Investigating groundwater recharge under small surface water reservoirs in crystalline bedrock environments : case of Kierma dam (Burkina Faso)

Groundwater Quality 2019

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Research objectives

In semi-arid regions of crystalline basement, most irrigation water come from small reservoirs which often dry up early. In this context, alluvial aquifer can provide water resources to support complementary dry-season irrigation. These small dams make a significant contribution to the recharge of these aquifers. The study case of the Kierma dam (Burkina Faso) contributes to a better knowledge of these alluvial aquifers and the mechanisms of their recharge.

Study site

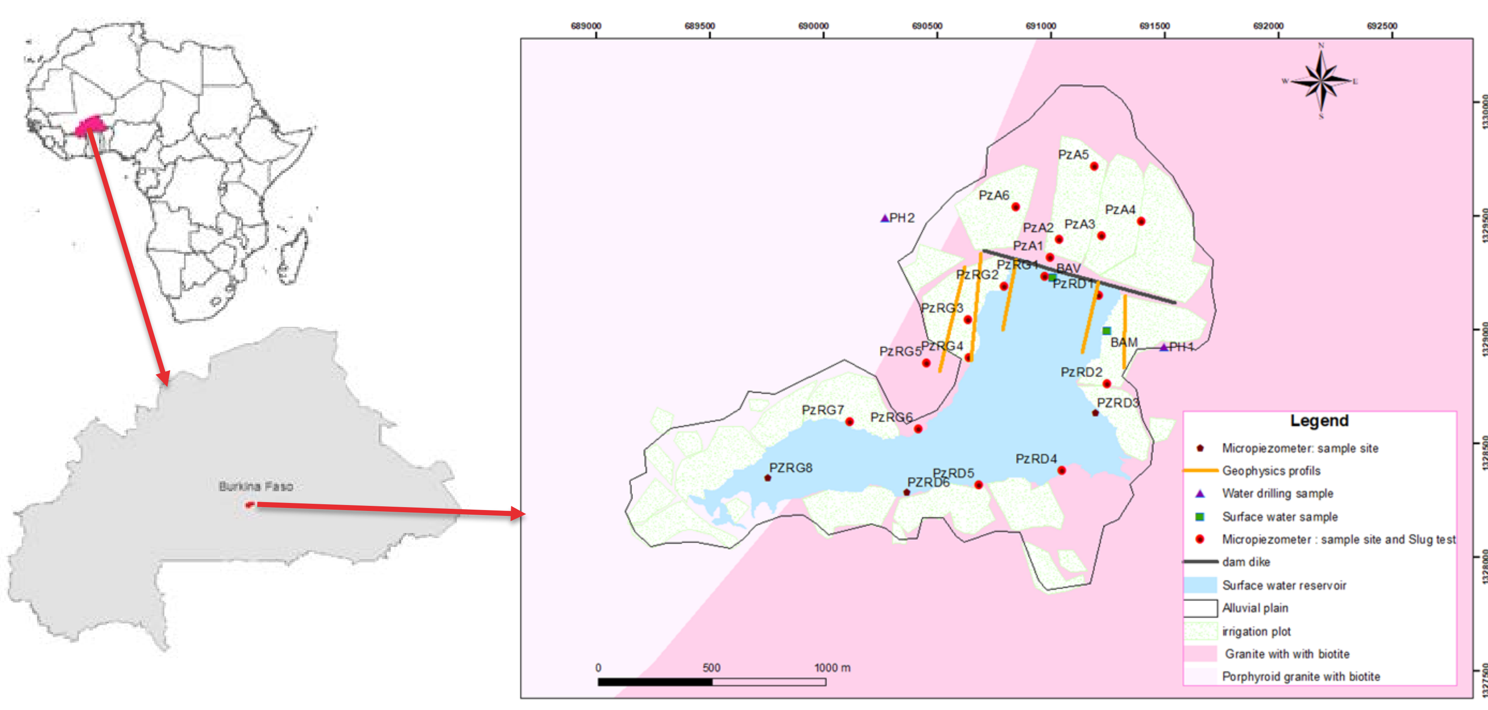


Fig.1. investigated site

- Reservoir : 916,000 m³
- Rainfall ≈ 900 mm/year
- Irrigation plots : 80 ha
- Catchment : 100 km²

Hydrodynamic and water budget approach

- Monitoring of surface and groundwater and slug tests (fig.1).
- Interaction between alluvial and surface water reservoir;
- Hydraulic conductivies range from 9×10^{-8} m/s to 2×10^{-5}m/s.

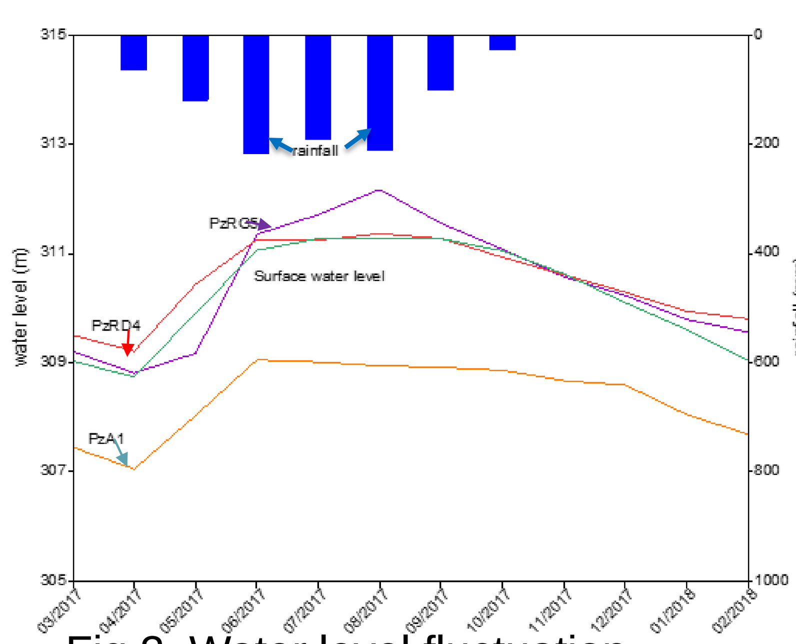


Fig.2. Water level fluctuation

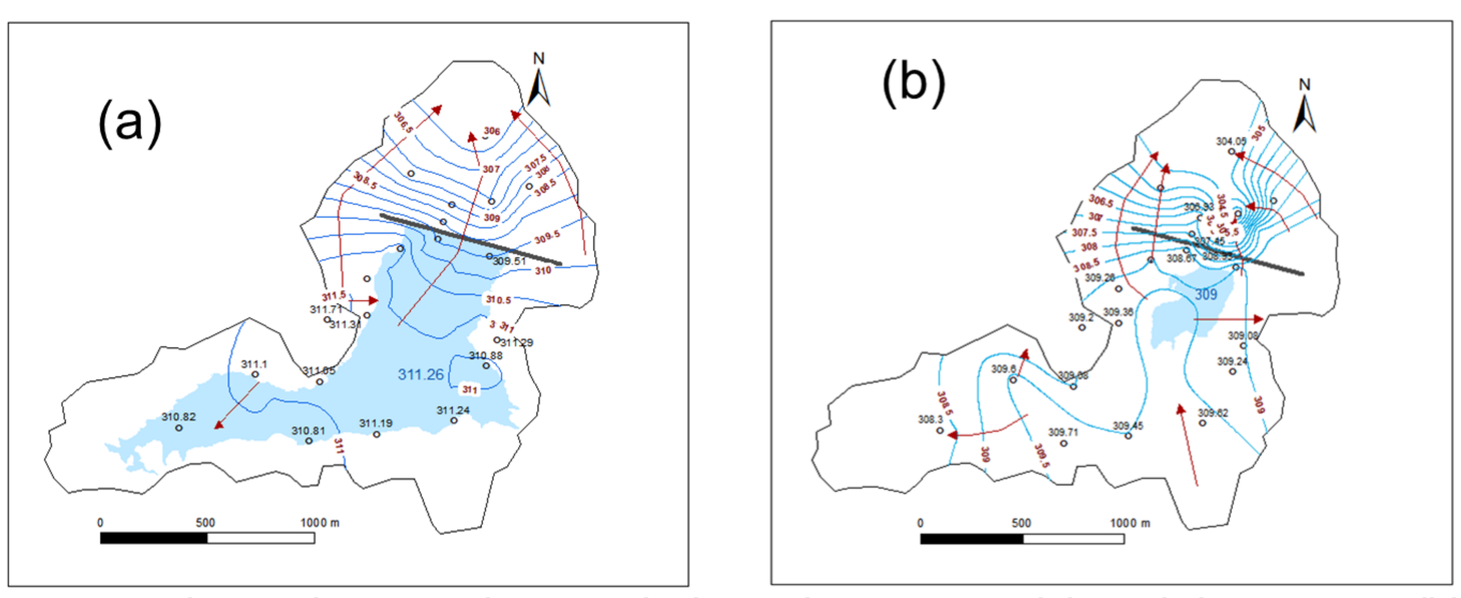


Fig.3. Piezometric map during rainy season (a) and dry season (b)

Tab.1.Water balance components [10^6m³]

Water budget components	2012-2013	2013-2014	2014-2015
Surface runoff	13.93	3.24	5.12
Direct rainfall	0.71	0.56	0.48
Annual total inflow	**14.64**	**3.80**	**5.59**
Evaporation losses	0.95	1.08	0.62
Overflow spillway	12.83	1.90	4.04
Potential recharge	0.40	0.41	0.33
Water withdrawals	0.49	0.56	0.59
Annual total outflow	**14.67**	**3.95**	**5.58**
Annual change in water storage	**0.08**	**-0.10**	**0.00**

- Estimated infiltration from the reservoir ≈ 400,000 m³/year

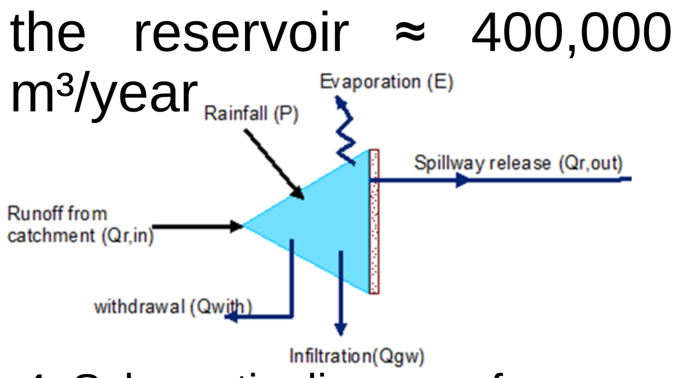


Fig. 4. Schematic diagram of Kierma reservoir

Hydrochemistry contribution

- Collection of 24 water samples (groundwater, reservoir…);
- Major ions analysis : Ca^{2+}, K^{+}, Mg^{2+}, Na^{+}, Cl^{-}, NO_3^{-}, SO_4^{2-}

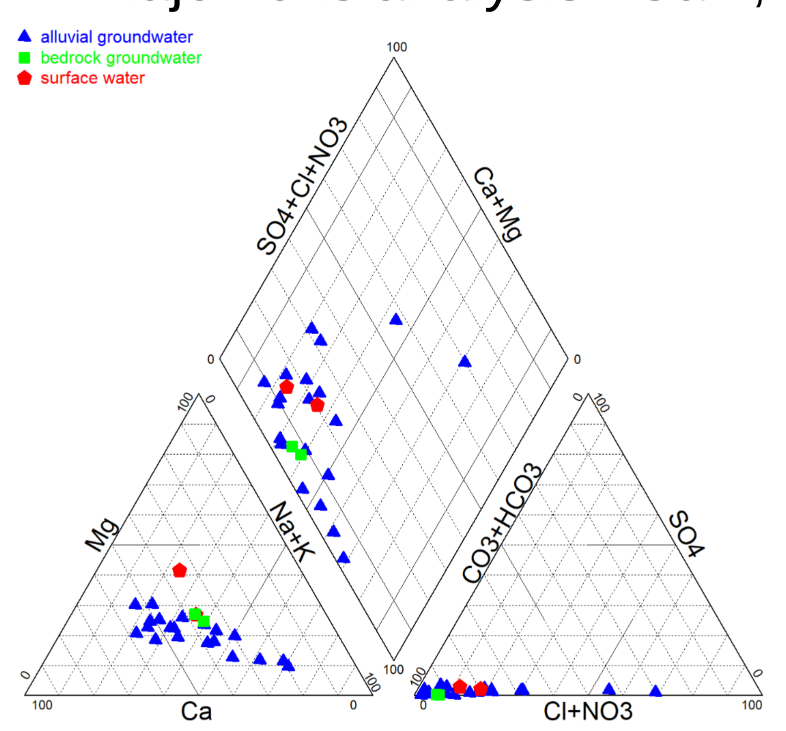


Fig.5.Piper's diagram

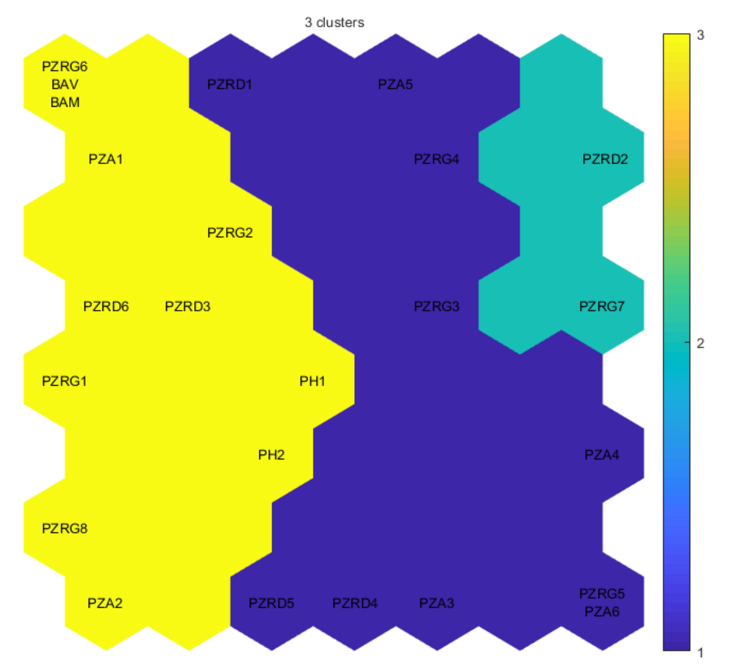
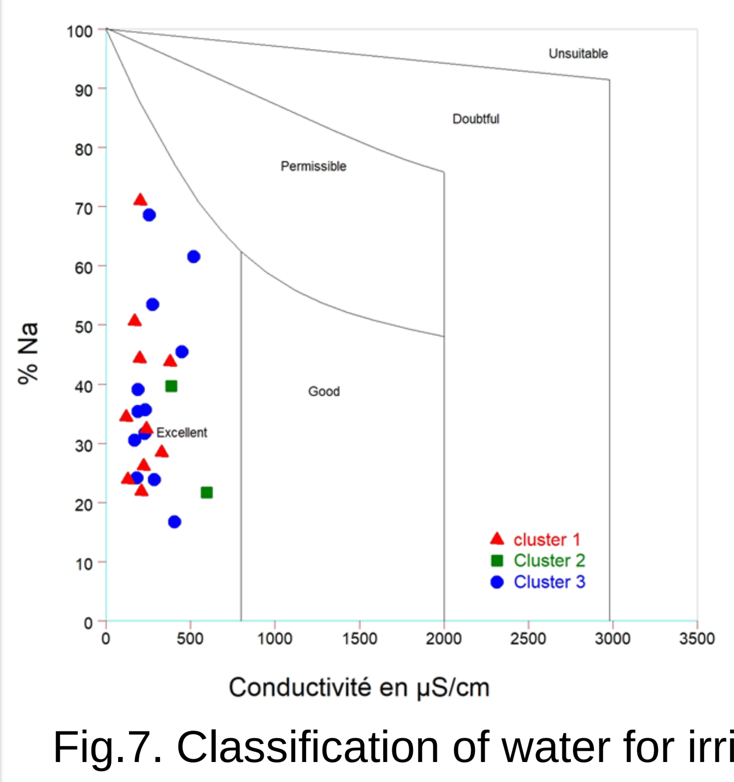


Fig.6. SOMs U-matrix and clustering

- Same facies for most of water : GW/SW interaction (fig. 5);
- Evolution of mineralization;
- Multivariate method (Som) classify the water samples in 3 clusters (fig.6)
- Cluster 3 : samples having chemical compositions similar to those of the surface water reservoir;



- All types of water are suitable for irrigation with a low risk of soil salinization;
- Low sodium risk for soil impermeability and hardening.

Fig.7. Classification of water for irrigation purpose

Conclusion

Alluvial aquifer is recharged by small dams in addition to direct recharge. The quantity of water infiltrated at the Kierma water reservoir represents about 70% of water withdrawal from the dam. This groundwater can therefore constitute a complementary water resource for the socio-economic activities in the area. Although it is of good quality for irrigation purpose, it remains vulnerable to anthropogenic pollution. The low K values restrict however low flow pumping rate for groundwater abstraction.