

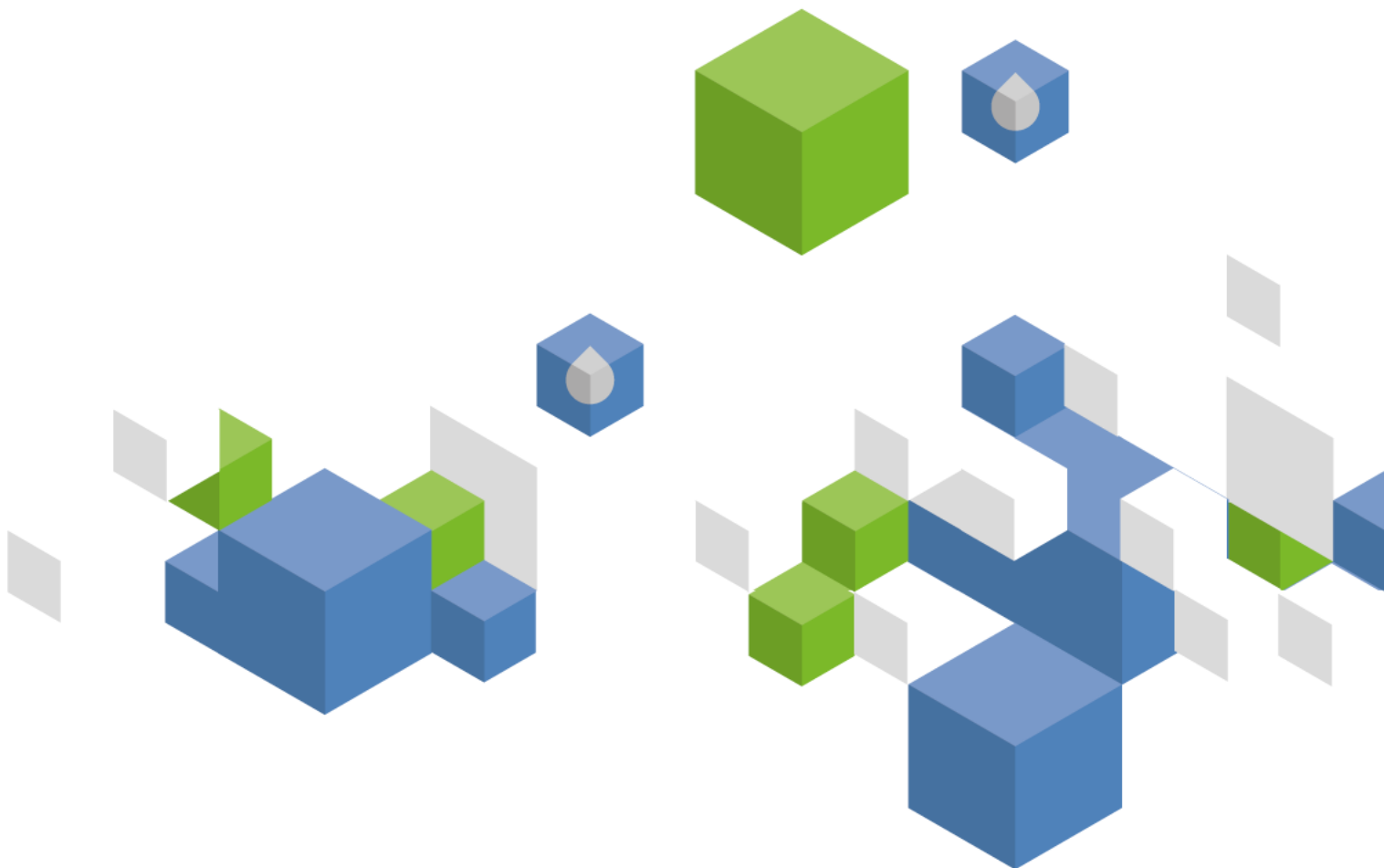


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Botswana

GEOGRAPHY, CLIMATE AND POPULATION

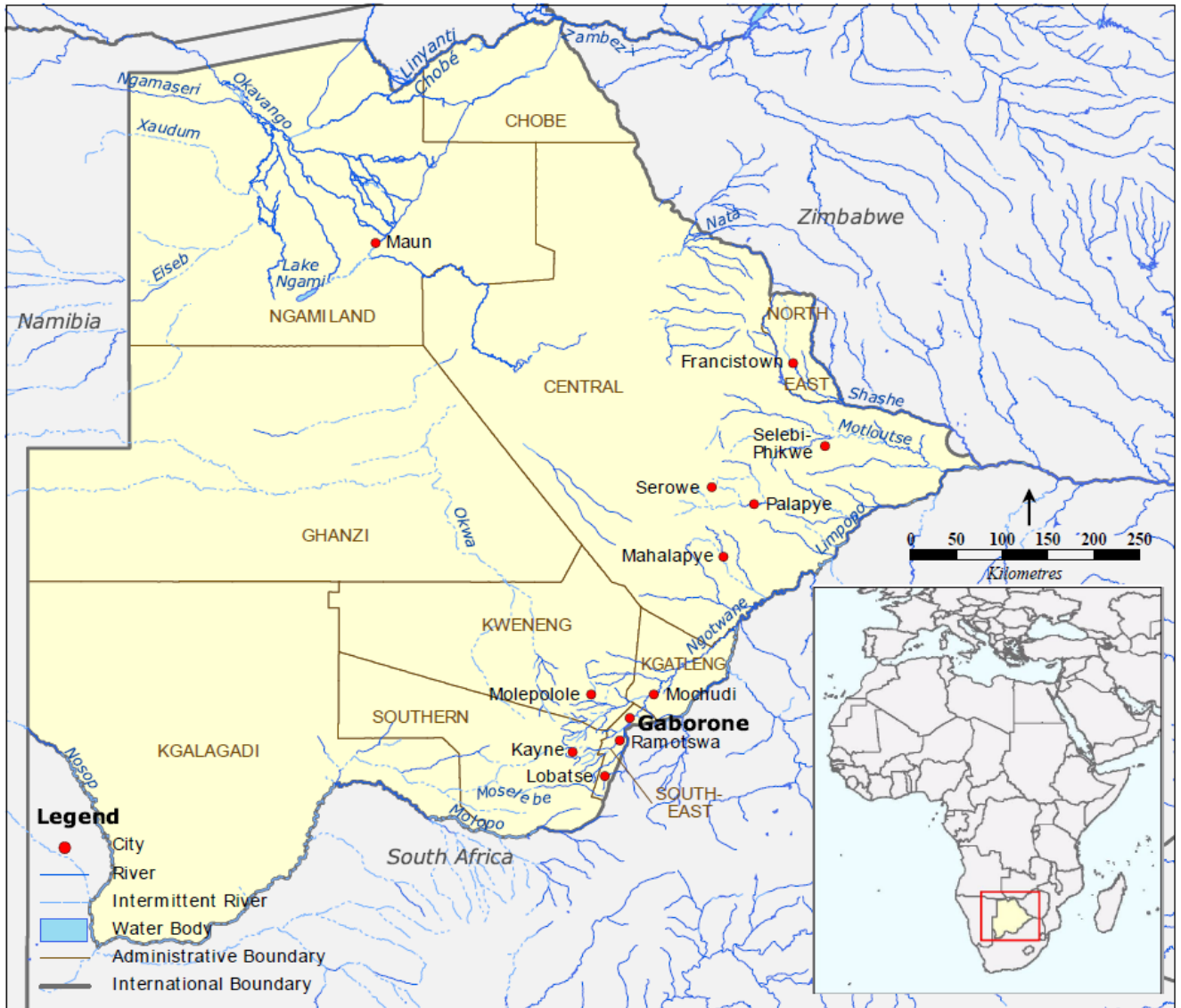
Geography

Botswana is a landlocked country lying in the centre of Southern Africa between Zambia, Zimbabwe, South Africa and Namibia. At no point is it closer than 500 km to either the Atlantic or the Indian Ocean. The total area within national boundaries is 581 730 km². Its altitude averages about 1 000 m above sea level, but most of the country is flat with gentle undulations and occasional rocky outcrops. The main forested areas are in the north and northeastern parts of the country. Most soils in the country are light with limited water-holding capacity. According to 2002 figures, only 5 percent of the land is suitable for agricultural production and less than 1 percent is cultivated (Table 1).

TABLE 1
Basic statistics and population

Physical areas:			
Area of the country	2002	58 173 000	ha
Cultivated area (arable land and area under permanent crops)	2002	380 000	ha
• As % of the total area of the country	2002	0.7	%
• Arable land (annual crops + temp fallow + temp. meadows)	2002	377 000	ha
• Area under permanent crops	2002	3 000	ha
Population:			
Total population	2004	1 795 000	inhabitants
- Of which rural	2004	48	%
Population density	2004	3	inhabitants/km ²
Economically active population	2004	808 000	inhabitants
- as % of total population	2004	45	%
- female	2004	45	%
- male	2004	55	%
Population economically active in agriculture	2004	352 000	inhabitants
- as % of total economically active population	2004	44	%
- female	2004	57	%
- male	2004	43	%
Economy and development:			
Gross Domestic Product (GDP) (current US\$)	2003	7 400	million US\$/year
• Value added in agriculture (% of GDP)	2003	2.5	%
• GDP per capita	2003	4 146	US\$/year
Human Development Index (highest = 1)	2002	0.589	-
Access to improved drinking water sources:			
Total population	2002	95	%
Urban population	2002	100	%
Rural population	2002	90	%

FIGURE 1
Map of Botswana



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BOTSWANA

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Three agro-ecological zones can be distinguished in the country:

- In the centre and west, the Kalahari Desert covers over two-thirds of the total area. Although it has low rainfall, the predominant landscape is not desert but savannah grasslands interspersed with woodland. The sandy soils are not well suited to cultivation, but support considerable numbers of cattle, goats, other livestock and wildlife;
- The east of the country, consisting of loamy clay soils, has a less harsh climate and more fertile soils than the Kalahari. Rainfall is generally in excess of 400 mm annually. The predominant landscape is savannah grasslands and woodlands, with a small amount of forest;
- In the northwest, the Okavango Delta presents a different landscape: vast areas of open water and lush, green wetlands with an abundance of wildlife. The area of the Delta varies according to season and rainfall. To the east of the Delta lie the Makgadikgadi Pans: vast, flat, salty depressions, where there was once a huge lake, the endpoint of the Okavango River.

Climate

The climate is arid and semi-arid, with low rainfall and high rates of evapotranspiration. Mean annual rainfall is 416 mm, ranging from 650 mm in the north to 250 mm in the extreme southwest. Rainfall occurs in the form of localized showers and thunderstorms, resulting in large temporal and spatial variations. Rain generally falls between October and March, but the pattern is highly irregular. Drought is a recurring problem, although in early 2000 record rainfall caused serious flooding. Daytime temperatures in summer can reach 40°C while winter days are invariably sunny and cool to warm (5-23°C). Annual open water evaporation varies from about 1 900 mm to 2 200 mm. Evaporation rates are highest in the summer when 80-95 percent of the rainfall occurs.

Population

Population is estimated at almost 1.8 million (2004) and about 48 percent of inhabitants are rural (Table 1). Average population density is 3 inhabitants/km², but 80 percent of the inhabitants are concentrated in the east where most of the livestock grazes and most crop production takes place. Population growth was only 1.5 percent between 1997 and 2003. As a result of the highest HIV/AIDS prevalence rates in the world, life expectancy has fallen sharply, from around 65 in 1991 to 38 years in 2002. Some 95 percent of the population has access to improved drinking water sources (100 percent in urban areas and 90 percent in rural areas). Primary school was completed by 90 percent of the children and 70 percent continued to secondary school in 2000. Unemployment was officially estimated at 15.8 percent of the labour force in 2000.

ECONOMY, AGRICULTURE AND FOOD SECURITY

The contribution of the agricultural sector to GDP decreased from 40 percent at independence in 1966 to 2.5 percent in 2003, partly because of the expansion of mining but also as a result of the stagnation of the sector itself and recurrent droughts. Despite all this, the agricultural sector remains fundamental as a source of food and income for nearly 50 percent of the total population (2001). HIV/AIDS has become another major challenge for the country, as it mainly concerns the skilled and productive section of the population, affecting 38 percent of the 15-49 age group and thus threatening Botswana's impressive economic gains (2002).

The contribution of agriculture to total exports and imports in 2001 was 5 percent and 17 percent respectively. Most of the exported agricultural production comes from the livestock sub-sector which is the third source of foreign exchange. A significant part of the annual cereal requirements of 250 000 - 300 000 tonnes is imported from South Africa. The undernourished population has increased from 17 percent to 25 percent between 1992 and 1998, making poverty one of the highest priorities of the government.

The agricultural sector is composed of two distinct farming systems, the commercial and the traditional systems which both engage in crop and livestock production. The difference between commercial and traditional farming is based on land tenure, use of technology and marketing as opposed to consumption of production:

- Commercial farms tend to specialize in cattle production. They cover 8 percent of the total land area and represent less than 1 percent of all farms. In 1993 they held 14 percent of all cattle and accounted for 37 percent of the total production of cereals and pulses;
- Two-thirds of traditional farmers practise mixed farming, with cropping on individually-managed holdings and livestock grazing on communal land. In 1993, traditional farms held 86 percent of all cattle, 98 percent of goats and 83 percent of sheep. As the incidence of drought is high, small farmers are highly vulnerable to crop failure because they are totally reliant on rainfed crop production and do not use drought-resistant varieties.

The average yield of cereal crops on commercial farms is 500 kg/ha, compared with 200 kg/ha on traditional farms. Commercial farms also have higher annual calving rates and lower animal mortality.

WATER RESOURCES

Five major drainage basins exist in the country:

- The Limpopo basin occupies about 14 percent of the country in the east;
- The Orange basin occupies about 12 percent in the south;
- The Zambezi basin occupies a small area (2 percent) in the north;
- The Okavango basin, which is an endorheic basin, occupies about 9 percent in the northwest;
- The South Interior, which also is an endorheic basin, occupies the remaining area (about 63 percent) and includes the Kalahari Desert and the Makgadikgadi Pans.

Low rates of surface runoff and groundwater recharge are typical. Even during the wet season stream flow is not continuous, with internal rivers only flowing for 10-75 days a year. The Okavango Delta in the northwest is a large inland delta including about 6 000 km² of permanent swamp and between 7 000 and 12 000 km² of seasonally inundated swampland. Together with the Chobe and Linyati rivers, it accounts for 95 percent of all surface water in the country. An estimated 11 km³ of water flows every year into the delta, but most of it is lost through evapotranspiration. There is a spillway from this area to the Chobe river in the Zambezi basin in periods of high floods.

Internal renewable surface water resources are estimated at 0.8 km³/year. Most dams on rivers have been constructed for urban water supplies or for livestock watering. The major dams are constructed on the larger rivers and some have required international agreements. It is considered that most 'good' sites for larger dams have now been used or are reserved for large water supply dams (for urban and industrial water uses), which are expected to be constructed in the near future. The smaller dams on smaller rivers currently suffer from sedimentation and irregular stream flows, making planning for use by irrigation difficult. Many earth dams built for livestock watering and irrigation (over 240 since 1970) have also suffered from lack of maintenance and many are now not in use.

Groundwater resources are used throughout the country for livestock and municipal watering and for small areas of irrigation. These resources are geologically old and quality can be affected by salinity and concentrations of fluorides, nitrates and other elements. Current groundwater recharge rates are equivalent to about 1.7 km³/year. Considering an overlap of about 0.1 km³/year between surface water and groundwater, the total internal renewable water resources are 2.4 km³/year (Table 2). In most parts of Botswana groundwater abstraction effectively mines a limited resource. It is estimated that over 21 000 boreholes exist in the country, but many are not used and capped. Just over half of the registered boreholes in the country are owned by the government, the remainder by private individuals. Although the amount of water potentially available is large, it is relatively expensive to exploit and it is saline in

many places. Aquifers also have to be protected carefully from contamination, mainly caused by faecal material from septic tanks and pit latrines.

TABLE 2
Water resources

Renewable water resources:			
Average precipitation		416	mm/yr
		241.83	10 ⁹ m ³ /yr
Internal renewable water resources		2.4	10 ⁹ m ³ /yr
Total actual renewable water resources		12.2	10 ⁹ m ³ /yr
Dependency ratio		80.39	%
Total actual renewable water resources per inhabitant	2004	6 819	m ³ /yr
Total dam capacity	1995	453.705	10 ⁶ m ³

INTERNATIONAL WATER ISSUES

Most of the rivers in Botswana (the Okavango, Limpopo, Zambezi and Orange rivers) are shared with other countries. The Okavango River Basin Water Commission (OKACOM) was created in 1994 between Angola, Namibia and Botswana, the three countries sharing this basin; and the Zambezi Watercourse Commission was created in 2004 between the eight countries sharing the basin.

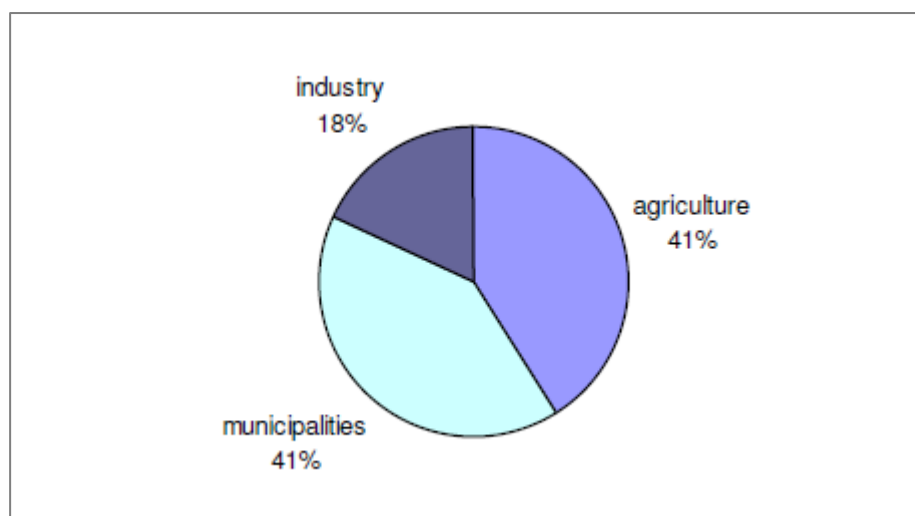
WATER USE

Human settlements are consuming an ever-increasing share of water in Botswana. Of the 113 million m³ of water consumed in 1992, irrigation and livestock accounted for 47 percent, municipalities 34 percent and industries 20 percent. In 2000, water withdrawals increased to 194 million m³, including 80 million m³ for irrigation, forestry, livestock and wildlife (41 percent), 79 million m³ for urban use, villages, settlements and small industry (41 percent) and 35 million m³ for mining and energy (18 percent) (Table 3 and Figure 2). By the year 2020, total water demands are expected to reach 336 million m³ annually and the municipal sector and small industry are expected to account for 52 percent of total consumption.

TABLE 3
Water uses

Water withdrawal:			
Total water withdrawal	2000	194	10 ⁶ m ³ /yr
- irrigation + livestock	2000	80	10 ⁶ m ³ /yr
- municipalities	2000	79	10 ⁶ m ³ /yr
- industry	2000	35	10 ⁶ m ³ /yr
• per inhabitant	2000	112	m ³ /yr
Surface water and groundwater withdrawal	2000	194	10 ⁶ m ³ /yr
• as % of total actual renewable water resources	2000	1.6	%
Non-conventional sources of water:			
Produced wastewater	2000	43	10 ⁶ m ³ /yr
Treated wastewater	1999	8	10 ⁶ m ³ /yr
Re-used treated wastewater		-	10 ⁶ m ³ /yr
Desalinated water produced		-	10 ⁶ m ³ /yr
Re-used agricultural drainage water		-	10 ⁶ m ³ /yr

FIGURE 2
Water withdrawal
Total 0.194 km³ in 2000



Groundwater supplies two-thirds of the water consumption. Rural areas depend on groundwater resources. Water from dams, rivers and other surface water sites currently contributes about one-third to national water consumption. Four large dams supply some of the urban areas with water. A pipeline of 360 km, from the dams of Letsibogo to the water plant of Mmamshia, is under construction with the aim of supplying water to the capital city of Gaborone. A pilot project using wastewater for irrigation is being developed in Glen Valley close to Gaborone.

IRRIGATION AND DRAINAGE

Evolution of irrigation development

Around 13 000 ha have been identified as suitable for irrigation on the basis of soil and water availability in the Limpopo, Okavango and Chobe river basins. However, this figure is based on major surface water resources thus ignoring the potential for small-scale irrigation from minor surface water or groundwater resources.

The 1 381 ha developed for full/partial control irrigation in 1992 increased to 1 439 ha in 2002, but only about 620 ha was irrigated in the dry season in 2002 (Table 4, Table 5 and Figure 3). The rest of the surfaces were not irrigated owing to factors such as no water, poor marketing conditions or simply the cost of irrigating. No recent figures on irrigation technology are available, but in 1992, 15 percent of the equipped area was equipped for surface irrigation, 65 percent for sprinkler irrigation and 20 percent for localized irrigation (Figure 4).

TABLE 4
Irrigation and drainage

Irrigation potential		13 000	ha
Water management			
1. Full or partial control irrigation: equipped area	2002	1 439	ha
- surface irrigation	1992	218	ha
- sprinkler irrigation	1992	892	ha
- localized irrigation	1992	271	ha
• % of area irrigated from groundwater	1992	44.3	%
• % of area irrigated from surface water	1992	51.8	%
• % of area irrigated from mixed water	1992	3.9	%
2. Equipped lowlands (wetland, ivb, flood plains, mangroves)		-	ha
3. Spate irrigation		-	ha
Total area equipped for irrigation (1+2+3)	2002	1 439	ha
- as % of cultivated area	2002	0.4	%
- average increase per year over the last 10 years	2002	0.4	%
- power irrigated area as % of total area equipped		-	%
- % of total area equipped actually irrigated	2002	-	%
4. Non-equipped cultivated wetlands and inland valley bottoms		-	ha
5. Non-equipped flood recession cropping area	1992	6 500	ha
Total water-managed area (1+2+3+4+5)	2002	7939	ha
- as % of cultivated area	2002	2.1	%
Full or partial control irrigation schemes: Criteria:			
Small-scale schemes	< ha	-	ha
Medium-scale schemes		-	ha
large-scale schemes	> ha	-	ha
Total number of households in irrigation		-	
Irrigated crops in full or partial control irrigation schemes:			
Total irrigated grain production		-	tonnes
- as % of total grain production		-	%
Total harvested irrigated cropped area		-	ha
- Annual crops: total		-	ha
. Vegetables	2002	299	ha
- Permanent crops: total	2002	321	ha
. Orchards/ citrus	2002	321	ha
Irrigated cropping intensity		-	%
Drainage - Environment:			
Total drained area		-	ha
- part of the area equipped for irrigation drained		-	ha
- other drained area (non-irrigated)		-	ha
- drained area as % of cultivated area		-	%
Flood-protected areas		-	ha
Area salinized by irrigation		-	ha
Population affected by water-related diseases		-	inhabitants

TABLE 5
Irrigation inventory in the dry season (March-October) of 2002

Region	Area developed (ha)	Area developed (ha)			Number of farms
		Vegetables, field crops	Orchard (citrus)	Total	
Western	49.8	1.9	0.09	1.99	39
Central	586.5	108.0	250.7	258.7	82
Francistown	208.3	41.3	4.2	45.5	61
Gaborone	149.7	29.3	9.4	38.7	50
Southern	249.9	96.3	7.0	103.3	32
North-West	194.4	21.8	50.1	71.9	21
Total	1 438.6	298.6	321.49	620.09	285

FIGURE 3
Evolution of irrigation area

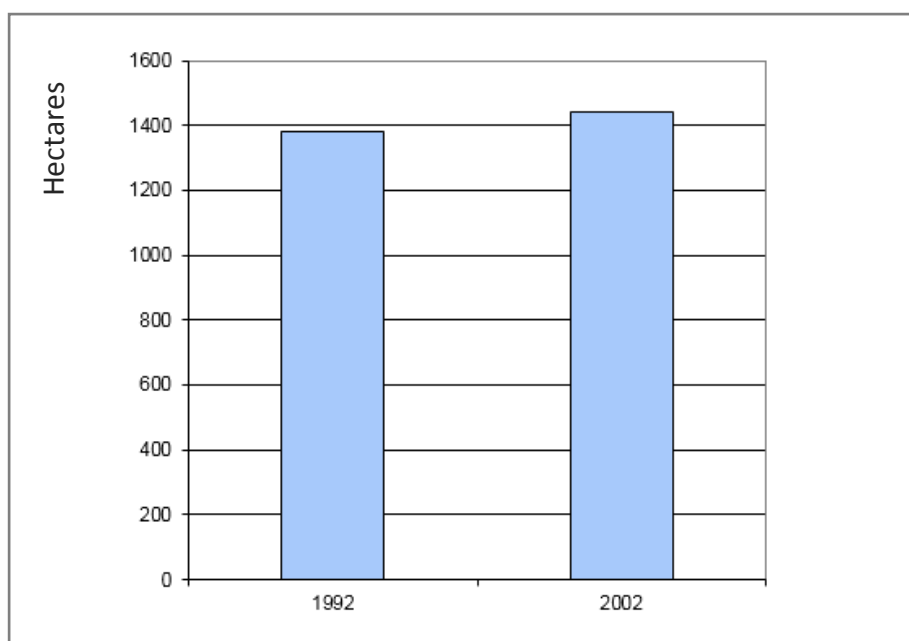
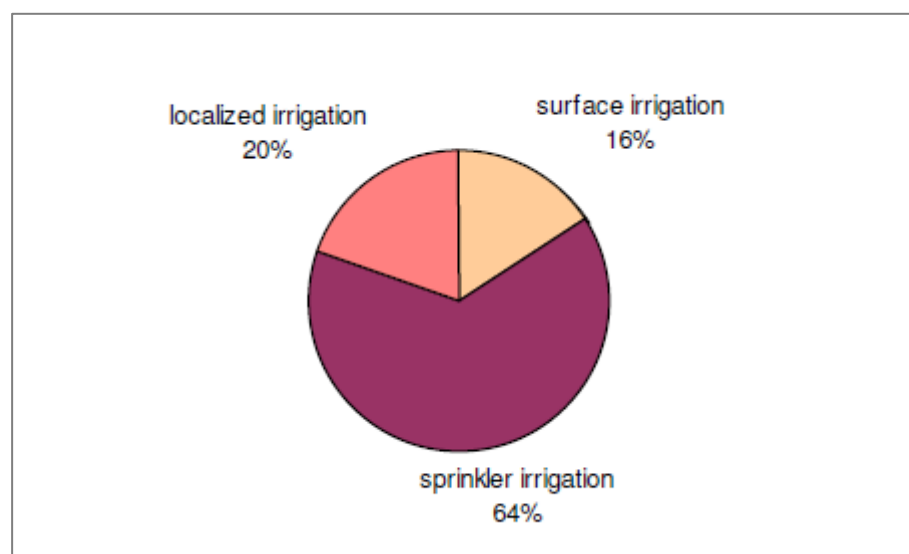


FIGURE 4
Irrigation techniques
Total 1 381 ha in 1992



Depending on the amount of flooding experienced, there are up to 6 500 ha of recession agriculture - molapo - in the Okavango and Chobe river basins, with the main areas being Chobe and Ngamiland West and East districts. Extensive low-lying areas regularly flood at two different times of the year:

- In the Chobe area this flooding begins with the start of the rainfall (runoff is constrained by flat topography and depressions with slightly heavier soils) in January-February and continues through to March-April when water is received from the Rivers Linyati (Kwando in Angola) and Chobe and also from the Zambezi (all with sources in Angola);
- In the Okavango area, further west, the flooding from the river starts in June-July. The Okavango has its source in Angola and rises in March-April but the floods are attenuated by the distance. These floods start to recede in October and then any residual moisture is supplemented by rainfall from November onwards.

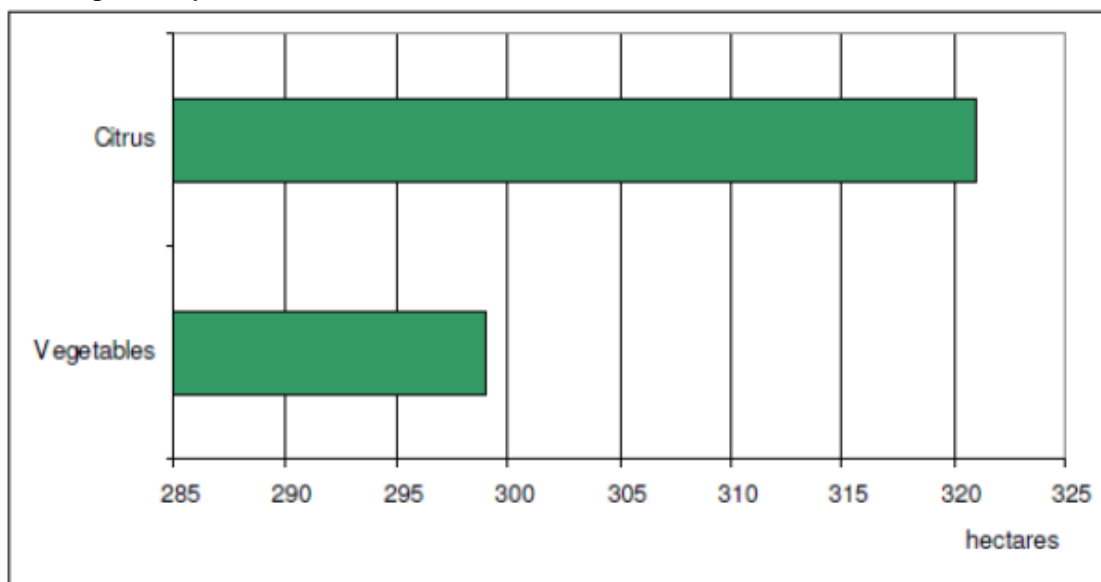
Local subsistence farmers have developed a system of agriculture to utilize residual moisture according to the time of year. At the end of the flood season, areas are ploughed (using animal power) and may be banded if further floods are possible. Bunds are usually used for protecting planted areas and not for water control. The flooding varies considerably from year to year and the farmers have developed a system to cope with these changes. Crops are planted on the ploughed areas and also on the margins of the receding flood and at other times on the banks or beds of the streams and rivers.

The main crop grown is maize for green mealies, sold in the markets of Maun and Kasane as early as December, and for grain. Other crops include water melons and pumpkins as well as vegetables, beans and similar short-season cash and food supplement crops. Cash crops tend to be grown more in locations close to the main towns of Kasane and Maun.

Role of irrigation in agricultural production, the economy and society

Irrigation in Botswana is more or less synonymous with horticulture. Some irrigation of fodder (mostly alfalfa) occurs in very small areas but generally irrigation is used for the production of vegetables (mainly tomatoes, potatoes, cabbage and leafy vegetables, green mealies, onions, water melons, butternut squash and beetroot) and citrus crops (mainly oranges) (Figure 5).

FIGURE 5
Main irrigated crops in 2002



The Ministry of Agriculture calculates in-field costs, excluding pumping and delivery costs to the farm/scheme boundary, as follows:

- Micro-jet (6 m x 6 m spacing for citrus or similar tree crops): US\$ 1 040/ha,
- Drip irrigation (0.9 m lateral spacing for row crops): US\$ 6 455/ha,
- Drip irrigation (3.0 m lateral spacing for trees): US\$ 2 180/ha,
- Sprinkler irrigation (3 laterals per ha - hand move): US\$ 2 745/ha,
- Centre-pivot (13-ha machine): US\$ 30 910/unit.

The recent Contract Award Wastewater Reuse Project to develop 203 ha (about 180 ha net) in Gaborone at Glen Valley has a contract cost of over US\$1.8 million which, with in-field works, is likely to have a development cost of over US\$ 13 000/ha: about US\$ 10 000/ha for land clearance, the main pumping station, provision of potable water and sewerage piping and drainage works and about US\$ 3 000/ha for the in-field sprinkler works.

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

Institutions

The main institutions involved in the water management are:

- The Ministry of Minerals, Energy and Water Affairs (MMEWA) is responsible for national water policy. There are two water supply units under the Ministry, the Department of Water Affairs (DWA) and the Water Utilities Corporation (WUC), which are responsible for managing the country's water supply systems. The WUC is responsible for supplying water to all urban and mining centres. The DWA is the lead agency in water resources and provides support to the National Conservation Strategy Agency in the implementation of the National Conservation Strategy (Okavango), and is responsible for supplying water to the 17 major villages;
- In some situations, such as in the livestock and agricultural sector, water provision is the responsibility of the Ministry of Agriculture (MoA) and its Irrigation Section (IS), established in 1982 under the Department of Crop Production and Forestry within the Land Utilization Division. The MoA constructs small dams in farming areas used for livestock and assists syndicates (user groups);
- In the rural areas, the District Councils under the Ministry of Local Government, Lands and Housing (MLGLH), oversee the water supply to rural villages.

Water management and finances

Until 1993 the MoA supplied water to farmers at no charge. Farmers were responsible for operating and maintaining the dams, which mainly involved building and maintaining fencing around the dams and keeping the spillways in good repair. In 1993 the ministry changed its policy and asked farmers to contribute 15 percent of dam construction costs. The ministry also gives grants to syndicates to finance a portion of the costs of sinking boreholes for livestock watering. Syndicates operate and maintain the boreholes, but pay nothing for the water. They are required to obtain water rights from the Water Apportionment Board, which are free of charge.

The National Development Plan 8 (NDP 8) consists of the construction of 30 small agricultural dams, maintenance and rehabilitation of existing dams, assisting farmers in establishing small-scale irrigation schemes and promoting the utilization of treated effluent for irrigated crop production. In order to implement NPD 8, the government earmarked the sum of US\$ 3.1 million for the period 1997/98 - 2002/03.

Policies and legislation

There are three main categories of land tenure: state land (25 percent), freehold land (5 percent) and tribal land (70 percent). State land consists of national parks and game reserves, forest reserves, wildlife management areas, and urban areas. Freehold land is used mainly for cattle ranching. Tribal land, which is either communal or leasehold, constitutes most of the national territory. All Batswana, irrespective of sex, are entitled to use communal land for residential, commercial or agricultural purposes. Responsibility for the allocation and supervision of tribal land, once the responsibility of traditional chiefs, now rests with local Land Boards. The land cannot be sold and generally stays within the same family indefinitely as long as it is used for the allocated purpose. The ownership of a borehole on tribal land, however, gives the owner de jure rights to the groundwater and de facto rights to the surrounding grazing land, as well as woodland and veldt products.

The National Water Supply and Sanitation Plan was written in 1999. The main objective was to estimate water demand and availability and the development potential of the water resources. Related legislation comprises the Water Act, the Water Utilities Corporation Act, the Aquatic Weeds (Control) Act and

Orders, the Boreholes Act, the Waterworks Act, the Town Councils (Public Sewers) Regulations and the Mines and Minerals Act.

ENVIRONMENT AND HEALTH

Water pollution is a growing problem that affects both surface water and groundwater. Groundwater becomes polluted primarily through pit latrines and livestock excrement.

PROSPECTS FOR AGRICULTURAL WATER MANAGEMENT

NDP 9 for the period 2003-2009 stresses the need to be less dependent on diamonds and to diversify the agricultural production base. For the latter, under the new plan, the government has adopted the following strategies in irrigation and water development:

- Development of a gender sensitive irrigation policy;
- Establishment of two irrigation schemes using treated effluent at Lobatse and Francistown;
- Establishment of an irrigation systems testing centre;
- Construction of new dams and assistance to farmers in rehabilitating existing dams and upgrading some of them to multipurpose status;
- Continuation of the well rehabilitation programme;
- Exploration of rainwater harvesting technologies in settlements to promote backyard gardening;
- Contracting private companies to complement government efforts in the development of irrigation and water resources.

Ample scope exists for developing irrigation for high value crops, including horticultural crops, and for fodder for the dairy industry, among others. However, the irrigation sub-sector is faced with several constraints, among which the lack of an Irrigation Policy and Strategy to guide the country's irrigation development. At present FAO is assisting the country in the formulation of an Irrigation Policy and Strategy with the active participation of stakeholders.

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