Groundwater recharge as one of the sustainable solution to Integrated Water Resources Management

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Water vulnerability

- Water is a very important resource for survival, for social and economic activities

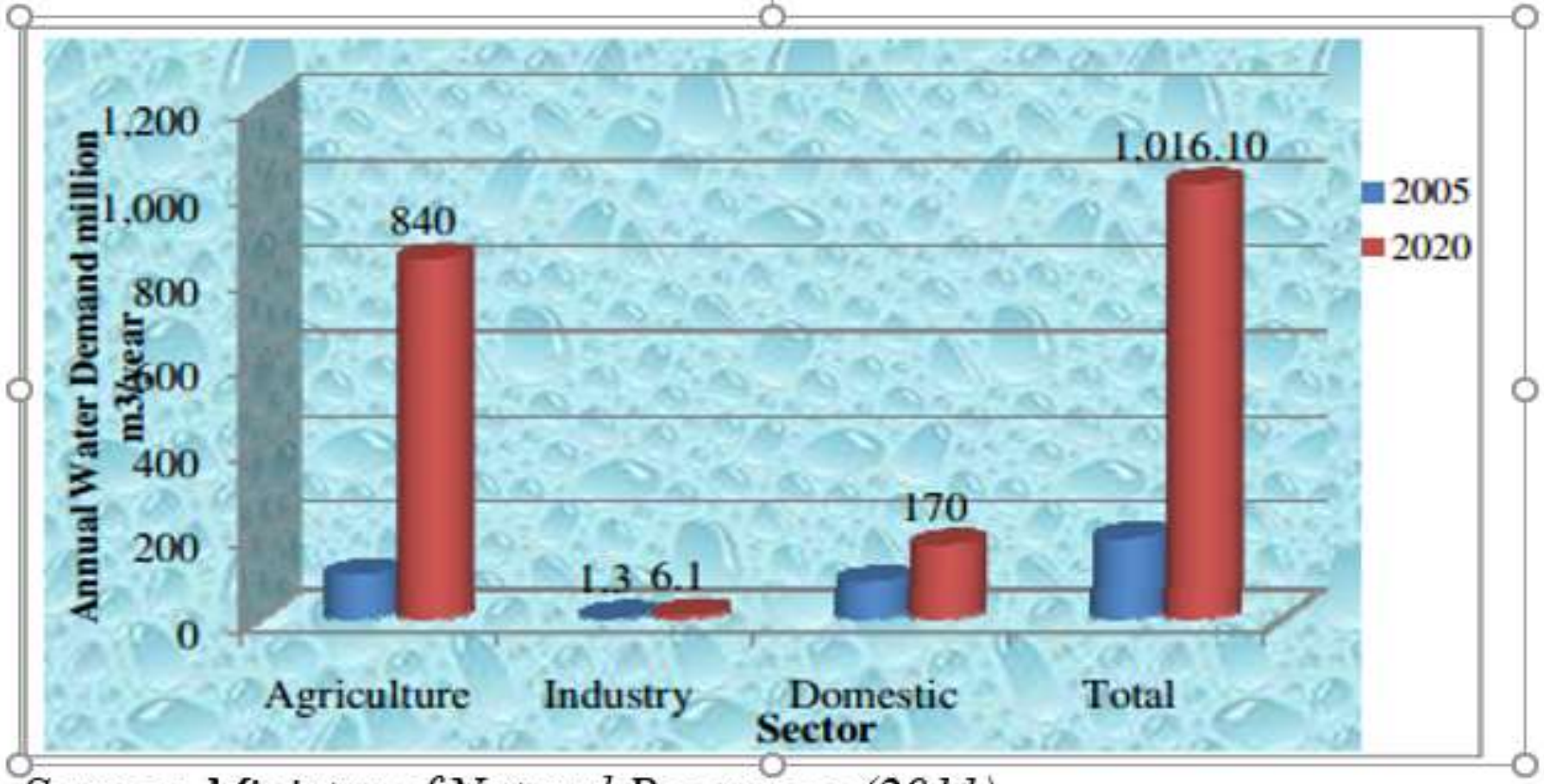
However this resources is vulnerable to:

- user's competitions, and
- the susceptibility to pollution and resilience, due to human activities

- *As consequence, appropriate sustainable strategies must be developed, so as to protect and use efficiently this precious resource, water*.

Comparatively, surface water is more affected by human kind than groundwater. According to Oke (2003), escalating demands for surface water for agricultural irrigation, domestic (municipal) consumption, and industrial uses are forcing stiff competition, this issue prevails all over the area of Rwanda.

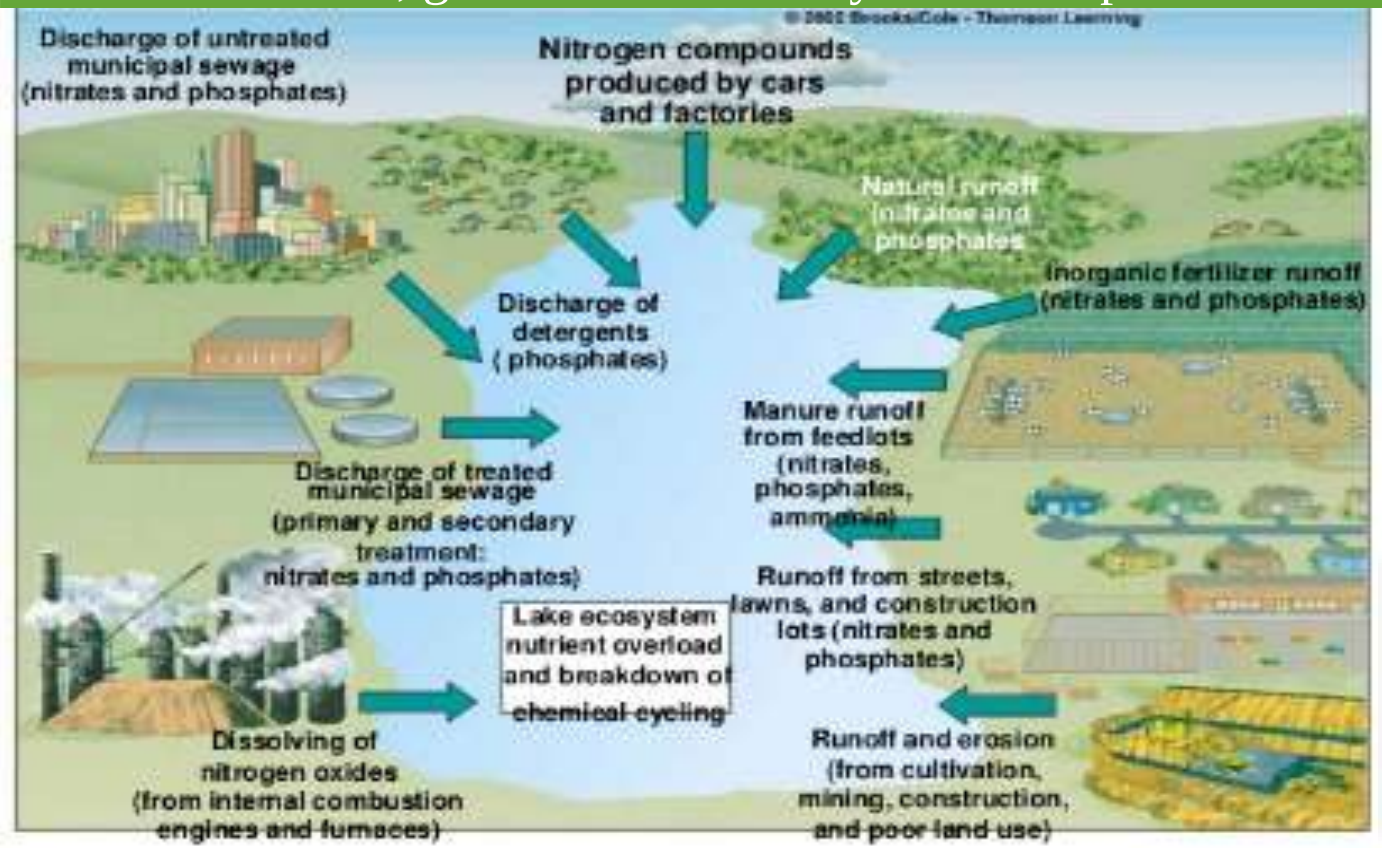
Figure 1. Water withdrawals by sector for 2005 and 2020



Source: Ministry of Natural Resources (2011)

- Similar to the rest of the world, surface water quality of Rwanda is highly affected by both natural factors (like type of soil, vegetation, geology, flow conditions, groundwater quality) and human activities (Chaudhry & Malik, 2017).
- *Particularly, the greatest threat to water quality in Rwanda is posed by point sources of water pollutants, like industrial, Mining and municipal activities.*

- On other hand, groundwater is likely to be less polluted and closer to the users



- The main challenge for Sustainable management of water: meeting increasing multiple water demands, in the face of declining water quantity and quality.

- The UN report states that global water shortage represents a full-scale emergency where the world water cycle seems unlikely to be able to adapt to the demands that will be made of it in the coming decades (UNEP, 1999, Sekomo, et al., 2011).

- In additional to water threats, different Rwandan territories experiences drought (water scarcity), this affect agricultural production.

- Specifically, Eastern province has been facing prolonged and repeated drought since 1998, the direct consequences which have been food insecurity and massive population movements (Ayachi, et al, 2006). On other hand, Groundwater accounts for 86% of safe drinking water supply for rural areas.

- Groundwater storage might be appropriate way for long storage of fresh water, for the reuse in case of the drought or water highly polluted.

Groundwater recharge

- Use of Groundwater and ground water recharge might be one of the sustainable solution to Integrated Water Resources Management
- Recharge to the water table occurs in most areas of the landscape but commonly at varying rates.
- Basically, groundwater recharge depends on:
  - ❑ the geological material of aquifer,
  - ❑ land use,
  - ❑ water head in the area
  - ❑ the topography of the landscape,
  - ...

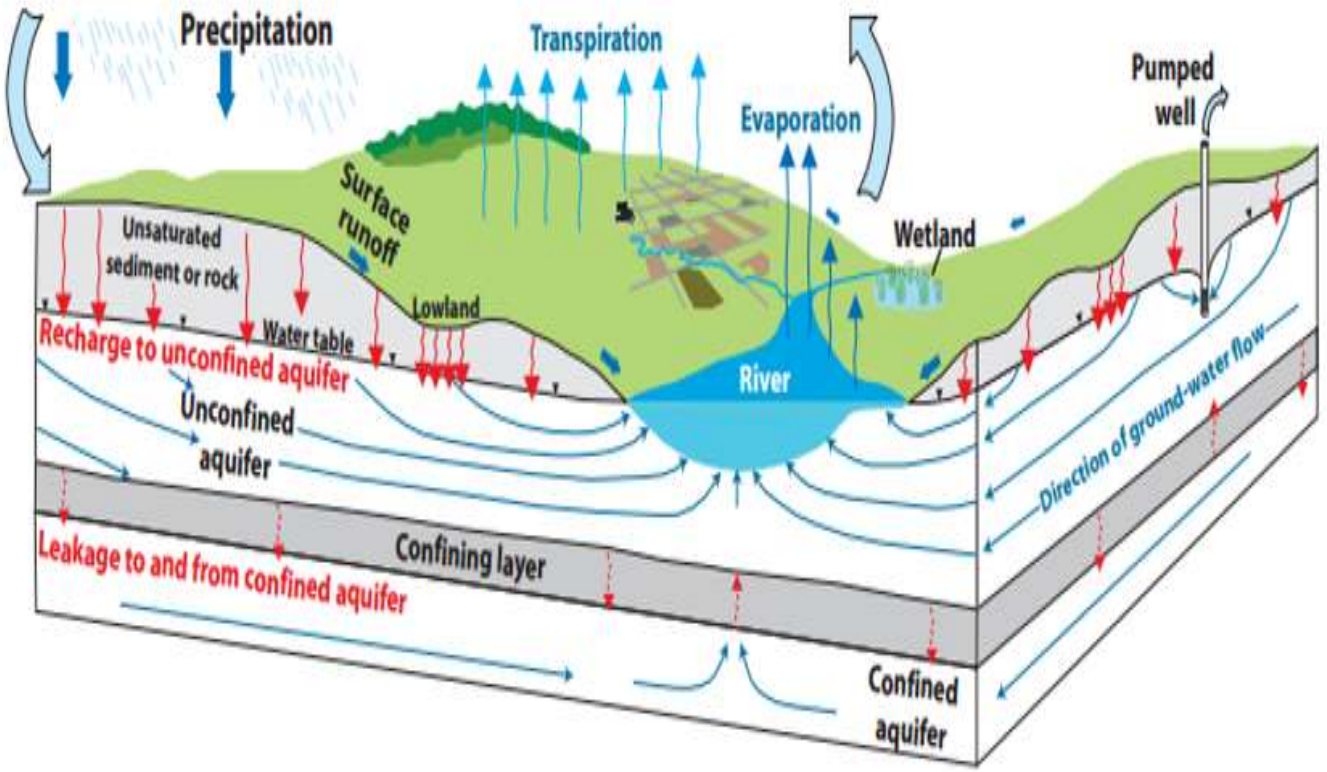


Figure 2: Ground-water recharge is an important part of the hydrologic cycle (U.S. Department of the Interior & U.S. Geological Survey, 2007)

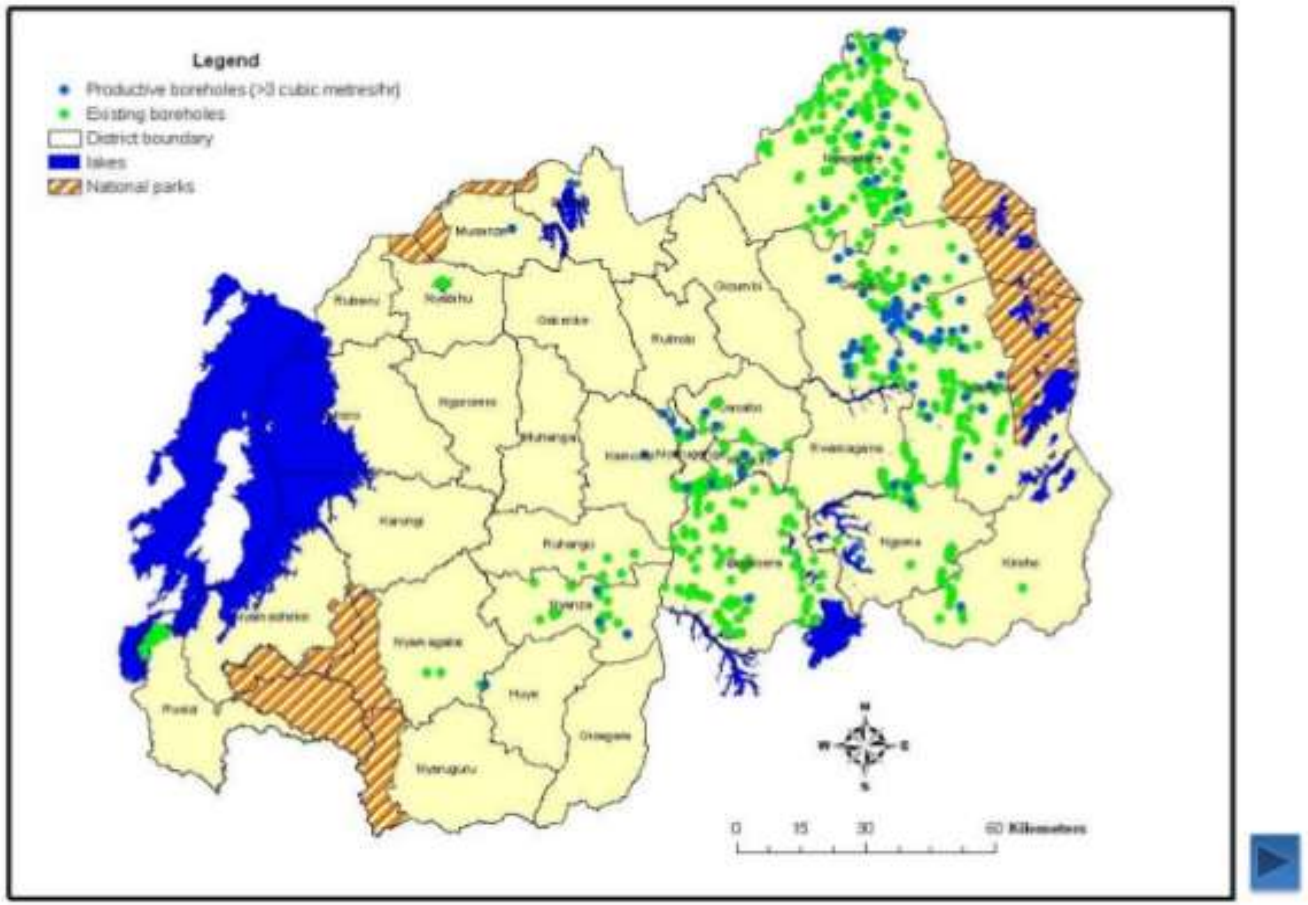


Figure 3: Boreholes Locations and Distribution (Mowo, et. Al, n.d.)

- Groundwater have been being used for water supply system: several boreholes has been drilled across the country accordingly (Figure 3).
- However, Only Natural groundwater recharge is in place in various forms of water courses: Swamps, rivers, lakes,…

According to the observation made, the boreholes are found in valleys or depressions.

Most of time surface water is running through or stored in those particular areas in various forms of water courses (streams, swamps, …), and sometimes results into temporal floods.

This is the great opportunity to recharge the aquifer that is constantly supplying water for various uses, because of water head permanently or temporally available in these areas.

Moreover, these boreholes are located in regions where underlying rock or soil materials are predominantly metamorphic rocks , with several volcanic and sedimentary rocks overlying these metamorphic rocks.

Geological profiles penetrated by Rwandan boreholes varies from one regions to another, these are exemplified by the profiles of boreholes drilled recently (see Table 1).

This results in variation of water storativity and conductivity, and the overall respondence of the aquifer to the pumping wells.

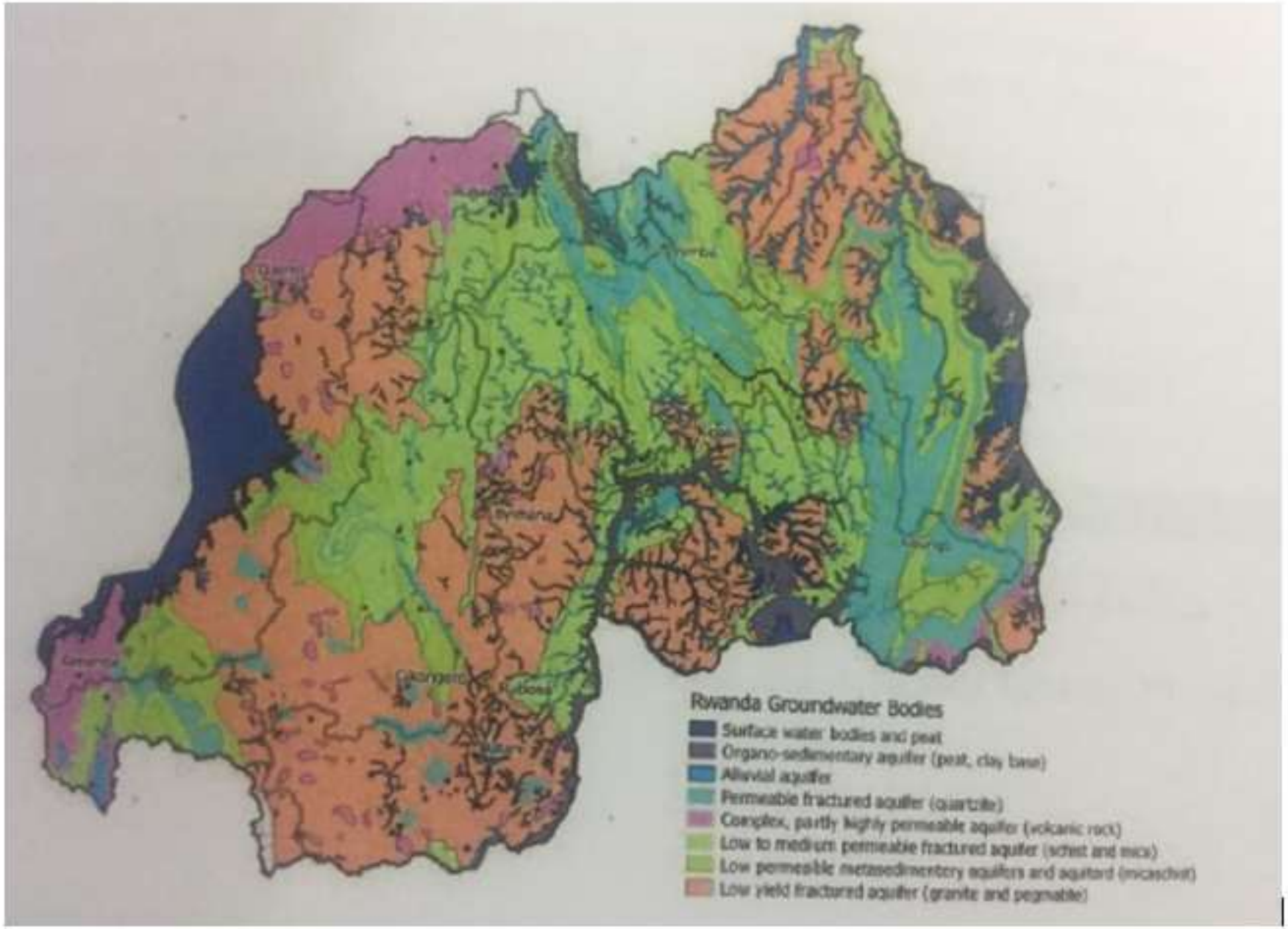


Figure 4: Rwanda Water Resources Master Plan, SHER Ingénieurs-Conseils (2014)

Different behaviour of Rwandan aquifers have been mapped by SHER-Ingenieurs (2014), for the purpose of establishing National Water Resources master plan (see Figure 4).

Table 1: Geological formation of different boreholes recently drilled by LWI*-Rwanda

Drilled Depth (m)	Soil or Rock Formation	
	Sonrise borehole (129.45SS,2939.32E,1832)	**Kabega borehole (212.35S,2945.84N,1718)**
0-15	Top porous basalts	Top red soil
15-35	Weathered basalt	Gneiss
35-42	Weathered basalt	Weathered Gneiss
42-59	Hard rock/basalts	Hard rock/ basalts
59-64	shales	Fractured granite or pegmatite
64-70	Hard basalts	Granite

Drilled Depth (m)	Soil or Rock Formation
	Mutima Boreholes (213.88S,2954.47E,1434)
0-4	Top sandy soil
4-15	Gneiss
15-30	Weathered gneiss
30-45	Weathered gneiss
45-57	Fractured granite
57-60	Hard granite

Table 1: Geological formation of different boreholes recently drilled by LWI*-Rwanda

Drilled Depth (m)	Soil or Rock Formation
	Mutima Boreholes (213.88S,2954.47E,1434)
0-8	Top red soil
8-25	Clay formation
25-50	Laterites
50-85	Basalts
85-95	Fractured quartzite
95-100	Quartzite
100-120	Quartzite

*Living Water International- Rwanda

- Obviously Rwanda has got the considerable geological and topography potentiality to recharge yield groundwater.

- However, we need to establish artificial recharge point such as Detention Dams, recharge wells, ponds located in the valleys, so as to increase groundwater quantity available for use, and prevent floods in some areas of the country.

- Wherever it is appropriate this precious resources might also be used for irrigation purposes, and therefore mitigate the issue effect of the drought affecting agricultural production.

The Efficient use groundwater resources needs regular and comprehensive monitoring of both surface and groundwater, and both quantity and quality, to optimize its recharge and its use.

Figure 6: Management cycle for water resources assessment in Rwanda

Therefore, detailed geological, hydrogeological and hydrological studies in combination with existing topographic data, should be conducted, in order to optimize the recharge, storativity and reuse of the groundwater.

Then, after establishing the recharge areas, hydrogeological studies of monitoring groundwater quality and quantity, therefore, elaborate the model of predicting groundwater available for uses.

Conclusion

In conclusion, despite deficiency in water resources, human activities and natural phenomena have adverse effects on quality and quantity of surface water and groundwater. Since groundwater is less polluted by human activities, and therefore requires minimum treatment for reuse, it is highly recommended to establish the groundwater recharge areas, so as to replenish the consumed groundwater.

Thank you!