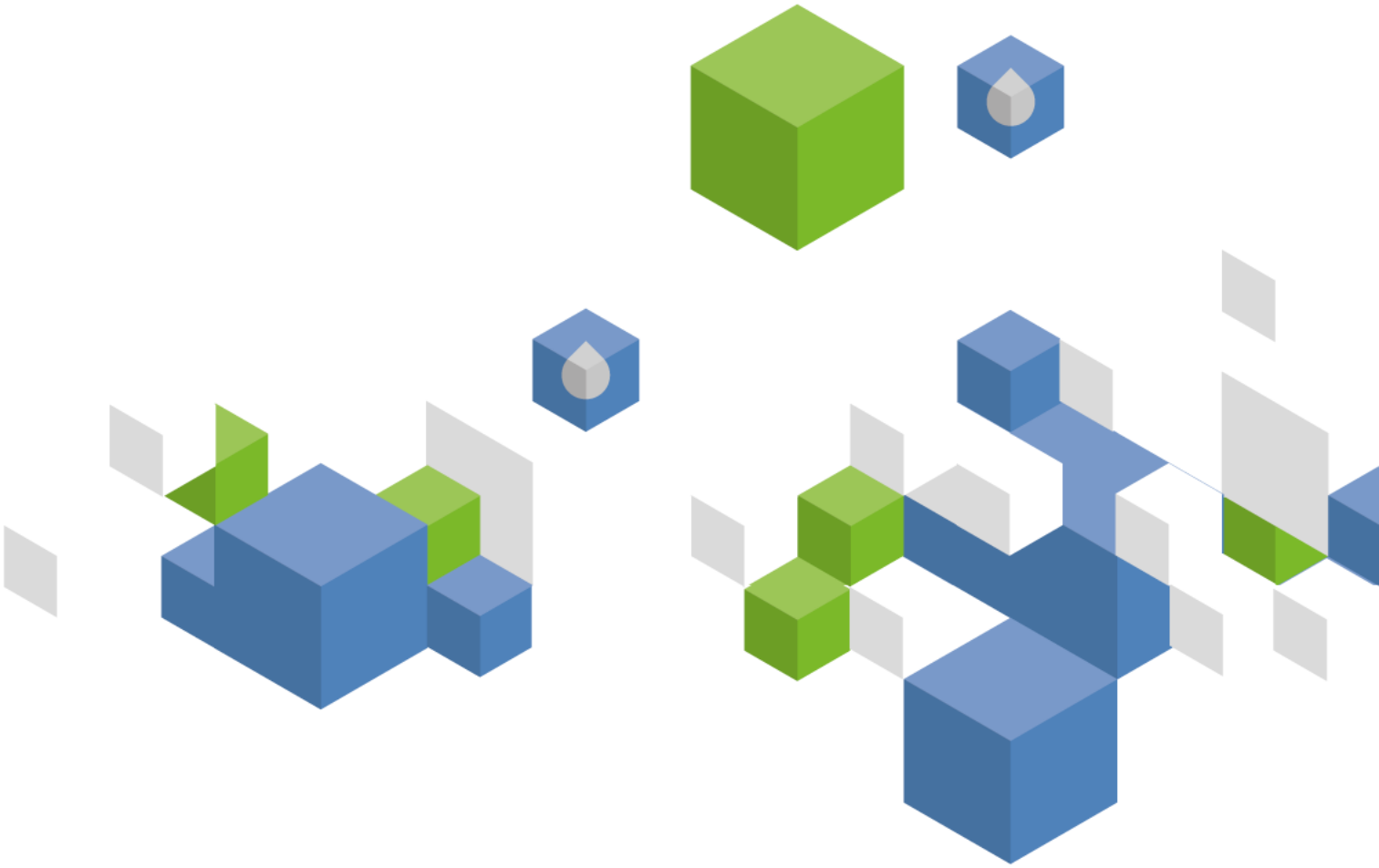
Food and Agriculture Organization of the United Nations

FAO AQUASTAT Reports

Country profile – Kenya

Version 2015



Recommended citation: FAO. 2015. AQUASTAT Country Profile – Kenya.
Food and Agriculture Organization of the United Nations (FAO). Rome, Italy

Kenya

GEOGRAPHY, CLIMATE AND POPULATION

Geography

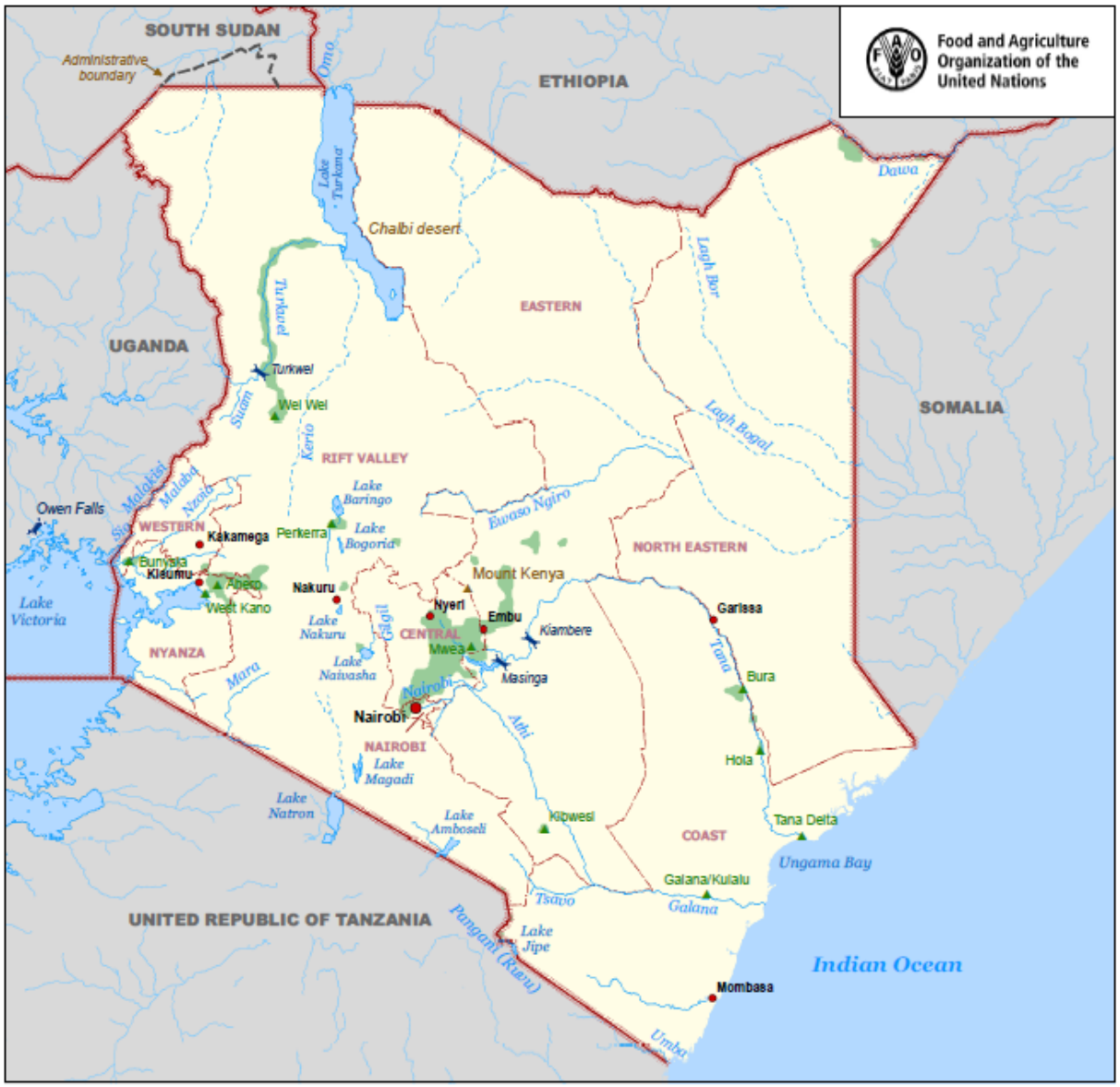
Kenya is situated on the East African coast and on the equator. It is bordered by South Sudan and Ethiopia to the north, Somalia and the Indian Ocean to the east, the United Republic of Tanzania to the south, and Uganda and Lake Victoria to the west. The total area of the country is 580 370 km², including 11 230 km² of inland water bodies in particular Lake Victoria and Lake Turkana. The Great Rift Valley dividing the Central Highlands is one of the main features of the country. The altitude varies from sea level at the Indian Ocean to the peak of Mt. Kenya, which is 5 199 metres above sea level. Kenya is also characterized by a large diversity of landscapes, from deserts, such as the Chalbi desert, to glaciated mountains, hosting a rich biodiversity.

It is estimated that 27.4 million ha is cultivable, of which 6.1 million ha is cultivated and 21.3 million ha are permanent pastures (Table 1). To protect Kenya's biodiversity, almost 47 000 km² of land are preserved in national parks, reserves and sanctuaries. However, only 3 456 km² are forested in 2008, including 54 km² of mangroves (NEMA, 2010).

TABLE 1
Basic statistics and population

Physical areas:			
Area of the country	2012	58 037 000	ha
Agricultural land (permanent meadows and pasture + cultivated land)	2012	27 430 000	ha
• As % of the total area of the country	2012	47	%
• Permanent meadows and pasture	2012	21 300 000	ha
• Cultivated area (arable land + area under permanent crops)	2012	6 130 000	ha
- As % of the total area of the country	2011	11	%
- Arable land (temp. crops + temp. fallow + temp. meadows)	2012	5 600 000	ha
- Area under permanent crops	2012	530 000	ha
Population:			
Total population	2013	44 354 000	inhabitants
- Of which rural	2013	75	%
Population density	2013	76	inhabitants/km²
Economy and development:			
Gross Domestic Product (GDP) (current US$)	2013	44 101	million US$/year
• Value added in agriculture (% of GDP)	2012	30	%
• GDP per capita	2013	994	US$/year
Human Development Index (highest = 1)	2013	0.535	-
Gender Inequality Index (equality = 0, inequality = 1)	2013	0.548	-
Access to improved drinking water sources:			
Total population	2012	62	%
Urban population	2012	82	%
Rural population	2012	55	%

FIGURE 1
Map of Kenya



KENYA **FAO - AQUASTAT, 2015**

Climate

Kenya's climate varies from tropical on the Indian Ocean coast to arid further inside the country, influenced primarily by the inter-tropical convergence zone, by relief (Great Rift Valley and high mountains) and by large water bodies. Long-term average annual precipitation is 630 mm, ranging from less than 200 mm in Northern Kenya to over 1 800 mm on the slopes of Mount Kenya. The rainfall distribution pattern is bimodal with long rains falling from March to May and short rains from October to December for most parts of the country (WRMA, 2013).

More than 80 percent of the land area, or around 490 000 km², is classified as arid and semi-arid land (ASAL), with an annual precipitation of 200-750 mm (WRMA, 2013). The ASALs are mostly covered by rangelands and nature reserves, hosting thus 80 percent of the country's livestock and 65 percent of its wildlife. The remaining area can be classified as medium to high potential agricultural land, where almost 80 percent of the population lives. In the high rainfall zone, with an annual precipitation of more than 1 000 mm, the semi-intensive and intensive agricultural systems predominate. In the medium rainfall zone, between 750 and 1 000 mm/year, farming includes cattle and drought-tolerant crops (MALF, 2015).

The temperature ranges from freezing to 40°C. The Penman estimate of annual evaporation from open water surfaces in Kenya varies from 1 000 mm in the central highlands to 2 600 mm in the arid north.

Population

The total population of the country is estimated at 44.4 million (2013), of which 75 percent is rural (Table 1). The annual population growth rate is 2.7 percent in 2013 and the average population density is 76 inhabitants/km². The population is concentrated on the medium to high potential agricultural land, representing less than 20 percent of the total area of the country.

In 2013, the Human Development Index ranks Kenya 147 among 177 countries. Life expectancy in Kenya is 61.7 years and the under-five mortality is 71 per 1000 births, both progressing from 56 years and over 100 per 1000 in the 1990s. With no significant distinction between boys and girls, around 84 percent of the children in 2013 are enrolled in primary education, but only 56 percent for secondary education (WB, 2015). Adult literacy is 72 percent for the 2005-2012 period (UNDP, 2015), with a gap between female literacy (67 percent) and male literacy (78 percent). Poverty concerns almost half of the population (47 percent) and is mainly a rural phenomenon. Poverty is particularly high in the ASALs affecting 80-90 percent of the population (NEMA, 2010). In 2012, 82 percent of the urban and 55 percent of the rural population were using improved drinking water sources, that is 62 percent of the total population This represents a major improvement since 2002 when only 54 percent of the population had access to an improved drinking water source (JMP, 2014).

ECONOMY, AGRICULTURE AND FOOD SECURITY

The economy of Kenya is largely dependent on agriculture and tourism. In 2013, the GDP was US$ 44 101 million (current $) with agriculture contributing 30 percent to the GDP. About 69 percent of the total economically active population is employed in agriculture. Agriculture accounts for 65 percent of Kenya's total exports and comprises five major sub-sectors: industrial crops, food crops, horticulture, livestock and fisheries (WB, 2014). Industrial crops and horticulture are the two main agricultural exports.

The agricultural sector is based predominantly on smallholder farmers producing around 75 percent of the agricultural production and 50 percent of the marketed one, on farms averaging 0.2-0.3 ha each. Large-scale farming mainly produces industrial crops such as tea, coffee, maize and wheat on farms of 50 ha in average, as well as livestock on farms up to 30 000 ha. Agriculture is mainly rainfed and maize, wheat, beans, tea, coffee and potatoes are the main crops. The bimodal rainfall allows two cropping seasons per year except in high altitude areas. However, their performances are highly .dependent on

the precipitation and were considerably reduced during the 2009 drought for example. In the humid areas the parcel size was reduced to almost uneconomical size due to high population density. In the ASALs, pastoralists raise livestock, in particular beef, dairy cattle, sheep, goats, camels, pigs and poultry. Livestock is estimated at 3.5 million of dairy cattle, 9 million of beef, and 31.8 million chickens (NEMA, 2010).

The 2010 Kenya Constitution ensures the right of adequate food for its people (MALF, 2015). However, 22 percent of the country's population is undernourished in 2012-2014 (FAO, 2015) and cereals imports in 2013 correspond to around one third of the country's needs (FAOSTAT, 2015). Due to this food deficit, regular famine occurs as a result of periodic droughts.

WATER RESOURCES

Most of Kenya's water originates from its five "water towers": Mau Forest Complex, Aberdare range, Mount Kenya, Mount Elgon and the Cherengani Hills. They are the largest montane forests in the country and form the upper catchments of the main rivers in Kenya (except Tsavo river flowing down Mount Kilimanjaro) (NEMA, 2010).

There are six main catchments in the country, used as unit for the water resources management by the Water Resources Management Authority (WRMA) (WRMA, 2013):

- Lake Victoria North Catchment Area (LVNCA), covering 3.0 percent of the country
- Lake Victoria South Catchment Area (LVSCA), covering 5.0 percent of the country
- Rift Valley Catchment Area (RVCA) which includes the inland lakes, covering 22.5 percent of the country
- Athi Catchment Area (ACA) stretching up to the coast, covering 11.5 percent of the country
- Tana Catchment Area (TCA), covering 21.7 percent of the country
- Ewaso Ng'iro North Catchment Area (ENNCA), covering 36.3 percent of the country

The water distribution in the drainage basins is uneven with, for example, 282 600 m^3/km^2 in Lake Victoria basin, or over 750 m^3/year per capita and 21 300 m^3/km^2 in the Athi Catchment, or 162 m^3/year per capita (WRMA, 2011).

Inland water bodies, mainly nine large lakes, cover 11 230 km^2. Most of them are saline, with the exception of the lakes Victoria, Naivasha and Baringo. The lakes Nakuru, Naivasha, Bogoria, Baringo and Elmenteira, as well as Tana River Delta, have been declared Ramsar sites of international importance for the conservation of biodiversity, totalling over 265 000 ha (RAMSAR, 2013).

Internal renewable surface water resources are estimated at 20 200 million m^3/year and renewable groundwater resources at around 3 500 million m^3/year, but 3 000 million m^3/year is considered to be overlap between surface water and groundwater, which gives a value of total internal renewable water resources (IRWR) of 20 700 million m^3/year (Table 2). External water resources are estimated at 10 000 million m^3/year, which is the inflow from Lake Omo from Ethiopia into Lake Turkana. Surface water leaving the country is estimated at 8 900 million m^3/year through the Lake Victoria to Uganda (8 400 million m3/year) and through the Ewaso Ng'iro river, also called Lagh Dera, into Somalia (500 million m^3/year). The dependency ratio is thus around 33 percent and the total renewable water resources are 30 700 million m^3/year, or 692 m^3/year per capita in 2014. This per capita value is projected to fall under the absolute water scarcity threshold of 500 m^3/year by 2030 due to population increase.

TABLE 2
Water resources

Renewable freshwater resources:			
Precipitation (long-term average)	-	630	mm/yr
	-	365 600	million m^3/yr
Internal renewable water resources (Long-term average)	-	20 700	million m^3/yr
Total renewable water resources	-	30 700	million m^3/yr
Dependency ratio	-	33	%
Total renewable water resources per inhabitant	2014	692	m^3/yr
Total dam capacity	2013	24.8	million m^3

There are six hydro-geological formations, which influence the distribution and availability of the groundwater resources: eastern quaternary sediment areas, bed rock areas, western quaternary areas, volcanic rock areas in the Rift valley, volcanic areas outside the Rift valley, older sedimentary areas. The volcanic and quaternary geological formations are rich in groundwater. The country's safe yield of surface water has been assessed at 7 400 million m³ per year while that of groundwater is about 1 000 million m³ per year (WRMA, 2013). However, this figure needs to be reviewed with the new aquifers identified in 2013 in Turkana country, and in particular with five deep high capacity groundwater reserves accounting for about 250 000 million m³. Among those, the Lotikipi aquifer, west of Lake Turkana, is estimated at over 200 000 million m³ of water and the small Lodwar basin aquifer that could serve as a strategic reserve for Lodwar, regional capital of Turkana county (UNESCO, 2013).

The total capacity of large and medium dams (> 15 m) is about 24 800 million m³, all for hydropower and urban water supplies. In addition, around 4 100 small dams and water pans increase the storage capacity by an additional 184 million m³ available for all uses (MALF, 2015).

INTERNATIONAL WATER ISSUES

Kenya shares a number of rivers, lakes and aquifers with neighbouring countries (Tables 3 and 4).

TABLE 3
Transboundary rivers (Source: FAO, 1997)

River name	Total basin area (km^2)	% of basin within Kenya	Sharing countries
Pangani basin (East Central Coast):	43 650	5	United Republic of Tanzania
• Umba • Ruvu (Lumi)			United Republic of Tanzania
Rift Valley basin:	637 593	20	Djibouti, Eritrea, Ethiopia, South Sudan, Uganda, UR Tanzania
• Omo (through Lake Turkana)			Ethiopia
Nile river basin:	3 112 369	1.5	Burundi, DR Congo, Egypt, Eritrea, Ethiopia, Rwanda, South Sudan, Sudan, UR Tanzania, Uganda
• Sio			Uganda
• Malaba			Uganda
• Malakisi			Uganda
• Mara (to Lake Victoria)			United Republic of Tanzania
Shebelle-Juba basin:	810 427	26	Ethiopia, Somalia
• Ewaso Ng'iro (Lagh Dera)			Somalia
• Lagh Bor			Somalia
• Lagh Bogal			Somalia
• Dawa			Ethiopia

Kenya is a member of the Nile Basin Initiative (NBI), an inter-governmental partnership launched in 1999, together with the then nine other Nile riparian countries. Because both the 1929 and 1959 Nile Water Agreement assigned the Nile's water to Egypt and Sudan without including Kenya and the other riverside nations, the NBI was intended to strengthen the cooperation within the basin. The NBI, the

headquarters of which are in Entebbe, Uganda, prepared a Strategic Action Programme, which consists of two sub-programmes: the Shared Vision Programme (SVP) and the Subsidiary Action Programme (SAP). The SVP is to help create an enabling environment for action on the ground through building trust and skill, while the SAP is aimed at the delivery of actual development projects involving two or more countries. Projects are selected by individual riparian countries for implementation and submitted to the Council of Ministers of the NBI for approval.

The NBI is intended to be a transitional institution until the Cooperative Framework Agreement (CFA) negotiations are finalized and a permanent institution created. This new Nile CFA was signed in 2010 by Kenya and four other countries–Ethiopia, Rwanda, Uganda and United Republic of Tanzania–and in 2011 by Burundi. Egypt strongly opposed this agreement which gives deciding power over large-scale hydraulic projects to a commission representing all the signatories, hence cancelling Egypt's historical right of veto. Sudan, South Sudan, and the Democratic Republic of the Congo are still to decide upon the CFA signature. The CFA was ratified by Ethiopia and Rwanda in 2013 and by United Republic of Tanzania in 2015. Signature of all countries would help organize a comprehensive management of the water resources between the basin countries and find an agreed solution to multiple projects of dams on the Nile for hydroelectricity generation in Uganda (see also the country profile for Uganda) (MWI, 2009).

The Ewaso Ng'iro is part of the larger Shebelle-Juba basin, of which one quarter lies within Kenya, for which there is no framework of cooperation between riparian countries, similarly to the other transboundary rivers mentioned in Table 3.

Lake Victoria, shared between United Republic of Tanzania (where 49 percent of the surface area of the lake is located), Uganda (45 percent) and Kenya (6 percent), is part of the Nile basin and is the world's second-largest freshwater lake (after Lake Superior in the United States of America) and the largest lake in Africa. The Lake Victoria Tripartite Agreement signed by Kenya, Uganda and United Republic of Tanzania established the Lake Victoria Environment Management Project (LVEMP). Its primary goal is to rehabilitate the Lake Victoria ecosystem (NEMA, 2010).

There is no cooperation framework between the riparian countries of the other transboundary lakes of Kenya, Lake Turkana (formerly Lake Rudolf) shared with Ethiopia and the smaller lakes Natron, Amboseli, Jipe and Chala shared with the United Republic of Tanzania. This lack of comprehensive management leads to tensions in particular with Ethiopia constructing dams impacting the water inflow of Lake Turkana (MWI, 2009), such as Gilgel Gibe III dam on the Omo river.

Table 4 below summarizes the transboundary aquifers.

TABLE 4
Transboundary aquifers (Source: IGRAC, 2014)

Aquifer name	Total aquifer area (km^2)	Sharing countries
Mount Elgon Aquifer	5 398	Uganda
Merti Aquifer	13 623	Somalia
Dawa	24 173	Ethiopia, Somalia
Sudd Basin	331 661	Ethiopia, South Sudan
Coastal Sedimentary Basin I	16 801	United Republic of Tanzania
Kilimanjaro Aquifer	14 579	United Republic of Tanzania

Finally, there are also some transboundary swamps:

- The Lotagipi Swamp, located 90 km west of Lake Turkana, in a floodplain that straddles the Kenya - South Sudan border.
- The Omo delta, previously located only in Ethiopia is expanding through the Ethiopian border towards Kenya (NEMA, 2010).

WATER USE

Rather than data on water withdrawal, Kenya provides data on water demand, which is slightly different but anyhow put in the Table 5 and Figure 2. The total water demand is estimated in 2010 to be over 3 200 million m³, aimed at agriculture for 59 percent, including irrigation for 50 percent, domestic uses for 37 percent and industry for 4 percent. Geographic distribution of the water demand is displayed in Table 6 (WRMA, 2013). In 2013, the water permits distributed by the WRMA allocate a total volume of 5 057 million m³, of which 64 percent are directed towards agricultural use, 22 percent towards municipalities and 14 percent towards industries (WRMA, 2015)

TABLE 5
Water use

Water withdrawal:			
Total water withdrawal	2010	3 218	million m³/year
- Irrigation	2010	1 602	million m³/year
- Livestock	2010	255	
- Fisheries	2010	42	
- Wildlife	2010	8	
- Municipalities	2010	1 186	million m³/year
- Industry	2011	125	million m³/year
• Per inhabitant	2010	78.7	m³/year
Surface water and groundwater withdrawal (primary and secondary)	2010	3 218	million m³/year
• As % of total renewable water resources	2010	10.4	%
Non-conventional sources of water:			
Produced municipal wastewater		-	million m³/year
Treated municipal wastewater		-	million m³/year
Direct use of treated municipal wastewater		-	million m³/year
Direct use of agricultural drainage water		-	million m³/year
Desalinated water produced		-	million m³/year

Note: The figures in this table refer to water demand and not water withdrawal.

FIGURE 2
Water withdrawal
Total 3 218 million m³ in 2010

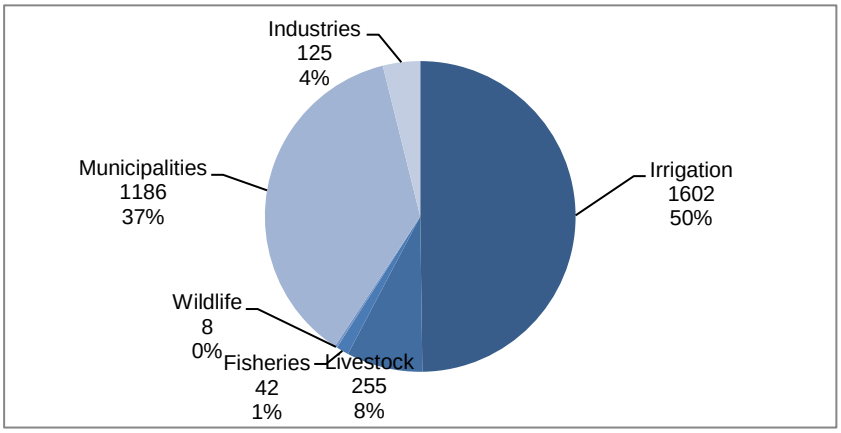


TABLE 6
Water demand: geographic distribution

Catchment	Water demand (million m³)
Lake Victoria North	228
Lake Victoria South	385
Rift Valley	357
Athi	1 145
Tana	891
Ewaso	212
TOTAL	**3 218**

Surface water is the main source of water withdrawn. There is limited seawater desalinization mainly for the hotels along the coast, as well as for Kizingitini Island off the coast (4 m³/day) and a clinic in Mombasa (2 m³/day). However, one of the key projects according to Kenya's national development strategy "Vision 2030" is a 100 000 m³/day (or about 36 million m³/year) desalination plant for Mombasa for 2017.

Sewerage systems have been constructed for only 29 urban centres, most of them before independence and thus requiring rehabilitation, with a treatment capacity of 341 000 m³/day (Table 7) (WRMA, 2013c).

TABLE 7
Wastewater treatment in 2010 (WRMA, 2013)

Catchment Area	Number of wastewater treatment plants	Total capacity m³/day
Lake Victoria North	8	21 000
Lake Victoria South	4	20 531
Rift Valley	4	18 393
Athi	8	244 060
Tana	6	32 343
Ewaso Ng'iro	1	4 617
TOTAL	**31**	**340 944**

IRRIGATION AND DRAINAGE

Evolution of irrigation development

The irrigation potential of Kenya has been estimated between 353 060 ha and 1 341 900 ha depending on the sources (Table 8). The highest potential of 1 341 900 ha assumes additional storage and improvement in irrigation efficiency (MALF, 2015) and includes between 250 000 ha (WRMA, 2013b) and 600 000 ha of floodplains that could be irrigated if equipped (NEMA, 2010). The medium potential of 539 500 ha, of which 75 percent is located in Tana and Lake Victoria Catchments (NEMA, 2010), does not always take soil suitability into consideration.

TABLE 8
Irrigation potential estimations (Sources respectively: WRMA, 2013b; NEMA, 2010; MWD, JICA, 1992)

Water Basin Catchment Areas	Irrigation potential HIGH (WRMA) (ha)	Irrigation potential MEDIUM (NEMA) (ha)	Irrigation potential LOW (MWD, JICA) (ha)
Lake Victoria	327 219	200 000	180 000
Rift Valley	84 200	64 000	52 500
Athi River	295 956	40 000	111 100
Tana River	566 995	205 500	
Ewaso Nyiro North	151 730	30 000	9 460
TOTAL	**1 341 900**	**539 500**	**353 060**

Irrigation development in Kenya has a long history since there are records indicating that there were irrigation systems in the 16th century along the coast, the lower reaches of Tana River and the Kerio valley (Marakwet escarpment), West Pokot and Baringo districts, mainly dependent on high flood flows. The system was so elaborate that a traditional water management system had evolved that maintained canals exceeding 15 kilometers, and water transfers from basin to basin along rugged terrains with technologies that puzzle the present-day engineer. The traditional water management system also allocated water between different clans and the water rotation among the different users could vary from year to year.

In the early 19th century, rice schemes were constructed by slaves along the river valleys around Kipini, Malindi, Shimoni and Vanga. In the late 19th century, Asian workers building the Kenya-Uganda Railway also started some irrigation activities around Makindu and Kibwezi. In the mid-1930s construction of drainage systems started in Central Kenya, especially in Karatina, putting large swamp

areas under crop production. During the 2nd World War, irrigation schemes at Karatina, Naivasha, Njoro Kubwa in Tavetta, in Mt Kenya and on the shores of Lake Victoria were constructed by prisoners of war and conscripted labour (Spate Network, 2008). The objective was to supply food to workers and soldiers. The above-mentioned pockets of development have greatly influenced the present day pattern and distribution of irrigation development in the country, whereby the communities have developed a tradition of water management.

In the mid-1950s, the African Land Development Unit of the British East Africa Protectorate initiated a number of state-owned irrigation schemes, including Mwea, Hola, Perkerra, Ishiara and Yatta using detainee labour (Spate Network, 2008). By 1963, the year of the country's independence, Kenya had developed a total of 2 500 ha of irrigation. Between 1963 and 1980, the new government expanded the existing schemes and developed new ones in the Lower Tana, Yala, Kano and Bunyala areas (WB, 2014). Small schemes were also equipped in the 1960s in the ASALs with assistance from international organisations as a result of the famine in the Turkwel and Ewaso Ng'iro basins (FAO, 2005). However, due to high development cost, the 1978-83 Development Plan shifted the emphasis from public irrigation development to small-scale farmer-managed irrigation. The Bura Irrigation Settlement Project, whose construction started in 1978, ended any remaining large-scale public irrigation development when it collapsed in 1989. Out of the 6 700 ha initially projected, the only 2 500 ha that had been equipped in 1989, despite large extra-budgetary costs, had poor returns on cotton growing. In 1985, there was around 52 000 ha equipped for irrigation (NEMA, 2010). Since the 1990s, export of horticultural crops is the main driver for irrigation development (WB, 2014).

Horticulture was also the main, if not the only, crop of the 2 200 ha of informal peri-urban irrigation done by 3 700 households within 20 km around Nairobi in 2000 (HR Walligford, DFID, 2001). None of the official reports mention this type of irrigation, but it was nonetheless considered similar in 2010 and added to the official figure in Table 9. The total water managed area in 2010 was about 150 570 ha, of which 141 900 ha (96 percent) was equipped for formal full control irrigation and 2 200 ha of peri-urban irrigation (Table 9 and Figure 3). The remaining 6 470 ha are under spate irrigation. Of the areas under full control, 70 percent were irrigated by surface irrigation, 22 percent by sprinkler and 8 percent by localized irrigation (Table 9 and Figure 4). By the end of 2013, approximately 161 840 ha had been developed (Table 10) (MALF, 2015).

Water lifting devices and pressurized irrigation date back to the late 1970s with large-scale commercial farmers producing mainly coffee. After that, it's mostly the horticulture industry that adopted new and modern water saving irrigation technologies such as drip and greenhouses for the production of high-value crops and flowers (Spate Network, 2008).Within the formal irrigation, there are four major types of irrigation schemes that can be grouped according to their ownership (private or public) (Table 10) (MALF, 2015):

- Private irrigation schemes:
    - Community-based: small and medium farmer-managed schemes belonging to groups of farmers sharing a common irrigation system operating as irrigation water users associations (IWUAs), cooperatives or self-help groups. There are about 3 600 smallholder irrigation schemes covering around 43 percent of the total area. They produce the bulk of horticultural produce consumed in Kenya, appreciable amounts of export crops, grain staples and tubers. Examples include South West Kano, Mitunguu, Lower Nzoia, Chala, Lower Kaya, Oluch Kimira among others. They often experience poor mobilization and participation.
    - Commercial farms: can be individual or firm irrigation schemes: cover about 39 percent. Most of them utilize modern irrigation technology and produce high-value crops for the local and export market, especially flowers and vegetables. Examples include Del Monte, Kakuzi, High grown and Equator Flowers.

- Public owned irrigation schemes:covering the remaining 18 percent; they are large-scale ranging from 800 ha to 12 000 ha each:
    - National schemes, such as Mwea, Ahero, West Kano, Bunyala and Hola, which are managed by the National Irrigation Board (NIB). In some national schemes, the government manages the schemes jointly with farmers' organizations such as WUAs through irrigation management transfer programmes.
    - Institutional schemes, such as the Galana Kulalu irrigation scheme, managed by Regional Development Authorities (RDAs), Agricultural Development Corporations (ADC), the National Youth Service (NYS), prisons, universities and colleges.

The public schemes are currently experiencing management problems with large areas non-operational, due to water shortages, such as in Perkerra, or failure of pumping units, such as in Hola. However, some of them were revived after collapsing, such as Ahero, which collapsed in 1995 due to poor management and low economic return but revived in 2005.

The actually irrigated area varies greatly depending on the scheme and the water availability for a given year (WB, 2014). Based on the previous irrigated crop calendar and actually irrigated area in 2003, the actually irrigated area was estimated at around 136 000 ha in 2010.

Water for formal full control irrigation (141 900 ha) originates predominantly from rivers and lakes (86 percent) and from groundwater (14 percent). Lack of sufficient water storage incurred recurrent water shortages for the irrigation schemes (MALF, 2015). Water is directed to the formal full control irrigation schemes mostly by gravity (78 percent), either through pipes (in the Mount Kenya area, in the Eastern and Central provinces), canals (in the flat areas of Coast, Rift Valley and Nyanza) or both. Power is used for the remaining irrigation from the source to the scheme (22 percent), including at least 5 600 ha of the public schemes (WB, 2014).

Expansion over the last decades is below expectations due to lack of investments. New development is mostly driven by the private irrigation development, focusing in particular on the export of horticulture crops (WB, 2014).

Out of the estimated 250 000 ha of drainage potential area (WRMA, 2013b), there is no consensus yet on the area that has been developed. Depending on the sources, there are between 6 470 ha in 2010 (WRMA, 2013b) and 31 894 ha in 2011 (Annual Water Sector Review Report 2010 in WRMA, 2013b) of spate irrigation. Irrigation from flood water, either spate irrigation or flood recession agriculture, is widespread along the lower parts of the river Tana, the Daua River and the Lagh Dera River. Traditionally sorghum is cropped under flood recession, which is sufficient for the whole crop cycle. Maize would require at least one additional rainfall to complete its cycle, hence is only cropped during the long rainy season. Bananas are also produced used on flood recession on embankments. Flood recession plots range from 1-2 ha and are mostly individual. However, also the Sagana and Ichiara irrigation schemes use flood water through lowered intakes for controlled irrigation, as well as the planned Bura irrigation scheme once its intake is constructed within low embankments to allow natural floods in (Spate Network, 2008).

TABLE 9
Irrigation and drainage

Irrigation potential		-	353 060	ha
Irrigation:				
1. Full control irrigation: equipped area		2010	144 100	ha
- Surface irrigation		2010	101 530	ha
- Sprinkler irrigation		2010	31 218	ha
- Localized irrigation		2010	11 352	ha
• Area equipped for full control irrigation actually irrigated			-	ha
- As % of area equipped for full control irrigation		2010	135 900	%
2. Equipped lowlands (wetland, ivb, flood plains, mangroves)			-	ha
3. Spate irrigation		2010	6 470	ha
Total area equipped for irrigation (1+2+3)		**2010**	**150 570**	**ha**
• As % of cultivated area		2010	2.5	%
• % of area irrigated from surface water		2010	87	%
• % of area irrigated from groundwater		2010	13	%
• % of area irrigated from mixed surface water and groundwater			-	%
• % of area irrigated from non-conventional sources of water			-	%
• Area equipped for irrigation actually irrigated		2010	141 700	ha
- As % of total area equipped for irrigation		2010	94	%
• Average increase per year		2003-2010	5.5	%
• Power irrigated area as % of total area equipped for irrigation		2010	21	%
4. Non-equipped cultivated wetlands and inland valley bottoms			-	ha
5. Non-equipped flood recession cropping area			-	ha
Total water-managed area (1+2+3+4+5)		**2010**	**150 570**	**ha**
• As % of cultivated area		2010	2.5	%
Size of full control irrigation schemes:	**Criteria**:			
Small schemes	< - ha		-	ha
Medium schemes	> - ha and < - ha		-	ha
large schemes	> - ha		-	ha
Total number of households in irrigation			-	
Irrigated crops in full control irrigation schemes:				
Total irrigated grain production			-	metric tons
• As % of total grain production			-	%
Harvested crops:			-	
Total harvested irrigated cropped area		2010	140 200	ha
• Temporary crops: total		2010	123 200	ha
- Rice		2010	25 000	ha
- Maize		2010	6 000	ha
- Vegetables		2010	45 200	ha
- Sugarcane		2010	8 000	ha
- Coffee		2010	20 000	ha
- Tea		2010	8 000	ha
- Flowers		2010	5 000	ha
- Cotton		2010	6 000	ha
• Permanent crops: total			17 000	ha
- Citrus		2010	8 000	ha
- Pineapple		2010	8 000	ha
- Bananas		2010	1 000	ha
Irrigated cropping intensity (on full control area actually irrigated)		2010	103	%
Drainage - Environment:				
Total cultivated area drained			-	ha
• Non-irrigated cultivated area drained			-	ha
• Area equipped for irrigation drained			-	ha
- As % of total area equipped for irrigation			-	%
Area salinized by irrigation		1999	30 000	ha
Area waterlogged by irrigation			-	ha

FIGURE 3
Water managed area distribution
Total 150 570 ha water managed area in 2010

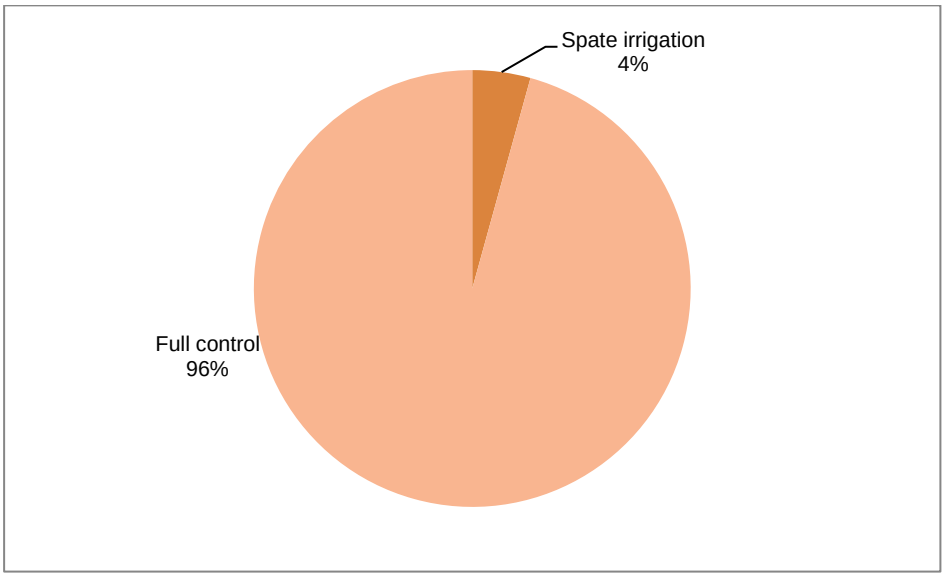


FIGURE 4
Techniques of irrigation
Total 144 100 ha equipped for full control irrigation in 2010

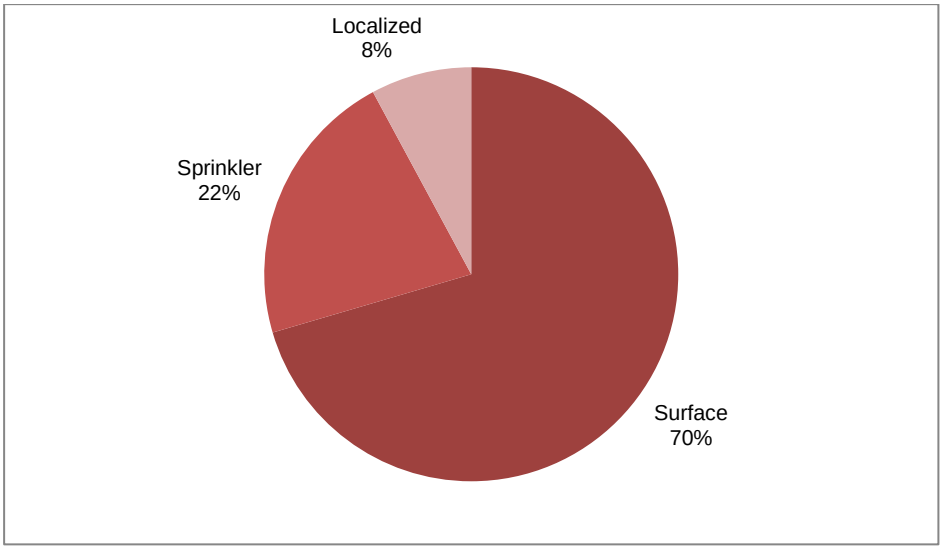


TABLE 10
Area equipped for irrigation: geographic distribution (Source: WRMA, 2013; MALF, 2015)

Catchment Area	In 2010 (ha)				In 2013 (ha)
	Large-scale	Small-scale	Private	TOTAL	
Lake Victoria North	363	1 327	186	1 876	20 206
Lake Victoria South	1 800	10 225	1 193	13 218	
Rift Valley	774	5 791	3 3022	9 587	15 089
Athi	0	13 524	31 374	44 898	47 710
Tana	11 200	14 823	38 402	64 425	70 427
Ewaso Ng'iro	0	6 233	1 663	7 896	8 408
TOTAL	**14 137**	**51 923**	**75 840**	**141 900**	**161 840**

Note: The above distribution does not include the 2 200 ha of informal peri-urban irrigation around Nairobi

Rainwater harvesting is also becoming a common practice for the medium and low potential areas of the country through the construction of individual water pans and the diversion of roadside runoff, to improve food security. Conservation agriculture is practiced on 33 100 ha in 2011.

Role of irrigation in agricultural production, the economy and society

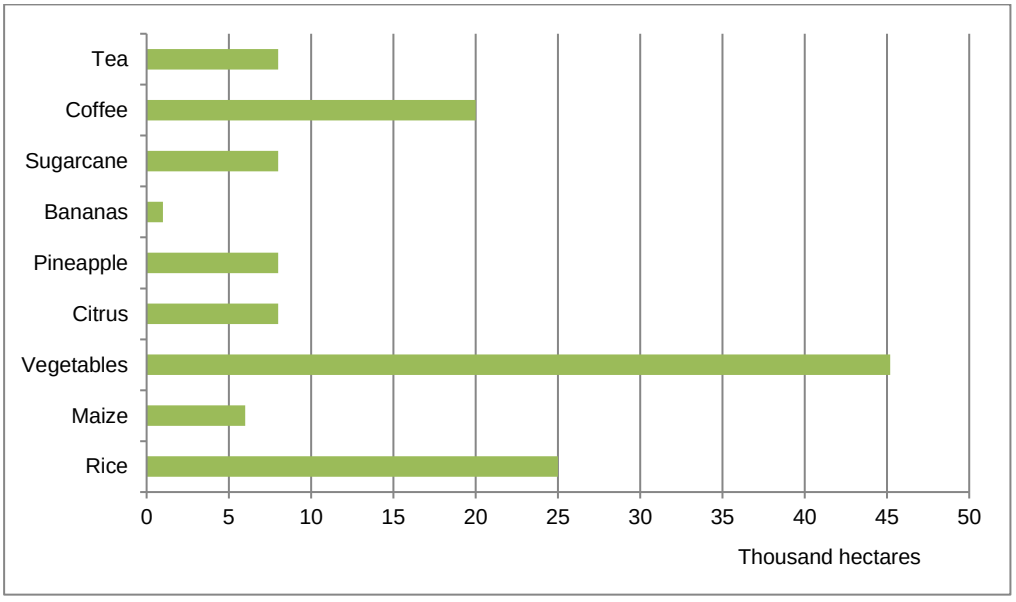
Agriculture in Kenya is mainly rainfed. Irrigated agriculture accounts for only 2.4 percent of the cultivated area, but contributes 3 percent to the GDP and 18 percent the national agricultural production. It employs about 3 million people: 900 000 directly and indirectly in public schemes, over 2 million in community-based schemes and around 82 500 in commercial farms. In the past, irrigation development not only aimed to secure and stabilize the food supply in face of droughts and to provide employment, but also to provide settlement for the landless when (re)distributing the equipped land (MALF, 2015).

The main irrigated crops include vegetables, rice, coffee, sugarcane, fruits (bananas and citrus), maize, cotton, as well as flowers (WB, 2014) (Table 9 and Figure 5). Cash crops, such as coffee, pineapples, sisal and lucerne were introduced in the 1930s-40s (Spate Network, 2008). The main public schemes, such as Mwea, Ahero, Pekerra, Bunyala and West Kano, predominantly produce water intensive crops, in particular rice. Smallholder irrigators produce mainly horticultural crops (NEMA, 2010).

In 2010, 72 500 tons of irrigated paddy rice was harvested only in the public irrigation schemes, where a total of 17 611 ha were harvested (KNBS, 2014). Paddy yields in Mwea scheme are "high and comparable to Asia" (WB, 2014). However, they are generally quite low, but range from 0.8 to 8.4 t/ha for paddy and 0.8 to 5.2 t/ha for irrigated maize. Cropping intensity is also generally just 100 percent, meaning only one crop cycle per year, even though it can be over 200 percent locally (WB, 2014).

The Galana Kulalu irrigation scheme is located in Tana and Kilifi counties between the Galana and Tana rivers. This food security project, initiated in 2014, aims to equip the Galana Ranch for irrigated sugarcane, maize and fruits; although the announced objective of 400 000 ha equipped for irrigation seem disproportionate compared to the regional irrigation potential. ThisRanch was established in 1968 and later acquired by ADC to provide a buffer zone for the Tsavo National Park. Similarly, there are also projects for cash crops, such as the Ramisi Sugar Factory, closed in 1989 after 60 years of operation, but revival was initiated in 2009 with an objective of 8 000 ha of irrigated sugarcane, including both nucleus and out-growers (NEMA, 2010).

FIGURE 5
Main irrigated crops in 2010
Total 140 200 ha harvested irrigated crop in 2010 (cropping intensity on actually irrigated area: 103 percent)



Women and irrigation

Traditionally, women and girls are the main collectors of water for domestic use. As a result, water scarcity affects them more than men and boys, having to walk further to find water. Men will only take the livestock to the source of water. If they fetch water, it's to sell it, as part of their job. Only in extreme cases they may assist in the fetching of water for domestic purposes, but in those cases carry it back on animal or bicycle.

There are some attempts by the government to raise the level of women participation in the water users associations in order to overcome the lack of gender focus in the water policy.

Women have also a dominant role in subsistence agricultural production due to rural-urban migration of men in search of more lucrative economic opportunities. However they paradoxically have little access to and control over land and own only 5 percent of the registered land in Kenya (NEMA, 2010).

WATER MANAGEMENT, POLICIES AND LEGISLATION RELATED TO WATER USE IN AGRICULTURE

Institutions

Overall responsibility for water management lies with the Ministry of Agriculture, Livestock and Fisheries (MALF), replacing the former Ministry of Water and Irrigation (MWI), and even before the Ministry of Water Resources Management and Development (MWRMD), established by the Water Act 2002. Within the MALF:

- The Irrigation and Drainage Directorate (IDD) is responsible for the overall coordination of irrigation and specifically for smallholder irrigation development (MALF, 2015).
- The National Irrigation Board (NIB) was formed in 1966 through the Irrigation Act (cap. 347) to manage the public irrigation schemes. It was the successor to the agency that was responsible during the colonial era for establishing and managing the large-scale public irrigation schemes, including Mwea Hola, Perkerra, West Kano, Ahero and Bunyala schemes. It expanded over time to include private community-based schemes.

Before the 2010 Constitution, the IDD was responsible for policy and planning while the NIB was responsible for implementation. However, the 2010 Constitution devolved both planning and implementation to local counties, at least for the projects they finance but this is yet not fully in place (WB, 2014). Counties can identify themselves the leading institution responsible for the local irrigation development (MAFL, 2015).

Other Ministries related to water include:

- Ministries of Environment, Water and Natural Resources, for control of pollution of water bodies and the prevention of water-related hazards
- Ministry of Energy,
- the National Treasury;
- Ministry of Devolution and Planning
- Ministry of Lands, Housing and Urban Development;
- Ministry of Industrialization and Enterprise Development, and
- Ministry of Health (MALF, 2015).

There are also a number of other institutions dealing with water management at national level:

- The Water Resources Management Authority WARMA responsible for the allocation of water and delivery of water permits;
- The National Environmental Management Authority (NEMA)

At sub-national level, the six Regional Development Authorities (RDAs), based on the main river basins of the country, have the responsibility to plan, coordinate, promote investment for integrated natural resource use, including irrigation projects. There is therefore duplication of functions between MALF and both its IDD and NIB, and the RDAs (MALF, 2015).

In relation to water supply and sanitation, the responsible agencies are (Republic of Kenya, 2014):

- The Water Services Regulatory Board (WASREB)
- The National Water Conservation and Pipeline Corporation (NWCPC)
- The Kenya Water Institute (KEWI)
- The Regional Water Services Boards (WSBs).

Institutions dealing with research on irrigation and drainage include the Kenya Agricultural Research Institute (KARI) and the Tegemeo Institute at Egerton University.

Water management

Before the 1990s, the NIB was central at every stage of irrigated agriculture: water conveyance, land preparation, inputs supply, marketing and processing. Since the late 1990s, an Irrigation Management Transfer (IMT) is implemented in public schemes to transfer operation and maintenance responsibilities to the farmers through Irrigation Water Users Associations (IWUAs). In community-based irrigation schemes, the group of farmers sharing a common irrigation system are grouped in IWUAs operating usually at scheme level with responsibilities on development, operation and maintenance of irrigation infrastructures, that can be expanded to agricultural supply and marketing (MALF, 2015).

Water allocation is performed by WRMA, who deliver water permits only after ecological and basic human needs, international treaties and inter-basin water transfers, reserve and domestic water demands have been met (WRMA, 2013).

There is currently a lack of comprehensive knowledge on the number and extent of irrigation schemes within the country, due to inadequate monitoring mechanisms and structures in place in water management especially of the traditional form of irrigation using flood water.

Finances

Government investment in irrigation development is low, but represents 70 percent of the total sub-sector budget. The remaining funds originate from development partners and the private sector. The 2013/2014 government contribution is however only a quarter of what is required to meet the targets of Vison 2030, estimated at 40 billion/year Kenyan shillings (MALF, 2015). The government grant to the water sector, which amounts to around 3 percent of the total government budget, is in its main part directed towards the irrigation sub-sector (WRMA, 2013).

Collection of water fees in public irrigation schemes does not cover the operation and maintenance required. In 2007, the water fee in irrigation was Ks 50cents/m^3 for the 1st 300 m^3/day, similar to the domestic, public and livestock uses, and 75 cents for the part over 300 m^3/day (WRMA, 2011).

The average cost of irrigation development is estimated at:

- US$ 15 000/ha for new public schemes with storage,
- US$ 10 000/ha for new public schemes without storage or new community-based scheme with storage,
- US$ 5 000/ha for new community-based scheme without storage.

The cost of rehabilitation is estimated at US$ 2 500/ha (WB, 2014).

Policies and legislation

The 2010 Constitution of Kenya is concerned with international waters and water resources (Fourth Schedule, Part 1 Clause 2), as well as protection of the environment and natural resources, in particular "water protection, securing sufficient residual water, hydraulic engineering and safety of dams" (Clause 22c.) (MALF, 2015).

Legislations specifically related to water and irrigation are under review. The National Policy on Water Resources Management and Development of Kenya was developed in 1999 and used as a basis for the 2002 Water Act (WRMA, 2013). The latter reformed the water sector with a view to improve efficiency by separating policy making and policy implementation with among other institutions the creation of the WRMA and WASREB, i.e. water management and water services delivery (MWI, 2012).

The irrigation sub-sector is governed by the 1966 Irrigation Act (Chapter 347), which does not reflect the realities anymore, in particular the community-based and commercial irrigation. But the 2015 Irrigation Bill Draft intends to bring the irrigation legislation up to date (MALF, 2015).

Policies on water and irrigation have been updated more recently. In between the two National Water Master Plans, the one of 1992 and its update of 2013, there also has been a National Water Resources Management Strategy 2006-2008 (WRMA, 2013b). In addition, a 2015 Draft National Irrigation Policy is currently under preparation. It will adopt principles of integrated water resources management (IWRM), environment management plans and agricultural water management strategy, including rainwater harvesting.

On water and sanitation, the following strategies apply: the National Water Quality Management Strategy 2012-2016 (MWI, 2012) and the National Water Services Strategy 2007-2015.

ENVIRONMENT AND HEALTH

The main environmental threat to water management in the country refers to the degradation of water catchment areas, especially within its five major water towers. Degradation of the forest in these areas due to settlements, poor farming practices such as overgrazing and over-cultivation, as well as cutting of trees without replantation, results in increased soil erosion and decreasing water flows (MWI, 2009; NEMA, 2010). The impact of irrigation on the forest cover is positive thanks to increasing agro-forestry and especially fruit trees, and this despite using uncovered lands like most agricultural systems (MALF, 2015).

Water pollution is not yet a serious environmental problem. The Athi river is nonetheless already contaminated due to inadequate wastewater treatment from Nairobi City and illegal dumping in its tributary, the Nairobi river. In recent years, both agricultural and industrial water discharge and sewage inflow degraded the water quality of Lake Naivasha, Lake Turkana, Lake Baringo and Lake Bogoria. Urban population growth threatens areas downstream of major cities due to uncontrolled discharges of wastewater, such as Lake Nakuru (WRMA, 2013). Such pollution also increases the cost of water treatment for domestic use (MWI, 2009).

Wetlands are also at risks, because they are used to dump industrial and municipal wastes causing eutrophication, or used for agricultural development. They also locally suffer lack of seasonal floods due to dams such as in the Tana River wetlands.

About 24 million ha are saline and sodic soils, of which 40 percent are located in the ASALs. This requires special attention if irrigation is developed (MALF, 2015). A case of environmental concern was experienced in the traditional irrigation area of Ngurumani, where waterlogging was threatening the long-term sustainability of the irrigation in the area. An area of conflict exists between the wildlife and irrigation schemes, since the latter are situated in ASAL where there is also a concentration of wildlife areas.

Whereas other countries of the Nile basin have large areas sold or leased to foreign investors, over a million ha in Uganda, Sudan and South Sudan, in Kenya there is only 14 000 ha leased for rice, sugarcane and flowers (GRAIN, 2012). This might be due to the indirect and weak access to water resources of the Nile basin and irregular rainfall.

Incidences of malaria and bilharzia are common in irrigated areas.

PROSPECTS FOR AGRICULTURAL WATER MANAGEMENT

Kenya's irrigation is facing significant challenges. In particular the irrigation development rate is low due to insufficient funding (MALF, 2015), which is inadequate to achieve the Vision 2030 objectives. It indeed plans an increase of the area under irrigation to the full high estimation potential of more than 1.3 million ha by 2030, requiring an average of 40 000 ha per year including an expansion of 32 000 ha and rehabilitation of 8 000 ha. Such objective would require increasing the public funding to irrigation to at least 5 percent of the annual national budget as required by the Comprehensive Africa Agricultural Development Programme (CAADP).

However, this unachievable objective was already reduced by the National Water Master Plan 2030 to a total of 765 575 ha based on water balance study, and further decreased to 672 700 ha because of the overall irrigation efficiency. The medium potential of 539 500 ha is retained by AQUASTAT (NEMA, 2010). The following expansion projects have been especially featured (MWI, 2009; NEMA, 2010):

- Expansion of the irrigation schemes in Ahero, Tan Delta, Kibwezi, Bunyal, Kano Plains, Nzoia (Upper, Middle and Lower), Pekerra, Kerio Valley, Mwea, Tavetta, Ewaso Ng'iro North and Ngurumani to reduce poverty and hunger;
- Reviving the collapsed irrigation schemes in the ASALs, in particular Hola and Bura irrigation schemes;
- Developing the largely untapped potential of the Tana and Athi river basins and the country's 253 km Lake Victoria shoreline.

Meeting the country's future water demand, is estimated at 21 468 million m^3 per year including 18 048 million m^3 for irrigation by 2030, compared to 1 602 million m^3 in 2010. However, the irrigation figure assumes that the full high estimation potential of 1.3 million ha would be actually equipped, which is also almost 10 times the area in 2010, which so far seems unrealistic or unachievable. Nonetheless, increase of the water availability for agriculture will require the construction of more storage reservoirs (WRMA, 2013), as well as the exploitation of all types of available water and in particular increase agricultural rainwater harvesting, direct use of wastewater, and exploitation of groundwater for irrigation (MALF, 2015).

From a management perspective, the creation of a number of additional institutions specific to irrigation and drainage is planned in order to build the capacity at all level from research to implementation, as well as to promote better participation of all stakeholders and increase funding of the sub-sector (MALF, 2015):

- a County Irrigation Development Unit (CIDU) in each county;
- a National Irrigation Development Service (NIDS) to facilitate irrigation development;
- an Irrigation and Drainage Research Center (IDRC) within the Water Resource Management Research Institute;
- an Irrigation Development Fund (IDF) to facilitate the development of irrigation;
- an Irrigation and Drainage Training Center (IDTC) for human resource development;
- a multi-agency Intergovernmental Coordinating Committee (ICC) cascaded down to each county.

Finally, finalization of both the legal and regulatory framework for the sub-sector awaits Assembly promulgation (MALF, 2015).

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