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Reducing and preventing health risks related to wastewater and casualty in

Kabul city

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Abstract: Globally, billions of people lack access to adequate sanitation and safe water. Due to the high population of Kabul city and also the great importance of this city, and also considering that no study has been done in this field so far, the present study was conducted to study the Reducing and preventing health risks related to wastewater and casualty in Kabul city. The data, which was collected by the standardized site, visits, questionnaire, and comparing analysis are checked and verified the process. Data entry and processing are done through the application of the Microsoft Excel programs for graphic presentation of data and ArcGIS. According to the advantageous and disadvantageous of stabilization pond, oxidation ditch, and conventional activated sludge, the priority for Kabul city is conventional activated sludge. As Kabul is the capital of Afghanistan, day by day increasing population, and one of the populated cities in the world the budget is available for development therefore conventional activated sludge a good technology, Aerobic decomposition by activated sludge. The retention time was 1.5 hours for primary sedimentation, 6-8 for aeration and 1.5 hours for final sedimentation, and a total of 0.5 days.

Key words: Health risks, wastewater, Afghanistan, Kabul

Introduction

Considering the lack of access to adequate sanitation and safe water, WHO estimates that 2.1 people die annually from diarrheal diseases (UNICEF and WHO, 2006; Massoud, 2009). Presently, the 1.1-billion population lack access to water supply and 2.4 billion to improved sanitation. In 2000, the estimated mortality balance due to water sanitation hygiene associated diarrheas, and other water/ sanitation- associated diseases was 2,213,000 (Bundesanstalt fur Geowissenschaften und Rohstoffe, 2003). All around Afghanistan 5 percent of the total population has access to sanitation. Afghanistan is one of the poorest countries to access safe drinking water and sanitation, one of the lowest coverage in the world. It is the main cause of high mortality and morbidity in the country. In Afghanistan, most of the quantitative and qualitative concerns have been indicated by the national groundwater monitoring wells networks (DACAAR, 2013).

Kabul is located in the center of Afghanistan and is one of the world's highest capital cities. The population of Kabul is 4.5 million people, but has no public sewage system; 18 percent of the people access to the water supply. Kabul is strategically situated in a valley surrounded by mountains at crossroads of north-southwest trade routes. According to the report of UNDP (2007), access to water consumption in Afghanistan inhabitants is 20 l/day/capita. Another big problems in the Kabul basin are the pollution of the open channel or river and receiving wastewater and flow directly to the Kabul river (Naim Eqrar, 2008).

We need to annihilate or remove the wastewater pollutants to protect the environment and protect public health. The people used water and discharge the environment and pollutant the surface and groundwater. When water is used by our society, the water becomes contaminated with the pollutant. If left untreated, these pollutants would negatively affect our water environment. For example, organic matter can cause oxygen depletion in lakes, rivers, and streams. This biological decomposition of organics could result in fish kills and or foul odors. Waterborne diseases are also eliminated through proper wastewater treatment. Additionally, many pollutants could exhibit toxic effects on aquatic life and the public (Dedication, 2007).

Sewage treatment plants, in general, depend on the biological decomposition of non-toxic organic wastes using bacteria. Such biological decomposition is carried out under aerobic conditions in presence of plenty of oxygen. The process, commonly used for municipal wastewater, the first stage of wastewater treatment to removed solid wastes from water by screening- any scum (suspended matter) the sludge (muddy solid or sediment) to settle tank at the bottom. The residual liquid is exposed to biological oxidation of soluble organic materials through a bed of microbes in activated sludge. Then the sludge was removed after sedimentation. Finally, the liquid effluent is subjected to chlorination for destroying pathogenic microorganisms. Now, this effluent is fairly clean and suitable for domestic use (De, 2001).

Due to the high population of Kabul city and also the great importance of this city, and also considering that no study has been done in this field so far, the present study was conducted to study the Reducing and preventing health risks related to wastewater and casualty in Kabul city.

Materials and Methods

Data Collection

The purpose of primary and secondary data collection from Kabul city was to find out information regarding the characteristics and current situation of wastewater in Kabul city. The data collected from Kabul city.

Primary Data

For finding the current situation of sanitation in Kabul city, primary data is very important. The primary data includes a site visit, observation of the area, and discussion with people about sanitation and taking an interview with the residence of the community and the effect of sanitation on groundwater, environment, and public health. The following list shows the primary data of Kabul city.

Site visits and Observations

The aims of the site visit to achieved adequate information from Kabul city:

- Current situation of sanitation system
- The living condition of households
- Excreta collection and disposal
- Challenge of sanitation system
- The impact of Poor sanitation system for settlement
- The environmental condition of the study area
- Wastewater collection, discharge, and treatment

The result of collecting primary data found no water supply in all 22 districts of Kabul city, most of the households used pit latrine (Traditional toilet) and discharge wastewater to Kabul River or vacant land, some of them used septic tank they transfer by private company tankers it takes 40 dollars.

Interview (Questionnaire)

Questionnaires are one of the primary data collection, more than two hundred questions were prepared and distributed to the local people like households, schools, hospitals, clinics, prayer rooms, shopkeepers, occupants, private sector, government office, and non-government organization (NGOs), institute, and universities. The questions were giving information about water supply and the current situation of sanitation in Kabul city. The residence selected water supply for improvement of sanitation and the second priority sewerage system.

Secondary Data Collection

The secondary was collected from documents, reports, journals, and maps, and also collected from ministries, government organizations, non-government organizations, experts, policy maker's planners, and researchers, total (15) offices were visited during the secondary data collection, they are as followings.

1. Kabul Municipality
2. Ministry of Rural Development
3. Ministry of Urban Development
4. Ministry of Public Health
5. Ministry of Energy and water
6. Ministry of Agriculture
7. National Environment Protection Agency
8. Japan International Cooperation Agency (JICA)
9. United Nations Human Settlements Program Office (UN-HABITAT)

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10. World Health Organization Office (WHO)
11. Danish Committee for Aid to Afghan Refugees (DACAAR)
12. Bundesanstalt fur Geowissenschaften und Rohstoffe (BGR)
13. Kreditansalt Fur Wiederaufbau (German government development) (KFW)
14. Central Statistics Organization (CSO)
15. United Nations International Children's Emergency Fund (UNICEF)

Characteristics of the three wastewater treatment Systems

Stabilization pond

Aeration is made by natural photosynthesis. Few electro-mechanical devices are required. Operation and maintenance are very simple. As a shallow pond and longer retention period (1-2 mo.) are required, vast land is necessary. Prevention of the environment from odors and mosquitoes is difficult. The location should be further from the residential area. As natural and vertical circulation is required in the pond, it is difficult to secure ideal efficacy in winter (In winter, circulation is prevented since the surface layer is cold, sometimes frozen, and the deeper layer is always warm.)

Oxidation ditch

It is a developed system of stabilization pond until a 1-2-day retention period. To facilitate the aerobic decomposition, mechanical aeration and activated sludge is utilized. It is categorized in activated sludge methods. The operation is relatively simple. The required land space is much smaller than the stabilization pond. The pond could be covered, thus, it is easier to prevent the environment from odors and mosquitoes as well as temperature control. The system is effective for nitrogen removal. Mechanical aerators would be large in scale; power consumption is accordingly larger. The system requires sludge removal and disposal.

Conventional activated sludge

It is the most proven system in technology. As it has a sedimentation process before aeration, retention time is much shorter than others. The pond could be covered, thus, it is easier to prevent the environment from odors and mosquitoes as well as temperature control. Operation and maintenance are the most complicated among the options. Mechanical systems require electrical power. The system requires sludge removal and disposal

Comparison Characteristics of Sewage Treatment system

Table 1. Comparison Characteristics of Sewage Treatment.

Item	**Stabilization pond**	**Oxidation ditch**	**Conventional activated sludge**
Mechanism	Aerobic decomposition by natural photosynthesis Retention time: around 1-2 months.	One of the activated sludge methods. No primary sedimentation and longer aeration. Retention time: 1-2 days for aeration and 6-12 hours for final sedimentation, Total 2-2.5 days	Aerobic decomposition by activated sludge. Retention time: 1.5 hours for primary sedimentation, 6-8 for aeration, and 1.5 hours for final Sedimentation. Total of 0.5 days.

Advantage	Very low cost for construction Simple O&M. Less skilled labor is needed O&M Little sludge. Little energy consumption.	Medium land space. Relatively Simple operation. Relatively effective for nitrogen reduction. Less generated sludge.	Small land space. Proven technology. Stable and controllable operation. Less electric power than oxidation ditch. Higher adaptability of Advanced treatment
Disadvantage	Very large land space. Generation of odor & mosquito. Difficult to keep efficiency in winter.	Higher electricity consumption.	Numerous facilities. More complicated O&M. More generated sludge.

Selection

According to the advantageous and disadvantageous of stabilization pond, oxidation ditch, and conventional activated sludge, the priority for Kabul city is conventional activated sludge, the best solution, for proven technology, retention time, Stable and controllable operation.

Data Analysis

The data, which was collected by the standardized site, visits, questionnaire, and comparing analysis are checked and verified the process. Data entry and processing are done through the application of the Microsoft Excel programs for graphic presentation of data and ArcGIS.

Result and Discussion

Domestic wastewater flows are commonly determined from domestic water consumption: according to this equation the average of wastewater calculated from 2020, up to 2035 in Kabul city.

$$Q_{ww} = 10–3kqP$$

Where Q_{ww} is the wastewater flow, m3/day; q is the water consumption, l/person day; P is the population connected to the sewerage system, and k is the 'return factor', the fraction of the water consumed that becomes wastewater. The value of k is usually 0.8–0.9. It is lower in rich areas where water is used for car washing and garden watering. The equation gives the -Domestic wastewater 'dry weather flow' (DWF) – a term used principally from the time when 'combined' sewers (ie sewers receiving both sanitary and stormwater flows) were common (Combined sewers do exist in developing countries, especially in city centers, but the current preference is to separate sanitary and stormwater flows). Dry weather flow is the average wastewater flow per day over seven consecutive days without any rain, which follows seven days with no more than 0.25 mm of rain on any one-day. The mean daily flow is often taken as 1.3 x DWF (Mara, 2004).

Calculation of Average Wastewater Flow

Assuming that the average wastewater flow is equivalent to average water consumption, the average wastewater flow is calculated as Table 4.1. The average unit wastewater flow is assumed at 100 LCD.

Table 2. Service Populations and Average Wastewater Flow.

Dis	Population 2015	Ave flow2015 (m3/d)	Population 2020	Ave flow2020 (m3/d)	Population 2025	Ave flow2025 (m3/d)
1	72,539	9430.07	73,020	10441.86	73,501	10510.643
2	92,554	12032.02	92,440	13218.92	92,326	13202.618

3	191,052	24836.76	187,081	26752.583	183,110	26184.73
4	402,561	52332.93	389,764	55736.252	376,967	53906.281
5	373,149	48509.37	364,144	52072.592	355,138	50784.734
6	242,790	31562.7	242,483	34675.069	242,175	34631.025
7	313,481	40752.53	309,532	44263.076	305,583	43698.369
8	337,287	43847.31	371,964	53190.852	406,641	58149.663
9	335,452	43608.76	364,710	52153.53	393,968	56337.424
10	422,182	54883.66	423,498	60560.214	424,813	60748.259
11	268,685	34929.05	257,069	36760.867	245,452	35099.636
12	203,696	26480.48	211,587	30256.941	219,477	31385.211
15	406,114	52794.82	393,820	56316.26	381,526	54558.218
16	171,474	22291.62	184,575	26394.225	197,675	28267.525
Total [Qavg]w	3,833,016	498,292	3,865,687	552793.241	3,898,352	557464.336

According to average water consumption calculated the average of wastewater flow per day, the below figure indicates the generation of average wastewater by each district in 2020, 2025, and 2035, this districts connected to the water supply, the current situation this amount of wastewater goes to through the river of Kabul or vacant land.

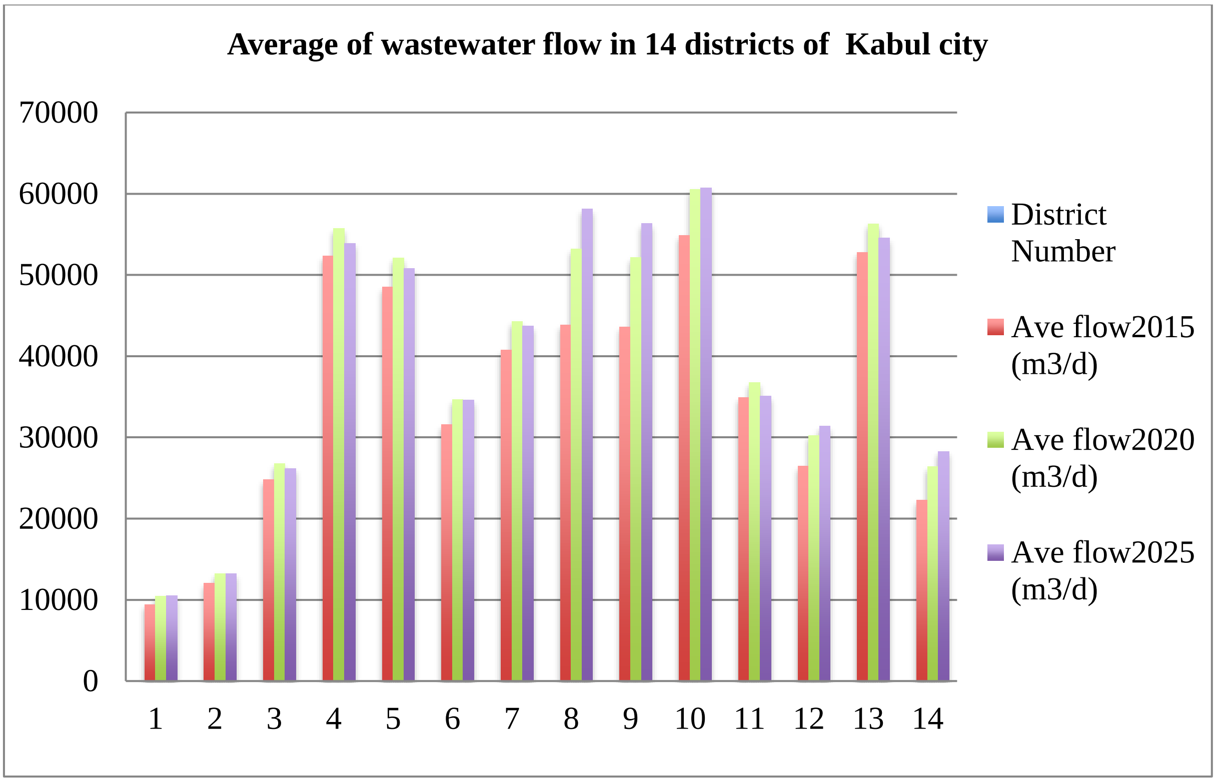

Figure 1. Generation Amount of Wastewater Per Day.

Figure 1 indicates the total amount of wastewater generated in Kabul city by 2020, 2025, and 2035, it is increasing per year.

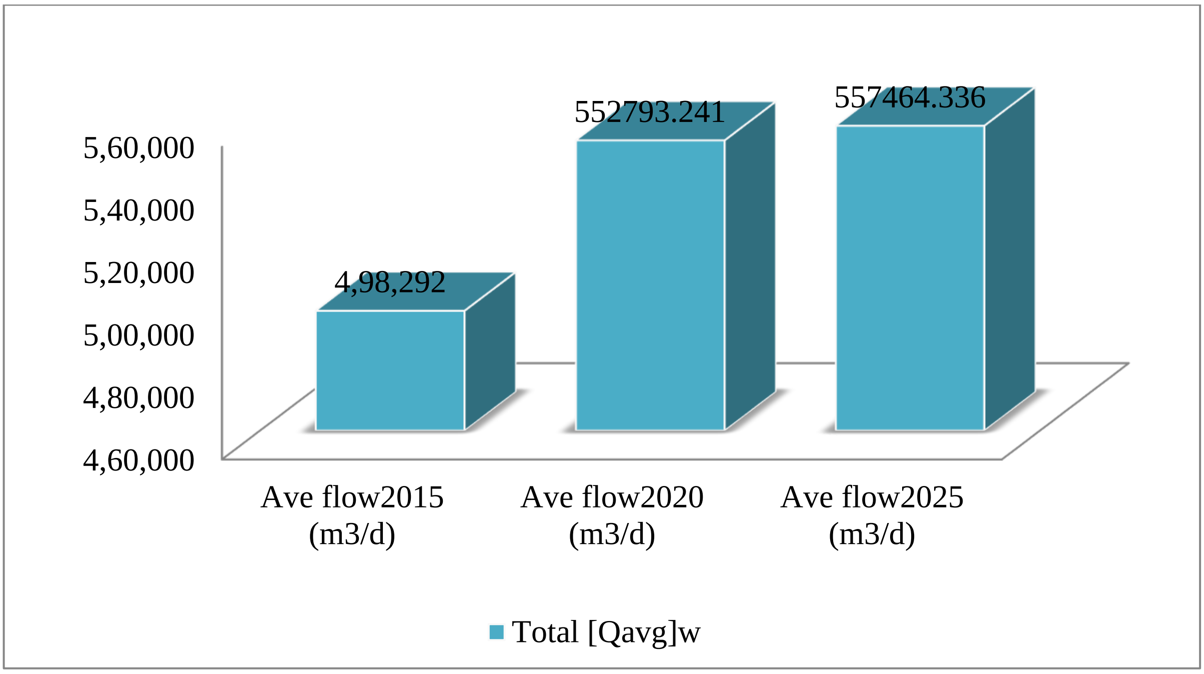

Figure 2. Total Average of Wastewater Per Day.

Estimation of Gas

Estimation of the size of digester required treating the sludge from a primary treatment plant designed to treat 498292m^3/d Kabul city wastewater produce in 2015 according to the average of water consumption. Check the volumetric loading, and estimate the percent stabilization and the amount of the gas produced per capita. For the wastewater to be treated, it has been found that the quantity of dry volatile solids and biodegradable COD removed is 0.15kg/m^3 and 0.14 kg/m3, respectively. Assume that the sludge contains about 95 percent moisture and has a specific gravity of 1.02. Other pertinent design assumptions are as follows:

1. The hydraulic regime of the reactor is complete-mix.
2. T=SRT=10 days at 35°C
3. The efficiency of waste utilization (solids conversion) E=0.70.
4. The sludge contains adequate nitrogen and phosphorus for biological growth.
5. Y=0.8kg VSS/kg bCOD utilized and k_d =0.03d^{-1}.
6. Constants are for a temperature of 35°C
7. Digester gas is 65 percent methane.

Solution

$$V = \frac{Ms}{Pw \times Ss \times Ps}$$

Where

W_s = weight of solids

S_S= specific gravity of solid$_s$

P_w= density of water

W_f = weight of fixed solids (mineral matter)

S_f = specific gravity of fixed solids

W_v = weight of volatile solids

S_v = specific of gravity volatile solids

$$V = \frac{Ms}{Pw \times Ss \times Ps}$$

V= volume of sludge, m^3

M_s= mass of dry solids, Kg

P_w= specific weight of water 10^3 kg/m^3

S_s = specific gravity of the sludge

P_s= percent solids expressed as a decimal

1. V= $M_s / P_w \times S_S \times P_s$

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$V= 498292\ m^{3/d}*0.15\ kg/m^3/1.02*1000\ kg/m^3*0.05= 1465m^3/d$

2. Determine the bBOD loading.

bBOD loading= $(0.14\ kg/m^3)\ (498292\ m^3/d)= 6970kg/d$

3. Compute the digester volume.

$\tau=V/Q$

$V=Q*\tau= (1465m^3/d)\ (10d)= 14650m^3$

4. Compute the volumetric loading.

$kgbCOD/m^3.d= 6970kg/d \div 14650m^3 \quad =4{,}79kg\ /d.\ m^3$

5. Compute the quantity of volatile solids produced

$s_o= 69760kg/d$

$s= 69760kg/d\ (1-0.70) = 20928kg/d$

$s_o-s=(69760kg/d-20928kg/d)= 48832kg/d$

$P_x= YQ(S_O-S) *(10^3g/kg)/1+k_d(SRT)^{-1}$

$P_x= (0.8)\ [(69760kg/d-20928kg/d)]\div 1+0.03d^1)(10d)= 11{,}48kg/d$

6. Computing stabilization

Stabilization %= $[(48832kg/d-1.42(19516kg/d)] \div 69760kg/d= 69.9\%$

7. Compute the volume of methane produced per day at 35°C (Conversion factor at 35°C= 0.40)

$V_{CH4}= (0.40)\ [(S_O-S)\ (Q)\ (10^3g/kg)-1.42\ P_x)]$

$V_{CH4}= \{(0.40kg/m^3)\ [\ (69760-20928)\ kg/d]\ -1.2(11.48kg/d)\} = 19516\ m^3/d$

8. Total gas $1956m3/d \div 69.9\% = 30024\ m^3/d$

Figure 3 shows the numerical calculation of Gas.

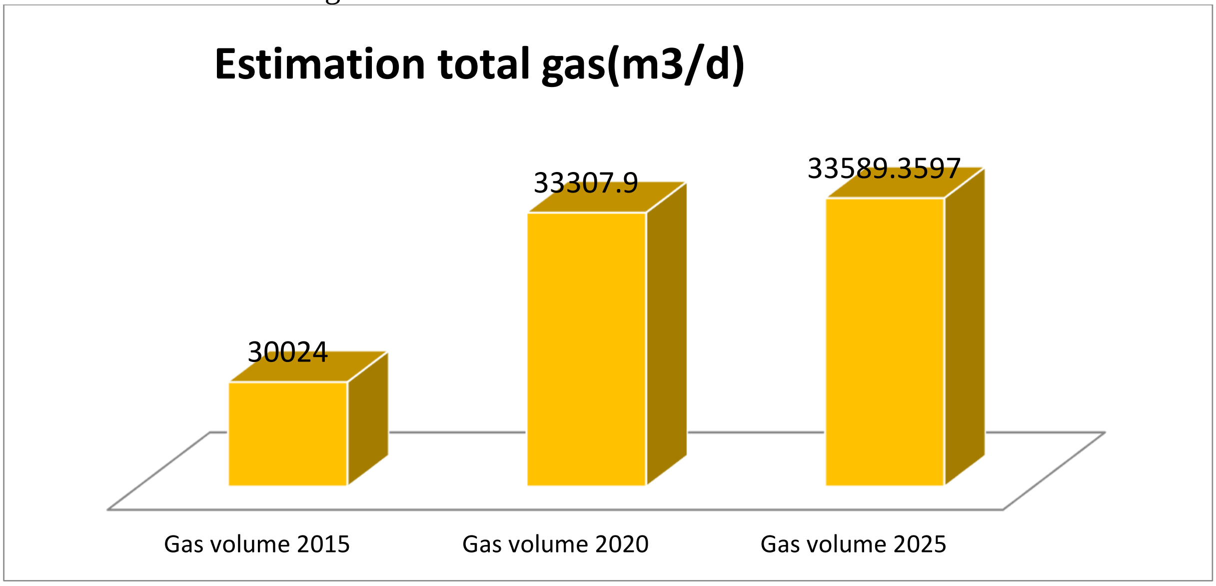

Figure 3. Numerical Calculation of Gas.

Sewerage Management and Location of Sewage Treatment Plant

According to the concentration of population restriction of topographic and water flow direction of Kabul city, three different locations for a centralized wastewater treatment system. The other area will connect by on-site sanitation.

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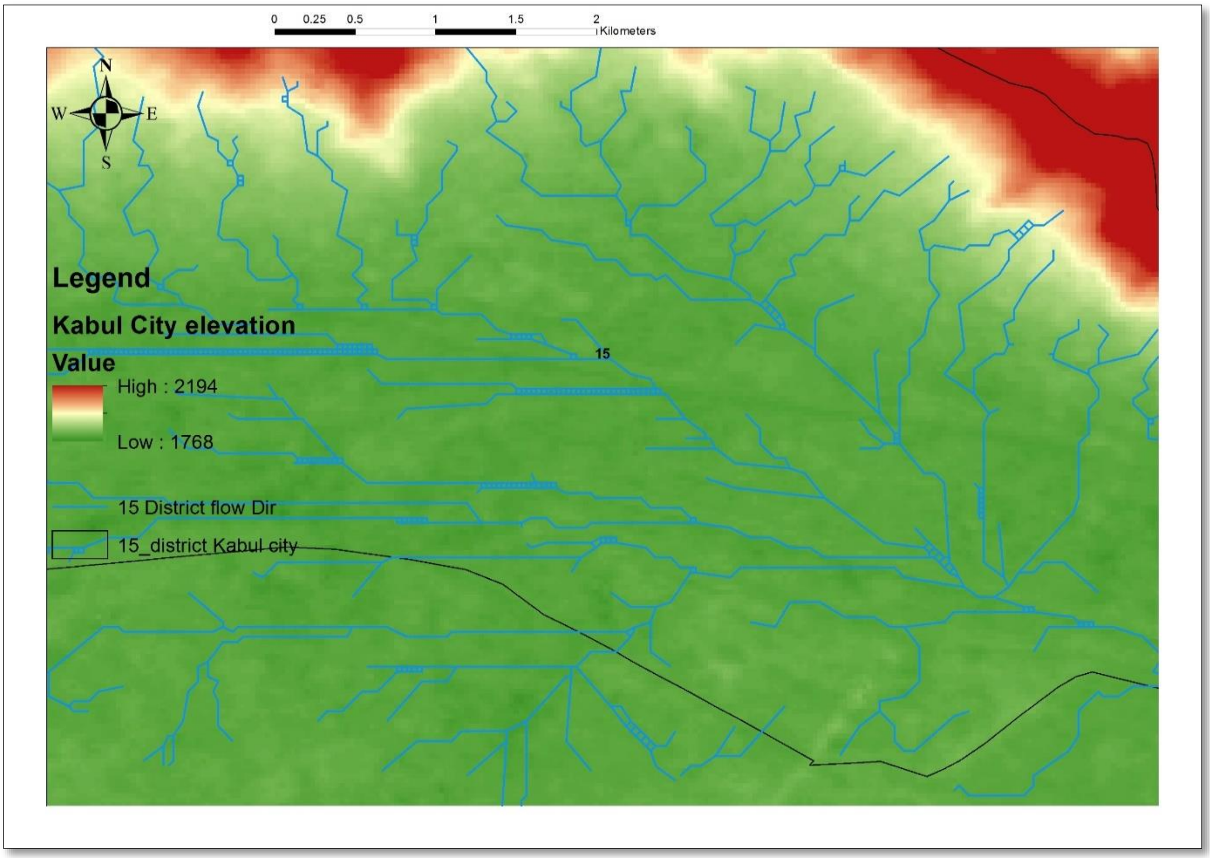

Figure 4. Illustrate water flow direction and accumulation in 15 distract of Kabul city.

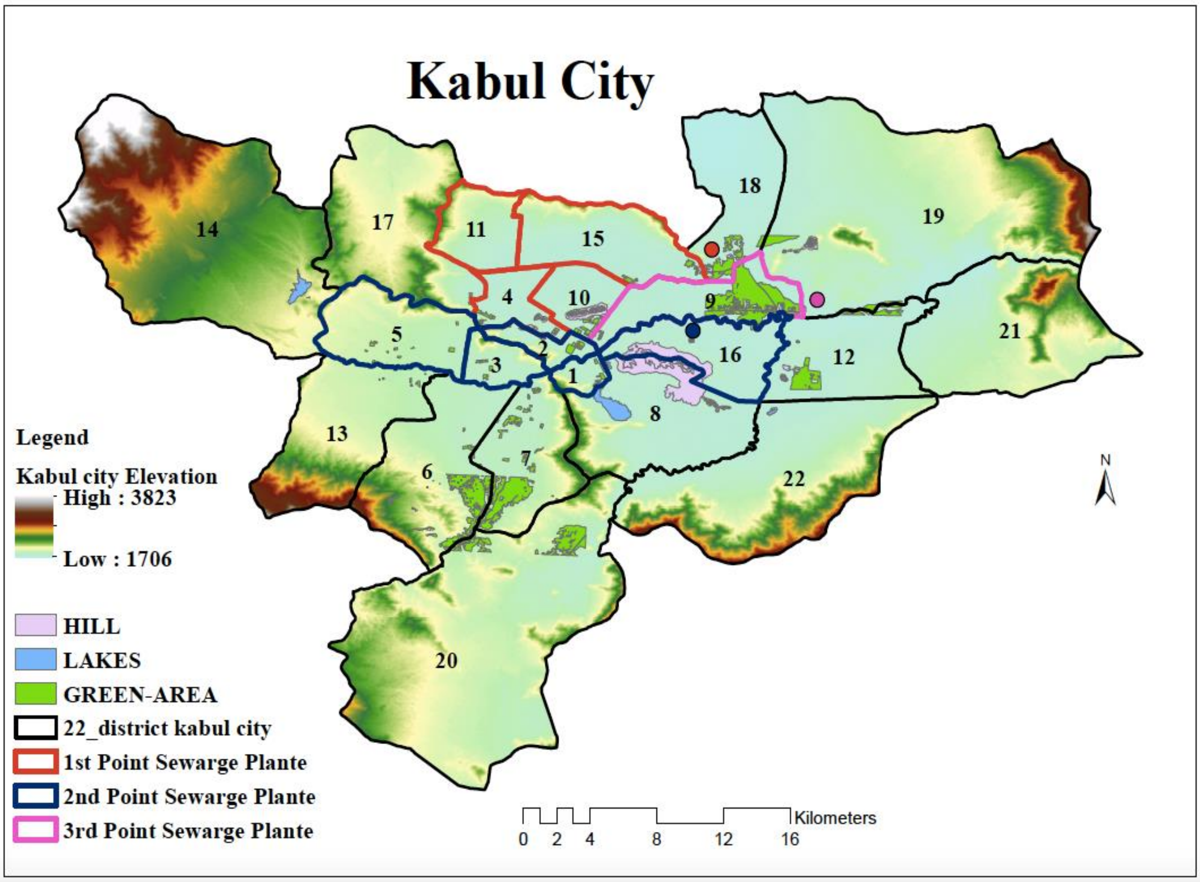

Figure 5. Wastewater Treatment Plant in Kabul City.

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Conclusions

The US Geological Survey found out that 70% of all wells in the Kabul basin are polluted by fecal bacteria, and this is one of the main causes of high child mortality in Kabul where one in four children dies before his/her fifth birthday. On one hand, the groundwater table is decreasing and on the other hand, the wastewater reuse practices are rising for agriculture/greenery, because of the shortage of water in Kabul city. As Kabul is the capital of Afghanistan, day by day increasing population, and one of the populated cities in the world the budget is available for development therefore conventional activated sludge a good technology, Aerobic decomposition by activated sludge. The retention time was 1.5 hours for primary sedimentation, 6-8 for aeration and 1.5 hours for final sedimentation, and total of 0.5 days.

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