two-third of its population do not have access to the water supply network, and the proper sanitation and its treatment system also do not exist in Kabul city. However, the main purpose of this study was to investigate the impact of urban development on water quality and to analyse the residents' perception about water quality. Therefore, the result achieved through analysing the data of the survey questionnaire circulated among 429 persons shows that more than half of the respondents were not satisfied with their home drinking water. Additionally, it has been revealed that the rapid urban development has its significant impact on the water quality and the major elements that contribute to the impact of urban development on the water quality are the fastest population growth, stormwater, water pollution, colour of water, septic tank, drainage and pit latrine which resulted because of fastest increase in informal settlements.

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