Short review on run-off water challenges in developing countries

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Abstract-
Run-off water has been the main source of water supply in most countries of the world. However, it is prone to pollution that can affect life form when not properly treated. In this short review, the two sources of pollution for run-off water were examined. It was discover that the main agent that affects run-off water in developing countries is variability of atmospheric precipitation.

Keywords: run-off, water, pollution

1. Introduction
Runoff water study is of huge relevance on the national and international scale. Runoff water is generally divided into surface runoff and base flow [1,2]. It provides water to over 1/3 of the earth’s population. It plays an important role in agriculture, majorly in agricultural irrigation in both high income and low-income countries. Despite the fact that dependence on run-off water is about 60 to 100%, its resources have been badly managed in 3rd world countries.

The problem facing run-off water supply includes: groundwater overdraft/mining, waterlogging, and seawater intrusion [3]. Run-off water could be polluted by hazardous industrial waste, leachate from landfills and use of fertilizers and pesticides in agriculture. Run-off water is cheaper and vulnerable to pollution. Run-off water influences the unconfined/confined aquifer (where water can flow from the surface to the saturated zone of the aquifer unrestricted) and water table (i.e. upper layer of the unconfined aquifer). For some underdeveloped countries, run-off water management is paramount. It is the act of making decisions to achieve goals without violating specified constraint and good management requires information on how the system would respond to activities carried on it. The information obtained enables decision makers to choose the best approach that will leave the constraint not violated. An example where this information would be useful is planning of mitigation measures once contaminations have been found in saturated or unsaturated zones. This information helps to predict how the contaminants respond to the planned activities. This idea brings us to the idea of theories that influence run-off water system as presented in Figure 1.
A complete physical and chemical description of the moving run-off water would also include the movement of fluid and materials dissolved in the fluid. In order to describe the transport of chemicals in run-off water, it is essential to solve the transport and ground water equation simultaneously. Some scientists have used these principles to calculate run-off on larger scale [4-5]. This study concentrates on the challenges of run-off water. The second and third sections of the paper examined the perennial sources of pollutants in run-off water.

2. Challenges of run-off water: Surface water pollution
As mentioned in the introduction, run-off water is prone to pollution. In this case, it affects aquatic systems that are above ground, such as streams, lakes and rivers. The pollutants transported by runoff water include salts, microorganisms and chemicals [6]. Run-off water pollutants mostly originate from city, construction site, fertilizers from farms, municipal waste and industrial site. Surface water may also be polluted with pathogens, burkholderia pseudomallei, salmonella, cryptosporidium parvum, giardia lamblia, and waterborne diseases, which is usually the result of sewage leaks and runoff from open sewage system. These pathogens are responsible human health problems such as typhoid, cholera, dysentery, diarrhoea, infections hepatitis etc. A typical example of run-off water pollutions is presented in Figure 2.
Studies have shown that pollutants from run-off water had lead to the occurrence of death e.g. 100,000 a year in Pakistan [7], India was about (0.64 million) [8].

As mentioned above, most of run-off water pollution is from indiscriminate waste disposal from the industry [9]. The emitted chemicals are very harmful. Examples of this pollutants or contaminants are lead, mercury, sulphur, asbestos, nitrates and many other harmful chemicals. In developing countries, there is indiscriminate waste disposal. The deposited waste sometime changes the color of water. More so, pollutants transported by run-off water from industrial site increases the amount of minerals in the water and pose serious hazard to water organisms.

Aside industrial waste, pollution comes from farms. Some farmers in under developed countries dispose their waste when there is a downpour of rain. Sometimes, run-off pollution may arise from leaking landfills. This source has huge potentials to pollute the run-off water with large variety of contaminants. Other sources of run-off water pollution include accidental oil spillage, urban development, flooding etc.

3. **Challenges of run-off water: Flooding**

Flooding is a temporary overflow of water bodies unto terrestrial surfaces (land) that was normally dry [10]. Floods are the most common natural disasters along coastal regions. As a result of flood over the past years, many lives, properties and damages has been incurred on land due to the inability to evacuate flooded area or the inability of the government to set up decrees in which flooding can be maintained and managed.
Flood most often times leave a traumatizing effect on their victims as a result of loss of lives of loved ones and irreplaceable assets.

Figure 3: Flooding in Missouri [11].

There has been various documented reports of flooding like the report of the 2010 Pakistan flooding which began as a result of unprecedented monsoon rains overwhelming the indus basin. It affected 78 out of 121 districts nationwide which engulfed an area of about 100,000 km² which claimed about 1985 lives, over 20.2 million people were affected, damaged 2.4million hectares of agricultural land and destroyed or damaged over 2.1 million houses and 515 health facilities [12].

In Japan, 20th of July, 2018, 225 people were confirmed dead across 15 prefectures with further reports of 13 people missing. It was the deadliest water related flood disaster since the 1982 Nagasaki flood which claimed the lives of 299 people [13]. In Nigeria, July 2012 flood is one of significant flood disasters to have happened in over a 40years period estimate which resulted in the death of over 363 people, and the after effect of the flood caused different diseases [14]. Flooding contaminates run-off water and it introduces deadly microorganisms such as escherichia coli, [15], salmonella typhimurium [15], shigella flexneri [15], hepatitis A [16], coliform [16]. Some countries have shown willingness to control pollutions arising from flooding. For example, the United State Flood control act [17], Water quality Act (1987) [18], River Law (1986) [19].

4. Typical run-off situation: Application of remote sensing

The interaction of water formation is described in Figure 4. Run-off is majorly affected by variability of atmospheric precipitation [20] and changes in land use [21]. In time past, satellite remote sensing images have been widely applied for detecting urban growth as regards the changes in land use [22]. It was reported that increased impervious surfaces along run-off [8]. Hence, rainfall-runoff model can be used to describe hydrologic cycle -antecedent moisture, infiltration, and surface run-off. In recent time remote sensing technique are used to monitor run-off because it collects multi-spectral, multi-resolution, and multi-temporal data, and turns them into information valuable.
The imagery of the run-off water was obtained from Giovanni. Giovanni is an acronym for the Goddard Earth Sciences Data and Information Services Center, or GES DISC. It is an interactive online visualization and analysis infrastructure that displays Earth science data from NASA satellites. The imagery shown in Figure 4 were obtained for the year 2001 (Fig 5a), 2006 (Fig 5b), 2011 (Fig 5c) and 2016 (Fig 5d). The location considered is the southern part of Nigeria.

Figure 4: Water formation mechanism

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It is observed that the run-off was very active between 2006 to 2012. This means that the main agent that affect run-off in developing country is the variability of atmospheric precipitation. This is particularly controlled by the weather system over West Africa and climate change in general.

5. Conclusion

It is shown that the main determinant of run-off water in tropical belt is atmospheric precipitation. Hence, the control of the sources of pollution can be curbed. In many countries, programs have been put in place or implemented to monitor flood to prevent run-off water pollution. It is recommended that there should be public awareness on indiscriminate dumping of refuse. This would stimulate the populace understanding on the hazards of run-off water pollution. Secondly, legal framework on environmental protection should be enforced to abolish indiscriminate refuse dumping. This action would protect water bodies such as streams, lakes, rivers and seas.

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Figure 5: Run-off in southern Nigeria
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