

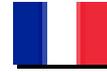
# Hydrogeology of Burkina Faso

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Burkina Faso is a landlocked, francophone Sahelian country. Gaining independence in 1960 and changing its name from the Republic of Upper Volta in 1984, the country embarked on an ambitious programme of socioeconomic improvement with an autonomist agenda. A public uprising in 2014 and military uprising in 2015 was followed by elections, a new president, the reversal of many previous Marxist policies, and the country becoming a strong ally of the USA and France in West Africa.

Burkina Faso has a low GDP and rapid population growth of 3%. Agriculture is the main occupation of most of the population, but now represents only about one third of GDP. Livestock rearing is important across the country, with arable crops particularly in the south and southwest. Mineral exports now make up the main export, replacing the previously dominant cotton, including gold, copper, iron and other metals.

Rainfall is highly variable both annually and spatially. Most water needs are met by surface reservoirs, and irrigation by dams has been encouraged by government since 1973. Most of Burkina Faso is underlain by low productivity aquifers, and groundwater use for irrigation is minimal. Although many challenges remain in water services, the state owned water utility (ONEA) has made great improvements over recent decades, with more than 75% of the rural population and more than 97% of the urban population classed as having access to safe drinking water.

A food price spike in 2008 has had long-term impacts on agricultural activities, and consequently water use, including leading government to reinstate fertiliser subsidies and control prices of some commodities. Another current source of pressure on water and other resources is the presence of refugees from Mali and some other regions in the north of the country.

□

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## Authors

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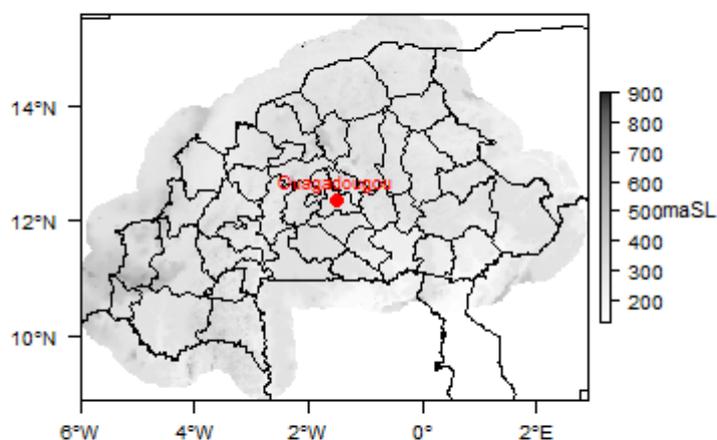
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# Geographical setting



Burkina Faso. Map developed from USGS GTOPOPO30; GADM global administrative areas; and UN Revision of World Urbanization Prospects. For more information on the datasets used in the map see the [geography resource page](#)

## General

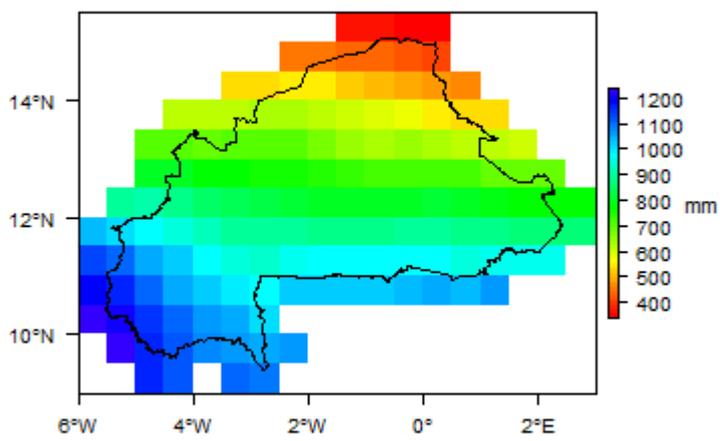
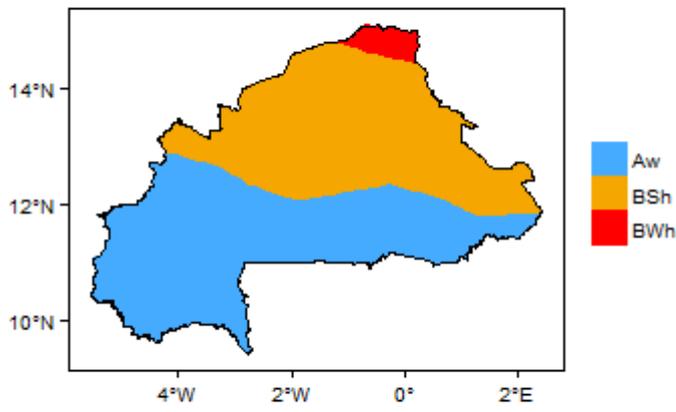
Much of Burkina Faso is a largely flat plain with an average altitude of 400 m above sea level, which is cut into by valleys and flood plains.

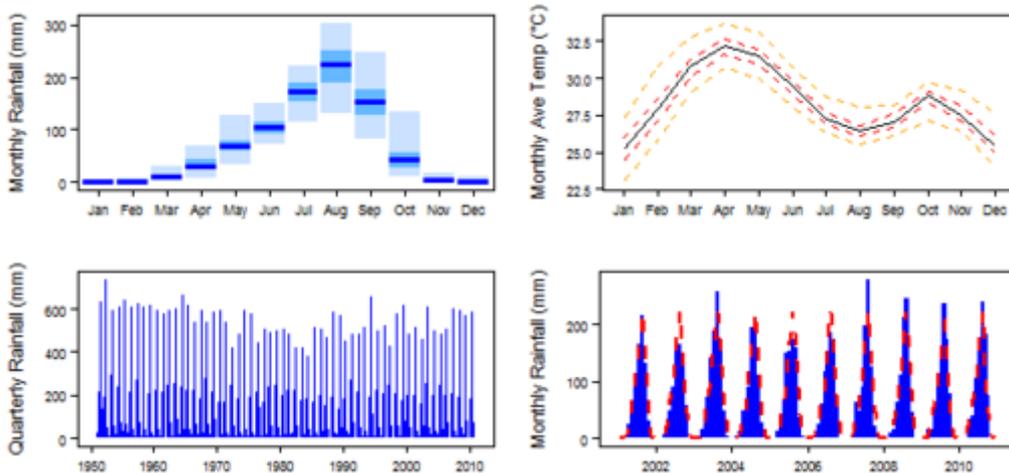
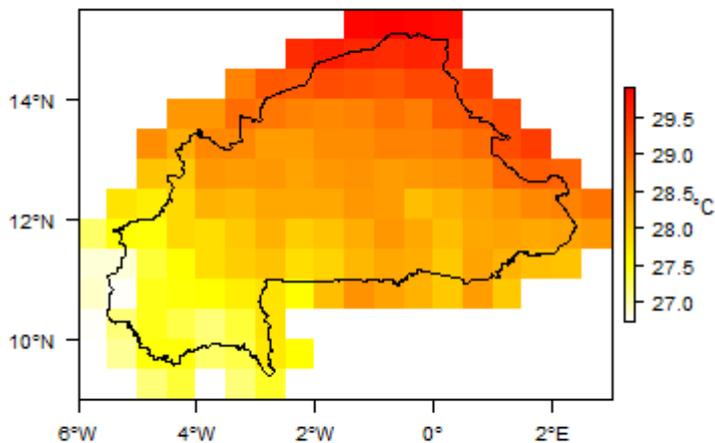
Capital city	Ouagadougou
Region	Western Africa
Border countries	Benin, Cote d'Ivoire, Ghana, Mali, Niger, Togo
Total surface area*	274,220 km <sup>2</sup> (27,422,200 ha)
Total population (2015)*	18,106,000
Rural population (2015)*	12,757,000 (70%)
Urban population (2015)*	5,349,000 (30%)
UN Human Development Index (HDI) [highest = 1] (2014)*	0.4023

\* Source: [FAO Aquastat](#)

## Climate

Burkina Faso can be divided into three climate zones, with rainfall decreasing from south to north. There is a distinct dry season during winter months, and wet season during summer months.





More information on average rainfall and temperature for each of the climate zones in Burkina Faso can be seen at the [Burkina Faso climate page](#).

These maps and graphs were developed from the CRU TS 3.21 dataset produced by the Climatic Research Unit at the University of East Anglia, UK. For more information see the [climate resource page](#).

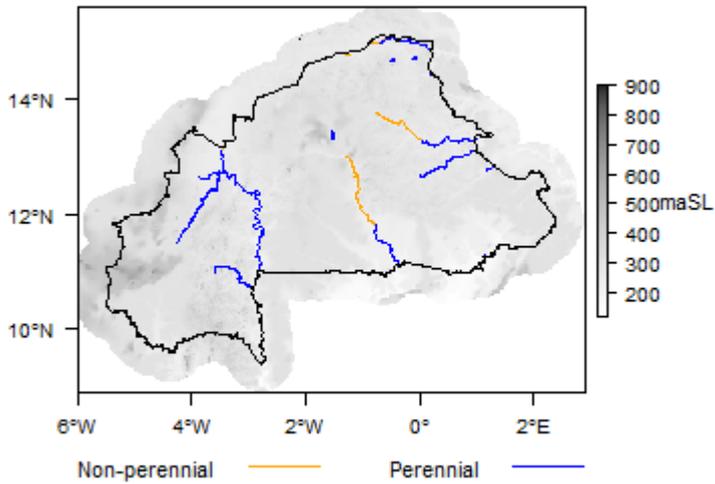
## Surface water

The Volta river basin covers 63% of the country's area, across the centre, south and west. Tributaries of the Volta system include the Nakambe, Mouhoun and Comoé rivers. The headquarters of the Volta basin authority are in Ouagadougou.

The north and east are drained by rivers of the Niger basin.

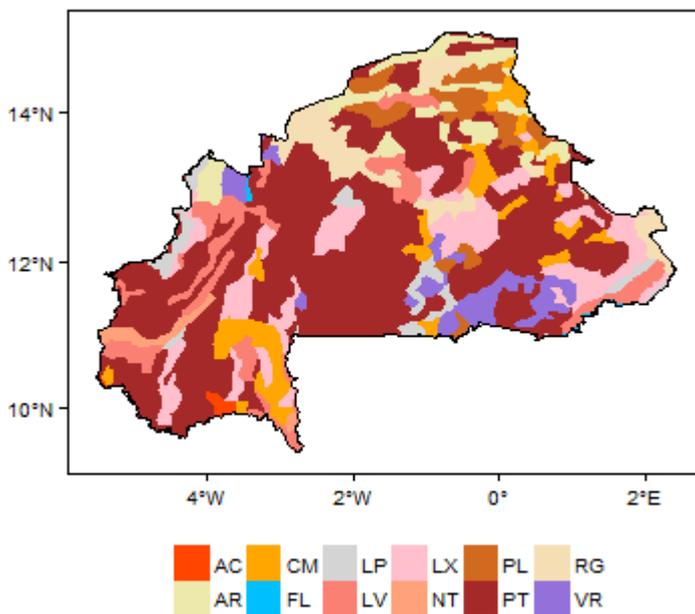
Many smaller rivers are ephemeral, drying during the dry season. There are a number of natural lakes. Many valleys are dammed to store wet season rainfall: in 2001 there were approximately 2000 reservoirs with a total storage volume estimated at 2.66 billion cubic metres (Obuobie and Barry,

2012)



Major surface water features of Burkina Faso. Map developed from World Wildlife Fund HydroSHEDS; Digital Chart of the World drainage; and FAO Inland Water Bodies. For more information on the datasets used to develop the map see the [surface water resource page](#)

## Soil



Soil Map of Burkina Faso, from the European Commission Joint Research Centre: European Soil Portal. For more information on the map see the [soil resource page](#)



Groundwater: leaving the country to other countries (total) (Million cubic metres/year)	No data	No data				
Industrial water withdrawal (all water sources) (Million cubic metres/year)			21.7			
Municipal water withdrawal (all water sources) (Million cubic metres/year)			375.6			
Agricultural water withdrawal (all water sources) (Million cubic metres/year)			420.7			
Irrigation water withdrawal (all water sources) (Million cubic metres/year)		420.7				
Irrigation water requirement (all water sources) (Million cubic metres/year)		128.9				
Area of permanent crops (ha)					100,000	
Cultivated land (arable and permanent crops) (ha)					6,100,000	
Total area of country cultivated (%)					22.24	
Area equipped for irrigation by groundwater (ha)	3,000					
Area equipped for irrigation by mixed surface water and groundwater (ha)	No data	No data				

Source and more statistics at: [FAO Aquastat](#).

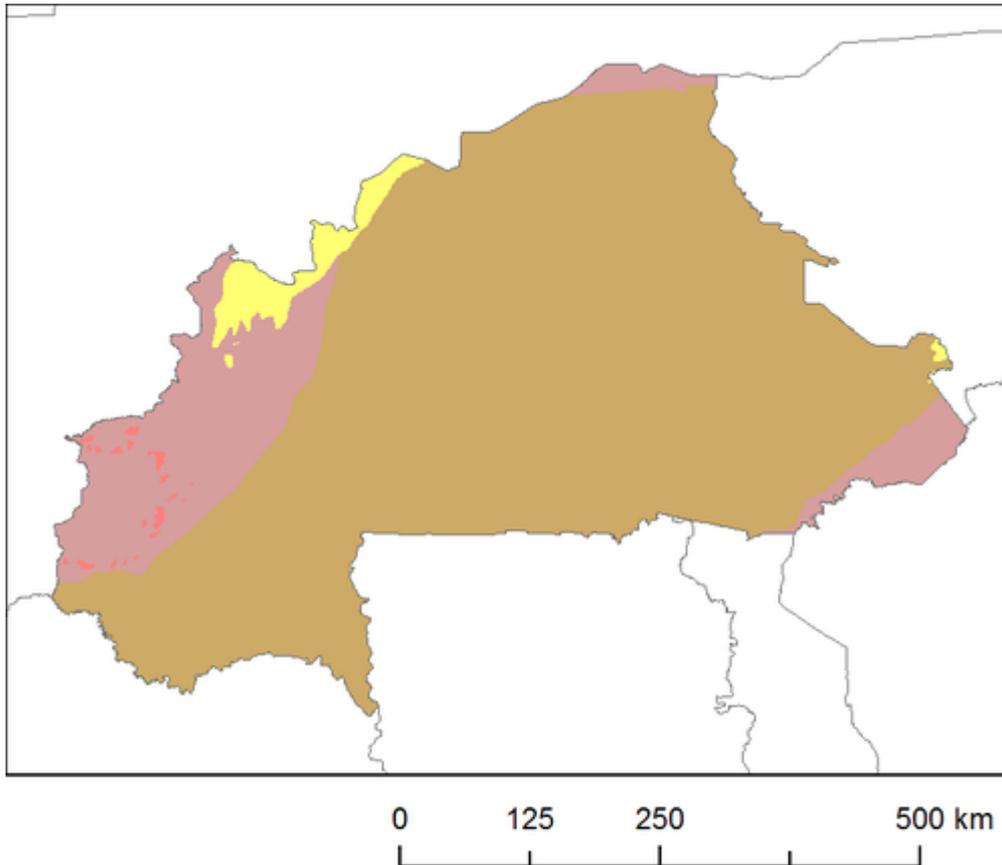
## Geology

This section provides a summary of the geology of Burkina Faso. More detail can be found in the references listed at the bottom of this page. Many of these references can be accessed through the [Africa Groundwater Literature Archive](#).

The geology map on this page shows a simplified version of the geology at a national scale (see [the Geology resources page](#) for more details).

**[Download a GIS shapefile of the Burkina Faso geology and hydrogeology map.](#)**

A higher resolution map at 1:1 000 000 scale is published by the Ministère des Mines, des Carrières et de l'Énergie (Castaing et al., 2003a, 2003b).



## Burkina Faso - Geology

- Continental Terminal
- Igneous intrusive - dolerite
- Proterozoic to Palaeozoic (meta)sedimentary
- Precambrian Crystalline Basement

Geology of Burkina Faso at 1:5 million scale. Developed from USGS map (Persits et al., 2002). For more information on how the map was developed see the [geology resource page](#). [Download a GIS shapefile of the Burkina Faso geology and hydrogeology map](#).

Key formations	Period	Geological environments Lithology	Structure
		<b>Unconsolidated</b>	
Alluvium	Quaternary	Detrital deposits: dominantly alluvium in river valleys; some lake deposits.	
Laterite	Quaternary	Iron-rich, hardened tropical soil	
		<b>Continental Terminal</b>	

Cenozoic

The Continental Terminal sequence unconformably overlies Proterozoic to Palaeozoic sedimentary dolomites and other formations in the Gondo plain in the north of the country. It consists largely of fluviatile and lacustrine deposits. In the north-west, it comprises a layer of alternating clays and sands 40 m thick; and in the east, a conglomerate-sandstone succession (Castaing et al., 2003b).

### **Proterozoic to Palaeozoic (meta)sedimentary**

Bandiagara and Koutiala sandstones, Toun Schists, Bobo Sandstone, Gobinangou Sandstone

Proterozoic (Late Precambrian) to Palaeozoic

These are consolidated, indurated sedimentary rocks, sometimes metamorphosed, which unconformably overlie basement rocks. They occur along the north-west and north, and in the extreme south-east of the country. They include sandstone-quartzites and conglomerates at the base, which are overlain by largely sandstone formations, interbedded with schists and rare dolomitic limestones in the west of the country. At the top of the sequence are mixed formations including argillaceous schists, quartzitic sandstones, interbedded limestones and dolomites, breccias, and marbled conglomerates. In the south-east are sandstone facies (e.g. the Gobinangou Sandstone) with pelitic schists and calcareous and phosphated strata.

### **Crystalline basement**

Birimian volcano-sedimentary and plutonic rocks; Eburnean granitoid rocks.

Precambrian

Basement complex of Archaean and Birimian age, consisting of belts of Birimian volcano-sedimentary and plutonic rocks intruded by large batholiths of Eburnean granitoid rocks. It includes basalt, andesite, rhyolite, rhyodacite, dacite, felsic tuffs, gabbro, diorite, granites, gneisses, shales, schists, quartzites and greenstones (Castaing et al., 2003b).

Two major north-north-east-trending sinistral shear zones divide the Basement rocks into three domains: eastern, central and western, with variably north-east or north to north-north-east-trending structural features (Castaing et al., 2003b).

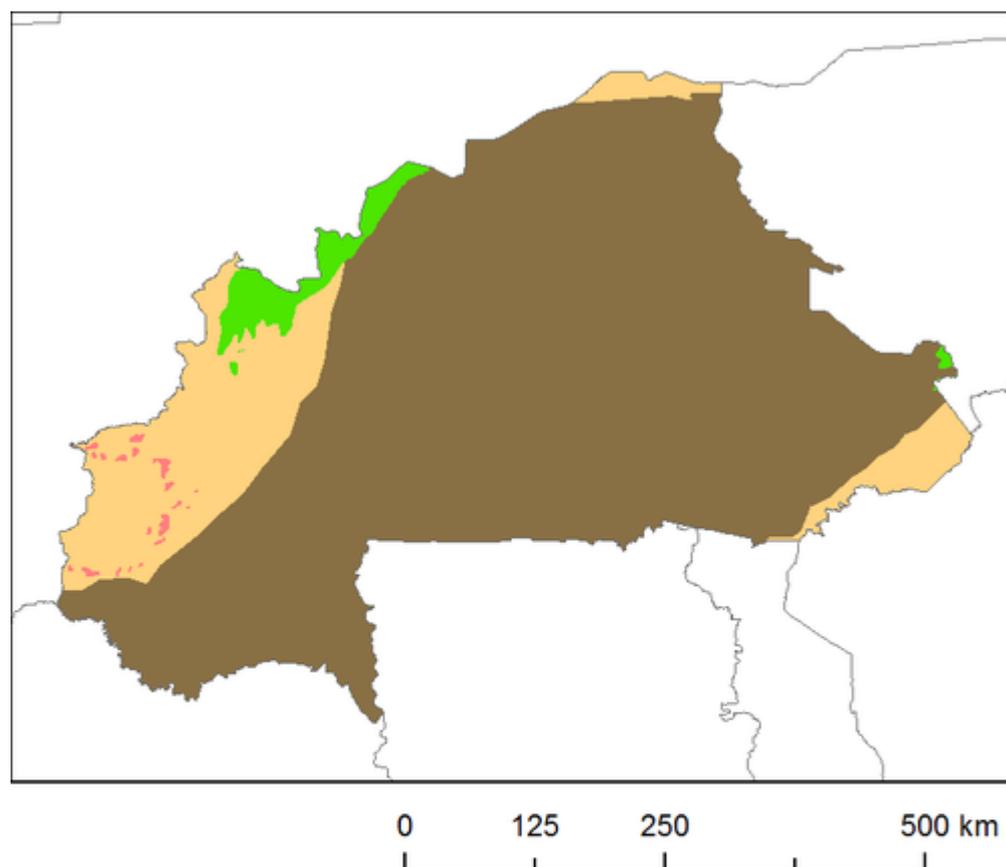
# Hydrogeology

Geology is the main control on aquifer productivity and groundwater potential.

This section provides a summary of the hydrogeology of the main aquifers in Burkina Faso. More information is available in the references listed at the bottom of this page. Many of these references can be accessed through the [Africa Groundwater Literature Archive](#).

The hydrogeology map on this page shows a simplified version of the type and productivity of the main aquifers at a national scale (see the [Hydrogeology map](#) resource page for more details).

[Download a GIS shapefile of the Burkina Faso geology and hydrogeology map.](#)



## Burkina Faso - Aquifer Type and Productivity

-  Sedimentary Intergranular - Moderate to High
-  Igneous Dolerite - Low to Moderate
-  Sedimentary Fracture - Low to Moderate
-  Basement - Low

Hydrogeology of Burkina Faso at 1:5 million scale. For more information on how the map was developed see the [Hydrogeology map](#) resource page. [Download a GIS shapefile of the Burkina Faso geology and hydrogeology map.](#)

**Unconsolidated**

Named aquifers	General description	Water quantity issues	Water quality issues	Recharge
Alluvium	Alluvial deposits in river valleys and floodplains can have high permeability and storage capacity, where they are dominated by coarse-grained sand and gravel. Alluvium can be up to 60 m thick. Where they are underlain by permeable bedrock - e.g. sandstones or weathered basement - groundwater in the alluvial deposits is often in hydraulic continuity with groundwater in the underlying bedrock aquifer. It may also be in hydraulic continuity with river water in nearby rivers. The water table in alluvium is often shallow, less than 10 m below the ground surface (Obuobie and Barry, 2012).	Alluvial deposits are not continuous and therefore form local aquifers. They can be exploited by shallow wells and by deeper boreholes.		Recharge is by direct rainfall infiltration and leakage from rivers, and is strongly seasonal.

### Sedimentary - intergranular flow

Named aquifers	General description	Water quantity issues	Water quality issues	Recharge
Continental Terminal	<p>This aquifer has variable lithology and irregular structure. The upper layers comprise mudstones and sandstones. Sandstones form aquifer layers, which are generally in hydraulic continuity with the underlying older dolomitic limestone. Where they are overlain by unconsolidated alluvial aquifers, groundwater in the sandstone can be in hydraulic continuity with groundwater in the alluvium. The aquifer is largely unconfined.</p> <p>The Continental Terminal aquifer ranges in thickness from 10 m thick at its edges, up to 100 m thick in the centre of the aquifer in the plain of Gondo.</p> <p>The water table can range from 10 m to more than 90 m below the ground surface. Borehole depths typically range from 40 m to 120 m. Relatively high yields of at least 10 m<sup>3</sup>/hour may be obtainable from deep boreholes into sandstone layers (Obuobie and Barry, 2012). Data from the Burkina national borehole database indicate that average yields may be over 30 m<sup>3</sup>/hour.</p>			Recharge is by direct rainfall infiltration and is strongly seasonal.

### Sedimentary - fracture flow

Named aquifers	General description	Water quantity issues	Water quality issues	Recharge

Proterozoic to Palaeozoic (meta)sedimentary rocks

Sandstones, dolomites and limestones form generally low productivity aquifer layers, which range from 50 to 1000 m thick. Dolomitic limestones form the best aquifers (BGS, 2002). The permeability of the upper aquifer layers has sometimes been enhanced by weathering (Obuobie and Barry, 2012). In some places they can be overlain by up to 60 m of alluvium, and groundwater is often in hydraulic continuity with the unconfined upper bedrock aquifer layers, with the water table ranging from 10 m to 60 m below the ground surface. The upper aquifer layers are typically unconfined.

Lower aquifer formations can be confined if overlain by dolerite intrusions or clayey layer. In confined aquifer layers, borehole water levels are typically less than 5 m below the ground surface, and in some cases are artesian. In the Bobo Dioulasso area, fractured and weathered schists and dolomites form a 10-30 m thick weathered aquifer, in which average borehole yields of 0.5 to 5 m<sup>3</sup>/hour and transmissivity values of between approximately 15 and 50 m<sup>2</sup>/day have been recorded (Obuobie and Barry, 2012). The Gres and Intracambrian aquifers in the Bobo Dioulasso area are thought to be particularly productive aquifers. They are thought to be around 100 m thick and to have a transmissivity of approximately 120 to 415 m<sup>2</sup>/day and a specific capacity of 1 m<sup>3</sup>/hour/m (Obuobie and Barry, 2012). Yield data from the Burkina national borehole database indicates average borehole yields of around 4.5 m<sup>3</sup>/hour.

The aquifer is used for water supply in rural and urban areas (70% of abstraction from the aquifer); and also for mineral water and other commercial/industrial use (25%) and other uses.

Most recharge to the aquifer is thought to occur from seasonal rainfall infiltration by preferential flow through fractures (Obuobie and Barry, 2012).

## Crystalline basement

Named  
aquifers

General description

Water quantity issues

Water quality issues

Recharge

Granites, gneisses, schists, quartzites and greenstones.	<p>Basement rocks form discontinuous aquifers. Groundwater storage and flow occur only where the rock is fractured and/or weathered. The upper part of the aquifer can be weathered to a depth of 10 m to 80 m. This weathered zone may be in hydraulic continuity with overlying alluvial aquifers (see Unconsolidated, above). The water table in the weathered zone can lie between 5 m and 30 m below the ground surface. Boreholes are typically from 40 m to 80 m deep. Groundwater in the weathered zone aquifer is typically unconfined. Fractured bedrock, sometimes underlying and associated with, weathered zones, also forms an aquifer in the basement rocks. Fractured aquifer zones can range from 10 m to 80 m thick, and the water table can range from 20 m to 60 m below the ground surface. Boreholes abstracting from this aquifer are between 40 and 150 m deep. Average borehole yields are around 2 m<sup>3</sup>/hour (Obuobie and Barry, 2012; yield data from the Burkina national borehole database).</p>	Groundwater from crystalline basement aquifers is dominantly used for rural water supplies (70%), with other uses being for mineral water and other commercial/industrial use (25%) and a small amount of abstraction for agriculture (2%).	Groundwater is thought to be generally of Ca-Mg-HCO <sub>3</sub> type (BGS 2002). Arsenic has been identified as a problem in some areas, particularly associated with zones of gold mineralisation in Birimian (Lower Proterozoic) volcano-sedimentary rocks (Smedley et al., 2007).	Recharge occurs from rainfall infiltration and is typically low. Indirect recharge in local depressions can be important (Obuobie and Barry, 2012).
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# **Groundwater status**

## **Groundwater quantity**

Average recharge rates are estimated at 5 mm/year in the drier north and 50 mm/year in the south, but locally, recharge can be much higher, with estimates ranging up to 250 mm/year (Obuobie and Barry, 2012). Estimates indicate that over the whole countries, groundwater abstraction is only a small proportion of recharge - less than 1% in the Volta basin, and more than 5% in the far north. However, locally, groundwater abstraction may exceed recharge.

## **Groundwater quality**

Generally, groundwater in Burkina Faso is of suitable quality for drinking water supplies, although there are local problems. Naturally occurring arsenic has been identified as a problem in some areas, particularly associated with zones of gold mineralisation in Birimian (Lower Proterozoic) volcano-sedimentary rocks (Smedley et al., 2007). Pollution from nitrate is thought to be common in shallow groundwater sources, derived from domestic waste as well as agricultural sources, often highest in areas of high housing density (BGS, 2002). Groundwater in some areas of north-west Burkina Faso has high salinity (BGS, 2002).

# **Groundwater use and management**

## **Groundwater use**

Groundwater in Burkina Faso is used mainly for drinking water supply, particularly for small supplies in rural areas and smaller towns. The second city of Bobo Diolasso, which lies on a moderately productive aquifer, relies relatively heavily on groundwater. The capital Ouagadougou, lying on the relatively low productivity basement aquifer, is largely dependent on surface water, but some 15% of its water supply comes from groundwater, which is particularly important in the dry season.

Some groundwater is used for small-scale market garden irrigation, for example supporting dry season cultivation in the south. It is also used for for livestock watering. Industry is the smallest user of groundwater in the country (Obuobie and Barry 2012).

Groundwater abstraction is mainly from drilled boreholes and hand-dug wells. The total estimated number of boreholes in Burkina Faso was 24,350 in 2005. Most boreholes are fitted with pumps: these are typically mechanised in urban areas, and hand pumps in rural areas.

## **Groundwater management**

The Ministère de l'Environnement et de L'Eau (MEE) is the government department with responsibility for sustainable use of groundwater and surface water resources in Burkina Faso. Different MEE departments are responsible for different aspects of domestic, agricultural and industrial use of water and for energy production.

The National Council for Water is responsible for ensuring implementation of laws governing surface and groundwater management (Obuobie and Barry 2012). The Water Management Policy Act (2001) provided for state ownership of all water resources (with limited exceptions) and established a

permit regime for water abstraction for non-domestic uses (Obuobie and Barry 2012).

The national organisation with responsibility for water supply is the Office National de l'Eau et de l'Assainissement (ONEA).

There is a national borehole database which currently stores information about more than 15,000 boreholes. The database includes detailed information about borehole location (coordinates and village/region); depth; whether the borehole was successful; the geology; and the borehole yield.

## **Transboundary aquifers**

There are no major transboundary aquifers in Burkina Faso.

For further general information about transboundary aquifers, please see the [Transboundary aquifers resources page](#)

## **References**

The following references provide more information on the geology and hydrogeology of Burkina Faso. These, and others, can be accessed through the [Africa Groundwater Literature Archive](#).

### **Useful websites**

[Bureau des Mines et de la Geologie du Burkina.](#)

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