

Hydrogeology of Liberia

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The Republic of Liberia began in its present form after 1822 as a settlement of the American Colonisation Society, who believed that Black Americans faced better chances there. The indigenous people inhabiting this area included the Kru and Grebo, many of whom had migrated from regions further east in past centuries. In 1847, the settlers declared Liberia an independent republic, with a constitution modelled on that of America, and retained its independence during the subsequent period of European colonialism. After the USA recognised Liberia in 1862, the two countries had reasonable diplomatic relations: Liberia supported the USA in WWII and the USA subsequently invested in Liberian infrastructure to a modest extent, albeit within the context of foreign direct investment in the rubber industry. There has been periodic ongoing tension between the minority of black settler-colonisers and indigenous peoples since the republic was founded. The settlers established and dominated the country's political system. A period of serious unrest began in 1980 with a military coup, years of military rule and two civil wars that devastated the economy, ending with a peace agreement in 2003. Since then, Liberia has experienced relative political stability and economic recovery, but the economy and infrastructure remains poorly developed, and recovery was affected by an outbreak of Ebola virus in 2014-15.

Rubber and timber plantations, ironically sometimes run with indigenous slave labour, dominated the economy from the start of the 20th century. Iron ore was another significant export until the industry declined during the civil wars. During those wars, Liberia was a transit point for diamonds from Sierra Leone, the funds of which were used to purchase weapons, and the international community banned trade in diamonds with Liberia during that period. Today, Liberia is one of the world's poorest countries, with one of the highest ratios of Foreign Direct Investment to GDP. The years of war left little water and electricity provision outside the capital. Liberia is a shipping 'flag of convenience': vessels from any country can register there, and this provides a large proportion of GDP.

Liberia, a tropical country, has high rainfall and abundant surface water supplies, but groundwater

is also widely used for both rural and urban supplies.

□

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Compilers

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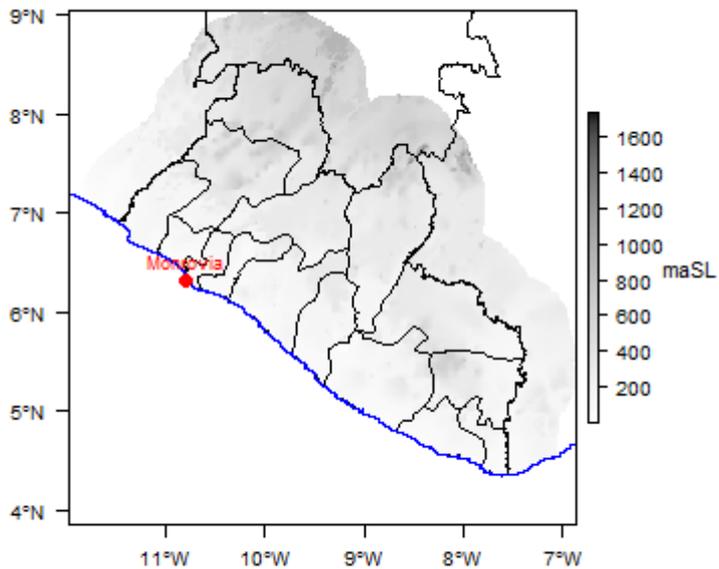
Please cite this page as: Upton, Ó Dochartaigh and Bellwood-Howard, 2018.

Bibliographic reference: Upton K, Ó Dochartaigh BÉ and Bellwood-Howard, I. 2018. Africa Groundwater Atlas: Hydrogeology of Liberia. British Geological Survey. Accessed [date you accessed the information]. http://earthwise.bgs.ac.uk/index.php/Hydrogeology_of_Liberia

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Geographical Setting



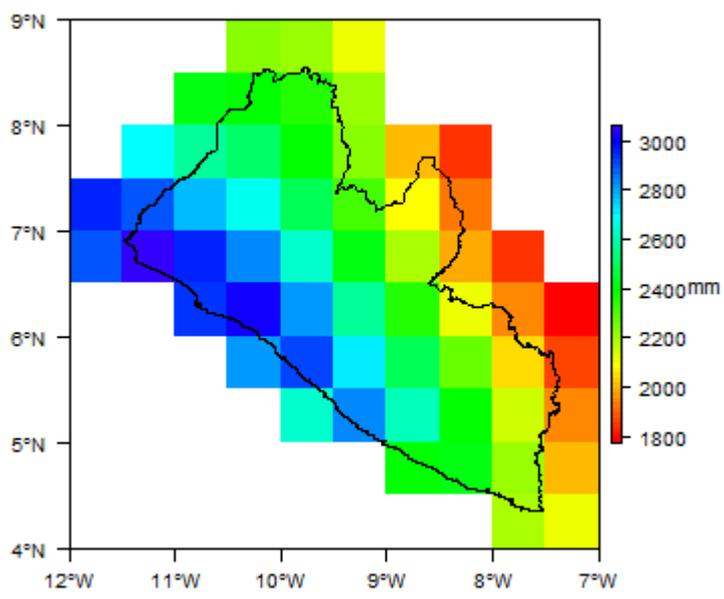
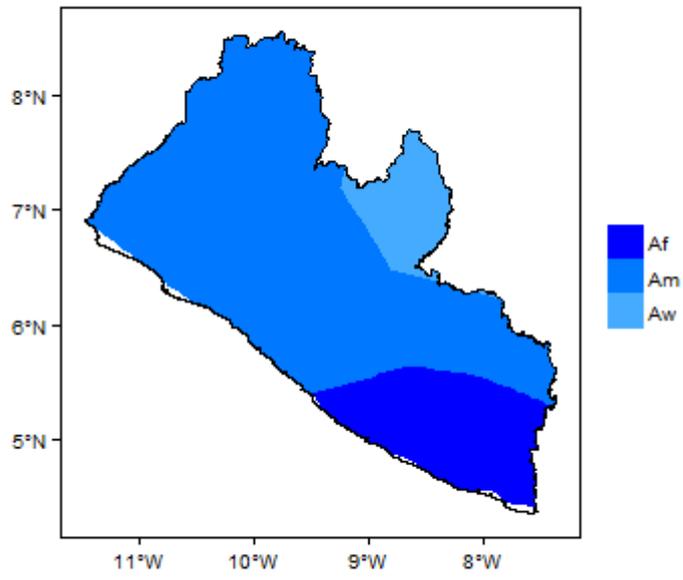
Liberia. Map developed from USGS GTOPOPO30; GADM global administrative areas; and UN Revision of World Urbanization Prospects. For more information on the map development and datasets see the [geography resource page](#).

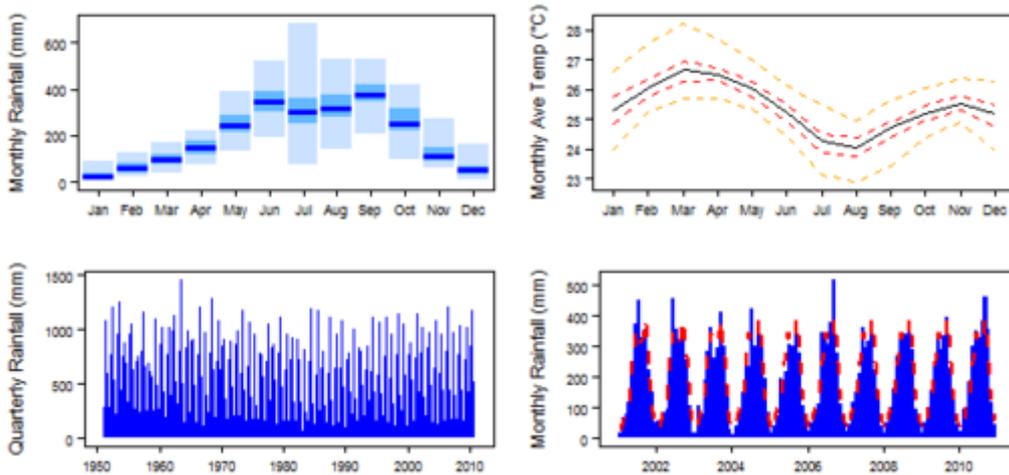
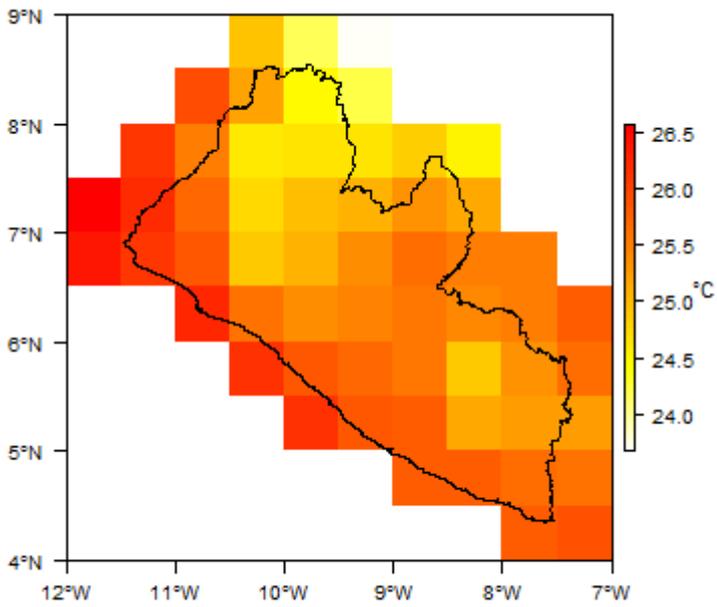
General

Capital city	Monrovia
Region	West Africa
Border countries	Sierra Leone, Guinea, Cote d'Ivoire
Total surface area*	111,370 km ² (11,137 ha)
Total population (2015)*	4,503,000
Rural population (2015)*	2,265,000 (50%)
Urban population (2015)*	2,238,000 (50%)
UN Human Development Index (HDI) [highest = 1] (2014)*	0.4297

* Source: [FAO Aquastat](#)

Climate



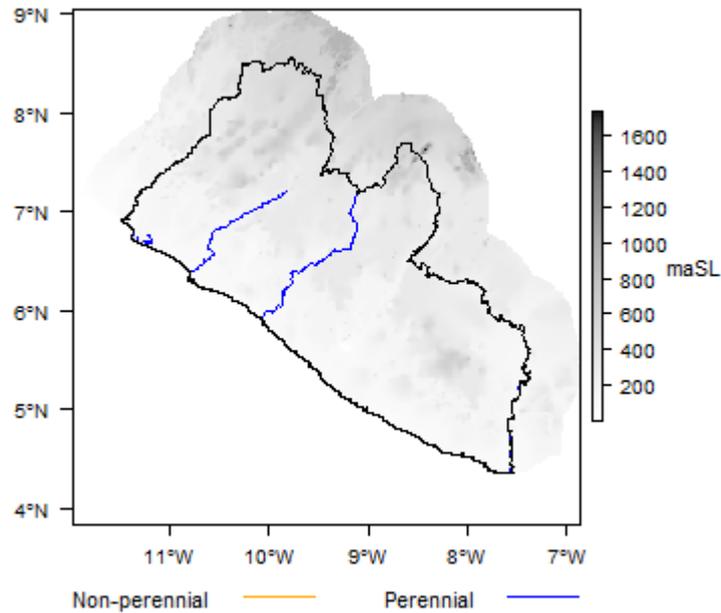


More information on average rainfall and temperature for each of the climate zones in Liberia can be seen at the [Liberia climate page](#).

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](#).

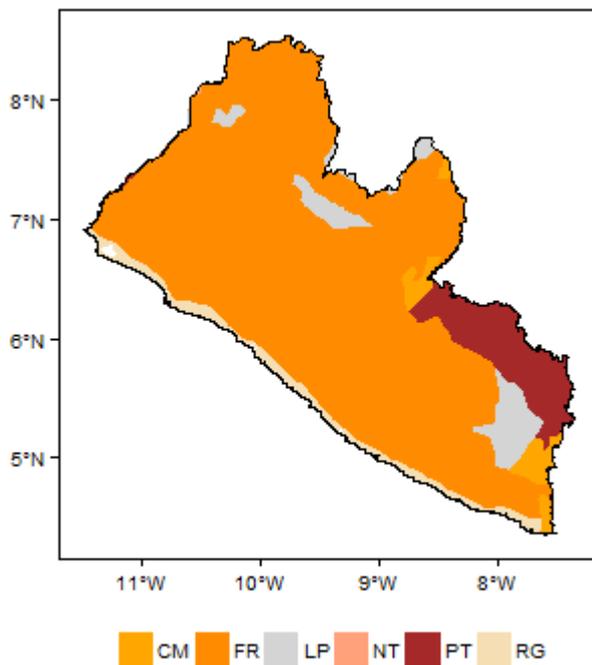
Surface water

Liberia has a number of major river systems originating in neighbouring countries and flowing generally from northeast to northwest, which drain the vast majority of the country. There are also a number of short rivers in the coastal zone that flow directly into the sea.



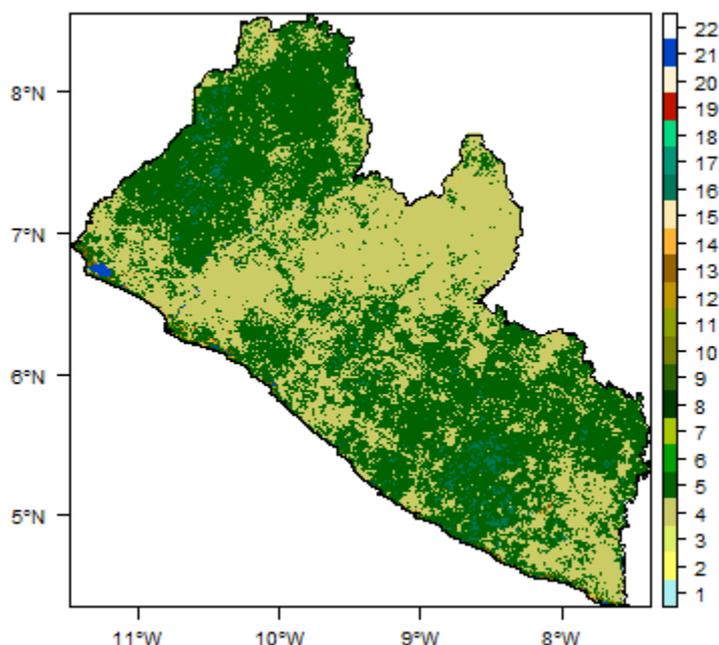
Major surface water features of Liberia. Map developed from World Wildlife Fund HydroSHEDS; Digital Chart of the World drainage; and FAO Inland Water Bodies. For more information on the map development and datasets see the [surface water resource page](#).

Soil



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

Land cover



Land Cover Map of Liberia, from the European Space Agency GlobCover 2.3, 2009. For more information on the map see the [land cover resource page](#).

Water statistics

	2000	2005	2014	2015
Rural population with access to safe drinking water (%)				62.6
Urban population with access to safe drinking water (%)				88.6
Population affected by water related disease	No data	No data	No data	No data
Total internal renewable water resources (cubic metres/inhabitant/year)			44,415	
Total exploitable water resources (Million cubic metres/year)	No data	No data	No data	No data
Freshwater withdrawal as % of total renewable water resources	0.0564			
Total renewable groundwater (Million cubic metres/year)			45,000	
Exploitable: Regular renewable groundwater (Million cubic metres/year)	No data	No data	No data	No data
Groundwater produced internally (Million cubic metres/year)			45,000	
Fresh groundwater withdrawal (primary and secondary) (Million cubic metres/year)	No data	No data	No data	No data
Groundwater: entering the country (total) (Million cubic metres/year)				
Groundwater: leaving the country to other countries (total) (Million cubic metres/year)				
Industrial water withdrawal (all water sources) (Million cubic metres/year)		53.4		
Municipal water withdrawal (all water sources) (Million cubic metres/year)		80.2		

Agricultural water withdrawal (all water sources) (Million cubic metres/year)	12.3			
Irrigation water withdrawal (all water sources) ¹ (Million cubic metres/year)	12.3			
Irrigation water requirement (all water sources) ¹ (Million cubic metres/year)	No data	No data	No data	No data
Area of permanent crops (ha)			200,000	
Cultivated land (arable and permanent crops) (ha)			700,000	
Total area of country cultivated (%)			6.285	
Area equipped for irrigation by groundwater (ha)	No data	No data	No data	No data
Area equipped for irrigation by mixed surface water and groundwater (ha)	No data	No data	No data	No data

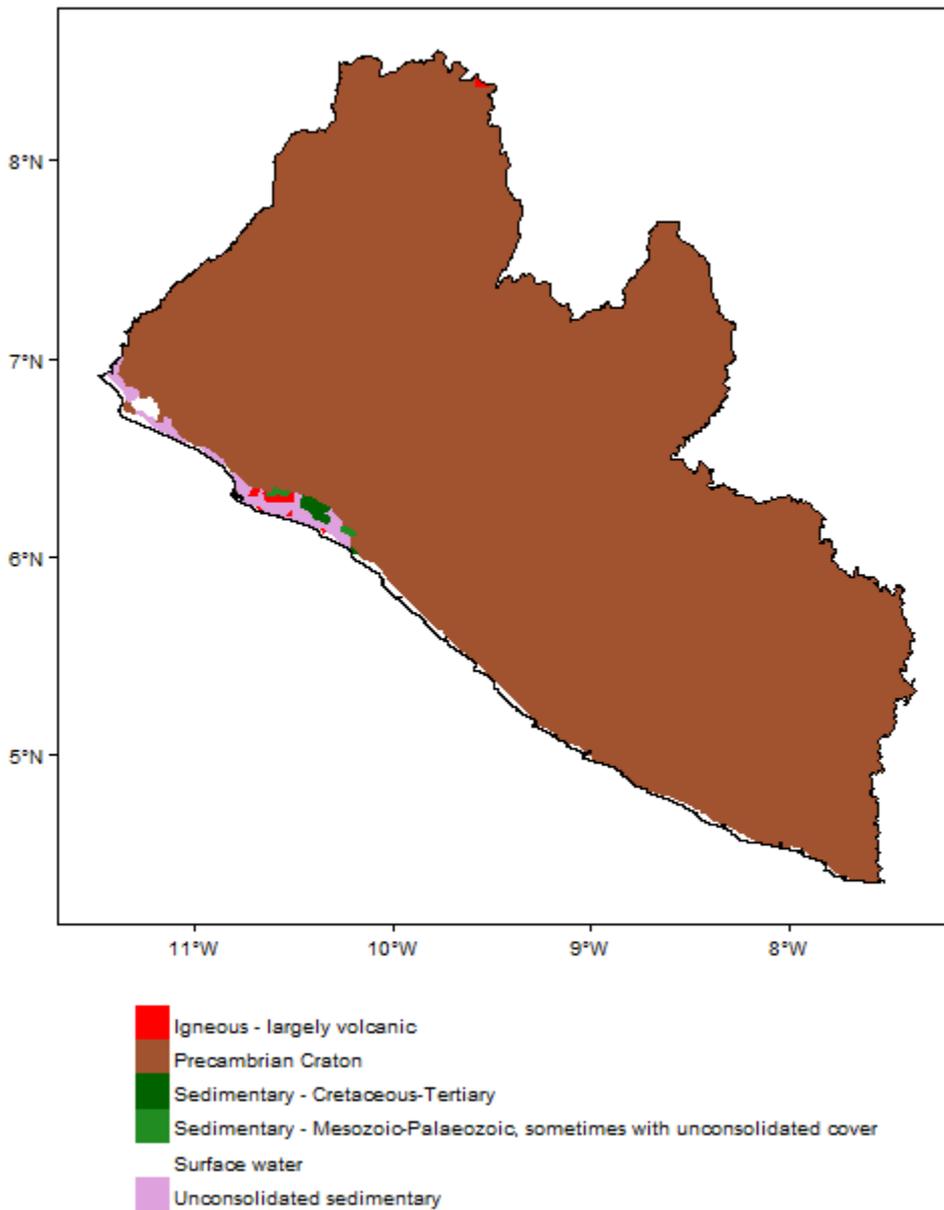
These statistics are sourced from [FAO Aquastat](#). They are the most recent available information in the Aquastat database. More information on the derivation and interpretation of these statistics can be seen on the FAO Aquastat website.

Further water and related statistics can be accessed at the [Aquastat Main Database](#).

¹ More information on [irrigation water use and requirement statistics](#)

Geology

The geology map on this page shows a simplified version of the geology at a national scale (see the [Geology resource page](#) for more details). More information is available in the report [UN \(1988\)](#) (see References section, below).



Geology of Liberia at 1:5 million scale. Based on map described by Persits et al. 2002/Furon and Lombard 1964. For more information on the map development and datasets see the [geology resource page](#).

Summary

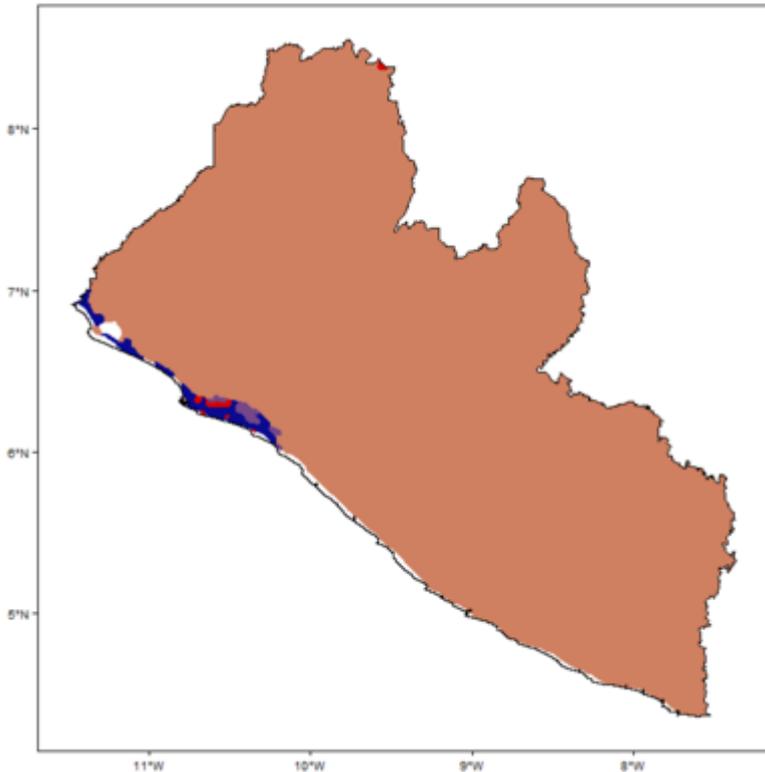
Almost all of Liberia is underlain by Precambrian (Archean and Lower Proterozoic) crystalline basement rocks, mostly granitic type. These form part of the West African Craton. Younger Phanerozoic rocks are only seen along a narrow coastal strip.

Period / Units	Lithology
	Quaternary Unconsolidated
Quaternary: Coastal and alluvial	Deltaic and other marine and coastal sediments are found along a narrow coastal strip. Significant outcrops and thicknesses of alluvial sediments are also found only along the coast, but minor, thin alluvial sediments may be present in river valleys inland.
	Sedimentary - Mixed Consolidated and Unconsolidated
Tertiary-Quaternary: Laterite	Much of the Precambrian basement is overlain by lateritic deposits, which can be up to 30 m thick (UN 1988).
Cretaceous (occasionally Devonian)	Sedimentary formations thought to be largely Cretaceous in age occur along a narrow coastal zone (often less than 5 km wide). These include sandstones, arkoses, siltstones and conglomerates (Schlüter 2006). In very small areas there may also be some older consolidated sedimentary rocks, possibly Devonian in age.
	Mesozoic Igneous
	Little is known of the igneous rocks in Liberia. They were reported to be of Jurassic age (UN 1988).
	Precambrian
	The Precambrian crystalline rocks consist mainly of an older series of metamorphic granulitic and migmatitic gneisses and amphibolites (schists) with subordinate granitoids. There are also remnants of slightly younger supracrustal rocks of sedimentary and volcanic origin, which are aligned predominantly in a SW-NE direction (Schlüter 2006).

Hydrogeology

The hydrogeology map below 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).

More information on the hydrogeology of Liberia is available in the report [United Nations \(1988\)](#) (see References section, below).



Hydrogeology of Liberia at 1:5 million scale. For more information on how the map was developed see the [hydrogeology map](#) resource page

Unconsolidated

Aquifer	Aquifer Productivity	Description
Quaternary coastal and alluvial sediments	Generally Moderate to High Productivity (variable)	Where these sediments are dominated by coarse sand and gravel, and are suitably thick, they will form productive local aquifers. In other areas, if the sediments are dominated by fine grained sand and silt, or clay, they will have low permeability and storage and will form less productive aquifers. In the most productive areas, it is probable that sustainable borehole yields of between about 0.5 and 3 litres/second (l/s) would be possible, and possibly higher.

Sedimentary - Mixed Intergranular and Fracture flow

Aquifer	Aquifer Productivity	Description
Laterite	Low Productivity	The laterite generally has low permeability (UN 1988).
Cretaceous (occasionally Devonian)	Low to Moderate Productivity	The coastal sandstones are likely to contain relatively small stores of groundwater. In an investigation by the Liberia Water and Sewer Corporation (LWSC) for new urban water supplies, boreholes were drilled to 100 m in the sandstones, and many provided a sustainable yield of 5 m ³ /hour (1.4 litres/second or l/s) (UN 1988).

Igneous

Aquifer	Aquifer Productivity	Description
Mesozoic Igneous Intrusive rocks - Unknown aquifer potential	Unknown	Very little is known of the aquifer characteristics of these rocks. They are likely to be crystalline with very low intergranular porosity and permeability, so that groundwater potential will depend largely on the degree and type of weathering and/or fracturing in the rocks. Groundwater is likely to be present mainly in the uppermost few tens of metres. Overall aquifer productivity is likely to be low.

Basement

Aquifer	Aquifer Productivity	Description
Precambrian	Low to Moderate Productivity	Groundwater in basement aquifers is found only in shallow weathered zones, and below this in fractures in the rock. Aquifer productivity and groundwater potential depend on the extensiveness of weathering and fracturing. Some information from aquifer tests is given in UN (1988): six boreholes in Buchanan town, between 80 and 100 m deep, gave specific capacity values of 0.25 to 2.60 m ³ /hour/m; and two boreholes in Zwedru town gave specific capacity values of 7.60 m ³ /hour/m (63 m deep) and 24.5 m ³ /hour/m (44 m deep). The higher yields are likely to be in areas with better developed weathering and fracturing, and may also be related to high recharge from abundant rainfall (UN 1988). The quality of groundwater from the boreholes in Buchanan and Zwedru was generally good. The pH was mostly neutral, except when boreholes drew water from the laterite cover (when pH was below 6). Specific conductivity values were less than 500 millimhos/cm; chloride concentrations were less than 100 mg/l; and combined iron and manganese concentrations were less than 0.3 mg/l (UN 1988).

Groundwater use and management

Groundwater use

In 1988, the UN reported that groundwater was used to supply five towns via urban distribution networks, three of which abstracted groundwater from 150 m deep boreholes and the other two from large diameter wells. Groundwater was also widely used in rural areas and small towns, usually from hand dug wells equipped with traditional equipment or modern hand pumps, and in some cases also from drilled boreholes. Many hand dug wells are dug into the laterite surface formations (UN 1988). Maintenance of handpumps was reported as a key problem in rural areas, often leading to abandonment of boreholes and wells (UN 1988).

In 1988 the UN reported that two mining companies use groundwater for their industrial use, but that very little groundwater was used in agriculture, mainly because of abundant rainfall. Groundwater was used to a limited extent in the dry season for nursery irrigation of commercial crops (e.g. oil palm, coffee and cocoa) (UN 1988).

Groundwater management

Water point databases exist with information on more than 3,000 hand dug wells and more than 600 boreholes in Liberia, although information for some parts of the country is not yet recorded. Most of this information was collated during the 2011 [Liberian Waterpoint mapping project](#). Most of the waterpoints recorded are groundwater sources - hand dug wells or boreholes, although only protected (improved) hand dug wells are recorded in the database. The waterpoint database does not contain much groundwater information: no geological log information is available for the groundwater sources, and most have no information on groundwater (rest/static) level. Some qualitative water quality information is available. The waterpoint database is available to view and download at the [WASH Liberia](#) website.

Transboundary aquifers

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

References

Other references with more information on the geology and hydrogeology of Liberia may be accessible through the [Africa Groundwater Literature Archive](#).

Schlüter T. 2006. [Geological Atlas of Africa](#). Springer Berlin Heidelberg New York.

United Nations. 1988. [Groundwater in North and West Africa: Liberia](#). United Nations Department of Technical Cooperation for Development and Economic Commission for Africa.

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