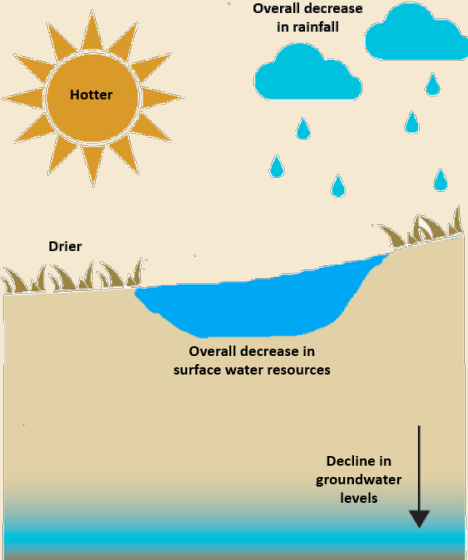
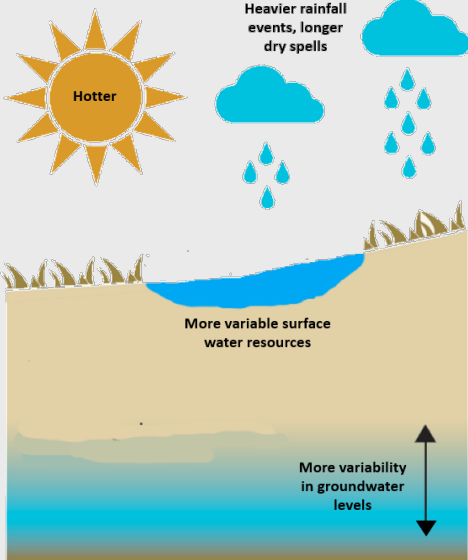
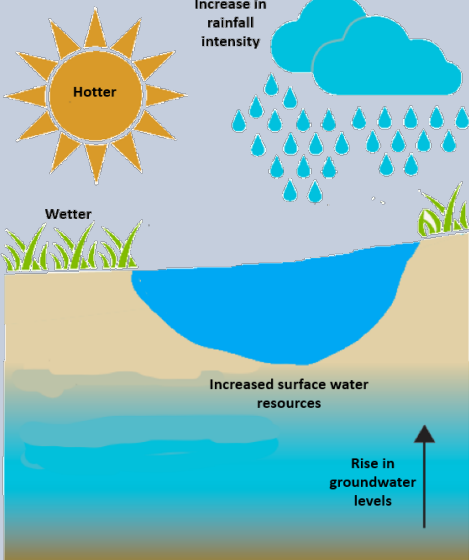


Possible futures for groundwater in Burkina Faso under a changing climate

This narrative* describes three possible future scenarios based on 2050 models for water resources in Burkina Faso, and the human and socio-economic impacts that might be experienced by people living in rural areas. The narratives aim to stimulate discussion towards realistic policy responses and the decision support tools needed to assist future planning needs. It is important to recognise that the scenarios do not represent every outcome projected by climate models and the resulting impacts will be contextualised by local circumstances. For more information about BRAVE and UPGro: upgro.org/consortium/brave2/.

FUTURE 1: GROUNDWATER RECHARGE SUBSTANTIALLY REDUCED RESULTING IN LESS GROUNDWATER STORAGE AND SIGNIFICANT LOWERING OF GROUNDWATER LEVELS	FUTURE 2: MORE VARIABLE GROUNDWATER RECHARGE WITH GREATER ASSOCIATED INTER-ANNUAL VARIABILITY IN GROUNDWATER STORAGE/LEVELS	FUTURE 3: SUBSTANTIALLY INCREASED GROUNDWATER RECHARGE RESULTING IN GREATER GROUNDWATER STORAGE AND HIGHER GROUNDWATER LEVEL
		
<p>Future 1: The climate is much hotter and drier with more erratic rainfall during the monsoon months. Inter-annual recharge is more viable but in the long term is significantly lower than currently.</p>	<p>Future 2: The climate is hotter with an increase in heavy rainfall events interspersed by longer dry spells. Recharge in the long term is similar to the current climate. Although the hotter climate leads to greater evapotranspiration, this is balanced by increased recharge due to the more intense rainfall events.</p>	<p>Future 3: The climate is much wetter and hotter with an increase in the frequency and intensity of rainfall events. Interannual recharge is more variable but increased rainfall outweighs increases in evapotranspiration, leading to a long-term rise in groundwater (GW) levels (GWL).</p>
<p>Headlines: Increased poverty with impact extending to urban communities as well as rural, agricultural dependant areas. What other national alternatives are there for supporting adaptation?</p>	<p>Headlines: Despite large aspects of uncertainty, this future is likely to have impacts similar to Future 1. How will the uncertainty of this future be managed and supported?</p>	<p>Headline Impacts: Improved agricultural production if the market can be managed effectively. How will equal economic growth be maximised in this future?</p>

*Key: GW/Groundwater; GWL/Groundwater Levels

For more information, please contact info@walker.ac.uk. See also, Cuthbert, M.O., Taylor, R.G., Favreau, G. et al. Observed controls on resilience of groundwater to climate variability in sub-Saharan Africa. *Nature* 572, 230–234 (2019) doi:10.1038/s41586-019-1441-7. © Walker Institute, University of Reading 2019. Available online at <https://doi.org/10.5281/zenodo.3533108> in November 2019 by the Walker Institute, University of Reading, Earley Gate, Reading, RG6 7BE, UK. This work is licensed under the Creative Commons Attribution-NonCommercial 4.0 International License. To view a copy of this license, visit <http://creativecommons.org/licenses/by-nc/4.0/> or send a letter to Creative Commons, PO Box 1866, Mountain View, CA 94042, USA. This publication is copyright but the text may be used free of charge for the purposes of advocacy, campaigning, education, and research, provided that the source is acknowledged in full and copies are not being sold commercially. The copyright holder requests that all such uses be registered with them for impact assessment purposes. For online use, we ask readers to link to the original resource on the Walker website (www.walker.ac.uk) or via UPGro (<https://upgro.org/consortium/brave2/>). For copying in a other circumstances, or for re-use in other publications, or for translation or adaptation, permission must be secured. Email info@walker.ac.uk. The information this publication is correct at the time of going to press. To cite this narrative: Cornforth, R. J., Macdonald, D.M., Osbahr, H., Ciampi L., Myers J., Verhoef, A., Black, E.C., Ascott, M., Cook, P., Clark, H., Talens, C., Gahi, N, Haruna, S. (2019). 'Possible futures for groundwater in Burkina Faso under a changing climate'. Version 1.0 <https://doi.org/10.5281/zenodo.3533108>

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IMPACTS

FUTURE 1

FUTURE 2

FUTURE 3

Water

- » Reduced surface water resources lead to widespread abandonment of shallow GW sources
- » Rain-fed agriculture is less viable with increasing dependency on GW for irrigation. This increased GW use lowers the water table and extraction is difficult and wells/boreholes fail more often.
- » As communities are relying on fewer GW sources, time to collect water increases and incidences of water-borne diseases rise.
- » People with more power/resources are capitalising on remaining water sources increasing gender and inter-community tensions.
- » Water quality deteriorates as older mineralised GW is abstracted.
- » Urban water supplies are under pressure due to widespread GW depletion through increased abstraction rates.

- » Reduced reliability in surface water supplies and rainfed crop production leads to a greater dependency on GW resources with similar impacts to those presented in Future 1, especially in times of low rainfall.
- » Depending on the length and frequency of dry periods, tensions over water access and use are rising.

- » The potential for abstraction increases as GW becomes shallower and more accessible.
- » Rain-fed cropping is more secure as surface water increases.
- » Conflict over water use is reducing as water is more readily available. However, the growing population, improved abstraction technology and greater economic opportunities are introducing new competition for water resources.
- » Flooding and waterlogging increases putting people and their livelihoods at risk. This flooding is geographically variable.

Disease

- » Poor diet due to water constraints and reduced yields, is exacerbating nutritional deficiencies and impacting heavily on the poorest people in the community as well as pregnant women, children, adolescent boys and the elderly.
- » Incidences of water-borne diseases are rising because communities are relying on fewer GW sources.

- » The long dry periods are reducing yields with knock-on impacts for poor diet and associated nutrition and health difficulties. Pregnant women, children, adolescent boys, the elderly and the poor are struggling the most.

- » Pollution in water sources is spreading rapidly due to higher water levels and WASH issues increases as well as diseases such as cholera.
- » The high GW table is increasing waterlogging and flooding. Stagnant water is increasing the risk of water-borne diseases (e.g. malaria, cholera). Vital medicines are in short supply.

Agriculture

- » Staple crop harvests are reducing due to limited water and increased incidences of pests. Some staples are failing completely.
- » Cash crops such as onions and dolo (local beer) are difficult to produce and livestock are dying due to lack of water and fodder.
- » Financial stress is exacerbating food security as households have less income for additional consumption goods to compensate for the poor staple crop harvests.
- » Some households are adopting more drought resistant crops despite the cultural barriers and related additional costs.
- » Poverty is rising as people lose vital assets and seek to diversify their livelihoods out of agriculture.

- » The hotter, drier periods are triggering similar impacts as Future 1.
- » Rain fed agriculture is uncertain and has to be supplemented with GW due to the variable and unpredictable nature of the climate.
- » Food production and food security is decreasing, particularly in recurrent drought years.

- » Vegetables and fruit harvests are plentiful as communities optimise their use of rain-fed cropping and irrigation, as well as increase staple crop production.
- » There is more waterlogging, so communities are changing to crops which grow better in wetter soils, such as rice.
- » Livestock are struggling with the increase in the number of floods and rising temperatures. Lifespan is decreasing.
- » As production increases, more communities are turning away from family labour and mechanising their production processes. They are keen to invest at other stages in the value chain such as in soil quality and conservation.

Livelihood

- » Migration increases into the urban centres as people turn away from agriculture and look for cash work and temporary labour. Urban infrastructure, sanitation and housing are under pressure with an increase in of poor peri-urban areas.
- » Migration south to wetter lands is increasing tensions and water competition. Concern increases for people entering the informal economy which lacks social safety nets.
- » Community bonds are eroding as historical commercialization success reduces. Tensions rise with the competing demands.
- » Financial constraints are limiting people's ability to adapt and increase reliance on social protection strategies.
- » Marginalised rural communities are experiencing greater poverty and the number of ultra- poor are increasing dramatically.

- » Due to the variability of this future, periods of low and/or high income are likely. This income unpredictability will leave people more risk averse.
- » Those with access to private wells will be more able to cope than those without which will exacerbate inequalities.

- » People are enjoying better diets with the increase in choice and availability of food. Market prices are falling.
- » People are struggling more with heat stress.
- » Communities look for more financial support systems such as insurance as flood events increase in frequency and intensity.
- » Increased heat and economic pressures are reducing the availability of manual labourers to keep up with production.
- » The transition to mechanisation is leaving a group of people behind who cannot afford this. Inequality is increasing.

POSSIBLE RESPONSES

FUTURE 1

FUTURE 2

FUTURE 3

Water

- Investments are increasing in regional and national (deeper groundwater sources, improved abstraction technology, supply to urban areas and domestic sources) infrastructure.
- GW extraction is managed more equitably so that abstraction is sustainable and marginalised groups can access water.
- Monitoring and management of water usage and the pollution of private wells and community water sources is in place.
- There is a better understanding of the causes of borehole failure and guidelines have been introduced to ensure investment in infrastructure is not wasted.

- Management of GW is in place to compensate for the increased rainfall variability.
- Large-scale investment in infrastructure has improved exploitation and management of GW resources that are available. People are able to deal with uncertainty and shocks to ensure continual supply.
- GW monitoring is enabling people to plan ahead and manage their own resources.
- Investment in education and access to integrated information services supports people's livelihood choices.
- Communities and farmers have adopted a more flexible approach to sourcing water and productive use of water.

- Investments have been made in water management systems such as irrigation and monitoring to support commercialisation, together with training of smallholders and extensions services.
- Policies are in place to ensure sustainable development of water-related livelihoods and the substantial exploitation of water resources.

Disease

- Investment in public services have made these more available to deal with the increases in health issues and disease epidemics.
- Investment in adaptive social protection services are helping to manage crises more effectively for the marginalised and vulnerable groups.

- Investment in adaptive social protection measures are helping to overcome the health issues relating to the longer dry spells and heavy flood events.

- There is much more investment and management of water borne diseases.
- Adaptive social protection measures are helping to overcome health issues related to frequent and heavy flood events.
- Household income has increased which is improving access to medication and better nutrition.
- Governments are investing in in flood protection, flood resistant rural roads and disaster response, as well as public health strategies to deal with heat stress.

Agriculture

- The national government has invested in financial and technical support to marginalised people to help introduce more drought resilient staple crops and livestock and avoid financial difficulties.
- An intensive focus on environmental management by planting trees, using agro-forestry techniques and conducting conservation agriculture has increased soil moisture and limited run-off.
- Increased regulation of the market has increased food imports.

- The investment in extension services is building diversity into livelihoods and supporting policy is enabling a people to diversify crop varieties grown, implement improved irrigation systems and access better information provision systems.
- People who cannot access wells are receiving greater support with policies in place to establish equitable access to water despite the high number of private wells in agriculture.

- More extension services are in place to support the increase in commercialisation needed and bridge the information gaps. Crop quality and diversity is increasing as a result with people able to access markets better.
- Investment in training for farmers is helping people to manage throughout the value chain and increase their necessary communication/coordination skills.
- Policies are in place to ensure that the agricultural intensification is sustainable and that the growth process is equitable, so marginalised groups are not left behind.

Livelihood

- Policies are in place to better manage the increases in destructive livelihoods (such as increased charcoal use witnessed in Ghana) and their associated impacts as livelihoods become unsustainable.
- Adaptive social protection measures are supporting people's livelihoods, in parallel with investments in monitoring, data collection and control, and the implementation of legislation mechanisms across the different governance levels.

- The provision of training to farmers by extension services, NGOs and government departments is increasing their confidence in flexing their agriculture practice and helping to support alternative income streams and avoid potential issues.

- Economic growth is being managed by ensuring the market is monitored, the whole value chain is accessible and supported as people become less risk averse and increase diversification and invest further in agriculture.
- Adaptive social protection measures are actively promoted to support the increasing flood risk.