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Evaluation of Wastewater Collection and Disposal in Kabul City and Its Environmental Impacts

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Abstract: Nowadays many water resources are polluted by anthropogenic sources including household, agricultural wastes and industrial processes. Public concerns over the environmental impact of wastewater pollution has increased [1], and become a critical issues in many cities in the world, especially in Kabul city. There is no centralized sewerage system in Kabul City. Sewer lines and wastewater treatment plants are operated only in some small scales and specific areas like new townships. Only the Macrorayon system has a sewerage system with partially treatment plants. Most residents use pit latrines or septic tanks for black and grey water, and discharge it to the streets side channels or city drains. Due to economic concerns of emptying septic tanks, their usages are difficult for most residents. According to the interview survey by the German Development Bank (KfW) water study, traditional toilets (pit latrines) are used by 86% of the city residents [2]. Sewage of pit latrines is vacuumed up periodically by private contractors and disposed at a solid waste landfill site or in agriculture land as fertilizer. Sludge of septic tanks are also vacuumed up periodically and disposed at the solid waste landfill site. Such conditions are not adequate, as overflow of sewage on streets is often observed which is threatening the quality of groundwater, surface water and air which causes risks for public health. The private contractors vacuum the sewage and sludge up for fees. They bring such sewage and sludge to the solid waste landfill sites for disposal. Most contractors, however, sell the sludge to farmers or dispose it into city drains. This paper reviews the present condition of sewerage system in Kabul city and its effect to the environment especially effects on groundwater of Kabul City which forms the only source of drinking water for the Kabul city with more than 5 million populations. Most parts of these sources are already contaminated and the presence of E. coli has been proven in most water wells. The paper focuses on potential environmental impacts of wastewater in the city by using checklist method of EIA and suggested suitable alternatives.

Key words: Kabul city, wastewater, groundwater, EIA

1. Introduction

The study covers the Kabul city. Kabul is the capital of Afghanistan, located in the eastern section of the country. According to estimates in 2018, the population of Kabul is 4.117 million [3]. Rapid urbanization had made Kabul the world's 75th largest city [4]. It is estimated that around 74% of the population resided in the informal settlement area [2]. The water situations in Kabul City are thoughtful, and the water availability will be the most critical constraint to the development of the capital city. The current water supply in Kabul depends exclusively on local groundwater resources which is at serious risk due to sewage contamination [5].

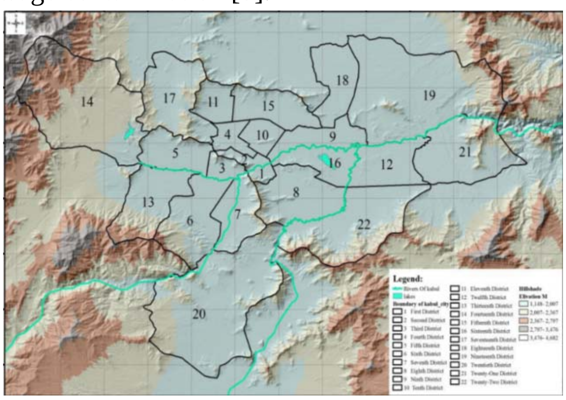

Fig. 1 The study area (Kabul City).

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2. Background

Existing sewer system : the study which is carried out by CDD (Consortium for DEWATS Dissemination) society and GIZ in Kabul, in the districts of 2, 3, 4, 5, 10, 11 and one half of district 17, shows that the disposal of black-water is different from the disposal of grey water. Only 1% of the households are connected to the sewerage system, 49% of the household use holding tanks[1] for their black-water, 37% use partially lined pits[2] and 10% dry latrines. Still, 84% dispose their grey water directly into the open environment and only 11% use either the same or a different holding tank for the grey water. 5% of the households also use a partially lined pit for the disposal of grey water. Also 94% of the pits and septic tanks do not have an outlet for overflow, but if such an outlet is there it is either connected to the open environment (37%) or to another soak pit (63%) [6].

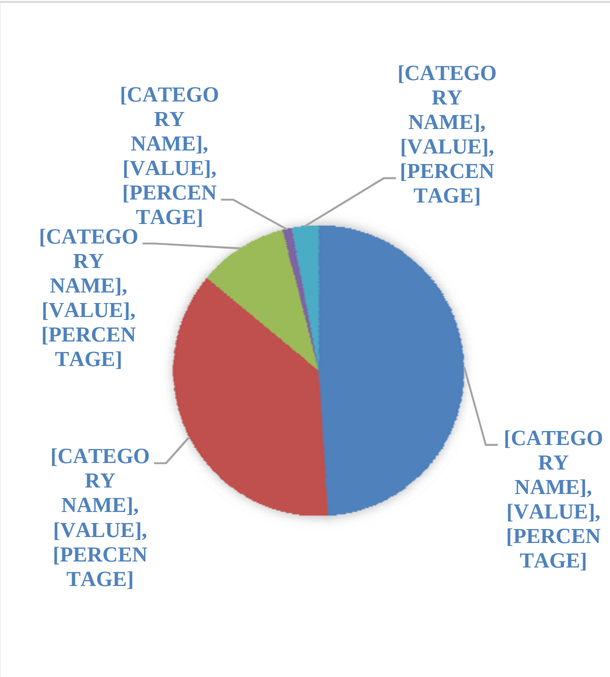

Fig. 2 Disposal of Black water households.

[1] Holding tanks: These tanks do not work as per the principle of a septic tank, but are mistakenly referred to as septic tanks. They only contain and confine the feces but do not allow any form of septic action, and minimal settling and reduction.

[2] Partially lined pit latrines: A "partially lined" pit latrine is one where the upper part of the hole in the ground is lined.

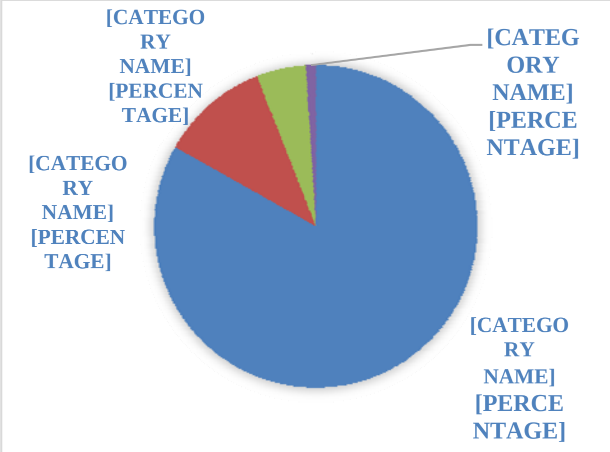

Fig. 3 Disposal of Grey water households.

The situation is a little different for the Commercial Establishments and Institutions: Most of them (81%) use holding tanks for their black-water, 13% have partially lined pits and only 1% uses dry latrines. But 1% also use small scale decentralized treatment systems. Most of the grey water (59%) is directly led into the open environment, about 26% of the establishments use either the same or a different holding tank. 5% use a partially lined pit, but again only a minority of those have outlets connected to either the open or another soak pit.

As mentioned above, this study has carried out only for districts such as: 2, 3, 4, 5, 10, 11 and one half of district 17, but the situation in some districts of Kabul city such as 13, 6 and18 is completely different, according to our observations and visiting the study

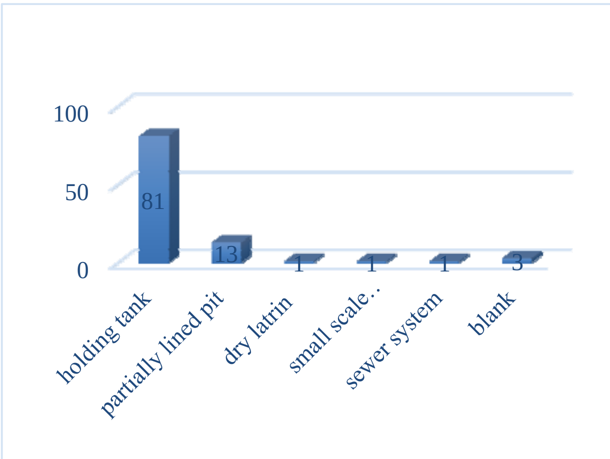

Fig. 4 Disposal of black water commercials.

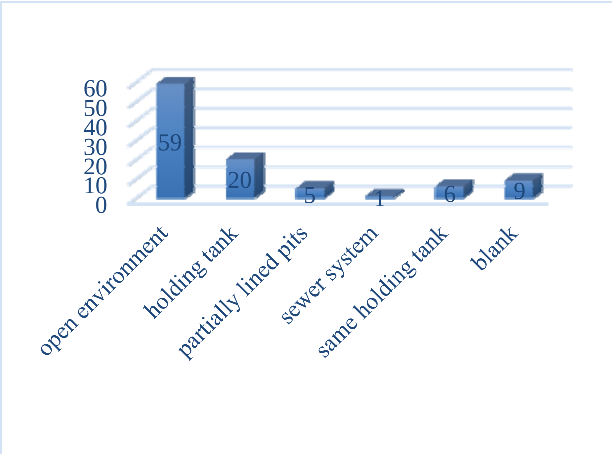

Fig. 5 Disposal of grey water commercials.

area, approximately 80% of the households use unlined pits[3] for both black and grey water.

3. Methodology

This research study is an exploratory research which is conducted based on a concrete data. Three kind of data has collected and analysed which are 1) Documents and Records (water quality data); 2) Questioner and Interview (From 10 Health Centres); 3) Observations (field visit and photographs). Based on these data and by using the Battelle method we have judged and evaluated the environmental impacts of wastewater collection and disposal system in Kabul City. Refer to Fig. 6 the methodology diagram.

4. Analyses and Result

The water quality data as shown in Tables 1 and 2 is one and half years' period data (January to December 2017 and January to June 2018) which are sampled and collected by GIZ from three selected sapling points that includes wells, reservoirs and households. The total number of samples which are taken from wells in 2017, are 160, from reservoirs are 69 and from households are 227. The total number of samples which are taken in 2018, from wells are 84, from reservoirs are 41

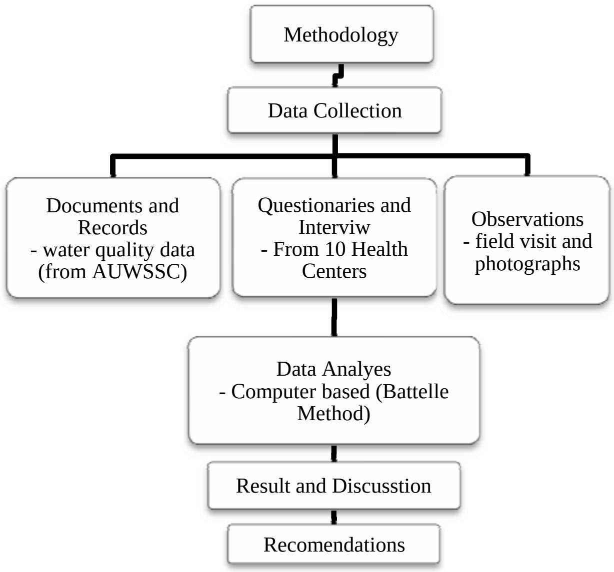

Fig. 6 Methodology diagram.

and from households are 132. For each samples the physical and biological parameters are measured and analysed, the parameters included: colour, odour, temperature, pH, Electrical conductivity, Turbidity, total coliform, faecal coliform. Most amount of this parameters are high than its Permissible limit, especially for households. It is because most of water supply network in the Kabul city is very old and no any sewer system exist. Also the water is supplied intermittently in the Kabul city that increase the risk of back siphon age from old network and it worse more, while the wastewater released to the surface without any treatment. The World Health Organization guidelines for safe drinking water suggest that E. coli and faecal coliform should be so low as to not be detectable in 100 millilitre of water and also EC should not be more than 1500 µS/cm.

Questionnaire forms data: The questionnaire form has designed for collection of data from health centre and hospitals within study area in the Kabul city. The mean purpose of this questionnaire form was to collect the number of patients which they are afflicted to water borne diseases during the year of 2017.

Several Hospitals and health centres has been visited but unfortunately most of them in Kabul city don't have a clear database for recording of patient numbers.

[3] Unlined pit latrines: The unlined pit latrines makes use of the basic principles of a pit latrine that collects human feces in a hole in the ground, and which allows permeation into the ground from the top all the way to the bottom.

Only the Antani Hospital has such documents which is shown in the Fig. 7. According this data, the number of water borne diseases are very high.

Also the BBC web page reported on the first of August 2017 that the doctors in Antani Hospital say which around 70% of patients in the hospital are related to water borne diseases [8].

Table 1 Water quality test report January-December 2017 [7].

Sample source	Parameters	Permissible limit	Units	Pollution limit		Total No.of sample	Contaminated sample		Safe sample	
				Min	Max		No. of sample	% of sample	No. of sample	% of sample
Wells	Total Coliform	0	CFU	100	100	160	1	0.625	159	99.375
	Fecal Coliform	0	CFU	0	0		0	0	160	100.00
	Electrical conductivity	1500	µS/cm	1845	3765		4	2.50	156	97.50
Reservoir	Total Coliform	0	CFU	10	230	69	10	14.49	59	85.51
	Fecal Coliform	0	CFU	4	21		9	13.04	60	86.96
	Electrical conductivity	1500	µS/cm	0	0		0	0.00	69	100.00
House connection	Total Coliform	0	CFU	10	250	227	48	21.15	179	78.85
	Fecal Coliform	0	CFU	2	150		35	15.42	192	84.58
	Electrical conductivity	1500	µS/cm	3660	3770		2	0.88	225	99.12

Table 2 Water quality test report January-June 2018 [7].

Sample source	Parameters	Permissible limit	Units	Pollution limit		Total No.of sample	Contaminated sample		Safe sample	
				Min	Max		No. of sample	% of sample	No. of sample	% of sample
Wells	Total Coliform	0	CFU	0	0	84	0	0	84	100
	Faecal Coliform	0	CFU	0	0		0	0	84	100.00
	Electrical conductivity	1500	µS/cm	1510	1531		2	2.38	82	97.62
Reservoir	Total Coliform	0	CFU	99	230	41	8	19.51	33	80.49
	Faecal Coliform	0	CFU	7	12		7	17.07	34	82.93
	Electrical conductivity	1500	µS/cm	0	0		0	0.00	41	100.00
House connection	Total Coliform	0	CFU	38	250	132	32	24.24	100	75.76
	Faecal Coliform	0	CFU	4	100		25	18.94	107	81.06
	Electrical conductivity	1500	µS/cm	0	0		0	0.00	132	100.00

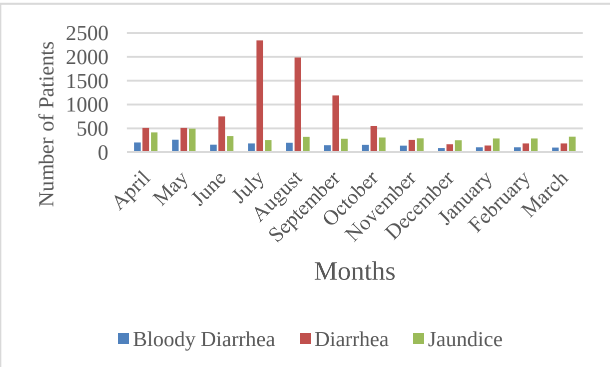

Fig. 7 Water borne diseases recorded in Antani Hospital from April 2017 to March 2018.

Site observation data (photos): According the site observation survey, most of black water pipes from households are connected directly to the surface water in the Kabul city. Refer to the Fig. 8 that is one example from thousand households which are in the same situation.

Battelle method: The Battelle Environmental Evaluation System (EES) methodology is used for conducting prevailing environmental impact analysis. The principle lies in splitting the environmental impact in four major categories: Ecology, Environmental contamination, Aesthetics and Human interest. These categories are divided in to thematic data. These thematic data are divided into environmental indicators. The EES identifies a total of four categories, eighteen components and seventy-eight parameters. The method follows three steps. First the goal of the method is to transform environmental indicators into environmental quality. The notation table defines a number from 0 to 1 (0 for poor quality and 1 for good quality). Thus it is possible to quantify evaluation both in the wrong or right direction (environmental deterioration or improvement). In the second step, a total of 1000 points (or Parameter Importance Unit: PIU) are shared among the indicators. They reflect the relative importance of each parameter. Finally, the comparison between the situation with and without the project is done in Environmental Impact Units (EIU). It can even reflect benefits or losses in terms of environmental conditions. Mathematically, it is represented as follows [9]:

$$\sum \mathrm{EIU} = \sum (\mathrm{EQi})_1 . \mathrm{PIU_i} - \sum (\mathrm{EQi})_2 . \mathrm{PIU_i}$$

Where:

EIU = Environmental impact unit.

(EQi)1 = Environmental quality for indicator "i" without the project (Prevailing Situation) condition. (lies between 0 to 1).

(EQi)2 = Environmental quality for indicator "I" with the project (complete sanitation system) conditions. (lies between 0 to 1).

PIUi = Parameter Importance Unit/Relative weight of the indicator "I".

Fig. 8 Black water pipe connected to the surface water in 6th district of Kabul city.

5. Conclusion

The Water quality data as shown in Figs. 9 and 10, indicates that the most amount of water quality parameters are higher than its permissible limits, especially for households and reservoirs. It is because of old water supply networks, lack of sewer system, lack of wastewater treatment plant and lack of proper water management system in the Kabul city. Also the water supply system in Kabul city is an intermittent system which is increased the risk of back-siphonage in the network and households. It worse more, while the wastewater released to the surface without any treatment. Fortunately, the water quality in the deep wells are acceptable it means the deep wells are not still contaminated by any pathogenic pollutants. But the water is highly contaminated in the shallow wells, reservoirs and the supply network. According to

Table 3 The battelle environmental evaluation system (EES).

No.	Environmental Categories	PIU	$(EQi)_1$	$(EQi)_2$	EIU
	Ecology	240			
	Species and Population				
1	Terrestrial browsers and grazers	14	0.5	0.75	-3.5
2	Terrestrial crops	14	0.5	0.8	-4.2
3	Terrestrial natural vegetation	14	0.4	0.8	-5.6
4	Terrestrial pest species	14	0.5	0.9	-5.6
5	Terrestrial upland game birds	14	0.7	0.9	-2.8
6	Aquatic commercial fisheries	14	0.7	0.9	-2.8
7	Aquatic natural vegetation	14	0.3	0.7	-5.6
8	Aquatic pest species	14	0.1	0.8	-9.8
9	Sport fish	14	1	1	0
10	Waterfowl	14	0.5	0.9	-5.6
	Habitats and communities				
11	Terrestrial food web index	12	0.3	0.8	-6
12	Land use	12	0.7	0.8	-1.2
13	Terrestrial rare and endangered species	12	0.7	0.8	-1.2
14	Terrestrial species diversity	14	0.5	0.8	-4.2
15	Aquatic food web index	12	0.2	0.9	-8.4
16	Aquatic rare and endangered species	12	0.7	0.8	-1.2
17	River characteristics	12	0.1	1	-10.8
18	Aquatic species diversity	14	0.4	0.8	-5.6
	Sub Total EIU				**-84.1**
	Pollution	402			
	Water				
19	Basin hydrologic loss	20	1	1	0
20	BOD	25	0.2	0.8	-15
21	Dissolved Oxygen	31	0.5	0.7	-6.2
22	Fecal coliforms	18	0.1	0.9	-14.4
23	Inorganic carbon	22	0.6	0.8	-4.4
24	Inorganic nitrogen	25	0.5	0.8	-7.5
25	Inorganic phosphate	28	0.6	0.8	-5.6
26	Pesticides	16	0.5	0.8	-4.8
27	pH	18	0.6	0.7	-1.8
28	Stream flow variation	28	0.9	1	-2.8
29	Temperature	28	0.8	1	-5.6
30	TDS	25	0.4	1	-15
31	Toxic substances	14	0.1	1	-12.6
32	Turbidity	20	0.3	1	-14
	Air				
33	Carbon monoxide	5	0.5	0.8	-1.5
34	Hydrocarbons	5	0.6	0.8	-1
35	Nitrogen oxides	10	0.6	0.8	-2
36	Particulate matter	12	0.5	0.8	-3.6
37	Photochemical oxidants	5	0.7	0.8	-0.5
38	Sulfur dioxide	10	0.7	0.8	-1
39	Other	5	0.7	0.8	-0.5
	Land				
40	Land use	14	0.9	0.5	5.6
41	Soil erosion	14	0.5	0.8	-4.2
	Noise				
42	Noise	4	1	1	0
	Sub Total EIU				**-118.4**

No.	Environmental Categories	PIU	$(EQi)_1$	$(EQi)_2$	EIU
	Aesthetics	153			
	Land				
43	Geologic surface material	6	0.3	0.8	-3
44	Relief and topographic character	16	0.3	0.8	-8
45	Width and alignment	10	0.6	0.8	-2
	Air				
46	Odor and visual	3	0.1	1	-2.7
47	Sounds	2	1	1	0
	Water				
48	Appearance	10	0.1	1	-9
49	Land and water interface	16	0.3	1	-11.2
50	Odor and floating materials	6	0.1	1	-5.4
51	Water surface area	10	0.3	0.8	-5
52	Wooded and geologic shoreline	10	0.6	0.8	-2
	Biota				
53	Animals - domestic	5	0.5	0.7	-1
54	Animals - wild	5	0.6	0.7	-0.5
55	Diversity of vegetation types	9	0.4	0.8	-3.6
56	Variety within vegetation types	5	0.5	0.7	-1
	Manmade objects				
57	Manmade objects	10	0.3	0.9	-6
	Composition				
58	Composite effect	15	0.3	0.9	-9
59	Unique composition	15	0.5	0.8	-4.5
	Sub Total EIU				**-73.9**
	Human Interest	205			
	Educational/Scientific Package				
60	Archaeological	13	0.2	0.9	-9.1
61	Ecological	13	0.3	0.9	-7.8
62	Geological	11	0.8	0.9	-1.1
63	Hydrological	11	0.8	0.9	-1.1
	Historical Package				
64	Architecture and styles	11	0.7	0.9	-2.2
65	Events	11	0.8	0.9	-1.1
66	Persons	11	0.8	0.9	-1.1
67	Religions and cultures	11	0.4	0.8	-4.4
68	Eastern frontier	11	0.4	0.8	-4.4
	Cultures				
69	Afghanis	14	0.5	0.8	-4.2
70	Other ethnic groups	7	0.5	0.8	-2.1
71	Religious groups	7	0.5	0.8	-2.1
	Mood/Atmosphere				
72	Awe-inspiration	11	0.3	0.8	-5.5
73	Isolation/solitude	11	0.2	0.8	-6.6
74	Mystery	4	0.2	0.5	-1.2
75	Oneness with nature	11	0.4	1	-6.6
	Life Patterns				
76	Employment opportunities	13	0.2	0.7	-6.5
77	Housing	13	0.3	0.7	-5.2
78	Social interactions	11	0.3	0.7	-4.4
	Sub Total EIU				**-76.7**

questioner form data (Fig. 7), and BBC report on 2017 the number of water borne diseases was very high which around 70% of disease in the hospital was related to water borne diseases.

Also the Battelle Environmental Evaluation System (EES) methodology is used for conducting prevailing environmental impact analysis of wastewater collection and disposal system in Kabul City. The result of this judgment is presented as color coding in Table 4. This color coding is shown the negative impact of the current situation of sewer system in Kabul city, which has -23.82 % effects on ecology, -33.53% causes the environmental contamination, -20.93% has impacts on aesthetic and -21.72 % has effects on human interest.

Indeed, according the above study and results we can conclude that the main issue in the Kabul is the untreated wastewater which is resealed on the surface area.

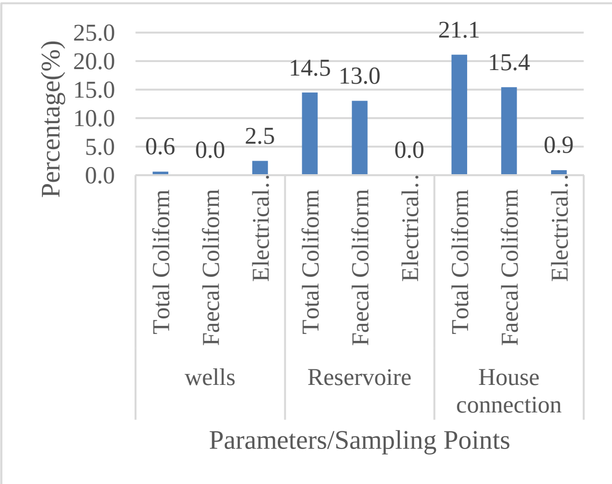

Fig. 9 Water quality test result 2017.

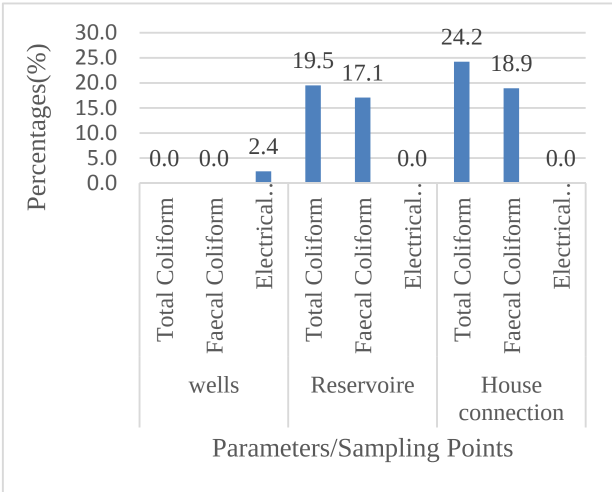

Fig. 10 Water quality test result 2018.

Table 4 Color codding for negative impacts.

THE CATEGORIES RESULTS					
NO.	CATEGORIES	PIU	EIU	EIU IN %	COLUR CODE
					0
1	Ecology	240	-84.1	-23.82	23.82
2	Environmental Contamination	402	-118.4	-33.53	33.53
3	Aesthetics	153	-73.9	-20.93	20.93
4	Human interest or social	205	-76.7	-21.72	21.72
TOTAL		1000	-353.1	-100.00	

THE COLOUR CODE RANGE FOR NEGATIVE IMPACTS

0	10	20	30	40	50	60	70	80	90	100

NEGATIVE IMPACT RANGES IN PERCENTS (%)

6. Recommendation

To prevent more potential impacts arising from wastewater system in the Kabul city, here is given several recommendations as a mitigation tools for future wastewater management plan:

1) Making it popular the Decentralized wastewater treatment system (DEWATS) because this kind of treatment plant has several advantages such as: it is very economic, easy to implement, need few space in terms of land use, has less impact on environment during construction and utilizing.
2) Repairing and rehabilitation of the old water supply networks in Kabul city
3) Improving the knowledge, Skills and capacity of technical staff for running of the water supply network.
4) Improving public awareness regarding the water quality and its contamination pathways.
5) Developing of a proper water management system.

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