October 7, 2024

J. Robert Oppenheimer on freedom and scientific inquiry

News and notes

Before going on to discuss the geology and geopolitics of Gambia, here are some news items I thought were interesting.

Geopolitics

- Israel bombs Lebanon, Gaza ahead of one-year anniversary of Oct. 7 attacks; Israel Launches Ground Invasion Of Lebanon: Operation Northern Arrows; Video commentary: Israel invades Lebanon.
- Iran's Oil Tankers Flee Biggest Export Terminal Fearing Israeli Attack.
- People flee to gold when they get the geopolitical jitters: Gold Overtakes Euro to Become Second-Largest Central Bank Reserve Asset; related: Gold repatriation shifting from north to south.
- New alliances: Turkey And Egypt To Move From Enmity To Friendship.
- Hurricane Helene barrelled through a crucial chip mining area in North Carolina; related: The world's semiconductor industry hinges on a single quartz factory in North Carolina.
- Austrian hard-right party WINS 'earthquake' election after pledging to close borders and end support for Ukraine: Leader called for 'non-ethnic Europeans' to be expelled.

Research and News

- Mineralogy and Geochemistry of Listvenite-Hosted Ni–Fe Sulfide Paragenesis – A Case Study from Janjevo and Melenica Listvenite Occurrences (Kosovo).
- Mass extinctions, geochemistry, and climate change: Diachronous end-Permian terrestrial crises in North and South China.
- Chemical warfare in the Archean and banded iron formations: Inhibition of phototrophic iron oxidation by nitric oxide in ferruginous environments; Phys.org summary here.
- Earth shattering kaboom: 3D anatomy of the Cretaceous–Paleogene age Nadir Crater; Phys.org summary here.
- Karst topography in Australia: Ironing out complexities in karst chronology: (U-Th)/He ferricrete ages reveal wet MIS 5c; related article in The Conversation.
- Petrology: Basalts record a limited extent of mantle depletion: cause and chemical geodynamic implications.
- Detrital zircons from the Jack Hills, Australia: Evidence for oceans pre-4300 Ma confirmed by preserved igneous compositions in Hadean zircon.

- A new issue of *New Mexico Geology* is available for free download here.
- The October 2024 issue of GSA Today is here.
- Folklore isn't science: Efforts growing to 'braid Indigenous knowledge' into science, UChicago biologist warns.
- Olivine alteration and the loss of Mars' early atmospheric carbon; h/t Ken M.
- Criminalizing Science Fraud; if you steal money by deception, it's fraud.
- Ooh, shiny: World-class amethyst-agate geodes from Los Catalanes, Northern Uruguay: genetic implications from fluid inclusions and stable isotopes; Phys.org summary here.

Sedimentology

- Wave-Influenced Delta Morphodynamics, Long-Term Sediment Bypass and Trapping Controlled by Relative Magnitudes of Riverine and Wave-Driven Sediment Transport.
- Evolution and architecture of an exhumed ocean-facing coarse-grained submarine canyon fill, Baja California, Mexico.
- Towards a new generation of fluvial facies models for the interpretation of ancient deposits, based on inter-annual peak discharge variance of modern rivers.
- Turbidites: Response of submarine braided channels to varying inflow hydrographs: Geomorphic experiments and stratigraphic implications.

Plate Tectonics

- Transition From Reverse to Left-Slip on the Eastern Haiyuan Fault, NE Tibetan Plateau, From the Structure and Age of the Ganyanchi Pull-Apart Basin.
- Relationships Between Upper-Plate Structure, Mantle Wedge Melting, and Fore-Arc Sliver Transport in the Nicaraguan Subduction Zone.
- Video: Recognising basin inversion.... by sketch restoration.
- Erosion, isostacy, and plate tectonics: Recent uplift of Chomolungma enhanced by river drainage piracy; SciTechDaily summary here.
- Mesozoic intraoceanic subduction shaped the lower mantle beneath the East Pacific Rise; Phys.org summary here.
- Detrital K-feldspar as a novel archive of continental crustal evolution using coupled *in situ* Rb-Sr dating and Pb isotope analysis.

Paleontology

- The discovery of a fossil whitefly from Lower Lusatia (Germany) presents a challenge to current ideas about Baltic amber.

- Sauropod tail clubs from the Kota Formation (Lower to Middle Jurassic) of India and their implications for early sauropod evolution; Phys.org summary here.
- Studying recent fossils: Human-driven breakdown of predator–prey interactions in the northern Adriatic Sea; Phys.org summary here.
- They all floated in the cretaceous: new rebbachisaurid (Sauropoda, Diplodocoidea) with a highly pneumatized skeleton from the Upper Cretaceous (lower Cenomanian) of Patagonia, Argentina; SciNews summary here.

Mining and Energy

- Burkina Faso plans to withdraw some mining permits, junta leader says .
- Oil Prices Set for a Strong Weekly Gain as Middle East Conflict Escalates.
- Apache Tribe takes fight against Resolution Copper to US Supreme Court.
- Ghanaians call on government to shut down all illegal gold mines.
- Antimony: Why Resurrecting An Old Gold Mine In Idaho Is A Matter Of National Security.
- Rio Tinto: Diavik diamond mine moves into commercial production underground; and Green Lithium to develop Europe's lithium supply chain.
- U.S. Administration Buys 6 Million Barrels of Crude for SPR.
- Lomiko's Quebec graphite project faces uphill battle in cottage country.
- Rumors of New Saudi Oil Price Target Are Warning to OPEC Cut Violators.
- Analysts Cut Oil Price Forecasts for Fifth Month in a Row.
- 3 Stocks To Play The Nuclear Renaissance.
- US breakthrough in sodium-ion batteries: New method enables 400 cycles.
- Saskatchewan: Canada opens critical minerals hub, challenging China's dominance and to built in Saskatchewan by Westinghouse: US firm's milestone 5MW nuclear microreactor ready for 2026 testing; Westinghouse is partly owned by Cameco, based in Saskatoon.

Environmental Geology and Hydrogeology

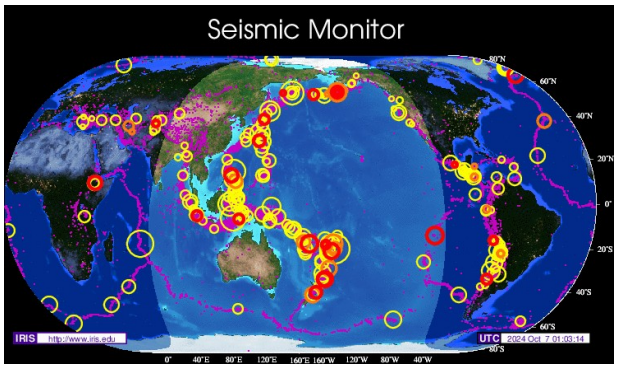
- Fluoride in drinking water poses enough risk to merit new EPA action, judge says; General Jack D. Ripper's opinion here.
- Managing waste water from oil production: What Tips the Balance in the Permian?
- Video from the Michigan Geological Survey: Introduction to Carbon Capture Utilization and Storage with Dr. Autumn Haagsma.
- New you can use in SE USA: Responding to Flooded Wells.

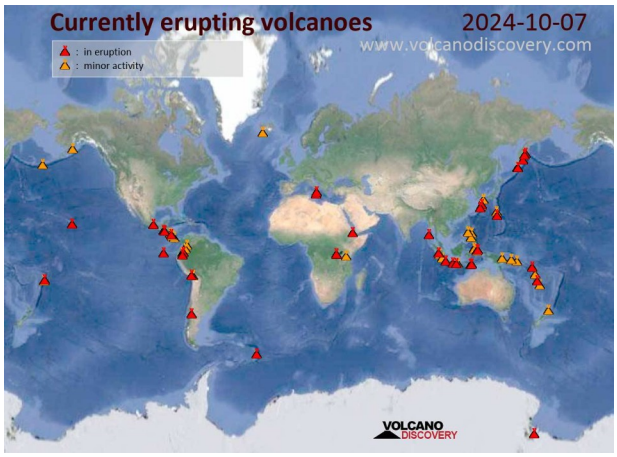
- Most soft plastic collected for recycling is burned, campaigners say.
- Remediation: Removal of per- and polyfluoroalkyl substances (PFAS) from wastewater using the hydrodynamic cavitation on a chip concept; Phys.org summary here.

Glaciers and Climate Change

- Sustained greening of the Antarctic Peninsula observed from satellites.
- Early Pleistocene glacier ice preserved in permafrost in the eastern Canadian Arctic.
- Why the most climate-resistant glaciers are hiding in plain sight.
- Periglacial landscape: Osmosis Drives Explosions and Methane Release in Siberian Permafrost; AGU summary here.
- Rising Extreme Meltwater Trends in Greenland Ice Sheet (1950–2022): Surface Energy Balance and Large-Scale Circulation Changes; SciTechDaily summary here.

Volcanoes, Earthquakes and Geohazards





Seismic Monitor **Active Volcano Map**

Volcanoes

- United States Geological Survey (USGS) Volcano Watch: First light (and flight) for HVO's new airborne lidar system.
- USGS Yellowstone Volcano Observatory: The history and importance of airborne thermal infrared imaging in Yellowstone National Park; Video: Biscuit Basin Hydrothermal Explosion Update (Yellowstone Monthly Update – October 2024).
- Smithsonian / USGS Weekly Volcanic Activity Report.
- Santorini Volcanic Complex (SVC): How Much Has the Crustal Velocity Structure Changed since the 2011–2012 Unrest, and at What Point Are We Now?

- Observing the SO_2 and Sulfate Aerosol Plumes From the 2022 Hunga Eruption With the Infrared Atmospheric Sounding Interferometer (IASI).
- Mt. Adams: Record spike in earthquakes at Washington's 'high threat' volcano sends researchers scrambling for answers; related video: Volcano in Washington Experiences More Quakes: Geologist Analysis; USGS report from the Cascades Volcano Observatory here.
- Philippines: Taal Volcano Eruption Update; New Eruption Occurs, Pyroclastic Flows Generated.
- Iceland: The chance of a shield eruption seems to be increasing.
- A Composite Seismic Source Model for the First Major Event During the 2022 Hunga (Tonga) Volcanic Eruption; Phys.org summary here.

Earthquakes and Tsunami

- Euro-Mediterranean Seismological Centre
- Earthquakes Monitoring Live Worldwide.
- Nearshore Propagation and Amplification of the Tsunami Following the 2024 Noto Peninsula Earthquake, Japan.
- Historic tsunami: Possible Indication of the Impact of the Storegga Slide Tsunami on the German North Sea Coast around 8150 cal BP.
- Closer look at New Jersey earthquake rupture could explain shaking reports; related papers here and here; USGS report here.

Other Geohazards

- There are lots of news items on the devastation inflicted upon the SE United States by Hurricane Helene, I thought that this article just about summed it up.

Upcoming Events

- October 19, IAEG Logging Course – 2024, Lisheen, Ireland.
- Central Canada Mineral Exploration Convention (CCMEC), Winnipeg, November 4 & 5
- GeoFutures: Planetary Geoscience Conference, 14-15 November 2024, hybrid meeting.
- The Saskatchewan Geological Open House, December 2 to 4, Delta Bessborough Hotel, Saskatoon; the Bessborough Hotel is the most beautiful building in Saskatoon.
- Groundwater Week 2024, December 10-12 in Las Vegas, Nevada.
- Copper to the World Conference, Tuesday 26 – Wednesday 27 August 2025, in Adelaide, Australia; report on 2024 conference here.
- 2024-2025 Society of Petroleum Engineers Distinguished Lecturer Schedule.
- List of geoscience events in 2025 from the International Union of Geological Sciences.

October 7, 2024

Geology and the Fate of Societies – The Gambia

Figure 1a – The Gambia
Credit: CIA World Factbook, public domain

Figure 1b – Location Map
Credit: CIA World Factbook, public domain

A former British colony centred on and named after the Gambia River, the Republic of The Gambia is located in West Africa and is completely surrounded by Senegal, except for its outlet on the Atlantic Ocean. The Gambia is a Unitary presidential republic; the President is Adama Barrow and the Vice President is Muhammad B.S. Jallow. The legislature is called the National Assembly, and the Speaker of the National Assembly is Fabakary Tombong Jatta. The Chief Justice of the Supreme Court of the Gambia is Hassan Bubacar Jallow. The Capital City is Banjul (pop. 31301) and largest metropolitan area in the Gambia is Serekunda (pop. 382,096).

The Gambia is the smallest country in Africa by area. According to the Central Intelligence Agency (CIA) World Factbook on Gambia, the total area of the country is 11,300 square kilometres (km^2), of which 10,120 km^2 is land and 1,180 km^2 is water. Also, according to the CIA World Factbook, 2,523,327 people live in Gambia, most along the Gambia River. The Gambia has a wide variety of ethnic groups, the percentage breakdown is: 34.4% Mandinka, 24.1% Fula, 14.8% Wolof, 10.5% Jola, 8.2% Soninke, 3.1% Serer, 1.9% Manjago, 1.3% Bambara, 0.5% Aku, and 1.5% other. English is the official language, the languages of the ethnic groups are also recognized as national languages. In terms of religion, most, 96.4%, Gambians are Moslem. Of the remainder, 3.5% are Christian, and the remaining 0.1% are something other. As far as education is concerned, only 58.1% of the population age 15 and over can read and write. Economically, the per capita GDP of The Gambia is $2,837, the Gini coefficient of inequality is 35.9, indicating medium inequality, and the Human Development Index (HDI) is low at 0.495.

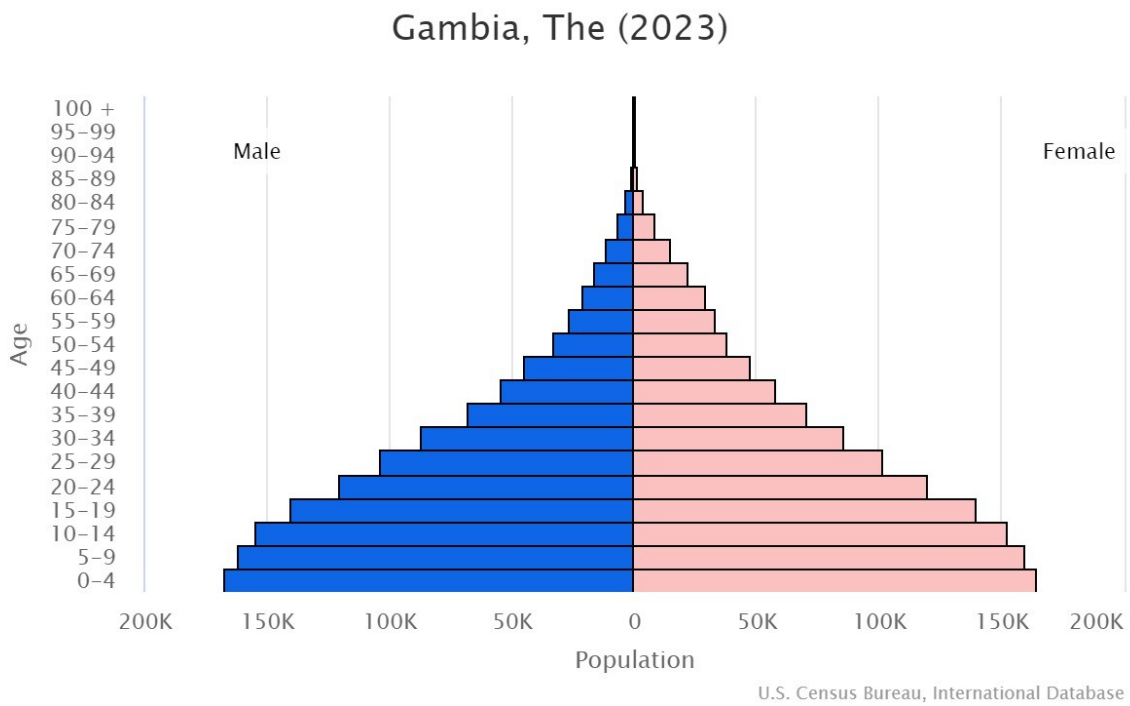
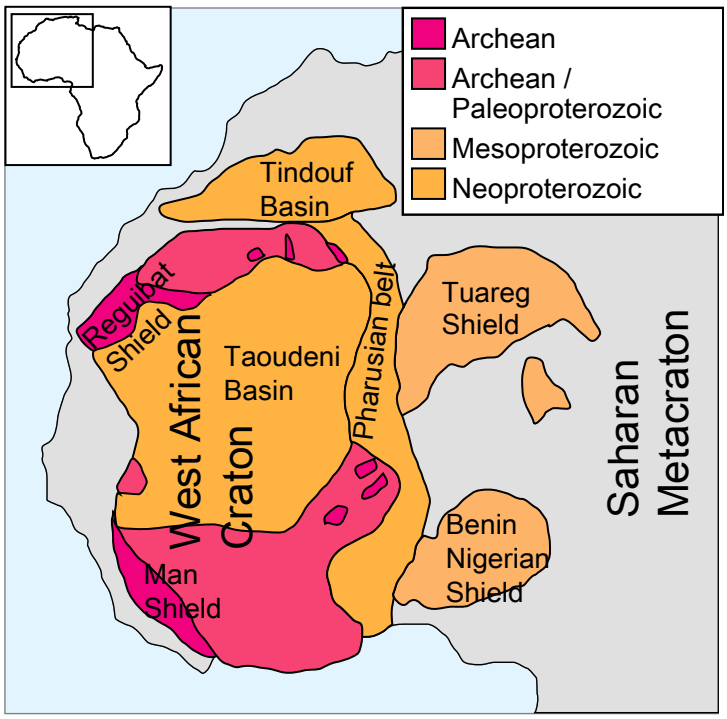


Figure 2 – Demographics of The Gambia
Credit: U.S. Census Bureau, International Database, public domain

The Gambia is a young country, where the median age is 20.2 years and 38.2% of the population is under 15. Total fertility rate is 3.66 births per woman, the annual growth rate is 2.2%, and the life expectancy at birth, for both sexes is 68 years.

Geology



Tectonically, The Gambia sits on the West African Craton; a part of the African Plate. The basement rock that underlies The Gambia is Precambrian in age but does not outcrop within the country and is not well understood.

Overlying the basement rock in The Gambia is a thick, ~1,000 m, sequence of sedimentary rock and unconsolidated deposits ranging in age from Holocene, near the surface to Cretaceous aged rocks at the bottom of the sequence. The details of the deposits are as follows:

Figure 3 – West African Craton
Credit: Aymatth2, public domain

At and near the surface are unconsolidated deposits, Quaternary and Pliocene in age and consisting of:

- ~20 m of Holocene aeolian sands/silts and alluvial clays; overlying
- ~20 m of Pleistocene sandy clays; and in turn overlying
- ~30 m of Pliocene fine-medium grained sands which contain varying amounts of silt, clay and laterites.

Underlying the unconsolidated deposits near the surface are the loosely consolidated deposits of the Senegal-Mauritanian Sedimentary Basin ranging in age from Miocene to Cretaceous and consisting of various of fluvial, lacustrine, and marine sediments. These sediments were deposited in the basin following the breakup of Gondwana. Going from top to bottom, the Senegal-Mauritian Basin deposits consist of:

- ~180 m of Neogene and Paleogene sediments including, from top down: Miocene aged shales and fine marly sands with subordinate limestones, some Oligocene aged marly limestones, Eocene aged shales and marly limestones with bands of flint near the base, and Paleocene aged limestones interbedded with dark grey marls;
- Next in the sequence is ~200 m of fine to coarse grained sandstones, with subordinate grey-black shales, phosphatic nodules and lignite bands, Maastrichtian in age; and
- At the bottom of the sequence, ~500 m of Campanian aged grey clays and marls interbedded with fine calcareous sandstones, dolomitic limestones, and lignite bands.

Resources

Agriculture

Figure 4 – Women Planting Rice in The Gambia
Credit: Sheena, public domain

According to the CIA World Factbook, 56.1% of the land in The Gambia is agricultural land (41% arable land, 0.5% permanent crops, 14.6% permanent pasture). The remaining 43.9% is forest. Agriculture contributes 24.6% of the country's GDP and employs about 75% of the labour force. 70% of the agricultural labour force are women, tending crops being considered "women's work". Much of the agriculture in The Gambia is subsistence farming.

Major crops in Gambia include: peanuts, dairy products, rice, millet, oil palm fruit, maize, cassava, mangoes, sorghum, and cashews. Rice and maize are the main cereal crops. Livestock raised in The Gambia include: cattle, sheep, goats, poultry, and, unusually for a predominately Muslim country, pigs. Statistics for agricultural production from the United Nations Food and Agriculture Organization (FAO) can be found here.

Food insecurity is a serious concern in The Gambia, according to the FAO, 59% of the population suffered moderate to severe food insecurity in the years 2021-23. For 2024, the FAO projects that about 227,000 people will be acutely food insecure during the 2024 lean season. Local farms only produce enough to meet about half the food requirements of the country. In general, agriculture is an underdeveloped resource in The Gambia.

Another underdeveloped resource in The Gambia is the fishery; the country salt and fresh waters have abundant and diverse resources and includes one of the richest fishing zones of the world in the neighbouring Atlantic continental shelf. Species presents include pelagic and demersal fish, as well as crustaceans and shellfish. Annual catch is about 45,000 million tonnes(MT) and some believe that could be increased to between 65,000 and 75,000 MT.

Forestry

Figure 5 – Makasutu Forest, The Gambia
Credit: Mark Hodson Photos, Creative Commons Attribution 2.0 Generic license

As noted in the CIA World Factbook, 43.9% of the country is forest. The Gambia is lies at the western extreme of the Sudanian savanna. The different types of natural ecosystems include: close woodland,

open woodland, tree and shrubs savanna, and wetland ecosystems. Typical trees found in The Gambia include mangroves, *Cordyla pinnata*, *Parkia biglobosa*, *Pterocarpus erinaceas*, *Adansonia digitata*, *Borassus aethiopum*, *Khaya senegalensis*, *Ziziphus mauritania*, *Spondias mumbin*, *Tamarindus indica*, *Vitex doniana* and *Cola cordifolia*. A common tree gown on plantations is *Gmelina aborea*. Statistics on forestry production in Gambia can be found here.

Minerals

Figure 6 – Zircon Sand
Credit: USGS, public domain

According to the USGS Minerals Yearbook, mineral production in The Gambia includes: clay, ilmenite, laterite, silica sand, and zircon. However, the report from the USGS indicates that there is not enough available information to adequately estimate mineral output or to determine the mineral sector's contribution to the economy. According to the AZO Mining site, mineral commodities production in 2010 was 174,000 million tonnes (MT) of laterite; 69.9 million MT of ilmenite; and 1.12 MT of silica sand.

With regards to oil and gas, there is no current production, although exploration efforts are underway offshore and are expected to continue into 2025. Australian based FAR Limited, which is also exploring offshore Senegal, has conducted most of the exploration offshore Gambia. There appears to lots of potential, it will be interesting to see what is found.

Climate

The Gambia has a tropical savannah climate with a hot, rainy season (June to November) and a cooler, dry season (November to May).

If you plan to visit The Gambia, note that the travel advisories for The Gambia (here and here) suggest that you exercise a high degree of caution due to crime such as theft, pick pocketing, and the like. If you still want to go, check out Climates to Travel and Lonely Planet.

History and Geopolitics

History

Figure 7 – Wassu Stone Circle, Gambia
Credit: Niels Broekzitter, Creative Commons Attribution 2.0 Generic license

Little is known about the earliest inhabitants of Gambia, although people have been living in the area since Paleolithic times. An early advanced culture left the Senegambian stone circles, such as the Wassu Stone Circle in Figure 7, above. The building of the stone circles began sometime around the 3rd century BC and the 16th century AD, into the era of the earliest state level organizations.

In the 10th Century AD, Muslim merchants established some of earliest large settlements in The Gambia for the trans-Saharan trade. They brought with them Islam, the dominant religion in The Gambia. They also bought kidnapped locals and sold them, together with gold, and ivory, in the trans-Sahara slave trade. The earliest state-level polity in the region of the Gambia River was the Mali Empire, which established rule over the region in the 13th Century AD. In the 16th century, the region came to be ruled by the Songhai Empire. (Check out Paul Cooper's podcast on the Songhai Empire.)

Between the 16th and 17th centuries, European colonial powers. beginning with the Portuguese and later the French and the United Kingdom (UK), began to trade in The Gambia, building on the trade systems first established by the Muslims. In 1664, the United Kingdom established a colony in The Gambia focused on exporting slaves in the Atlantic Slave Trade. During the roughly 300 years of the Atlantic Slave Trade, the UK and other European powers may have exported as many as 3 million people from The Gambia until the British Empire abolished slavery within its realm 1833. From 1821 to 1965, Gambia the UK administered The Gambia as the Gambia Colony and Protectorate.

The Gambia gained its independence from the UK in 1965. Between 1982 and 1989 Gambia and Senegal formed the short-lived confederation of Senegambia, but it didn't work out.

In the post-colonial era, The Gambia has a history of unstable government with unsuccessful military coup d'état in 1981, 2014, and 2022 and a successful one in 1994. In that year, Yahya Jammeh led a successful military coup overthrowing the president and banning political activity. He subsequently won every presidential election until December 2016, when he lost to Adama Barrow. Jammeh was unwilling to concede defeat, and in 2017, an armed intervention by members of the Economic Community of West African States (ECOWAS) enforced the results of the election. Barrow won reelection in 2021 and remains President to this day. The Gambia does not have presidential term limits, so Barrow could presumably remain in office for quite some time.

Geopolitics

Figure 8 – Senegalese WMA-301 near the Gambian border in 2017
Credit: Ricci Shryock/Voice of America, public domain

Internally, The Gambia problems include a poorly educated population, about half the people can't read and write, together with underdeveloped agriculture and mineral industries. As a result of these problems, the people live in desperate poverty with for most of the country's citizens having to worry where their next meal is coming from. Add to this desperate poverty is serious government corruption. The Gambia rates 98 out of 180 countries on Transparency International's Corruption Perceptions Index. Not quite at the bottom of the barrel, but not exactly a shining example of responsible government. They have a lot of work to do if they want to improve living conditions in their country. The Gambia also has problems with human rights abuses, also not a feature of good government.

In terms of its foreign relations, The Gambia's most pressing external challenge is to manage their relationship with Senegal. When ECOWAS intervened in 2017 to enforce the results of the 2016 Election, that intervention was through Senegal and Senegalese troops were in the forefront. The border between Senegal and Gambia has been in dispute since the dissolution of the of Senegambia Confederation in 1989. Fortunately, the parties are attempting to resolve the dispute by diplomatic means

and they appear to be close to resolving the issue. On a positive note, the two countries are pursuing economic cooperation.

Further afield, The Gambia is part of ECOWAS. For the people of The Gambia, this proved to be a positive benefit when their President attempted to ignore the result of an election and ECOWAS troops from Senegal, Nigeria, Ghana, Mali, and Togo. Nigeria is the elephant in the room here. As a rising power in Africa, it will have a strong influence on all the West African countries and ECOWAS will probably one their tools to extend that influence.

Also further afield, The Gambia has had an on again/off again relationship with the British Commonwealth, leaving the organization for 5 years prior to rejoining in 2018. Organizations like the Commonwealth act as conduits for diplomacy, increasing the chances of peaceful relations. Also, trade and aid often follow diplomatic relations.

Then there are Gambia's relationships with the Great Powers, the United States and China. The United States and Gambia currently have good diplomatic relations marked by favourable trade relations. The Chinese are also interested in having a good relationship with Gambia, as part of China's larger engagement with Africa. Gambia could leverage good relations with both Great Powers to its advantage, but it's a tricky game. You don't want to be in the middle when the relations between the Great Powers becomes kinetic.

That kind of wraps up this short look at The Gambia. I don't know what to make of its prospects for the future of The Gambia. They could remain trapped in a situation where most live in poverty and a few corrupt officials live high off the little surplus wealth that the country generates. On the other hand, a determined program to develop the country's resources, especially its people, could return huge benefits.

Standard Caveat