THE CAPE VERDE ISLANDS

The Cape Verde Islands are located in the central eastern Atlantic (14°50'–17°20'N, 22°40'–25°30'W), *ca*. 750 km west of Senegal. There are 10 islands (of which nine are inhabited) and eight islets, totalling a land area of 4,033 km^2. The archipelago was formed by rock accumulation, resulting from eruptions from a hotspot under submarine platforms. The coastline is 965 km long and the shelf (depth <200 m) is 5,934 km^2. The largest island, both in size and population, is Santiago, where the capital of Praia is located. The climate is arid tropical, with two seasons: a moderate season (December–June, with an average seawater temperature of 22°–23°C) and a warm season (26°–27°C). Precipitation is meagre and erratic – indeed Cape Verde can be seen as an island extension of the arid Sahel zone. The three easternmost islands (Sal, Boavista, Maio) are relatively flat, highly eroded and have a very arid climate due to their exposure to dry and hot winds coming from the Sahara. In contrast, the more western and geologically younger islands (Santiago, Fogo, Brava, São Nicolau, Santo Antão) have a rugged landscape of high peaks, ridges, plateaux and deep valleys. Coastlines of the islands are often cliff-lined or bound by steep slopes that descend to rocky shores or to beaches of black or white sand.

The four largest islands (Santiago, Santo Antão, Boavista, Fogo) comprise *ca.* 71% of the total territory, against 28 % for the remaining islands (São Vicente, São Nicolau, Sal, Maio, Brava). The uninhabited island of Santa Luzia and the islets of Raso and Branco (which now have the status of nature reserve protected by law) represent an area of 47 km^2.

Santiago (991 km^2) is the largest island of Cape Verde, its most important agricultural centre and home to half the nation's population. It was the first of the islands to be inhabited and it is also home to the nation's capital city of Praia. The island is mountainous, although slightly flatter in the southeast. The wetter climate of the interior and the eastern coast contrasts with the dryer one in the south and southwest.

The second largest island is **Santo Antão** (779 km^2), which is both the most western and most northern islands in the archipelago of Cape Verde. The island is entirely made up of volcanic material (basalts) and is one of the most mountainous of Cape Verde. The highest mountain is Topo de Coroa, reaching a height of 1,979 m, the second highest is Pico da Cruz with 1,585 m.

SOILS

Despite the limited size of its territory, Cape Verde has a great variety of soils, mainly composed of igneous rock formations, with a small number of sedimentary rocks also being present. The different soils are also reflected in the microclimates found in the archipelago, the vegetation of which depends on these microclimates and on the particular topographical features of a local area.

Soils in Cape Verde were formed from volcanic rocks, including basalts, fonolits, tufs, escories, traquits, andesits and (mainly calcareous) sedimentary rocks. In the relatively flat eastern islands of Sal, Boavista and Maio soils of calcareous origin can be found. In high and dry zones with weak slopes, and also in zones with weak slopes benefiting from specific climatic conditions, developed, layered and deep soils are found. Due to the arid climate and topographical relief, most soils are poorly defined as they were predominantly formed under the influence of past microclimates. The original soil was little developed (xerosoils, regossoils, litossoils) and poor in organic matter as a consequence of bad farming techniques.

Because of the volcanic nature of the rocks, soils have low potassium content, high phosphorus retention, while the pH is neutral to alkaline. The capacity of cationic changes is good in ground soils (argil contents), but is poor in organic matter. In contrast, this capacity is weak in sandy soils. Due to their volcanic origin, Cape Verde soils are difficult to use for agriculture and usually consist of only a thin layer, which has mostly been destroyed on the higher slopes of most islands.

The most important mineral resource of the archipelago is rock for building construction: basalts, piroclasts and fonolits. Other mineral resources are poorly explored yet: 'pozolana', in Santo Antão, sulphur in small quantities in Fogo, gypsum ($CaCO_3$) in Maio, clay in Boavista, mineral water in São Nicolau, Santo Antão and Brava, and yolk salt in Sal. According to the typology of soils presented in the White Book of the Environment in Cape Verde, we can differentiate eight types of soils: salt soils, by wind, arid with calcareous covering, deserted, browned, from mountains, laterites and red lands/soils. Only 10% of floor land/soils are potentially capable of being ploughed for agriculture, 95% of which is used for dry farming and the other 5% for irrigated farming.

Balance of Soil use in the Cape Verde islands

Type of Soil Use	Gain in Area	Lost in Area	Stable Situation
Sylvi-pasturing	S. Antão, S. Nicolau, Maio, Brava	Other areas	Santiago, Sal
Dry agriculture	S. Nicolau, Maio	Other areas	None
Irrigated agriculture	S. Vicente, Fogo, Santiago	Other areas	None

The next table presents the different areas according to the use of the different types of soil, based on fieldwork in 1986 (updated in 1992), exclusive of 4,600 ha and the uninhabited islets.

Occupation potentiality of soils in Cape Verde

Potentiality	Surface (ha)	% of C. Verde surface
farmed land	38,969	9.7
irrigated	3,350	
pluvials	25,827	
agro-sylvi-pasturing	9,792	
sylvi-pasturing areas	55,457	13.7
forest of production	9,050	
forest of protection	46,407	
extensive pasturing domain	87,164	21.6
uncultivable lands	217,110	53.8
Total	**398,700**	**98.8**

From: CNUAD 92 – Report of Cape Verde

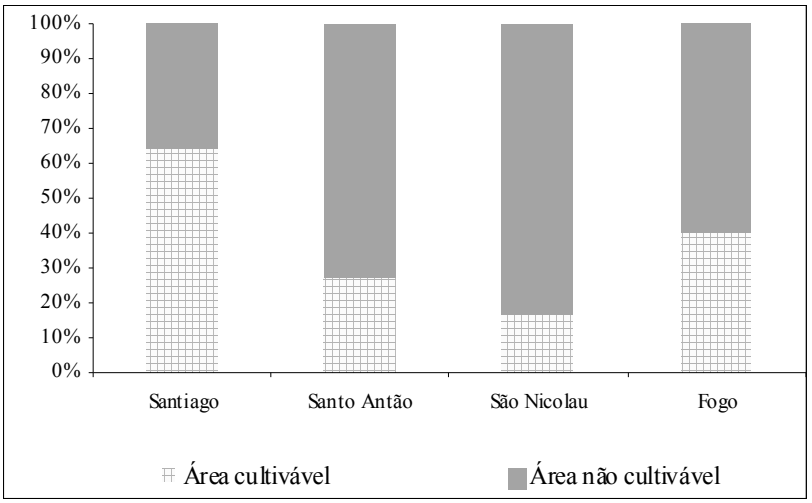
The annual loss of soil was estimated at *ca.* 7.8 tons/ha, worsened by bad soil use associated with dry agriculture (maize, bean, peanut) and excessive pasturing by ruminants. This problem is aggravated by the difficulty to improve soil and water conservation.

Land use in the principal agricultural islands of Cape Verde is presented in the next table, showing high relative percentage of agriculture soil for Santiago and Fogo.

Distribution of soil quality (ha) in most important farming islands

Soil Quality	Santiago	Santo Antão	São Nicolau	Fogo
Irrigated soils	677	1,357	69	12
Soils potentially irrigated	1,365	881	60	6
Cultivated soils with dry farming	20,155	6,401	1,806	5,730
Good dry farming, slope <15%	5,100	518	432	312
Good dry farming, slope under 15 and 50%	7,755	1,789	404	2,078
Dry farming of weak quality, slope >25%	4,135	877	103	1,127
Dry farming of weak quality, variable slope	3,901	3,437	488	2,765
Good quality pasture land	20,665	5,910	3,170	7,230

Cultivable area	63,753	21,270	6,532	19,260
(%)	64%	27%	17%	40%
Total Island Area	**99,100**	**77,900**	**38,800**	**47,600**



Relative percentage of agriculture soils for principal farming islands of Cape Verde. Legend: square – farmed areas, greyscale – none farmed areas.

The next table shows surface (land area) division from the chart of soils with farming use in Cape Verde, showing *ca.* 68% for dry agriculture, 26% for agro-sylvi pasturing and only 6% for irrigated agriculture.

Farming soil vocation (use) in Cape Verde (ha) – (classes 1 to 5),

Classes*	Santiago	São Nicolau	Maio	Boavista	São Vicente	Fogo	Brava	Santo Antão	Sal	TOTAL
1	1,365	60	35	10	0	6	24	881	0	2,381
2	3,625	371	0	0	0	1,059	436	686	0	6,177
3	8,250	276	0	0	72	1,436	708	1,297	0	12,039
4	5,115	292	0	0	176	1,022	142	1,201	0	7,948
5	3,901	488	159	81	123	1,638	225	3,437	0	10,052
TOTAL	**22,256**	**1,487**	**194**	**91**	**371**	**5,161**	**1,535**	**7,502**	**0**	**38,597**

* Class 1: based on irrigated soils in riverside alluvium or on slopes located in valleys;
Class 2, 3 & 4: those that present actual vocation for dry agriculture;
Class 5: can potentially be used for agro-sylvi pasturing.

WATER

Cape Verde is an insular country, located in the Sahel zone, and has an arid climate. The mean precipitation is around 225 mm/year and has been decreasing since the 1960s, with negative impacts on agriculture and water supplies. Around 20% of precipitation is lost to the sea, 13% infiltrates in the soil and 67% evaporates.

Apart from desalinized water, most water used is of subterranean origin and derives from rain. Subterranean sources are estimated at 124 million m^3 per year, 65 million of which is technically exploitable in a year of regular rainfall.

In seven municipalities, water for human consumption has been diminishing gradually, but has been growing in others because of the investment in infrastructure for soil conservation and improvement of surface water catchment from rain, subterranean water and enlargement of water desalinisation capacity. São Vicente, Sal and Praia (Santiago) water quality is good because of the quality control system, but in other municipalities (Santo Antão, São Nicolau, Maio) water quality is decreasing, mainly in coastal areas because of contamination with sea water. Subterranean water level is decreasing and has a negative impact on agriculture, cattle raising and industrial development.

Precipitation is mainly in August and September (60% to 80%) and differs from island to island. In mountainous islands such as Santo Antão (237 mm), Santiago (321 mm), Fogo (495 mm) and Brava (268 mm), rains often occur because of their topography and high altitude. In the flat islands (Sal, Boavista) the rainy season is very short, while in the other islands rain values are intermediate. There are no permanent surface fresh water sources in Cape Verde.

Rural supply is taken from subterranean wells and fountains, except in those islands (São Vicente, Sal, Boavista, Praia city) where natural resources of water are poor and desalinized water is used. In 2000, 54% of the population was supplied by fountains, 42% by traditional fountains and only 4% of the population had fresh water from the tap directly to their homes.

The captation of surface water is inexistent and the natural production is essentially derived from water-springs, horizontal galleries dug in basalt, alluvial aquifers (wells and drains) and deep holes. Estimation shows that there are *ca.* 2,304 water-springs and galleries, 1,173 wells and holes, producing a total of 99,400 tons/day.

In Santo Antão, Santiago and Fogo, spring water from high altitudes and alluvial aquifers are accessible and fully exploited. In islands without natural sources or with insufficient subterranean water, production comes from desalinization of sea water, estimated at 1,785,998 tons/year (São Vicente – 55 %, Sal – 19 %, Boavista – 1,5, Praia – 24 %). The lack of natural resources, the irregular and insufficient rain, combined with the inefficient usage of resources, is an important problem in Cape Verde. The high transmissivity of alluvial aquifers and beach degradation due to sand extraction directly affect soil and water quality in coastal regions. Large areas of banana culture were abandoned in Santiago, Maio, São Nicolau due to the contamination of soil with salt and may occur in other agricultural areas in the country.

Water supply for cattle raising is estimated at *ca.* 1,600 ton/year. The lack of alternative activities for the rural population makes this natural water resource more vulnerable to human pressures. The priorities in the management of hydric resources should focus on two main issues - increase the availability of hydric resources and their distribution and improvement of their utilization. The management of resources should be guided by an increase in availability in water supplies, different ways of water capitation, and better distribution and production. The present shortage of water is an obstacle to social-economical development. Therefore, it is important to find ways to improve the utilization of water and obtain maximum benefits of this resource.

The sea is another important resource and crucial to the economic development of Cape Verde. There are many economic activities that depend on the sea, e.g. fisheries, navigation, tourism. Desalinization is increasing as an alternative water supply for domestic and other uses. A treated wastewater project was implemented a few years ago in São Vicente. A barrage was recently built near São Lourenço dos Orgãos in Santiago island and more are planned. In relatively flat islands such as Sal, Maio and Boavista, the slope of streams is 5%. Fogo and Santo Antão have the highest average slopes of the country. The biggest basin is in Boavista with 199.2 km^2, basins in other islands have surfaces less than 70 km^2.

Water points & caudal explored (n) in Cape Verde

Ilha/ Concelho	Número de pontos de água explorados				Caudal explorado (m³/dia)			
	Nascente	Poço	Furo	Total	Nascente	Poço	Furo	Total
R. Grande	568	22	4	594	13.828	3.252	372	17.452
Paul	204	5	2	211	5.310	690	326	6.326
P. Novo	284	6	10	300	6.894	240	426	7.560
S. Antão	1.056	33	16	1.105	26.032	4.182	1.124	31.338
S. Vicente	38	292	5	335	91	974	176	1.241
S. Nicolau	202	41	15	258	4.326	279	850	5.455
Sal	0	36	0	36	0	220	0	220
Boavista	9	55	5	69	59	234	49	342
Maio	0	122	13	135	0	1.558	444	2.002
Tarrafal	158	64	28	250	1.241	1.231	3.152	5.624
S. Catarina	400	85	50	535	10.563	2.508	1.597	14.668
Santa Cruz	153	170	45	368	2.396	9.584	5.313	17.293
Praia	216	260	60	536	9.540	1.749	5.115	16.404
Santiago	927	579	183	1.689	23.740	15.072	15.177	53.989
Fogo	67	15	1	83	1.811	224	200	2.235
Brava	5	0	0	5	2.587	0	0	2.587
Total	2.304	1.173	238	3.715	58.646	22.743	18.020	99.409

Fonte: Esquema Director dos Recursos Hídricos, 1993, adaptação Emanuel Monteiro - 1989

Legend – *Nascente*: water-spring, *Poço* – natural spring; *Furo* – perforation.

The total volume of exploited underground water resources is around 99,409 ton/day and 36.28 million ton/year. Springs contribute 61% of this value, wells 24% and holes 15%.

Balance between existent and explored recourses

Ilha	Águas subterrâneas período seco (10^6 m³/ano)	Águas subterrâneas período médio (10^6 m³/ano)	Recursos explorados (10^6 m³/ano)	Diferença período seco (10^6 m³/ano)	Diferença período húmido (10^6 m³/ano)
Santo Antão	14,50	21,30	11,400	+3,100	+9,900
São Vicente	0,20	0,40	0,452	-0,252	-0,052
São Nicolau	1,50	2,50	1,991	-0,491	+0,509
Sal	0,05	0,10	0,080	-0,030	+0,020
Boavista	0,30	0,70	0,124	0,176	+0,576
Maio	0,50	0,90	0,730	-0,230	+0,170
Santiago	16,50	26,00	19,705	-3,205	+6,295
Fogo	9,30	12,00	0,815	+8,485	+11,180
Brava	1,00	1,60	0,944	+0,056	+0,656
Total	44,00	65,00	36,280	+7,609	29,254

Fonte: Esquema Director dos Recursos Hídricos, 1993

Fogo has the biggest excess volume followed by Santo Antão and Santiago. In dry years Santiago has a negative balance. Because of their accessibility, these altitude springs and alluvial aquifers are overexploited. Some islands, like Boavista, Sal and São Vicente have few subterranean resources and desalinization is the main means of production.

In general, subterranean waters vary little in temperature (20 to 23ºC), pH (6.5 to 8), CO_2 (15 to 50 mg/l) and O_2 (7 to 10 mg/l). High levels of dissolved oxygen show that water is of recent origin. Recent water from basalts has few minerals. Dry residues are normally under 300 mg/l, chlorine compounds less then 60 mg/l, hardness less then 10º F, and conductivity varies between 300 to 1.000 S/m. Silicate varies between 20 to 50 mg/l, values normal to volcanic soil. Sodium cations vary from 40 to 500 mg/l, increasing near the coast. Calcium varies from 60 to 150 mg/l and magnesium from 50 to 400 mg/l.

VEGETATION

The vegetation of the Cape Verde Islands is sparse and consists of various shrubs, aloes, and other drought-resistant species. On the lower and drier islands the vegetation before human colonization

probably consisted of savannah or steppe vegetation, with the flattest inland portion supporting semi-desert plants. At higher altitudes, a form of arid shrubland was probably present.

On the higher and somewhat wetter islands the climate is suitable for the development of dry monsoon forest, as this vegetation is believed to have been present in the past. However, most vegetation has now been converted into agricultural land and forest fragments are restricted to areas where cultivation is not possible, such as mountain peaks and steep slopes. Much of the terrain devoid of vegetation cover comprises a stony, sandy or bare-rock desert-like landscape.

The natural vegetation of Cape Verde, divided in several fitocenoses allied to different physiographic and climatic zones, is poor due to three factors: 1) periods of prolonged drought, 2) dry winds that blow from the African mainland desert and 3) the use of inefficient techniques in the supply and distribution of water. One surviving and original species is the dragon tree *Dracaena draco*, the largest numbers of which are found in São Nicolau, Brava and Santo Antão. The floristic heterogeneity in Cape Verde is high, as is usual in island ecosystems.

Plant diversity in Cape Verde has been inventoried and characterized into 45 climatic zones, containing 134 different plant communities. Plants identified were classified in Angiosperms, Gymnospermae (introduced species only), Pteridophytes and Bryophytes. About 80% of the endemic plants are concentrated in areas of high altitude. The flora of Cape Verde consists of 240 native species, 85 of which are endemic. The island of Santo Antão has the largest number (150) of native species, followed by Santiago (135), São Vicente (118) and Fogo (110). The largest number of endemics species is found in Santo Antão (50), followed by São Nicolau (45), Santiago (38) and Fogo (37).

The islands with most vegetation cover (Santo Antão, Fogo, São Nicolau) also hold the largest vegetation cover in endemic biotopes, i.e. Moroços, Ribeira da Torre and Ribeira do Paúl in Santo Antão, Bordeira, Chã das Caldeiras and Pico Novo in Fogo, and Monte Gordo and Monte do Alto das Cabaças in São Nicolau. These areas also have the highest diversity in endemic species. Of 308 species of medicinal plants, 162 are naturalized, 122 cultivated and 24 are considered endemic to Cape Verde.

Bryophytes are now mainly found in humid cliffs, on rocks or on land in exposed areas, such as epiphytes, or on rocks in areas with an excess of fog. Inventories and taxonomic studies have so far shown the existence of 36 species of liverworts and 110 species of mosses. Ferns are found in various types of ecological zones (swampy areas, wetlands and sub-humid, semi-arid and hot areas and fumaroles in Fogo), according to soil and climatic factors. Of pteridophytes there are 32 taxa in Cape Verde.

An estimated number of 320 species of lichens and fungi of the class Ascomycetae associated with lichens, exist in the Cape Verde Islands. From the biogeographical point of view, the flora of capeverdian lichens is dominated by cosmopolitan species, pan-tropical and Mediterranean, and endemic taxa of Macaronesia and Cape Verde are uncommon.

Plants have always been a source for human survival. It is estimated that over 80% of plants are used as fodder for cattle, goats, donkeys and pigs. Afforestation began in a systematic way in 1975, soon after the independence of Cape Verde. The forested area increased from 3,000 ha in 1975 to 82,000 ha in 1998. Besides the influence of vegetation in buffering climatic extremes through moderation and balance of ecosystems, the programmes implemented have contributed to the recovery of a considerable number of places extremely degraded by years of successive droughts and human and lifestock pressure. Afforestation plays an important role in the fight against desertification and the restoration of the vegetation cover and in meeting energy needs through fodder production, as well as contributing to a positive change in landscape.

CLIMATE

Cape Verde's climate is milder than that of the adjacent African mainland. Because the island is surrounded by the ocean, temperatures are generally moderate with low amplitude. Average daily high temperatures range from 25 °C (77 °F) in January to 29 °C (84 °F) in September. Cape Verde

is part of the Sahelian arid belt and lacks the rainfall levels of the West African mainland. When it does rain, most of the rainfall occurs between August and October, with frequent brief but heavy downpours. A desert is usually defined as terrain which receives less than 250 mm of annual rainfall. Cape Verde's average total (261 mm) is slightly above this criterion, which makes the area's climate a semi-desert one.

Average figures for rainfall can be misleading as they can differ considerably between islands. Sal, Boavista and São Vicente receive very little rain, while at higher altitudes in Santo Antão and Fogo there can be up to 2 m of rainfall per year, making these areas lush and green.

The dominant climatic features of the Tropical Atlantic region are the massive convection centres over Africa and South America, the relatively narrow marine Intertropical Convergence Zone (ITCZ) that stretches between them, just north of the equator, and the trade wind systems that converge into the ITCZ from north and south in which shallow convection areas are embedded. At the ocean surface, there are features that roughly resemble the main features of the equatorial Pacific Ocean: an eastern ocean 'cold tongue' area and a matching warm pool region on the western side.

These surface features are linked to a three-dimensional circulation, the meridional (Hadley) and zonal circulation cells in the atmosphere and the horizontal equatorial current systems of the upper ocean as well as the shallow meridional overturning cells that connect the equatorial ocean with the northern and southern subtropics. The Tropical Atlantic climate system exhibits an intricate, mainly latitudinal, seasonal migration and contains transient components, such as easterly waves and tropical storms, which travel from east to west across the basin.

The first dry periods with impact on human live occurred during the early 1500s, shortly after the discovery of the islands around 1460. In recent times, serious dry spells have occurred, having a grave impact on human live and biodiversity on several islands.

Dominant winds blow from the northeast (78% in Mindelo and 72% in Praia) and from the north and east with around 5% and 10%, respectively. Calm days are rare (less them 4%) and the calmest months are from July to September. Data from Sal indicate a 7.22 m/s mean, almost similar to Santiago from January to June. Data taken at a heigth of 2 m, show that the mean wind velocity is high in São Vicente (4.7 m/s) and lower in São Nicolau (0.7 m/s). Air pollution is very low in Cape Verde. However, it is important to give attention to the recent and exponential growth in vehicles, which has diminished air quality in urban centres. Dust from the Sahara is a main source of air contamination and has been growing in the last years, with negative impacts on human health and air traffic.