

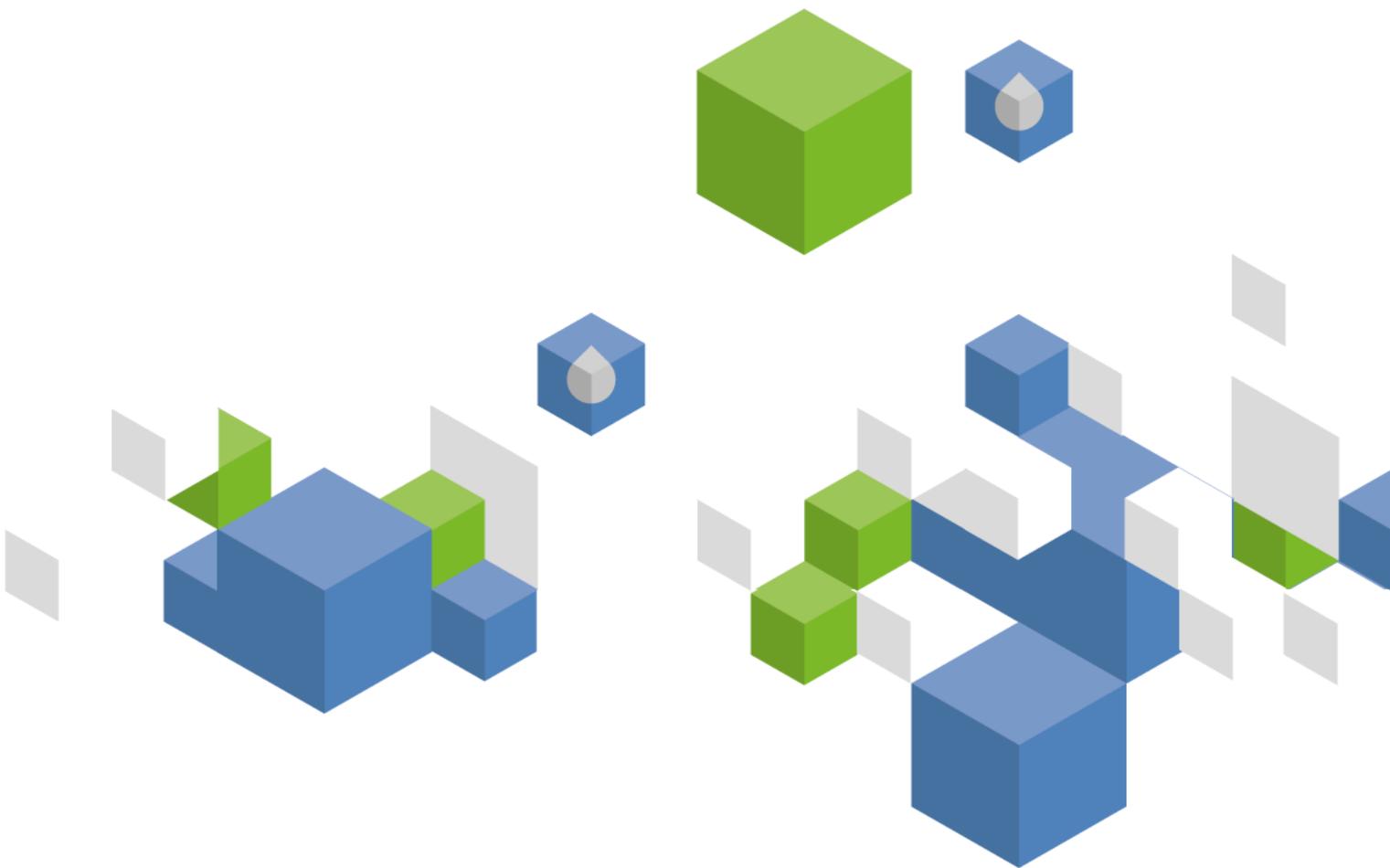


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United Republic of Tanzania

GEOGRAPHY, CLIMATE AND POPULATION

Geography

The United Republic of Tanzania consists of the mainland and Zanzibar, which is made up of the islands Unguja and Pemba. Its total area is 947 300 km². The country is bordered in the north by Uganda, Lake Victoria and Kenya, in the east by the Indian Ocean, in the south by Mozambique and in the west by Lake Nyasa, Malawi, Zambia, Lake Tanganyika, Democratic Republic of the Congo, Burundi and Rwanda.

The terrain comprises plains along the coast, a plateau in the central area, and highlands in the north and south. The border with Kenya is dominated by Mount Meru and Mount Kilimanjaro. Southwards is the Central Plateau reaching elevations above 2 000 m. The mountain range of the Southern Highlands separates the Eastern plateau from the rest of the country.

Land cover is dominated by woodland, grassland and bushland which account for about 80 percent of the total area. Agricultural land is estimated to be about 40 million ha, or 42 percent of the total area. In 2013, 15.65 million ha or 17 percent of the country was cultivated, comprising 13.5 million ha of arable land and 2.15 million ha of permanent crops (Table 1).

TABLE 1
Basic statistics and population

Physical areas:			
Area of the country	2013	94 730 000	ha
Agricultural land (permanent meadows and pasture + cultivated land)	2013	39 650 000	ha
• As % of the total area of the country	2013	42	%
• Permanent meadows and pasture	2013	24 000 000	ha
• Cultivated area (arable land + area under permanent crops)	2013	15 650 000	ha
- As % of the total area of the country	2013	17	%
- Arable land (temp. crops + temp. fallow + temp. meadows)	2013	13 500 000	ha
- Area under permanent crops	2013	2 150 000	ha
Population:			
Total population	2015	53 470 000	inhabitants
- Of which rural	2015	69	%
Population density	2015	56	inhabitants/km ²
Economy and development:			
Gross Domestic Product (GDP) (current US\$)	2014	49 184	million US\$/year
• Value added in agriculture (% of GDP)	2014	31	%
• GDP per capita	2014	920	US\$/year
Human Development Index (highest = 1)	2014	0.521	-
Gender Inequality Index (equality = 0, inequality = 1)	2014	0.547	-
Access to improved drinking water sources:			
Total population	2015	55.6	%
Urban population	2015	45.5	%
Rural population	2015	77.2	%

Climate

The climate varies from tropical along the coast to temperate in the highlands. There are two types of seasonal rainfall distribution:

- The unimodal type, where rainfall is usually from October/November to April, found in the central, southern and southwestern highlands;
- The bimodal type, comprising two seasons: the short rains (*Vuli*) fall from October to December, while the long rains (*Masika*) fall from March to June. This type occurs in the coastal belt, the north-eastern highlands and the Lake Victoria Basin.

Annual rainfall varies from 500 mm to 1 000 mm over most of the country. The highest annual rainfall of 1 000 mm to 3 000 mm occurs in the northeast of the Lake Tanganyika basin and in the Southern Highlands. Mean annual rainfall is 1 071 mm. Zanzibar and the coastal areas are hot and humid and average daily temperatures are around 30°C. October-March is the hottest period. Sea breezes however temper the region's climate and June-September is coolest with temperatures falling to 25°C. In the Kilimanjaro area, temperatures vary from 15°C in May-August to 22°C in December-March.

Population

The total population of the country is estimated at 53.5 million in 2015, of which 69 percent is rural (Table 1). The annual population growth rate is 3.2 percent for the 2005-2015 period and the average population density is 56 inhabitants/km². The vast majority of the population lives inland, far away from the coastline.

In 2014, the Human Development Index ranks the United Republic of Tanzania 151 among 188 countries and the Gender Inequality Index ranks it 125 among 155 countries for which information is available (UNDP, 2016). Life expectancy in 2013 is 64 years and the under-five mortality in 2015 is 49 per 1000 births, both progressing from 49 years and almost 160 per 1000 in 1995. Around 84 percent of the children in 2013 are enrolled in primary education, but only 33 percent for secondary education. With only 3 point difference in both cases, the female proportion attending school is higher in primary school but lower in secondary school. Adult literacy is 79 percent in 2013, with a gap between female literacy (74 percent) and male literacy (84 percent). Poverty concerns in 2011 over a quarter of the population (28 percent) and is mainly a rural phenomenon (33 percent of rural population). However, urban poverty (16 percent of urban population) has accompanied rapid urbanization (WB, 2016). In 2015, 77 percent of the urban and 46 percent of the rural population were using improved drinking water sources, which is 56 percent of the total population. This represents a minimal improvement since 2002 when 55 percent of the population had access to an improved drinking water source. Yet, it is still better than the sanitation situation which finds in 2015 only 16 percent of the population with improved sanitation facilitation, and only 8 percent in rural areas against 31 percent in urban areas (JMP, 2015).

ECONOMY, AGRICULTURE AND FOOD SECURITY

The economy is largely based on services and agriculture. In 2014, the gross domestic product (GDP) was US\$ 49 184 million (current US\$), with an annual growth of 7 percent. It has been constantly more than 5 percent since 2000. Agriculture contributed 31 percent to the GDP in 2014, down from 45 percent 20 years earlier. The sector employs still 67 percent of the active population (WB, 2016) and thus continues to drive the economic growth of the country (MWI, 2009) in spite of the emergence of the new high-growth sectors of mining and tourism.

Despite its importance, agriculture is very affected by unreliable rainfall and periodic droughts (MWI, 2009). Smallholder farming covers over 14 million ha, with an average farm size ranging from 0.2 to 2 ha, while commercial farming is spread over 1.5 million ha for just over 1 000 farms. Agricultural

production remains predominantly based on smallholder production, with commercial farming concentrating on cash crops.

The main food crops grown are maize, dry beans, rice, sunflower, cassava, sorghum, groundnuts, sweet potato and coconuts. Maize is the dominant crop with a planted area of over 4 million ha, followed by dry beans with over 1.1 million ha and rice with around 1 million ha.

Traditionally, the country was a net exporter of agricultural products, but it has become a net importer in recent years (FAO, Agwa & IFAD, 2014). The main agricultural products exported are green coffee, tobacco, cashew nuts, cotton, sesame and tea for the 2009-2011 period, while the main agricultural products imported are soybeans, wheat and palm oil.

Prevalence of undernourished people is almost 35 percent in 2014 in Tanzania (FAO, 2015), progressing from 41 percent in the last decade. The country has also some of the highest level of malnutrition, with 42 percent of under-five children suffering from malnutrition.

WATER RESOURCES

The United Republic of Tanzania has nine major drainage basins that are the basis for water resources management through nine corresponding basin water boards (MWI, 2009):

TABLE 2
Drainage basins in the United Republic of Tanzania

Water basin	Draining outlet
Lake Victoria (part of the Nile river basin)	Mediterranean Sea
Pangani river	Indian Ocean
Ruvu/Wami river	
Rufiji river	
Ruvuma river	
Lake Nyasa (part of the Zambezi river basin)	
Lake Tanganyika (part of the Congo river basin)	Atlantic Ocean
Lake Rukwa	
Internal drainage (including lake Natron, Eyasi and Manyara)	Rift Valley endorheic basin

River discharge and lake levels start rising in November-December and generally reach their maximum in March-April with a recession period from May to October/November. Many of the larger rivers have flood plains, which extend far inland with grassy marshes, flooded forests and ox-bow lakes.

The lakes and swamps cover 5.4 million hectares and comprise 5.8 percent of the country (SEI, 2007), in particular Lake Victoria, Lake Tanganyika and Lake Nyasa (Tanzanian name for Lake Malawi), which also form the border to neighbouring countries (Table 4). Other lakes include Lake Rukwa, Lake Eyasi, Lake Manyara, Lake Natron, Lake Balangida.

Internal renewable surface water resources are estimated at 80 000 million m³/year and renewable groundwater resources at around 30 000 million m³/year, but 4 000 million m³/year is considered to be overlap between surface water and groundwater, which gives a value of total internal renewable water resources (IRWR) of 84 000 million m³/year (Table 3). External renewable water resources are estimated at 12 270 million m³/year, which is the inflow from the Kanyaru river from Rwanda (4 670 million m³/year) contributing to the Kagera river, and from the Kagera river from Burundi (7.6 million m³/year). Surface water leaving the country is estimated at 15 640 million m³/year through Lake Victoria to Uganda (10 700 million m³/year), through the Kagera border river to Rwanda (7 600/2 = 3 800 million m³/year), through Lake Malawi to Malawi (140 million m³/year) and through Lake Tanganyika to the Democratic Republic of the Congo (1 000 million m³/year). The dependency ratio is around 13 percent and the total renewable water resources are 96 270 million m³/year, or 1 800 m³/year per capita in 2015.

TABLE 3
Water resources

Renewable freshwater resources:			
Precipitation (long-term average)	-	1 071	mm/yr
	-	1 015 000	million m ³ /yr
Internal renewable water resources (Long-term average)	-	84 000	million m ³ /yr
Total renewable water resources	-	96 270	million m ³ /yr
Dependency ratio	-	13	%
Total renewable water resources per inhabitant	2015	1 800	m ³ /yr
Total dam capacity	2015	104.2	million m ³

There are 633 dams (MWI, 2009) and the total capacity of large dams is almost 104 200 million m³. This includes 100 000 million m³ which is considered to be the Tanzanian part of the additional storage capacity created in Lake Victoria (shared with Kenya and Uganda) through the construction of the Owen Falls dam at the outlet of Lake Victoria in Uganda. The main dams in the United Republic of Tanzania are the Mtera, Nyumba ya Mungu, and the Kidatu dams. Leakage, siltation and inappropriate or damaged features are very common: about 21 percent of the 633 dams experience spillage and 12 percent have silted up, requiring hence rehabilitation (MAFSC, 2013). About 90 percent of the country electricity is generated through hydropower from the Great Ruaha and Pangani rivers only (DE, 2006). Small dams are called *Charco* dams for irrigation, municipal and livestock purposes. Hydrological and topographic conditions largely restrict dam construction in the country, but three major dams are planned: the Farkwa dam in Dodoma; the Lugoda Dam in Iringa; and the Kidunda dam in Morogoro (MW, 2014).

Due to the very low rate of population with access to improved sanitation (16 percent), there is little wastewater collected—47 million m³ in 2012—and even less treated and directly used. Similarly, there is little desalinated water, despite the fact that that would help reduce water shortages especially on the Zanzibar islands.

INTERNATIONAL WATER ISSUES

The country shares six international lakes (Table 4), five international rivers included in three of the largest African river basins—Nile, Congo and Zambezi (Table 5)—and seven international aquifers (Table 6). This is more than any other nation in Africa. A large part of the country's international borders are water bodies: the Ruvuma river with Mozambique, Lake Tanganyika with the Democratic Republic of the Congo, Lake Nyasa and the Songwe river with Malawi, the Kagera river with Rwanda and Uganda and Lake Victoria with Uganda and Kenya. As a result, the United Republic of Tanzania is part of numerous transboundary institutions and agreements for the management of these shared water resources as detailed in the respective tables below.

The country is a signatory to the SADC's Shared Water Course Systems Protocol and its revised version, which provides the basis for the management of international rivers in the SADC region, which consists of 14 countries.

Lake Victoria, shared between United Republic of Tanzania, Uganda and Kenya, 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 the three countries, established the Lake Victoria Environment Management Project (LVEMP) to rehabilitate the Lake's ecosystem.

United Republic of Tanzania 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 Tanzania 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 Tanzania and four other countries—Ethiopia, Rwanda, Uganda and Kenya—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 and Ethiopia (see also the respective country profiles) (MWI, 2009).

The United Republic of Tanzania is also member of the Zambezi Basin Watercourse Commission (ZAMCOM) created in 2004 between the eight countries sharing the basin: Angola, Botswana, Malawi, Mozambique, Namibia, United Republic of Tanzania, Zambia, and Zimbabwe.

The country is also part of the Congo river basin, the world's second largest river basin after the Amazon river basin, together with Angola, Burundi, Cameroon, the Central African Republic, Congo, Democratic Republic of the Congo, Rwanda, and Zambia. The country is however not member of the International Commission of the Congo-Ubangi-Sangha Basin (CICOS), regrouping only four of the nine riparian countries. Similarly, there is no specific joint management of the smaller lakes—Chala, Jipe and Natron—with Kenya, or for the transboundary aquifers.

Finally, there are some bilateral agreements and institutions, such as the Songwe River Development Programme with Malawi—aiming to stabilize the course of the river which changed because of floods the corresponding boundary (MW, 2013)—and the Malawi/Tanzania Joint Permanent Commission of Cooperation (JPCC).

TABLE 4
Transboundary lakes

Lake	Lake's area (km ²)	Basin	Riparian countries and respective share	International management
Victoria	68 800	Nile	Kenya (6%), United Republic of Tanzania (49%), Uganda (45%)	Lake Victoria Basin Commission Nile Basin Initiative
Tanganyika	32 900	Congo	Burundi, Democratic Republic of the Congo, United Republic of Tanzania (41%), Zambia	Lake Tanganyika Authority
Nyasa (Malawi)	30 800	Zambezi	Malawi, Mozambique, United Republic of Tanzania (18%)	Zambezi Basin Watercourse Commission (ZAMCOM)
Natron	1 040	Shebelle-Juba	Kenya and United Republic of Tanzania	-
Jipe	30	East Central Coast	Kenya and United Republic of Tanzania	-
Chala	4.2	-	Kenya and United Republic of Tanzania	-

TABLE 5
Transboundary rivers

River	Total basin area (km ²)	Sharing countries and respective share	International management
Kagera	59 800	Burundi, Rwanda, United Republic of Tanzania, Uganda	Defunct Kagera Basin Organisation (KBO) up to 2004
Mara	13 504	Kenya	Nile Basin Initiative
Ruvuma	152 200	Malawi (0.3%), Mozambique (65.3%), United Republic of Tanzania (34.3%)	Ruvuma River Joint Water Commission
Songwe	4 200	Malawi and United Republic of Tanzania	Songwe River Basin Developments Programme
Pangani (Umba/Ruvu)	43 650	Kenya (5%) and United Republic of Tanzania (95%)	Pangani Basin Water Board (PBWB) Pangani Basin Water Office (PBWO)

Table 6 below summarizes the transboundary aquifers.

TABLE 6
Transboundary aquifers (Source: IGRAC, 2014)

Aquifer	Total aquifer area (km ²)	Sharing countries
Coastal Sedimentary Basin III	23 075	Mozambique, United Republic of Tanzania
Karoo Sandstone Aquifer	40 007	Mozambique, United Republic of Tanzania
Weathered basement	25 842	Malawi, United Republic of Tanzania, Zambia
Tanganyika	222 297	Burundi, Democratic Republic of the Congo, Rwanda, United Republic of Tanzania
Coastal Sedimentary Basin I	16 801	Kenya, United Republic of Tanzania
Kilimanjaro Aquifer	14 579	Kenya, United Republic of Tanzania
Kagera Aquifer	5 779	Rwanda, United Republic of Tanzania, Uganda

WATER USE

Total water withdrawal in mainland Tanzania was estimated for the year 2002 to be 5 142 million m³. Agriculture was the largest water withdrawal sector with almost 90 percent of total, and in particular irrigation (86 percent), while the municipal sector used 10 percent and industry less than 1 percent (Table 7).

Without more recent data, the 2002 National water Policy and the 2009 *Water Resources Management Act* consider that irrigation withdraws about 85 percent of the total water withdrawals.

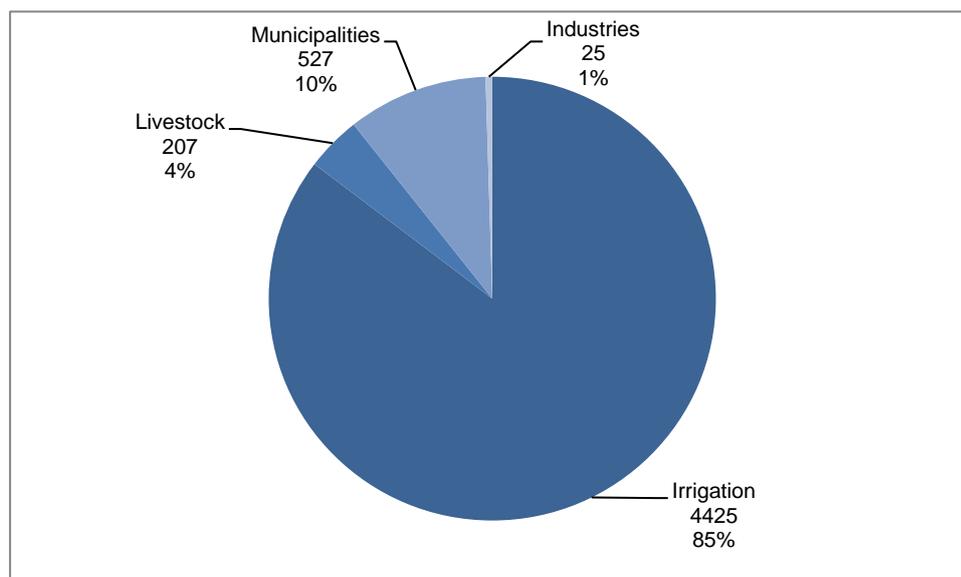
Total drinking water production in 2010 for Dar es Salaam comes to around 300 000 m³/day, i.e. almost 110 million m³/year, although approximately half of this is lost through leakages. The demand, including from industries in Dar es Salaam, is almost 146 million m³/year. Most of this water originates from the Ruvu river, as well as from some boreholes (UNDP, 2011).

In 2010, groundwater withdrawal is estimated to be around 462 million m³, mostly for domestic purposes (60 percent), but also for livestock, fishing, etc. (28 percent), irrigation (10 percent) and industries (2 percent). Groundwater is only used for irrigation purposes in sugarcane, fruits such as grapes, vegetable and flower farming. Use of groundwater for industries mostly takes place in urban areas, especially Dar es Salaam where 80 percent of the industries are located (IWMI, 2010).

TABLE 7
Water use

Water withdrawal:			
Total water withdrawal	2002	5 184	million m ³ /year
- Irrigation	2002	4 425	million m ³ /year
- Livestock	2002	207	
- Municipalities	2002	527	million m ³ /year
- Industry	2002	25	million m ³ /year
• Per inhabitant	2002	143	m ³ /year
Surface water and groundwater withdrawal (primary and secondary)	2002	5 184	million m ³ /year
• As % of total renewable water resources	2002	5.4	%
Non-conventional sources of water:			
Produced municipal wastewater		-	million m ³ /year
Treated municipal wastewater		-	million m ³ /year
Direct use of treated municipal wastewater		-	million m ³ /year
Direct use of agricultural drainage water		-	million m ³ /year
Desalinated water produced		-	million m ³ /year

FIGURE 2
Water withdrawal by sector
 Total 5 184 million m³ in 2002



IRRIGATION AND DRAINAGE

Evolution of irrigation development

Irrigation potential is estimated by the 2002 Study on the National Irrigation Master Plan (NIMP) to be 2 123 700 ha in mainland Tanzania, while for Zanzibar it is estimated to be 8 521 ha. The criteria for this estimate are water resources potential, land resources potential and socio-economic potential. The high potential areas are located in roughly four locations:

- Mara, Mwanza and Kagera regions
- Arusha and Kilimanjaro regions
- Morogoro region
- Mbeya and Iringa regions

The total irrigation potential from wetlands only is estimated at 851 000 ha (DE, 2006).

Irrigation in the form of traditional irrigation schemes goes back hundreds of years in the country. Traditionally, irrigation was practiced on slopes but never in the wetlands. Only flood retention cultivation was carried out in the floodplains. In the early 20th century in the Mbeya region some families introduced stream diversion for rice production, a practice that was rapidly adopted locally (MALC, 2005).

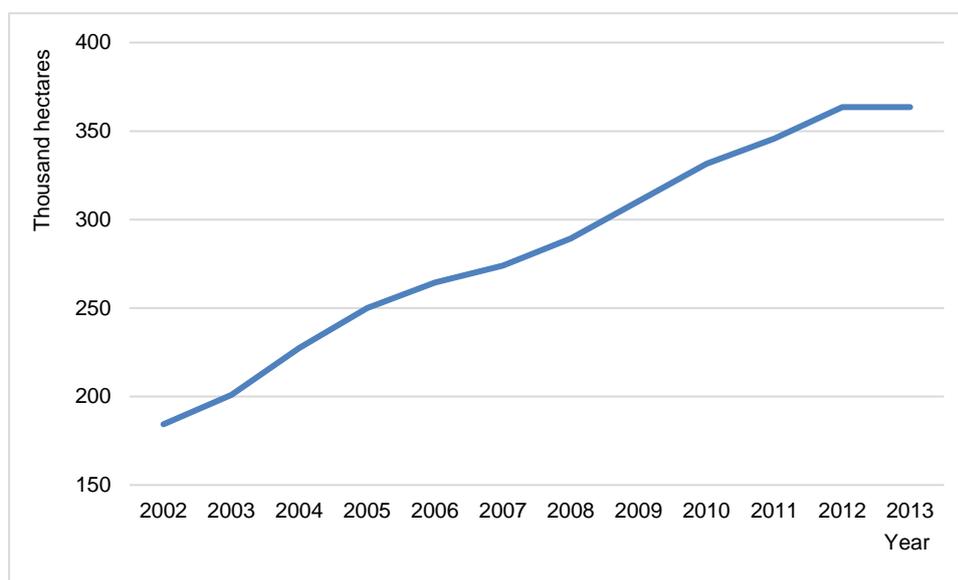
Modern irrigation was introduced in the 1930s by private companies and the Department of Agriculture. In the 1950s, additional traditional irrigation schemes were established by smallholders with the support of the government for infrastructures and extension provision, but irrigation development funds were mostly allocated to state farms. In the 1960s, unrealistic targets of irrigation development of 10 000 ha/year were never achieved because of low level of government commitment and funds until the 1974-75 drought that resulted in a major food crisis. In the 1970s, private commercial irrigated farms growing coffee, tea and sugarcane and performing well were nationalized. In the 1980s, priority was given to rehabilitation of traditional irrigation schemes and construction of new modern schemes for parastatal (rice, tea and sugarcane) and smallholders, but both were mostly unsuccessful. External support from 1985 onwards increased the irrigation development rate, but performance remained low. The Government launched a major irrigation development plan in 1994 to address constraints to the sector

development. In the late 1990s, the horticultural and floricultural industry developed private irrigated estates with high efficiencies.

The total area equipped for irrigation was 184 330 in 2002, of which 122 630 ha of traditional irrigation schemes in equipped wetlands. Geographically, 183 988 ha were located in mainland Tanzania and 342 ha in Zanzibar. At that time 1 428 irrigation schemes (including water harvesting schemes) in mainland Tanzania and 19 irrigation schemes in Zanzibar were inventoried. Figure 3 shows the evolution of the area equipped for irrigation since then. In 2013, 363 514 ha are equipped for irrigation, including 117 000 ha of equipped lowlands by traditional smallholders schemes and 1 000 ha of spate irrigation. However, at least 54 380 ha of irrigation schemes need rehabilitation / modernization (FAO, Agwa & IFAD, 2014). In 2013, out of the 363 514 ha total area equipped for irrigation, the harvested irrigated crop area was 450 392 ha were irrigated and harvested of which 60 863 ha in large irrigation schemes. The harvested irrigated crop area on the full control equipped area of 245 514 ha is estimated to be 333 392 ha.

FIGURE 3

Evolution of the area equipped for irrigation (Source: MWI, 2009; MAFSC, 2011; MAFSC, 2011b; NBS, 2015)



Most of the irrigated areas are characterized by reliance on the run-of-the river water abstractions for gravity-fed irrigation schemes (MWI, 2009). Water distribution is usually by lined and unlined canals, and furrows and basins are widely used. Sprinkler irrigation is used by a few large-scale commercial farmers, in particular on sugarcane plantations. It is not common amongst smallholders. Localized irrigation is rarely used, mostly to irrigate horticulture and flowers. In 2002, almost all irrigation water on the mainland is surface water, groundwater is utilized on only 0.2 percent of all irrigated areas, in particular by large commercial irrigated farms, such as the Tanzania Planting Company-Moshi (TPC Limited, over 7 800 ha) and Kilombero sugar estates (IWMI, 2010). More recently, among the 400 irrigation schemes that received financial support for rehabilitation from the Agriculture Sector Development Programme between 2006 and 2013, the major source is surface water, while groundwater supplies only 7 percent of the area, of which 6 percent are from springs (ASDP, 2013).

Referring to the total area equipped for irrigation of 363 514 ha (Table 8 and Figure 4), the following types of irrigation are distinguished:

- Large irrigation schemes (55 229 ha): these are formally planned and designed schemes with full irrigation facilities and usually a strong element of management by the government or other external agencies. Those schemes are developed in the regions of Kilimanjaro, Morogoro and Mbeya. All parastatal managed irrigation schemes and large-scale commercial irrigated farms also fall under this category.

- Traditional irrigation schemes (1 137 schemes covering 117 000 ha): these have been initiated and operated by the farmers themselves, with no intervention from external agencies. They include schemes based on traditional furrow irrigation for the production of fruit and vegetables in the highlands and simple water diversion schemes on the lowlands, wetlands or flood plains for rice, called bunded basin flood irrigation (*majaluba*). Maize is often grown as a flood recession crop during the dry season. Irrigation structures are often temporary and do not allow for full water control, and there are often no drainage structures. Due to poor infrastructure, the water use efficiency of these schemes ranges from 15 to 30 percent (MAFSC, 2013). Most of the traditional irrigation is located in Pangani, Rufiji, Wami-Ruvu Basins.
- Improved traditional irrigation schemes (190 285 ha): these are traditional irrigation schemes on which, at some stage, there was intervention by an external agency, such as the construction of a new diversion structure. Hence, they have permanent structures for full control irrigation, drainage and flood protection.
- Spate irrigation (1 000 ha): There are some attempts of spate irrigation schemes using flash flood irrigation. The Mlandala scheme (Iramba District) developed in 2006-07 and covering 300 ha was out of irrigation after the intake was damaged, but fortunately repaired in 2011. Also at Igurubi spate/supplementary irrigation scheme (MAFSC, 2013) covers 334 ha (FAO Agwa & IFAD, 2014). Spate is locally called “Kitivo” in Makanya irrigation scheme covering 300 ha.

In addition, there are rainwater harvesting based schemes. This type of artificial water control is not considered as irrigation as such, so these rainwater harvesting based schemes are not included in the irrigated area. Most of these schemes are found in the arid and semi-arid areas of central and western part of the country. In 2001, they cover about 27 200 ha for a catchment area of 220 000 ha in mainland Tanzania, mainly located in the regions of Dodoma, Manyara, Shinyanga, Singida and Tabora and parts of Mwanza, Mara and Arusha. In rainwater harvesting schemes, rainfall is captured directly into small bunded basins or runoff is diverted from residential areas, paths and transient streams to fields in the bottom of the valleys, where mainly paddy rice is grown. The most important system is the diversion of ephemeral streams for distances up to 2 km. Recently, backyard rainwater harvesting also started to be practiced (MWI, 2009).

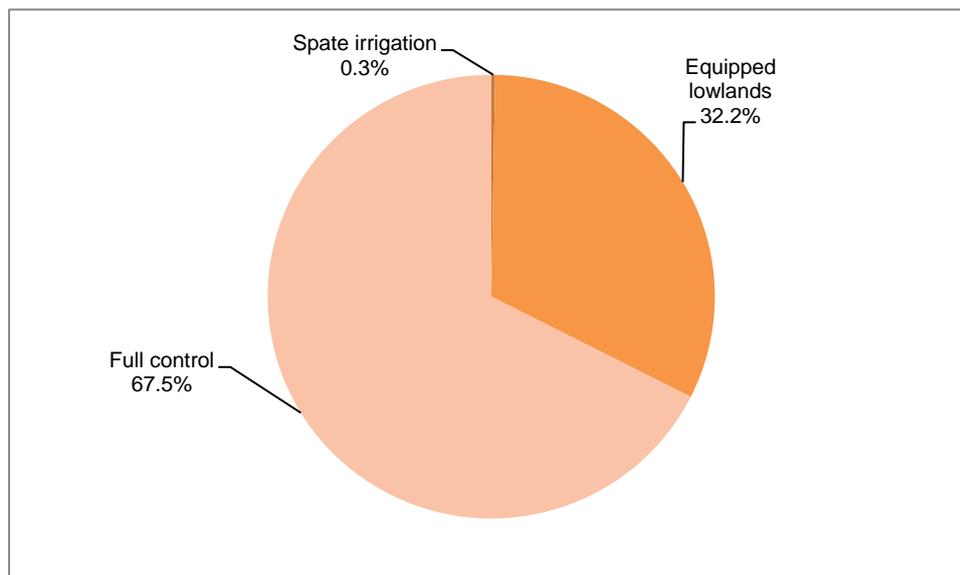
In 2002, gravity-fed irrigation schemes account for over 99 percent of the irrigated area, while the rest uses pumps for water abstraction. The latter schemes are mainly located in the regions of Kagera, Mara and Mwanza.

The regions with the largest amount of irrigation are Kilimanjaro, Morogoro, Arusha and Mbeya (FAO, 2005).

TABLE 8
Irrigation and drainage

Irrigation potential		2 132 221	ha
Irrigation:			
1. Full control irrigation: equipped area	2013	245 514	ha
- Surface irrigation		-	ha
- Sprinkler irrigation		-	ha
- Localized irrigation		-	ha
• Area equipped for full control irrigation actually irrigated	2013	245 514	ha
- As % of area equipped for full control irrigation	2013	100	%
2. Equipped lowlands (wetland, ivb, flood plains, mangroves)	2013	117 000	ha
3. Spate irrigation	2013	1 000	ha
Total area equipped for irrigation (1+2+3)	2013	363 514	ha
• As % of cultivated area	2013	2.3	%
• % of area irrigated from surface water		-	%
• % of area irrigated from groundwater		-	%
• % of area irrigated from mixed surface water and groundwater		-	%
• % of area irrigated from non-conventional sources of water		-	%
• Area equipped for irrigation actually irrigated		-	ha
- As % of total area equipped for irrigation		-	%
• Average increase per year	2002-2013	6.4	%
• Power irrigated area as % of total area equipped for irrigation		-	%
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)	2013	363 514	ha
• As % of cultivated area	2013	2.3	%
Size of full control irrigation schemes:		Criteria:	
Small schemes	< 200 ha	2013	190 285 ha
large schemes	> 200 ha	2013	55 229 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	2013	332 392	ha
• Temporary crops: total	2013	325 679	ha
- Rice	2013	71 370	ha
- Maize	2013	124 000	ha
- Other cereals	2013	15 477	ha
- Vegetables	2013	41 721	ha
- Roots and tubers	2013	6 400	ha
- Pulses	2013	26 627	ha
- Oil crops	2013	7 074	ha
- Sugarcane	2013	13 333	ha
- Cotton	2013	14 700	ha
- Other temporary crops	2013	4 977	ha
• Permanent crops: total	2013	6 713	ha
- Coffee	2013	2 768	ha
- Tea	2013	2 570	ha
- Fruits	2013	1 375	ha
Irrigated cropping intensity (on full control area actually irrigated)	2013	135	%
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	50 000	ha
Area waterlogged by irrigation		-	ha

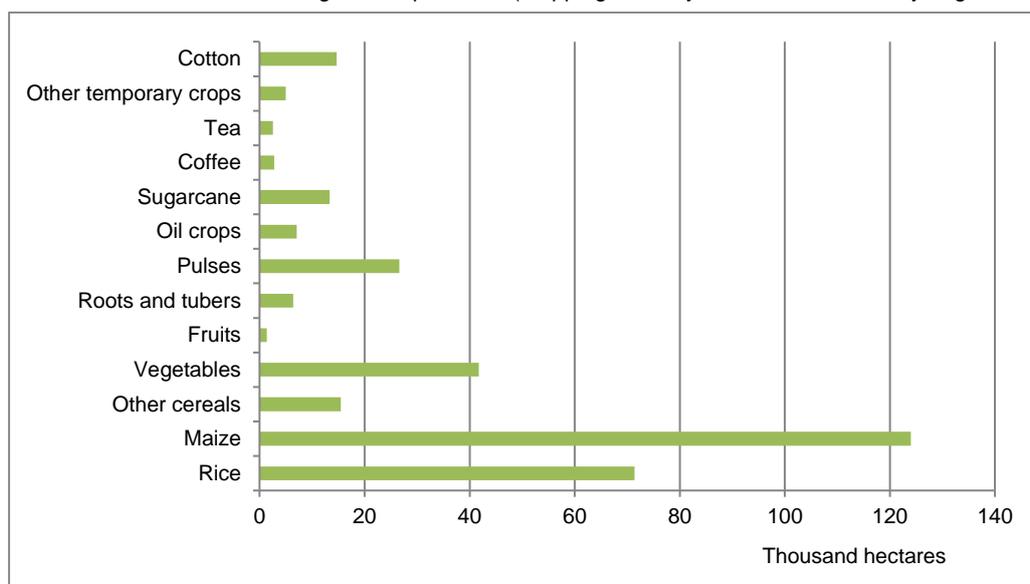
FIGURE 4
Areas equipped for irrigation
 Total 363 514 ha equipped for irrigation in 2013



Role of irrigation in agricultural production, the economy and society

The main irrigated crops are maize and rice, accounting for about 37 percent and 21 percent of the full control harvested irrigated crop area of 332 392 ha in 2013 (Table 8 and Figure 5). Other irrigated crops, accounting for the remaining 42 percent, comprise vegetables (including onion, tomato and leaf vegetables), pulses, sugarcane, cotton, oil crops and roots and tubers. There are also limited areas of irrigated coffee, tea and tobacco. From the above figures, the cropping intensity is 135 percent. Private irrigation schemes produce cash crops such as tea, coffee, cotton and sugarcane.

FIGURE 5
Main irrigated crops in 2008
 Total 332 392 ha harvested irrigated crop in 2013 (cropping intensity on full control actually irrigated area: 135 percent)



The performances of improved irrigation schemes have gradually improved in terms of water management and crop yields. For example, paddy yields of up to 10 tons/ha have been achieved by some smallholder farmers or on some previously parastatal farms (now privatized due to high operational costs). However, average yields of 4 to 5 tons/ha only are common on improved traditional or new

schemes, but can be as low as 1.8-2 tons/ha. The bulk of rice produced is locally consumed although considerable amounts are exported to neighbouring countries.

Production and productivity in most irrigation schemes are generally below expectation, in particular in traditional irrigation schemes. Inappropriate or inefficient methods of land preparation and cultivation contribute to low production and productivity, especially with the dominating use of hand hoe (MWI, 2009). A total of 441 974 households used irrigation according to the 2007/2008 census.

Women and irrigation

Water fetching is mostly the responsibility of girls, who as a result drop out of school (MAFSC, 2011b). Women play major roles in rural economic development especially in irrigated agriculture, but are limited by customary laws and traditions. Land is indeed largely under the control of male farmers and traditionally women would not inherit, which thus limits their access to land. In addition, traditionally, it is said that women were not supposed to talk in meetings when men are present.

They perform nearly all the tasks related to agricultural production, both in rainfed and irrigated farming, and are often working longer hours than their husbands since these tasks add on to household and childbearing activities. However, a study in the Usangu Plains in 1994 evidenced a clear sexual division of labour in rice operations, where only men are irrigating, while women are responsible for or participate in most other tasks. Gender imbalances in irrigation schemes were further evidenced: only 10 percent could access irrigated plots, 20 percent could access irrigation water and irrigation extension services, and 10 percent could receive incomes from sales of irrigated crops (Kweka, 1998). The inequitable access for women to water and irrigated lands set by traditions was reinforced by the lack of resources, supports and skills they could gain. This gender inequity is still to be addressed in 2009 according to the Ministry of Water and Irrigation (MWI, 2009).

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

Institutions

The main institutions involved in agricultural water management are:

- The Ministry for Water (MW) was created in 2008 from the former Division of Irrigation and Technical Services of the Ministry of Agriculture. Previously there had already been some Ministries responsible for Water: the Ministry of Lands, Settlements and Water Development in 1964, the Ministry of Water Development and Power in 1973 before irrigation management was transferred to the Ministry of Agriculture in 2002. MW is responsible for the development and management of water resources, the preparation of integrated water resources management plans, the planning and designing of dams and the promotion of rational allocation of water with formal water use permits. These tasks are done through the implementation of the National Irrigation Policy in collaboration with the Ministry of Agriculture. Locally, MW also provides technical services through the Zonal Irrigation Units (ZIUs) working with the regional administration and the local governments, as well as promotes integrated water resources management in the basins with the Basin Water Offices (BWOs). The Water Development and Management Institute (WDMI), is the MW entity responsible for research on water management.
- Ministry for Agriculture, Food Security and Cooperatives (MAFSC) implements the National Irrigation Policy from crop production and productivity perspective, in particular through its:
 - Ministry of Agriculture Training Institutes (MATIs) and
 - Ministry of Agriculture Research Institutes (MARIs).
- The National Environmental Management Council (NEMC) is the advisory body to the Government on environmental matters.

- The National Water Board, established in 2012, advises MW on multi-sectoral coordination, integrated water resources planning and management as well as resolution of national and international water conflicts.

Linkages between relevant institutions are weak and their respective roles and responsibilities are not clearly defined to the detriment of effective irrigation development. Other constraints to irrigation development include the lack of staff and detailed data on the sector (MWI, 2009).

In relation to water and sanitation, two public sector institutions are officially responsible in Dar es Salaam: the Dar es Salaam Water and Sewerage Authority (DAWASA) owns the water supply infrastructure and the Dar es Salaam Water and Sewerage Corporation (DAWASCO) manages the water supply practically (UNDP, 2011). The Energy and Water Utilities Regulatory Authority (EWURA) is in charge of the technical and economic regulation of the water sectors, as well as the electricity, petroleum and natural gas sectors.

Water management

Water resources in the United Republic of Tanzania are managed according to the *2009 Water Resources Management Act (WRMA)* at five levels, from national to local: i) national water board, ii) the nine basin water boards, iii) catchment water committees, iv) district councils and v) water users associations (WUA). The latter are organized in water catchments and are responsible for managing allocation of water resources at local level, managing equitable allocation of resources during drought, and mediating local disputes (Medmu, Magayane, 2005). Irrigators' organizations, formed from the early 1990s onwards, are to be converted in WUAs. Irrigators' organizations are custodian of the irrigation scheme ownership and get the Water User Permit from their corresponding basin water board, for which they pay a fee. They organize the operation and maintenance of the schemes, distribution of the water, collection of water fees on behalf of the basin water board, resolve conflicts among members and participate in the scheme development and improvement. They can also guarantee irrigators' access to financial institutions for credits and establish cooperatives for capacitating and empowering farmers. Most irrigation schemes in Tanzania have management problems due to limited funds, skills and capacities in both financial management and law enforcement. In particular, the *2009 WRMA*, does not allow the associations to impose a penalty to the users who fail to pay the service charges (MWI, 2009).

The nine basin water boards are preparing IWRMD Plans in Tanzania, each at various progress stages (MW, 2014). They also re-register all water rights granted before the *2009 WRMA*, as well as the customary water rights and record the former unregistered ones (MW, 2013). The catchment water committees were still under formation in 2014.

Regarding water supply and sanitation services, Community-Owned Water Supply Organizations (COWSOs) are in charge in rural areas, and Water Supply and Sanitation Authorities (WASSA) in urban areas.

Finances

Irrigation development is constrained by low level of government funding for both irrigation and water storage infrastructures and low rate of private investments due to insecure land ownership rights (MWI, 2009). As a result, irrigation development, together with sustainable water resources and land use management, was set as priority investment in the Tanzania Agriculture and Food Security Investment Plan for 2011 to 2021 (TAFSIP 2011) and two funds—the District Irrigation Development Fund (DIDF) and the National Irrigation Development Fund (NIDF)—were established (MAFSC, 2014).

The cost of irrigation infrastructure varies across the irrigation schemes and can be as high as US\$18 500/ha for example for a 10 ha new Igingilanyi irrigation scheme in Iringa, which uses groundwater. Unit cost of investment of new irrigation scheme and rehabilitation in Tanzania is lower

than the equivalent cost in Sub-Saharan Africa, but the cost for improvement is slightly above (MAFSC, 2013)

Policies and legislation

The main regulatory framework for irrigation in the United Republic of Tanzania is the *2009 WRMA No.11*, which repealed the previous *1974 Water Utilization (Control and Regulation) Act. No.42* as amended by the *1997 Water Laws (Control and Regulation) Act*, but not the *1999 Water Laws (Miscellaneous amendments) Act*. The *2009 WRMA Act* stipulates that all water in mainland Tanzania is vested in the United Republic of Tanzania and introduces more participatory management through the five levels of water management in the country (see water management section above). It was completed by the *2013 National Irrigation Act* establishing a National Irrigation Commission. Finally, the *2009 Water Supply and Sanitation Act (WASSA)* organizes the water provision services and establishes the National Water Investment Fund (MW, 2014). More generally, the *2004 Environmental Management Act (EMA)* requires irrigated agriculture to protect the land, surface water and groundwater resources, as well as the community.

A wide range of policies further define the water and irrigation sectors:

- The 2002 National Water Policy (NAWAPO 2002), which amended the first National Water Policy of 1991, was prepared in part as a response to the growing water use conflicts, especially in the Pangani and Rufiji basins, most of which involve irrigation. It addresses the need for participatory agreements on the allocation of water use and to involve private sector in the resources' management. It recognises irrigation as a dominant consumptive user the water resources.
- The 2002 National Irrigation Master Plan (NIMP) proposed an irrigation development programme for 405 421 ha to be implemented by 2017 that includes only smallholder schemes.
- The 2006 National Water Sector Development Strategy (NWSDS) aims to develop a comprehensive framework for sustainable development of the country's water resources, together with the NAWAPO 2002.
- The 2006 Water Sector Development Programme 2006-2025 (WSDP) was prepared to implement objectives of NAWAPO 2002 and NWSDS 2006 (SEI, 2007).
- The 2010 Nation Irrigation Policy provides a vision and step-wise prioritization of irrigation development in the country and research with reference to the NIMP. It leads towards the establishment of financing mechanisms for irrigation—DIDF and NIDF (see section finances above). It has the objective of ensuring sustainable availability of irrigation water and its efficient use for enhanced crop production, productivity and profitability that will contribute to food security and poverty reduction.

Finally, the Tanzania Agriculture and Food Security Investment Plan for 2011-12 to 2020-21 (TAFSIP) and the National Agricultural Policy of 2013 detail the priority for the agricultural production (FAO, Agwa & IFAD, 2014).

ENVIRONMENT AND HEALTH

The major environmental problems remain the deterioration of water quality and pollution of water resources from natural and anthropogenic activities, already identified by the 1997 National Environment Policy. They are evident in many parts of the country in particular for surface water (MW, 2014). The quality of groundwater is generally good to acceptable for most uses. Salinity and high fluoride concentrations may exceed standards in the Pangani Basin.

The country's surface waters have deteriorated over the years due to both point and non-point sources of pollution. Rivers in urban centres, for example Msimbazi in Dar es Salaam, have been used as dumping sites for waste from various sources, polluting these rivers and thus making the water unsafe both for domestic consumption or irrigation, without costly treatment. In addition, outbreaks of waterborne diseases such as cholera and typhoid are common in both urban and rural areas of Tanzania (NBS, 2015).

Salinity is building up in some irrigation scheme as a result of poor irrigation management and lack of adequate infrastructures (MAFSC, 2013).

Finally, tremendous increasing trends of flows in most of the rivers and water levels in dams and lakes have been observed from 2006 to 2014, in particular in Lake Victoria and Lake Tanganyika with an increase of the latter's water level by 2 meters.

PROSPECTS FOR AGRICULTURAL WATER MANAGEMENT

The 2006 Agriculture Sector Development Strategy has set a target of irrigating about one million hectares by 2016, but data from the 2006-2013 period shows that this target will definitely not be achieved on time (MAFSC, 2013; NBS, 2015). The more realistic target of 405 400 ha equipped for irrigation by 2017, set by the 2002 National Irrigation Master Plan (NIMP), is still limited by the financial capacities available but is not impossible, especially with regards to ongoing projects such as the Rice Centre of Excellence in Eastern Africa, for which around 20 000 ha are to be equipped for irrigation, and the Kilangali Seed Farm project, with irrigated agriculture on about 100 000 ha. The irrigation development rate increases in the last years, with the 2011-2016 target of an additional 40 000 ha hectares under small-scale improved irrigation infrastructures almost completed through the construction of small scale dams in particular (MAFSC, 2014). The abundant sources of water, co-existence of several agro-ecological zones and the almost unexploited 2.3 million ha irrigation potential still permits tremendous irrigation expansion and diversification in crop production that could contribute significantly to stabilizing agricultural production and increasing income. Only access to both water and land locally and for some vulnerable groups may be a binding constraint in some cases.

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