



# Water dynamics in the seven African countries of Dutch policy focus: Benin, Ghana, Kenya, Mali, Mozambique, Rwanda, South Sudan

## Report on Rwanda

Written by the African Studies Centre Leiden and  
Commissioned by VIA Water, Programme on water innovation in Africa

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## Water - Rwanda

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### Political geography of water

The Republic of Rwanda (Kinyarwanda: Repubulika y'u Rwanda; French: République du Rwanda), is a sovereign state in central east Africa. Located a few degrees south of the Equator, Rwanda is bordered by Uganda, Tanzania, Burundi, and the Democratic Republic of the Congo. The whole country is at a fairly high elevation, with a geography dominated by mountains in the west, savannah in the east, and numerous lakes throughout the country. The capital city Kigali is located in the Nyaborongo-Kagera river basin, as part of the upper headwaters of the Nile.

Most of Rwanda belongs to the headwaters of the Nile Basin; the only exception is the western part that is part of the Lake Kivu water basin (and of the Congo Drainage Basin). As the maps below indicate on the northern shore of Lake Kivu the Rwandan/DRC border town of Goma is located; on the southern shore Bukavu. The Rusizi River enters the Lake from the South, coming from Burundi and from Lake Tanganyika. The latter is estimated being the world's second largest freshwater lake. The Rwandan portion of the Nile waters is the Kagera River system, that forms the boundary between Rwanda and part of Burundi and the complete boundary between Rwanda and Tanzania. A few lakes are connected.

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<sup>1</sup> The report has been realized on the basis of short-term desk research and makes no claim of being definitive, complete or scientifically substantiated.

Figure 1 Map of Rwanda



Figure 2 Map of the Nile Basin

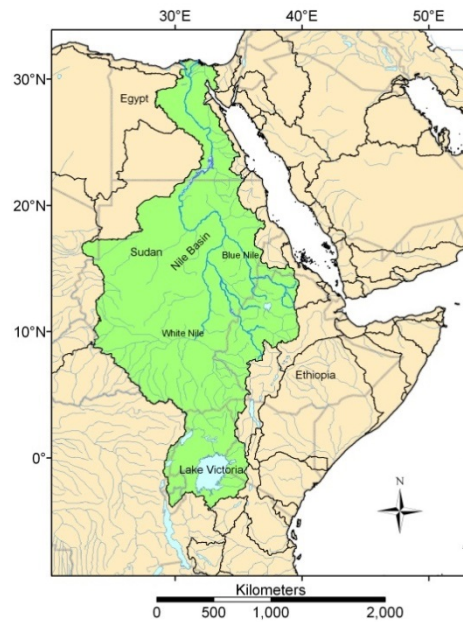


Figure 3 Satellite map of Rwanda



Figure 4 Relief location map



Source 1: <http://countryportal.ascleiden.nl/rwanda>

Source 2: [http://www.eeescience.utoledo.edu/Faculty/Becker/images/Nile\\_Basin.jpg](http://www.eeescience.utoledo.edu/Faculty/Becker/images/Nile_Basin.jpg)

Source 3: [http://upload.wikimedia.org/wikipedia/commons/thumb/d/d1/Rwanda\\_satellite\\_map.png/800px-Rwanda\\_satellite\\_map.png](http://upload.wikimedia.org/wikipedia/commons/thumb/d/d1/Rwanda_satellite_map.png/800px-Rwanda_satellite_map.png)

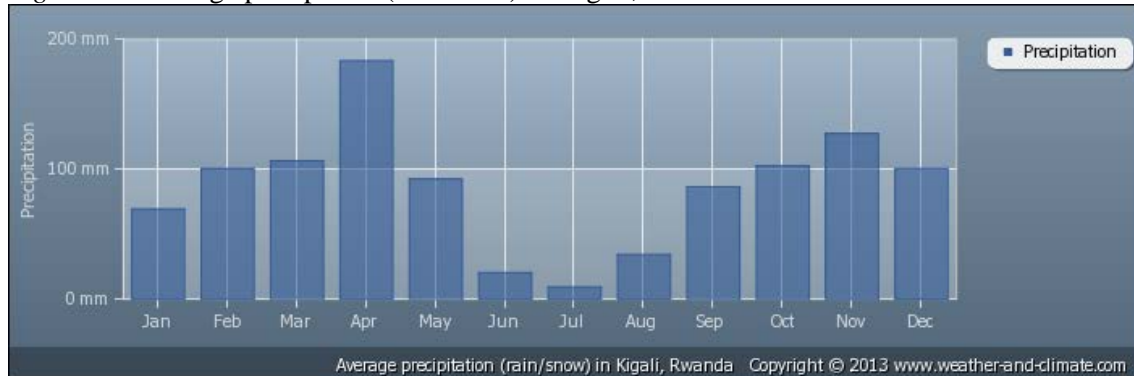
Source 4: [http://upload.wikimedia.org/wikipedia/commons/thumb/0/0a/Rwanda\\_relief\\_location\\_map.jpg/684px-Rwanda\\_relief\\_location\\_map.jpg](http://upload.wikimedia.org/wikipedia/commons/thumb/0/0a/Rwanda_relief_location_map.jpg/684px-Rwanda_relief_location_map.jpg)

Rwanda has a mountainous, humid climate, and very fertile soils, making it an ideal location for farming activities. However, as one of the most densely populated countries in Africa, Rwanda's food security is under constant pressure. To ensure sufficient food production and economic sustainability coherent policies on water-management and land reform practices become essential.

There are two rainy seasons: one with a peak in April and one with a (lower) peak in November. The climate is temperate to subtropical, with two rainy seasons and two dry seasons every year (Wikipedia-EN; see

<http://countryportal.ascleiden.nl/rwanda>). Despite the fact that rainfall is well distributed throughout the year, there exists spatial and temporal fluctuation (Pandey, 2014). For example, the northern and western provinces experience abundant rainfall, while simultaneously the eastern and southern provinces are heavily affected by extensive dry periods.

Figure 5 Average precipitation (rain/snow) in Kigali, Rwanda



Source: <http://www.weather-and-climate.com/uploads/average-rainfall-rwanda-kigali.png>

## Demographic situation: Population, urbanization, water consumption trends

Rwanda is Africa's most densely populated country. It has approximately 12 million citizens and an annual population growth of 2.6%. Merely 19.4% of the total inhabitants live in urban areas (UNDP, 2013). Although the country remains predominantly rural, there is a tremendous transformation taking place as it now has one of the fastest growing urbanization rates in the world (World Bank, 2007). In fact, according to official figures, Rwanda currently has an urbanization rate of 4.5% annually. Only five other countries in the world hold a higher rate of urbanization (Madagascar: 4.7%, Niger: 4.9%, Eritrea: 5.0%, Uganda: 5.7%, and Burkina Faso: 6.0%) (CIA, 2013).

According to the WHO /UNICEF Joint Monitoring Programme for Water Supply and Sanitation 2014, in 2012, 81% of the urban population and 68% of the rural population had access to improved drinking water sources (protected sources), hence 19% of the urban population and 32% of the rural population had access to unimproved drinking water sources (unprotected sources and surface water). About 64% of the total population had access to improved sanitation facilities and 36% of the total population had access to unimproved sanitation facilities.

Table 1

1990-2011	NATIONAL POPULATION			URBAN POPULATION			RURAL POPULATION		
Water	% growth population	% growth access to improved water source	% growth NO access to improved water source	% growth population	% growth access to improved water source	% growth NO access to improved water source	% growth population	% growth access to improved water source	% growth NO access to improved water source
Benin	91	237	41	152	198	35	59	255	53
Ghana	69	174	-50	144	170	15	27	181	-60
Kenya	78	152	21	151	126	432	63	166	12
Mali	83	324	-11	178	367	-35	54	309	-9
Mozambique	77	144	42	161	179	113	54	112	36
Rwanda	54	71	26	485	414	1200	31	44	12
South Sudan	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sub-Sah. Africa	70	119	24	125	128	112	49	117	12
Northern Africa	41	49	-13	58	60	32	24	38	-32
Africa	65	98	21	106	106	102	45	95	10
1990-2011	NATIONAL POPULATION			URBAN POPULATION			RURAL POPULATION		
Sanitation	% growth population	% growth access to improved sanitation facility	% growth NO access to improved sanitation facility	% growth population	% growth access to improved sanitation facility	% growth NO access to improved sanitation facility	% growth population	% growth access to improved sanitation facility	% growth NO access to improved sanitation facility
Benin	91	607	128	152	351	120	59	1162	142
Ghana	69	266	56	144	286	124	27	238	20
Kenya	78	106	68	151	199	134	63	96	52
Mali	83	168	68	178	195	170	54	116	47
Mozambique	77	273	57	161	206	137	54	594	43
Rwanda	54	193	-12	485	457	534	31	167	-27
South Sudan	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sub-Sah. Africa	70	96	61	125	120	129	49	88	40
Northern Africa	41	76	-50	58	61	18	24	93	-57
Africa	65	88	52	106	93	123	45	90	32

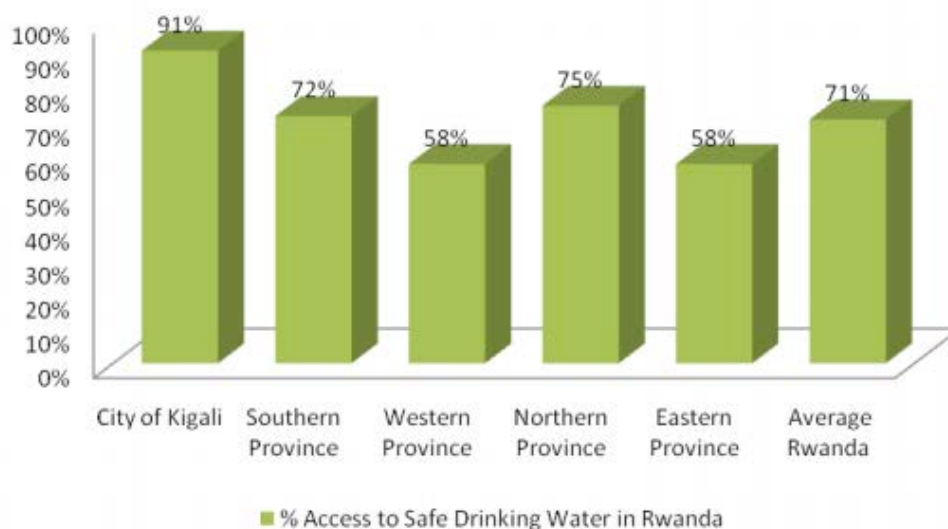
Source: WHO/UNICEF (2013), Progress on sanitation and drinking-water: 2013 update, pp. 14-35  
Geneva / New York: World Health Organization / United Nations Children's Fund.

Let's, however, look at a longer stretch of time. According to WHO/UNICEF (2013), there was not only an increase of the number of people with access to improved drinking water, but also an increase in the number of people with NO access to such facilities. This applies in particular to the urban areas, and Rwanda stands out with a growth of 1200 % of the people with NO access to improved drinking water sources in its urban areas. However, with respect to improved sanitation facilities it becomes clear that there was a *decrease* in the number of people in the rural areas with NO access to improved sanitation facilities.

Through national policies the current government aspires to reach a 100% coverage rate by 2017 for water supply and sanitation services (Republic of Rwanda, Ministry of Infrastructure, 2010).

In reality, execution of such nationwide water and sanitation-policies will prove to be difficult. Especially in Rwanda's rural areas water shortages still persist, as the majority of the people live far away from local water resources. At the same time agriculture is the largest consumer of fresh water resources, thus creating a tension between agricultural production and urbanization (most notably in the eastern parts of Rwanda) (Biranga, 2014). Regarding the access to clean water, a clear discrepancy exists between urban and rural areas in Rwanda, as the figure below indicates.

Figure 6 Access to safe drinking water in Rwanda



Source: WaterAid/ DFI (2012), Financing of the water, sanitation and hygiene sector in Rwanda

Moreover, existing water sources are depleted because of inappropriate land usage (Dushimumuremyi, 2009). Also, the quality of the drinking water in Rwanda is questionable as ground water is polluted by industrial activities while insuffi-

cient maintenance of the current water distribution pipes constitute an additional major concern (Bayavuge, 2008).

Hoang-Gia and Fugelsnes (2010) argue that these existing shortcomings in the current water distribution system can be resolved through developing public-private partnerships for piped water schemes. To ensure effective cooperation, capacity building among various stakeholders is needed. An example of fruitful cooperation between the development sector and local capacity organizations in water and sanitation is the case of Coforwa (Mukakalisa, 2009). However, to a great extent the current political realities in Rwanda complicate the emergence of public/private partnership.

## Political situation and institutional setting

### *Political situation*

In Rwanda's political and institutional framework there exists a clear distinction between 'local' versus 'government' ownership. The latter seems to be predominant, as civic participation in politics is limited. Most government policies envision fortifying the powerbase of the current RPF-regime (Wilén, 2012). President Paul Kagame consolidated its grip on power via general elections in 2013. The RPF and its four coalition partners won 98% of the votes in 2013. Opponents accuse Kagame and his RPF regime of authoritarianism, of trampling on civic, political and human rights and of intimidation of political opponents. Progress in public service delivery became slow in 2013 as donors cut or suspended aid as a sanction for Rwanda's alleged support of M23 rebels in the DRC. In some government sectors foreign aid used to account for some 40% of the national budget (Africa Yearbook, 2014).

With regard to the Rwandan genocide of 1994, economic inducements can partially explain the transformation of ordinary citizens into ruthless killers. Especially the lack of available land caused grave tensions within communities prior to the genocide (Verpoorten, 2012; Platteau and Andre, 1998). In the increasingly overpopulated country the land-issue, in the run-up to the killings, was not a negligible incentive. Especially because at the time approximately 90% of the Rwandan population relied on small-scale farming while simultaneously the country was locked in a 'neo-Malthusian' trap due to insufficient progress in agricultural intensification (Verpoorten, 2012).

A way of integrating returning refugees has been to implement compulsory land sharing. Critics state that the land reform is too much a centrally planned, top-down policy, with less emphasis on rural realities. [The still growing population is putting pressure on land sharing, as well as the usage of natural resources \(including water\) in general, thus leading to communal disputes.](#)

In short, land and resource-scarcity in Rwanda proved to be a determinant factor for (ethnic) conflicts in the recent history of tragic events (Brahmana, 2011). As a response, the government attempted to implement several regulatory bodies and reforms to control access and usage of land. However, these established regulations merely invoked already existing antagonisms in society (Brahmana, 2011).

#### *Institutional setting of water*

The 2005 Organic Land Law states that the country's lakes, rivers, and groundwater are in the public domain, and the use of water resources is shared by all. Rwanda's water sector has experienced dramatic improvements in service, sustainability, and coverage, since sector reforms began in 2000. A revised National Water Policy was adopted in 2004. Programs have been developed and prioritized within the Economic Development and Poverty Reduction Strategy (EDPRS), and targets developed for the MDGs by 2015.

The Ministry of Infrastructure (<http://www.mininfra.gov.rw/>) is responsible for the overall water and sanitation sector. The National Water Commission creates water resource development plans and programs to support the Ministry's policies (Rwanda Environment Management Authority, 2009a).

Rural water supply, management of water resources and sanitation are the responsibilities of the Ministry of Natural Resources (<http://minirena.gov.rw/index.php?id=3&L=0>), through its Directorate of Water and Sanitation. The Ministry of Natural Resources also helps with national water policy, represents the government in intergovernmental organizations and promotes international and regional cooperation on water resource issues.

At district level, basin committees are responsible for preparing district level water management plans. The district basin committees have the power to delegate authority for management of water resources and water infrastructure to local water user associations.

The use of water for agricultural purposes is governed by the Ministry of Agriculture and Animal Resources (<http://www.minagri.gov.rw/index.php?id=16>).

According to USAID (2010), Rwanda is currently delegating all WSS (water supply and sanitation) service responsibilities to communities and districts, with the exception of planning, regulation, hygiene promotion, monitoring, and oversight. A new 'National Water Agency' should catalyze the decentralization process through increased technical assistance, thereby strengthening local level efforts and ensure self-sufficiency. To complement these plans, the National Investment Strategy aims to promote increased private sector participation to attract investment and operate and maintain WSS infrastructure. The Government is also cognizant that current water rates do not generate the required revenue to



offset costs. Income surveys have demonstrated that urban ratepayers can afford more, and policies are being promulgated to secure access for all through pro-poor arrangements (USAID, 2010).

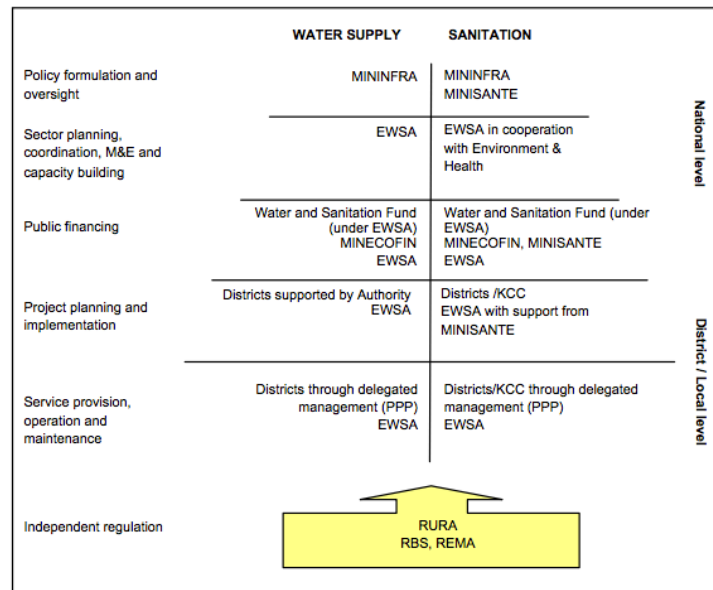
Within the city of Kigali and other main *urban* centers in Rwanda, water services are provided by RECO-RWASCO. The utility is struggling to produce and distribute enough water to satisfy urban demand due to commercial and technical constraints. The struggle was exacerbated by a severe drought that greatly reduced the amount of water in the country's reservoir lakes. In 2008, a three-year agreement was entered into with the National Water and Sewerage Corporation (NWSC) of Uganda for performance improvement and to promote commercial service delivery. The contract promotes information transfer, commercial collaboration, staff development, capacity building, and training (USAID, 2010).

Rwanda's *rural* water supply has faced many challenges. These include top-down programming of investments, poor cost recovery, limited private sector participation, and high per capita investment costs for system construction. Early attempts to introduce community participation and ownership of facilities failed in the absence of strong government commitment to decentralization. By 2004, the Government had abandoned the community management concept in favor of Public-Private Partnerships (PPPs). By 2007, 140 rural piped water systems (approximately 25 percent of total) were managed by PPPs, with the remainder managed by local communities. Recent rural projects have begun to yield results. Some of the rural systems are quite large, with the largest one serving 120,000 users in villages several miles apart. Although these systems are 'piped', this typically means that water is distributed to water points in the village where users must go to retrieve water. Income-qualified users are able to obtain water for free. The proportion of the rural population receiving tap water in their homes is relatively negligible (USAID, 2010).

In figure 7 and figure 8 all key government water agencies are indicated, including their main responsibilities.

Figure 7-Figure 8

KEY GOVERNMENT AGENCIES	
Agency	Description
MINIRENA	<ul style="list-style-type: none"> <li>National water resources and sanitation policy and strategy development.</li> <li>Provides WSS service in areas where District providers are not present.</li> </ul>
MININFRA	<ul style="list-style-type: none"> <li>Public works and infrastructure policy, strategy, development, and master planning.</li> </ul>
RURA	<ul style="list-style-type: none"> <li>Regulate WSS service standards and rates;</li> <li>Promote fair competition;</li> <li>Environmental protection through waste disposal and byproduct treatment enforcement.</li> </ul>
RECO-RWASCO (formerly ELECTRO-GAZ)	<ul style="list-style-type: none"> <li>Provides WSS service to 10 cities and Kigali.</li> </ul>
Community Development Fund (CDF)	<ul style="list-style-type: none"> <li>Receives and redistributes WSS sector funding from government and donors.</li> </ul>
District Providers	<ul style="list-style-type: none"> <li>WSS service providers in rural areas;</li> <li>~25 % are PPPs;</li> <li>~60 are privately owned.</li> </ul>



Source (left): USAID (2010), Rwanda Water and Sanitation Profile: <http://www.washplus.org/sites/default/files/rwanda.pdf>

Source (right): WaterAid, DFI (2012), Financing of the water, sanitation and hygiene sector in Rwanda

Despite the Rwandan water resources being in the ‘public domain’, in reality large portions of the population are unable to access proper drinking water, primarily in the rural areas. For example, in the Rugezi wetland (Northern province) local authorities posed a ban on agricultural activities, thus restricting the local community from getting access to natural resources, while enlarging the production of hydro-electricity in the region (Hategekimana, 2010). Thus, this situation exemplifies an increasing tension between national economic ambitions and local realities. In other words, legal and institutional frameworks are used as govern-

ment-tools to control the marshland management, hence increasing productivity, but not reducing poverty (Brahmana, 2011).

In addition, the country suffers from a high percentage of non-revenue water (NRW): in 2012 an average of 41% was estimated to be escaping water payment, while only few people are properly trained to enable reduction in NRW (Kabandana, 2014).

## Economic setting: economic situation, transport system, innovation, ICT

About 90% of the population is engaged in (mainly subsistence) agriculture and some mineral and agro-processing. Tourism, minerals, coffee and tea are Rwanda's main sources of foreign exchange.

Foreign aid used to account for some 40% of the budget, so the recent cut in foreign aid had several consequences: GDP growth rate slowed down from 7.3% in 2012 to 4.5% in 2013, also due to lower domestic public spending and poor tea and coffee receipts. The regime looked for closer relationships with China, which led to an economic agreement of \$5 m of interest-free loans in 2013, in addition to \$9 m in loans in 2012. (UNDP, 2013; Africa Yearbook, 2014).

With Kenya and Uganda, Rwanda has formed a Coalition of the Willing (CoW), in which they want to push forward with regional economic integration. This includes an agreement to construct the railway line that connects the three countries, to build a joint oil pipeline (the Lamu project, see Kenya report) and refinery. The three countries also cooperate economically with Tanzania and Burundi within the East African Community.

The cabinet adheres to its second Economic Development and Poverty Reduction Strategy (EDPRS II, 2013), which runs from 2013 to 2018 and focuses on four themes: economic transformation, rural development, private sector productivity, and accountable governance. A rather ambitious plan, as 80% of Rwandans earn a daily average subsistence income of \$1.50 and, as the government itself has stated, are not 'contributing to economic growth' (quote from the Africa Yearbook, 2014).

Mineral exports accounted on average for 28% of Rwanda's total export earnings (second only to tourism and well ahead of tea and coffee exports).

Rwanda's two major drainage basins, the Upper Nile basin and the Congo basin, and agricultural use account for 68% of water withdrawal, while domestic use and industry account for 24% and 8%, respectively (REMA, 2009; FAO, 2009; GoR Water Policy, 2004).

Rwanda is experiencing increasing industrial activities, most notably in its wetland-areas (Kabanda, 2008). Consequently, due to pressure on available land,

the establishment of these industries in Rwanda's natural wetlands (e.g. the Nyabugogo swamp) causes heavy metal pollution in the available ground water (Nkuranga, 2007).

Rwanda has 7 airports, a small roadway system, and three ports: Cyangugu, Gisenyi, Kibuye (Lake Kivu). The above mentioned Lamu project should connect Rwanda to its first railway system.

The Rwandan Government is seeking to become regional leader in information and communication technologies. In 2010, Rwanda neared completion of the first modern Special Economic Zone (SEZ) in Kigali. The SEZ seeks to attract investment in all sectors, but specifically in information and communications technologies, trade and logistics, agribusiness, mining, and construction.

## Agricultural dynamics

Agriculture is the main economic activity for the majority of Rwandans, employing 80 per cent of the population. It accounts for a third of Rwanda's Gross Domestic Product and provides 90 per cent of the national food needs and generates over 70 per cent of the country's export revenues. According to a report on agricultural dynamics of Rwanda between 1961-2011, based on FAO-stat data and compiled by the African Studies Centre's Ton Dietz (Dietz, 2013), Rwanda's food producing sector may be said to have performed reasonably well between 1961 and 2009, but not much more than that (and the tragic events around 1994 created a major land use and land ownership upheaval). The total production of cereals (x5.0) and roots & tubers (x4.7) increased by a factor larger than the total population (x3.3), whilst the increase in the total production of pulses (x3.1) and plantains (x3.0) was slightly less than the factor increase in the population. The yield increases over the period 1961-2009 were disappointing. As Rwanda is Africa's most densely populated nation (on the mainland), a relatively large portion of the total arable land is already under cultivation. In 2005, Rwanda had the highest percentage of total arable land already under cultivation (45%) in sub-Saharan Africa, with the exception of Mauritius. As a result, yields in Rwanda will need to increase relatively more than in many other African nations (where potential arable land is still abundant) in the near future if food production is to keep pace with population growth. However, the calorie intake per capita from cereals, pulses, and roots & tubers has increased, which means that the country's average food security level has improved.

Nevertheless, the high population growth (currently 2.6% annually) necessitates an increase in the country's food production. Due to a lack of available land, the only possibility to increase the amount of cultivable land is through reclamation programs of new land (most notably wetlands) or increased productivity

through fertilizers (Uwimpuhwe, 2011). Unfortunately land-reclamation often causes erosion, thus effecting the poor quality of the ground water (Murekatete, 2013).

The government aims to transform agriculture from subsistence farming to a productive, high-value, market-oriented sector. Simultaneous to demographic pressures this transformation will increase tensions between communal usages of water resources versus the needs of an emerging commercialized agriculture sector.

The government also plans to create a more climate-resilient agriculture, for example through the construction of extensive irrigation facilities. In the EDPRS II (2013), Rwandan authorities aim to develop a total of 100,000 ha under irrigation (of which 65,000 ha marshland and 35,000 ha hillside irrigation) to increase food production and thus obviate demographic pressures.

The National Agriculture Exports Board (NAEB) has embarked on a plan to increase coffee and tea production. It comes after the values and volumes for tea and coffee exports, Rwanda's leading export revenue earners after tourism, dipped during the last half of 2013. Coffee exports went down with receipts of \$50 million in the first eleven months of 2013. Tea exports didn't perform any better either in the first 11 months of 2013, fetching \$56.5m during the year, down from \$63.9m the previous year. 13,650,000 tea and 8,073,000 coffee seedlings have been planted countrywide. Water dams will be constructed to harvest rain water which will then be used for irrigation during the dry seasons. Lack of skills among farmers and agro-processors and high power rates are among the challenges that have to be faced. The board targets to increase tea and coffee export earnings to \$147m and \$157m annually by 2017 (Interview with Corneille Ntakirutimana, the director in charge of production at NAEB, in *The New Times*, 13 January 2014).

## Energy dynamics

In 2010, about 47% of Rwanda's capacity was derived from hydroelectric plants, and some 52% from fossil fuels (CIA World Factbook). These figures will change considerably over the next few years as several hydropower plants are being built and the government has also started testing geothermal drilling to meet Rwanda's unmet demand for electricity.

The energy sector will become the main pillar for economic transformation in Rwanda, as authorities aim to increase its capacity from 35 MW to 563 MW in the period between 2000 and 2017 (Hakorimana, 2014). At the same time, local agricultural activities are negatively affected by increased hydropower production (e.g. decrease in water resources) (Hategekimana, 2010). As a result, losses

are incurred by local farmers in terms of revenues and available land, while at the same time stakeholders on the government level profit from increased hydropower production.

The World Bank commits \$ 340 m to fund a new 80 MW hydropower plant at Rusumo Falls on the Rwanda-Tanzania border. This should supply large parts of Rwanda, Tanzania and Burundi with electricity. Another huge hydropower project is the Nyabarongo I Hydro Power Project, located in Mushishiro sector-Muhanga District. This should produce 28 MW. The approximately \$110 million project is being financed through the Government of India (EXIM Bank of India) and the Government of Rwanda.

However, due to climate change and increased usage of water resources, ongoing decline in water levels endanger hydro-electricity-production in the region. This confirms the vulnerability of the emerging energy sector to climatic conditions (Lujara, 2007a, 2007b).

## Climate change and environmental issues

Rwanda periodically deals with droughts. Environmental issues are deforestation from uncontrolled cutting of trees for fuel, overgrazing, soil exhaustion and erosion (Lujara, 2007a, 2007b). These factors will have a deteriorating effect on the quality of water supplies in Rwanda, and decrease accessibility to clean water sources in general.

Small semi-subsistence farm households are vulnerable to climatic conditions (IRIN, 2013). The IMF (2013) identifies climatic vulnerability, such as flooding, as the main internal risk to growth and poverty reduction in Rwanda. The objective is to create a more climate-resilient agriculture, for example through the construction of extensive irrigation facilities. In the EDPRS II (2013), Rwandan authorities aim to develop a total of 100,000 ha under irrigation (of which 65,000 ha marshland and 35,000 ha hillside irrigation) to increase food production and thus obviate demographic pressures.

The country is party to the following international agreements: Biodiversity, Climate Change, Climate Change-Kyoto Protocol, Desertification, Endangered Species, Hazardous Wastes, Ozone Layer Protection, Wetlands.

## Pressing needs

### *\* Integration of national and communal interests & involvement of communities*

First of all, national ambitions of the Rwandan regime often deviate with local realities and communal interests. For example, the economic importance regarding the increase in hydropower diverges with local interests in agricultural subsistence farming. Communities are often scarcely involved in managing their own local water resources (Dushimumuremyi, 2009).

There is a need to integrate local communities in capacity building efforts, while monitoring the effects of national projects on local realities (Ingabire, 2013; Hoang-Gia, 2010). An example of local capacity building is the Water Sanitation & Hygiene (WASH) service, formulated by UNICEF and SNV (Verweij, 2008).

Through enhanced cooperation between ministries and public and private stakeholders, proper guidelines for development projects can be established (Ingabire, 2013). Unfortunately, at the moment there is inadequate funding, lack of collaboration among stakeholders and a lack of public involvement (Hakorimana, 2014).

### *\* Reformation of the water resource management in agriculture*

Growing demographic pressure leads to a rapidly increasing demand for agricultural output. This necessitates significant reforms and improvement of the (water) resource management in the next decade (IMF, 2014). The irrigation system is insufficiently developed; hence agriculture depends on rainfall (Dushimumuremyi, 2009). Moreover, technical innovation in Rwandan agriculture is lacking and absence of alternative income opportunities outside of the (subsistence) farming activities results in increased social tensions (already highlighted in Andre & Platteau, 1998). Demographic pressure also evokes competition over natural resources, most notably over accessible water sources and cultivable land (Brahmana, 2011).

### *\* Create a climate-resilient agriculture*

Small semi-subsistence farm households are vulnerable to climatic conditions (IRIN, 2013). The IMF (2013) identifies climatic vulnerability, such as flooding, as the main internal risk to growth and poverty reduction in Rwanda. The objective is to create a more climate-resilient agriculture, for example through the construction of extensive irrigation facilities. In the EDPRS II (2013), Rwandan authorities aim to develop a total of 100,000 ha under irrigation (of which 65,000 ha marshland and 35,000 ha hillside irrigation) to increase food production and thus obviate demographic pressures.

*\* Measures to create balanced regulations and policies with respect to land rights*

Insecure regulations on land rights and access to water remain problematic for younger generations, as ownership is often concentrated among the older population (Africa Development Forum, 2014). In many areas farmlands are small and, due to conventional inheritance rights, increasingly shrinking while the population is growing. Therefore, clear policies and regulations need to make sure a careful balance is created in the distribution of land.

*\* Improvement of access to drinking water and sanitation*

The Government of Rwanda seeks to increase the rate of access to drinking water and sanitation to 100% by 2020, a hugely ambitious goal. The estimated costs to achieve these targets are approximately \$820 million (USAID, 2010). Water availability is projected to decrease in the near future: while in 2008 the average annual amount of renewable internal freshwater resource per capita was approximate 977 m<sup>3</sup>, this amount will decrease to 875 m<sup>3</sup> by 2015 (USAID, 2010). Thus, the government's efforts to reach its targets will have to be enormous. Meanwhile the government increasingly outsources the operational management of their water management to decentralized public-private-partnerships. For example in the city of Kigali and other urban centers in Rwanda, the water-supply is provided by RECO-RWASCO. This utility, however, is struggling to produce and distribute enough water to satisfy urban demand due to commercial and technical constraints, exacerbated by droughts that have greatly reduced the amount of water in the country's reservoir lakes.

*\* More efficient water usage*

Innovative reforms should be implemented to ensure sustainable water management. For example, increasing training programmes to reduce non-revenue water and constructing water saving mechanisms will increase efficiency in water usage (Biranga, 2014).

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