Climate Change Profile

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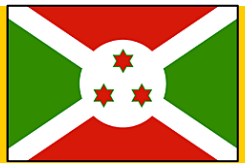
Rwanda



Burundi

General Climate

Rwanda and Burundi are landlocked countries in East Africa, just to the south of the Equator and bordered by Tanzania, Uganda and the Democratic Republic of Congo. The countries sit within the Great Rift Valley and this is reflected in their topography, altitude and general climate. The Albertine branch of the Rift Valley runs along the western borders of the countries, and therefore western regions are predominantly mountainous (and volcanic) with elevations of over 2000m. The altitude reduces towards the hills of the central plateau (1500 to 2000m) and again to the east, towards Tanzania, with savannahs and plains rather than hills and mountains (<1500m).

As a result of the high elevation, the climate of the two countries is temperate, and temperatures vary little between seasons (averaging approximately 21°C annually). There are regional differences, however, with colder temperatures towards the west (approx. 15°C) and warmer towards central plateau (approx. 18-20°C) the plains in the East (average of over 20°C) (RoR, 2005; RoB, 2007).

Both countries experience two rainy seasons (a 'bimodal' pattern) of March-April-May (MAM) and October-November-December (OND), with approximately a third of annual rainfall occurring in each of the seasons. Rainfall is highest in the western areas, experiencing approximately twice the rainfall of the lower plains to the east. The two wet seasons are driven by the movements of the Inter-Tropical Convergence Zone (ITCZ). The ITCZ is the point of convergence of easterly trade winds from the northern hemisphere (north-east trades) and the southern hemisphere (south-east trades) in a zone of low pressure (Godwin, 2005). During the course of a year, the ITCZ migrates between the northern and southern tropics, bringing rain to the countries over which it passes (Marchant *et al*., 2007).

Rainfall amounts are affected by climate phenomena, such as the El Niño-Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD) (Tierney *et al*., 2008). Warm ENSO events ('El Niños') and positive IOD events are associated with unusually wet conditions in the OND season, while the opposite cool phase of ENSO (La Niña) is associated with less OND rainfall.

Key climate vulnerabilities: Drought; flooding; infectious disease epidemics; food insecurity; landslides.

Current Climate Vulnerability

Tables 1 and 2 list the natural hazards that have affected Burundi and Rwanda over the past 20 years. Both countries suffer particularly from drought, flooding and associated disease epidemics. For Rwanda in particular, landslides are also a further hazard associated with flooding.

Drought is a hazard that affects the greatest number of both countries; in the drought of 2009 in Rwanda, for example, water rationing was implemented in major towns across the country in an effort to keep some supply in spite of a 22,000 cubic metre daily deficit (ReliefWeb, 2009). Lack of water supply can also then affect public health, as outbreaks of cholera and dysentery can occur when the lack of water forces people to use untreated water sources.

Failed rains have a major affect on livelihoods and food security as both countries rely heavily on agriculture. Insufficient rains in Burundi during the late rainy season in 2009 damaged the January harvests of maize and bean in 2010, leaving around 180,000 people short of food and resulted in many people travelling across the border to Rwanda in search of work and food (IRIN, 2010a). Food shortages also affect public health; in Burundi, for example, over 60 percent of the population are classed as food insecure, and the chronic malnutrition rate is over 50 percent (IRIN, 2011). The 2005-2006 drought in northern and eastern areas of Burundi resulted in 120 deaths in Muyinga, over 150 cases of malnutrition, and forced almost 4,000 children to miss school because of physical weakness (IRIN, 2006).

Flooding and landslides are also particularly damaging, causing loss of life, property, crops and livestock. Flooding in the western provinces of Rubavu and Nyabihu in Rwanda in March 2010, for example, killed four people and damaged houses and a hospital – requiring both the hospital and surrounding homes to be evacuated by the government (Mugabe, 2010). Flooding later in that same rainy season caused landslides that killed 11 people and swept away over 600 homes and 30 hectares of crops (Mugabe & Mukombozi, 2010). In western Burundi, flooding in late 2006 and early 2007 destroyed 50-80 percent of the November harvest and much of January harvest as well, putting 2 million people at risk from food shortages (BBC, 2007).

Hazard	Number of Events	Deaths	Total of Population Affected
Drought	5	126	3,062,500
Average per event		25	612,500
Epidemic (unspecified)	1	6	448
Average per event		6	448
Epidemic (bacterial)	9	411	30,393
Average per event		46	3,377
Epidemic (parasitic)	2	359	1,338,625
Average per event		180	669,313
Epidemic (viral)	1	-	8,000
Average per event		-	8,000
Flood (unspecified)	15	38	62,671
Average per event		3	4,178
Flood (flash)	4	10	18,200
Average per event		3	4,550
Storm	5	9	49,315
Average per event		2	9,863

Table 1 – Natural Hazards in Burundi (1990-2011) (CRED, 2011)

Hazard	Number of Events	Deaths	Total of Population Affected
Drought	6	237	4,156,545
Average per event		40	692,758
Epidemic (unspecified)	1	5	140
Average per event		5	140
Epidemic (bacterial)	11	317	7,259
Average per event		29	660
Flood (unspecified)	8	149	1,967,540
Average per event		19	245,943
Flood (flash)	1	10	-
Average per event		10	-
Landslide	3	45	7,937
Average per event		15	2,646

Table 2 – Natural Hazards in Rwanda (1990-2011) (CRED, 2011)

Climate Change Projections[1]

As Rwanda and Burundi are relatively small countries, the regional differences in temperature and precipitation change are not encompassed by the relatively coarse resolution of many climate models. The projections presented below for the two countries were encompassed by the modelling for Tanzania, and are limited to just four grid cells and hence should be treated with caution. See 'A note on the projections' at the end of this document for more information on these maps.

Temperature

- The mean annual temperature is projected to increase by 1.8 to 2.6°C by the 2060s, and 2.2 to 4.0°C by the 2090s, up to a maximum projection of 3.1°C and 4.9°C for the 2060s and 2090s respectively.
- Projected rates of warming are greatest in the JJAS season (June through to September), increasing by 2.3 to 4.4°C by the 2090s, with the maximum projection of 5.4°C.
- All projections indicate increases in the frequency of days and nights that are considered 'hot' in current climate.
- Annually, projections indicate that 'hot' days will occur on up to 63 percent of days by the 2060s, and up to 77 percent of days by the 2090s.
- All projections indicate decreases in the frequency of days and nights that are considered 'cold' in current climate. These events are expected to become exceedingly rare, and do not occur at all by the 2090s in any projections under some climate change scenarios.

Precipitation

- Projections of mean rainfall show increases in annual rainfall and in all seasons, with small increases in the two dry seasons of JF and JJAS and larger increases in the two rainy seasons of MAM and OND.
- Projections for MAM show an increase of 5 to 8 percent and 5 to 15 percent for the 2060s and 2090s respectively, with the upper end of projections showing maximum increases of up to 52 percent by the 2090s.
- For OND, the projections show slightly smaller increases, 3 to 6 percent by the 2060s and 6 to 8 percent by the 2090s. The upper end of the projections shows a maximum increase of up to 24 percent by the 2090s.
- The proportion of rainfall that falls in heavy events is projected to increase, from 5 to 8 percent in annual rainfall by the 2090s, to a maximum of 15 percent. These increases are largest in the MAM season, with increases of up to 19 percent by the 2090s.
- Maximum 1- and 5-day rainfall totals are projected to increase for annual and seasonal rainfall; by up to 27mm in 1-day events, and up to 41mm in 5-day events annually by the 2090s.

Climate Change Impacts

Flooding

The risk of flooding in both countries is likely to increase as a result as climate change projections show increases in both mean and extreme rainfall. Increases in rainfall are projected for both rainy seasons, including increases in heavy rainfall events and 1-day and 5-day totals. The implication for Burundi and Rwanda is an increasing risk of flood events as higher amounts of rainfall runoff and quantity of rainfall and runoff over short periods overwhelms river systems. In hilly areas, the added risk is that of landslides, which will increase

Water Resources

With projected increases in rainfall under climate change, water availability could increase for Burundi and Rwanda. However, variability in rainfall from year to year will result in droughts still occurring and the requirement for water resources to be managed to ensure that sufficient storage is in place to take advantage of rainfall increases. A potential increase in rainfall supply will have to be balanced by a potential increase in demand as a result of rising temperatures. With warmer conditions, the irrigation requirements in agriculture will increase, as will domestic demand for water. Climate change is therefore only one of many elements to the management of water resources.

[1] McSweeney, C. *et al.* (2008) unless otherwise stated

Agriculture & Food Security

Burundi and Rwanda suffer from food insecurity that is greatly affected by drought and flooding events and their affect on crop yields, the availability of staple foods and their process. With increases in extreme rainfall, the risk of flood damage to crops will increase; while droughts will still occur as a result of year-to-year variability in rainfall.

Principle food crops include beans, bananas, sweet potatoes, maize, cassava and sorghum (Ansoms & McKay, 2010). A study by Liu *et al*. (2008) found slight increases in crop yields of maize, cassava and sorghum for Rwanda and Burundi by the 2030s, with larger increases for millet but decreases for wheat. However, the paper concluded that because of wider pressures such as population growth, the overall situation for food security for the two countries is unlikely to improve (ibid).

For East Africa under climate change by 2050, yields of the staple crop maize are likely to increase for highland areas up to an average temperature of 18-20°C, whereas lowlands, semi-arid areas will see reductions in yield as average temperatures rise above 20°C (Thornton *et al*., 2009). This decrease is likely to be in response to increasing water stress (ibid). Although projections indicate an increase in rainfall (though these increases are smaller in semi-arid areas), benefits to soil moisture may be offset by increasing evapotranspiration as a result of warmer temperatures. There is also the increasing risk to the damage to crops and loss of livestock through heavy rainfall and flooding.

Public Health

Public health problems in Burundi and Rwanda are closely linked to extremes in rainfall, with lack of clean water and crop failures brought about by both much rainfall (flooding) and too little (drought). Cases of dysentery, for example, amount to tens of thousands per year in Burundi and a rise in cases coincides with the beginning of the late rains in October (Gayer *et al*., 2005). Transmission of disease increases as a result of migration and overcrowding (e.g. measles, meningitis and tuberculosis) – both often occur during and after drought or flooding incidences as many are forced to take temporary shelter in displacement camps. The risk of Cholera, for example, is highest in the first half of the year in Burundi, from the end of one rainy season and into the next; the northeastern provinces of Bururi (Rumonge), Bubanza, Cibitoke, Bujumbura Urbain and Bujumbura Rural are most at risk (ibid).

Insect-borne diseases are closely related to rainfall patterns, with outbreaks of malaria following periods of heavy rain, which provides standing water in which mosquitoes breed. With the projected increase in mean temperatures, the potential habitat for mosquitoes may move into highland areas that are currently not endemic for malaria. Increases in heavy rainfall events may also result in greater opportunities for mosquitoes to breed and hence increase disease incidence. In Burundi, for example, Malaria is the most common cause of illness and deaths, with 68 percent of the population at risk (ibid). Cases of malaria each year can amount to several million, and have increased in recent years with the expansion of irrigated agriculture, warmer temperatures and high rainfall (ibid).

Housing & Communities

Homes, schools and community buildings and infrastructure will be at increasing risk from flooding and landslides as a result of an increase in heavy rainfall events under climate change.

Biodiversity & Conservation

A wide variety of habitats are found in Rwanda and Burundi, including forests, savannahs, steppes, wetlands and lakes. These are home to important species such as, in Rwanda for example, mountain gorillas, 13 species of primates, 275 species of birds, elephants, hippopotamuses, crocodiles and turtles. Many areas of both countries are protected as national parks and Ramsar sites, though they are still under threat from floods, droughts, erosion, pests and diseases, as well as population growth, overexploitation, poaching and bush fires (RoR, 2003). Drought, for example, can also have an impact on wetlands as a result of competing demands for water. In Kigali, for example, the Mulindi wetland is the main source of water for around a million residents as well as being a source of irrigation water (ReliefWeb, 2009). During the drought in 2009, the public utility company, Electrogaz, initiated talks with local farmers to share water (ibid). Climate change is likely to make conservation activities more challenging through warmer temperatures and more extreme rainfall events.

Livelihoods

Livelihoods in both countries rely heavily on agriculture; in Rwanda, for example, it is the main source of income for around 87 percent of the population and accounts for around 47 percent of GDP (REMA, 2009). Coffee and tea are the most important crops for export, accounting for the majority of revenue earned; Arabica coffee in particular has become a sought after product from both countries (USAID, 2006). Livelihoods are therefore likely to be affected by climate change in much the same way as agriculture and

food security, with drought and crops lost to flooding both having a damaging effect on crop yields. In 2010, for example, forecasts for coffee production in both Rwanda and Burundi were revised downwards by 23 and 26 percent respectively as a result of reduced yields brought about by drought (Doya, 2010; Ojambo & Bigiramana, 2010). Coffee crops are also a risk from pests, such as the black beetle, *Hypothenemus hampei* (or 'Coffee Berry Borer'), which causes millions of dollars of damage to coffee producers worldwide – particularly in East Africa. Rising global temperatures may increase the populations of the beetle, expanding its habitat and putting wider areas of coffee crops in danger (Bosire, 2009).

Energy

For both Burundi and Rwanda the principle form of energy used is biomass, accounting – for example – of over 80 percent of all energy use in Rwanda, and over 98 percent of energy used for cooking (wood and charcoal) (Safari, 2010). Both countries have very low rates of electricity consumption; however, bring mountainous, there is substantial potential for using hydropower to increase supply.

With increasing rainfall under climate change, there may be more water available for energy generation, but this will depend heavily on capacity of hydropower installations, and how competing demands for water are managed.

Transport

Flooding and landslides can damage transport networks, cutting off communities and making it more difficult for emergency services and aid to reach them. With an increase in heavy rainfall events, transport infrastructure will be at a greater risk of damage from flooding and landslides.

Government Response

Both Burundi and Rwanda have published a First Communication on climate change to the UN Framework Convention on Climate Change (UNFCCC) and a National Adaptation Plan of Action (NAPA).

There has been a campaign by the Ministry for Infrastructure in Rwandan to reduce the amount of deforestation for firewood by 50 percent by promoting the use of biogas. In partnership with World Vision, the National Domestic Biogas Project aims to encourage biogas use in schools and prisons across the country (Mugisha, 2010). There is an overall government target of increasing forest cover by 30 percent by 2020 as part of the Forest Conservation Project (IPS, 2011).

The governments of both Burundi and Rwanda have signed the new accord for the River Nile riparian states, which aims to share the waters of the Nile more equitably across countries; included in the accord are two new hydropower dams for Burundi with the aim to produce 410 megawatts (Nduwinmana. 2011).

Others to add from Country Rep?

Likely Adaptation Options

The following are a selection of possible adaptation options for Burundi and Rwanda:

- Use of terracing on hillsides to allow a greater area to be cultivated agriculture and reduce the risk of erosion and landslides. This has been successful implemented in Cyungo in central Rwanda, increasing the area cultivated from 25 percent to 95 percent of available land and growing wheat, potatoes and fodder for cows in the process (WFP, 2010).
- Smart phones can be used to help provide information on food needs by allowing data to be collected easily and accurately. The World Food Programme has been using them in Burundi for a trial period and has collected information from households on their food needs (IRIN, 2010b). This can help in forecasting food security issues and provide a targeting response during shortages (Baddorf, 2010).
- Programmes of reforestation to prevent runoff and erosion during heavy rainfall, and reduce the risk of landslides.
- Set up information systems of hydro agrometeorologic early warning system and rapid intervention to reduce the exposure of the population and sectors at risk of extreme events and climate catastrophes (RoR, 2006).
- Improve the adaptation capacity of rural population vulnerable to climate change through the promotion of income generating non-agricultural activities (RoR, 2006).
- Reduce the pressure of woody combustible and hence reduce the overexploitation and degradation of forests through the promotion of energy sources alternative to firewood (RoR, 2006).
- 'Micro-insurance' for individual farmers who can insure their crops as and when they plant them.

- Provision of advice on land preparation and soil conservation, use of fertilisers, and suitable seed varieties for famers, as well as supporting farmers financially for fertilisers and irrigation schemes.
- Implementation of flood prevention schemes that increase water storage through small dams and rainwater harvesting, while reducing soil erosion and runoff through afforestation.

Useful Websites

- UNDP Climate Change Country Profiles: http://country-profiles.geog.ox.ac.uk/
- UNFCCC NAPAs from Non-Annex I Countries: http://unfccc.int/national_reports/napa/items/2719.php
- UNFCCC First Communications on Climate Change for Non-Annex I Countries: http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php
- Adaptation Learning Mechanism: http://www.adaptationlearning.net/
- IPCC Reports: http://www.ipcc.ch/publications_and_data/publications_and_data_reports.htm

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A note on the projections…

The climate change projections used in this profile were developed as part of a UNDP project, carried out by McSweeney *et al.* (2008), to produce a series of climate change projections for individual developing countries. The study uses a collection, or 'ensemble', of 15 General Circulation Model (GCM) runs to produce projections of climate change for three of the SRES emissions scenarios (see Nakićenović & Swart (2000) for more details on emission scenarios). The three emissions scenarios used in the study were 'A2', 'A1B' and 'B1', which can be broadly described as 'High', 'Medium' and 'Low' respectively (McSweeney *et al*., 2010).

The figures quoted here refer to the 'central estimates' (i.e. the median results) from the 15 GCMs across the 3 emissions scenarios. Where maximum figures are also quoted, they refer to the upper end of the model results for the 'High' (A2) scenario.

For a more detailed description of the UNDP Climate Change Country Profiles, please see McSweeney *et al*. (2010). Complete projections (with maps, plots, supporting text and data files) for all 52 countries are available to download via the website at http://country-profiles.geog.ox.ac.uk/.

Note: This profile is designed to give a brief, non-technical overview of the current and future climatic conditions of Rwanda and Burundi; this should not be considered as a country strategy. The key climate impacts are summarised by sector; however, this should not be taken as an exhaustive list, and the corresponding list of adaptation options are as a guide of likely or possible alternatives.

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