

### 3.4 COTE D'IVOIRE

#### Introduction

Cote d'Ivoire has an area of 322 465 km<sup>2</sup>, and a coastline of 540 km along the Gulf of Guinea. Inland it has borders with Liberia in the southwest, Guinea in the northwest, Mali and Burkina Faso in the north, and Ghana in the east. It stretches approximately 690 km from N-S between latitudes 4°22' and 10°32'N, and 660 km from W-E between longitudes 2°28' and 8°36'W. The capital, Abidjan, is situated in the southeast of the country (5°19'N/4°01'W) on Ebrie Lagoon. In 1983 the population was 9 270 000, giving a mean population density of 28.7 persons/km<sup>2</sup>.

From the Liberian border eastwards as far as Fresco (5°03'N/5°31'W), the coast is of comparatively high relief with rocky promontories and cliffs, as well as some sandy beaches. However, in the eastern sector the coast is flat and sandy, with a continuous littoral sand-bar built up by the prevailing longshore drift. In this sector the narrow coastal strip is occupied by a series of lagoons and marshes, which are maintained by the coastal sand-bar which attains 6-10 m in height between the lagoons and the sea. Inland, the coastal lowlands rise by a series of shallow stepped plateaux to undulating plains, which in turn continue to rise gently to an altitude of about 100 m. From the parallel 6°N the land again slopes upwards reaching a high plateau, 300-500 m asl, beginning close to the parallel 8°N. A mountain range forms the borders between the Cote d'Ivoire and Liberia and Guinea, with the highest peak, Mt. Nimba (1752 In), situated just inside Guinea where the three countries meet. The highest point in Cote d'Ivoire is Mt. Tonkoui (5°28'N/7°37'W) in the Man Highlands, 80 km due east of the Nimba Mountains. About 20% of Cote d'Ivoire, west of a line drawn between Man (7°31'N/7°37'W) and Ferkessedougou, is mountainous and quite deeply dissected, with 4 peaks exceeding 1000 m and many reaching 800 m asl.

Drainage of 90% of the country is to the Atlantic Ocean by a series of rivers flowing more or less due south. The most westerly of these is the Cavally, which for 400 km forms the border with Liberia, and which is interrupted by no less than a dozen cataracts in descending from the interior plateau to the coast. From here, in passing eastwards, the other rivers are the Dodo, Nero, San Pedro, Brime and Sassandra (also riven by cataracts in its lower reaches) which all discharge directly to the sea. However, from Fresco, approximately midway along the coast, to the eastern border, the beach is formed by an almost continuous sand-bar, and the rivers from the central and eastern regions discharge behind the sand-bar into coastal lagoons. Many small lagoons have coalesced to form the three large lagoonal complexes. The eastern rivers are, sequentially, the Bolo and Nioumouzou, which enter Fresco Lagoon, the Baubo, Go and Bandama, which flow into Tadio Lagoon, the Ira, Agnebi, Me and Komoe, which flow into Ebrie Lagoon, and the Soumie, Bia and Tano, which discharge into Aby Lagoon. The last of these, the Tano, forms the border with Ghana for about 50 km inland from its mouth.

A watershed occurs on the highlands of the north, from which a small part of Cote d'Ivoire drains northwards to the Niger River, principally via the Baoule and Bagoé Rivers, while in the northeast, some ephemeral streams flow eastwards into Ghana as affluents of the Black Volta.

## **Climate**

At the coast, in the west, there are only two seasons, one wet and one dry, but in passing eastwards a short dry season begins to become manifest in the middle of the wet season, so that there are then four seasons. For example, at Tabou (4°28'N/7°20'W) in the far west, mean annual rainfall is 3000 mm and the rains persist for 11 months; only February is dry. By contrast at Abidjan (5°19'N/4°01'W), where mean annual rainfall is 2047 mm, January, February and August are dry. Here the mean monthly rainfall maximum is 574 mm in June, while the mean monthly minima are 41 mm in August and 32 mm in January. However, in passing inland, the August dry season is lost, but the January dry season increases in duration. At Cagnoa (6°04'N/5°55'W) the wet season lasts 11 months, and January is dry. At Bouake (7°42'N/4°01'W) the wet season lasts 9 months and November-January is dry, while at Ferkessedougou (9°30'N/5°10'W) the wet season is 7 months long and November-March is dry. Tabou has 170 rainy days/year, Abidjan has 160, Bouake 110, and Ferkessedougou 100. The central coastal region, near Grand Lahou, is much drier than the eastern and western coastal extremities, with only 70 rainy days/yr, and a mean annual rainfall of less than 1500 mm.

Temperatures are remarkably constant throughout the year. The mean temperatures of the warmest and coldest months are very close, being 27 and 24°C for Bouake and Tabou, 28 and 25°C for Abidjan, and 29 and 26°C for Ferkessedougou. The mean annual air temperature is 26.2°C at Abidjan, where March is the warmest month and August the coolest month. This centre receives a mean average of 1812 hours of sunshine/yr, with 200 hours in March and 80 hours in August. However, incidental solar radiation is greatest in April (mean 19.7 MJ/m<sup>2</sup>/day) and lowest in August (mean 11.5 MJ/m<sup>2</sup>/day), with a mean annual figure of 15.7 MJ/m<sup>2</sup>/day.

Winds are predominantly from the southwest, with the greatest velocities in August and September and the lowest in October-December. The mean annual velocity is given as 5 km/h for Abidjan. Potential evapo-transpiration for Abidjan is 1356 mm/yr, with the greatest in March (mean 142 mm/month) and the least in August (mean 82 mm/month). Mean humidity is 85% at Abidjan. We have no data for the more westerly regions.

## **Wetlands**

The entire country enjoys a humid climate with at least 7 rainy months, and most of the interior receives 1000-1500 mm rain/yr, while no part receives less than 1000 mm rain/yr. Since precipitation over the highlands varies greatly from season to season, the northern rivers are all prone to flood. For example, at Odienné (9°36'N/7°32'W) in the far northwest, the mean three monthly total for the December-February period is 29 mm, while by contrast, that for July-September is 952 mm. Thus the rivers, which have risen

steadily during May and June, all tend to overtop their banks in August and September. Few of the northern rivers have broad flood plains because of the hilly nature of the terrain, but they may become raging torrents in places, and deep swift moving currents in others. The riparian vegetation reflects this, with many rheophytes in the river beds and on islands and banks which are dry for much of the year. Where the rivers traverse depressions there are swamp forests, and where they traverse flat places there are floodplains, but in the main these are too numerous and too small to detail individually.

In a few localities the flats are long enough and broad enough for a river to meander, and here extensive floodplains do occur, e.g. along the Bago River (9°52'-10°13'N), the Upper Bandama River (8°30'-9°02'N) and along the northern border on the Komoè/ Leraba Rivers (9°37'-10°16'N). In addition there are major impoundments on the Sassandra, Bandama and Bia Rivers, and these have formed large lakes.

Small mangrove stands occur at the mouths of western rivers, but the principal wetlands are the large coastal lagoons and their associated swamps.

### **List of Wetlands Described**

#### 1. Major Lagoons

- (a) The Ebrie Lagoon Complex
- (b) The Tadio Lagoon Complex
- (c) The Aby Lagoon Complex

#### 2. Minor Lagoons

- (a) Petit Digoue Lagoon
- (b) Digoue Lagoon
- (c) Katibo Lagoon
- (d) Fresco Lagoon
- (e) Heb6 & Kodioboue Lagoons

#### 3. Riverine Wetlands

- (a) Minor Western Rivers
- (b) The Cavally & Sassandra Rivers
- (c) The Bandama River
- (d) The Komoè River
- (e) The Gbanhala, Baoule & Bagoé Rivers

#### 4. Artificial Impoundments

- (a) Lake Kossou
- (b) Lake Buyo
- (c) Lake Ayamè
- (d) Minor Impoundments

## 1. Major Lagoons

### (a) The Ebrie Lagoon Complex

**Country:** Cote d'Ivoire

**Coordinates:** 5°16'N/3°33'-4°57'W

**Area:** 77 600 ha (56 600 ha open water + 21 000 ha swamps)

**Altitude:** sea level

**Nearest Towns:** Abidjan; Grand Bassam (on lagoon)

**General:** Ebrie is a long (150 km), narrow (1-9 km) lagoon complex which comprises Ebrie, Aghien, Potou and Ono Lagoons, with a number of small isolated subsidiary lagoons. The capital city, Abidjan, is situated on the banks of the complex, the long axis of which lies E-W, parallel to the coast, but the subsidiary basins of Aghien and Potou are orientated SE-NW.

Aghien Lagoon at the eastern end, is 14 km long and 2-3 km wide, and communicates with Potou Lagoon, some 16 km long and 1-3 km wide, through a narrow channel 4 km long. The Me River enters this channel midway between the lagoons. Both these lagoons and the connecting channel are oriented NW-SE. Another broad channel, about 1 km wide, leads from the southern end of Potou Lagoon past the eastern end of the main Ebrie basin, which is oriented E-W parallel with the coast, to the sea at Grand Bassam (5°12'N/3°44'W). The Assinie Canal leads east from here for 65 km to communicate with Aby Lagoon. Ebrie Lagoon extends westwards from the junction with the channel below Potou Lagoon, for over 150 km. It is 1-9 km wide and contains several large, and numerous small, islands. The main basin of Ebrie Lagoon connects with the ocean by the Vridi Canal, opened as a dredged and navigable passageway in 1950. The opening at Grand Bassam is subject to heavy silting during the dry season.

The small subsidiary lagoons around the periphery of Ebrie Lagoon account for about 2% of the open water surface of the complex, and the numerous long narrow arms, which lead off from the main basin, account for a further 8%. Aghien Lagoon, which is upstream of the Me River, and is comparatively isolated, accounts for a further 3-4%. The Ira and Agnebi Rivers enter the main Ebrie Basin, the former in a highly indented estuary at the western end, the latter in the middle section. The Me enters in the east between Aghien and Potou Lagoons, and the Komoe enters the extreme eastern end of the basin near the origin of the Assinie Canal, and only a few kilometres above the natural mouth of the system at Grand Bassam. Another small lagoon, Ono Lagoon (5°22'N/3°33'W), measuring 4km x1km, is situated on the Amia River, a tributary of the Komoe, some 10 km above the confluence of these streams and about 30 km upstream of Ebrie Lagoon.

In general, the substrates of the basin, which was initially flooded by the last great marine transgression, are composed of sandy clays of Miocene-Pliocene origin in the north, and silico-argillaceous soils from the early Holocene in the south, while the littoral sand-bar comprises marine sands of Recent origin. The lagoons are fringed by marshes and permanent swamps, and there are about 20 000 ha of seasonally inundated lands behind these, the largest single block of which is at the western end of the complex between the head of the lagoon and the estuary of the Bandama River. Other patches of land subject to

seasonal inundation lie 10 km to the north of the lagoon complex in a depression between the Ira and Bandama Rivers. Useful references are Charles & Durand (1982) and Durand & Skubich (1982).

**Hydrology & Water Quality:** The surface area of the drainage basin is 93 600 km<sup>2</sup>, of which 65% is in the drier upland zone, receiving 1100-1500 mm rain/yr. There is considerable variation in freshwater run-off from year to year, but it averages 9.85 billion m<sup>3</sup>/year. Of this the Komoe contributes 7.1, the Me 1.5, and the Agnebi 0.9 billion m<sup>3</sup>/year. The Komoe, which receives much of its water from the upland zone, is in flood in September and October, whereas the other rivers peak in June and July. Direct precipitation accounts for 1.1 billion m<sup>3</sup>/year. Tidal exchanges through the Vridi Canal account for the movement of 38 billion m<sup>3</sup> of water per year. The residence time of river water entering the lagoon varies from place to place with a mean of 104 days. However, in open regions it is only about 12 days, while in secluded bays it may be as long as 912 days. Man made canals link Ebrie Lagoon with the two neighbouring lagoons.

Great variations in the physico-chemical parameters of the water occur from place to place in the lagoon, and also from season to season. Mean surface temperatures range from 25-31°C throughout the lagoon, with extreme values of 22.5-35°C. The water is generally very turbid, especially in the open areas near the city of Abidjan, where dissolved inorganic nitrogen averages 12 µg/l, dissolved organic nitrogen 350 µg/l and particulate nitrogen 700 µg/l. Dissolved phosphate levels average 40 µg/l and particulate phosphorus 42 mg/l in the same area. These levels are much lower in both the more rural open waters and in the numerous closed bays. The pH values vary between extremes of 10.0, recorded in the evening in eutrophic zones during low water periods, and 6.5, recorded in the morning in the proximity of river mouths. Disturbance of the water by wind and currents keeps the shallow waters well mixed, but this is not the case in the deepest regions. An unusual period of calm in 1980 resulted in the formation of a deep, anoxic, reducing layer which gradually spread towards the surface, and eventually resulted in a mass mortality of fish. Horizontal mixing is brought about by the twice daily tidal rhythms and by wind seiches which develop over the lagoon. A certain amount of layering occurs at the mouth of the estuary (Vridi Canal) where the sea water forms a wedge beneath the outflowing, less dense, freshwater.

Phosphate is limiting in the closed areas and nitrogen in the open areas. In closed regions autotrophic productivity is almost exclusively maintained by internal cycling of nutrients, augmented a little by minerals from river and sea water. Overall, Ebrie Lagoon imports nutrients as minerals and organic detritus, and exports undegraded plant material to the sea. Mean annual losses of nitrogen are estimated at 3500 tonnes.

**Flora & Fauna:** Mangroves occur in the mouths of the system, and upstream in the west as far as Potou Lagoon. The calm bays and banks of the main lagoon are dominated by herbaceous vegetation. Generally one finds an outer zone of free-floating hydrophytes, a middle zone of rooted hydrophytes, both floating leaved and submerged species, and an inner zone of emergent macrophytes comprising reeds, sedges and grasses. These zones merge with each other and their boundaries are not always clear. Extensive areas of swamp land occur at intervals around the lagoon, covered by tall herbs, and often by trees, the latter especially at the western end. These vegetational zones are regressing rapidly because of local urbanisation, land clearance, agricultural development and the cutting of mangrove timber for firewood, and this despite the paramount importance of the

vegetation to the ecology of the lagoonal ecosystems.

In the lagoon zooplankton biomass is relatively low compared with that of other planktonic forms. However, the calanoid, *Arcatia clausi*, plays an important role in Ebrie Lagoon. It is practically the only species in the western part, and is dominant in the central and eastern parts. In shallow waters, down to about 3 m, polychaetes, crustaceans (isopods, amphipods, decapods), molluscs, oligochaetes and nemerteans are found. The lamellibranch 'ship worms', *Bianka bagridaeusis* and *Teredo petiti*, are abundant in Ebrie Lagoon where they parasitise any woody material in the lagoon. The former is found in salinities of 16-35‰ and the latter in ones of 3-10‰. Important crustaceans include the prawn *Penaeus duorarum notialis*, This species reproduces at sea, but the larvae migrate into the lagoon to complete their development. Another prawn *Macrobachium* sp. reproduces in the rivers and frequents the more brackish parts of the lagoons, while the crabs *Callinectes arnnicola* and *Callinectes pallidus* (which grow to 14 cm across the carapace and weigh 150 g) are common.

The fish fauna is typical of the West African coast, as described in the regional introduction. More than 100 species have been recorded, the most abundant being *Chrysichthys nigrodigitatus*, *C. walkeri*, *Elops lacerta* (mostly juveniles), *Ethmalosa fimbriata*, *Liza falcipinnis*, *Pomadasys jubelini*, *Sardinella maderensis*, *Tilapia guineensis*, *T. hendelo*, *T. jentinki* and *Tylochromis jentinki*. Animal life is abundant in the swamps, but several species are now rare or endangered, in particular *Choeropsis liberiensis*, *Crocodilus cataphractus*, *C. niloticus*, *Osteolaemus tetraspis* and *Trichechus senegalensis*. Roth & Waitkuwait (1985) discuss the status of the latter species.

**Human Impact & Utilisation:** What follows also applies, at least in major part, to the other large lagoonal complexes of Aby and Tadio. Significant changes have occurred in and around the three major lagoonal systems during the past decade, due primarily to dramatic increases in population. For example, the population of Abidjan was 550 000 in 1970, but had increased to 2 000 000 before 1984. It is apparent that in recent years a number of factors, operating in concert, have altered the ecological status of the coastal lagoons. These include increases in salinity, brought about by the construction of permanent canals between the lagoons and the sea; changes in the hydrological regimes of the rivers, brought about by the construction of dams; and overfishing and pollution, both brought about by a burgeoning population on the lagoon shores.

**Fishing:** This is the major industry of the coastal lagoons. In 1981 the total annual fish production from the three lagoons approximated 10 000 tonnes, although in previous years catches of 15 000-20 000 tonnes were recorded. Although in the past the lagoons were fished both individually and collectively, traditional methods were used which did not destabilise the stocks. Today, in Ebrie Lagoon in particular, much fishing is carried out by foreign licencees using highly efficient collecting techniques. From 1964-75 the use of seine nets and ring nets increased by 360%, and during this time the length of the nets increased by a factor of 4-5 times, and for a while some reached 2000 m in length, and the mesh size was decreased from 40 mm to 14 mm. Hence the quantity of fish taken and the proportion of juveniles increased dramatically. However, some measures to prevent abuse have recently been taken (see conservation status). In Ebriè Lagoon fishing is carried out using many different kinds of tackle: gill

nets, cast nets, multi-hooked lines for individual fishing, beach seine nets and ring nets for collective fishing. It is estimated that 700-800 seine net operations catch the same quantity of fish as 3000 individual fishermen.

Eight species comprise more than 85% of the catch; *Ethmalosa fimbriata* (61.3%), *Tilapia guineensis* and *T. heudelotti* (6.1%), *Elops lacerta* (5.5%), *Chrysichthys nigrodigitatus* and *C. walkeri* (5.0%), *Tylochronzis jentinki* (4.3%) and *Sardinella maderensis* (4.2%). There is also a thriving prawn and shrimp fishing industry.

**Agriculture:** In and around the lagoonal areas large industrial plantations and smaller family concerns produce coffee, cacao, palm oil, coconuts, rubber, bananas and pineapples. Further north are found cotton and sugar-cane plantations. Pesticides are reputedly used in only moderate amounts, yet some residues (e.g. DDT, lindane) are found in lagoon sediments, and there is evidence of increased siltation.

**Manufacturing Industry:** This is concentrated at Abidjan. The largest enterprises utilise agricultural products and give rise to much organic pollution. 25 % of the organic pollution in Ebrie Lagoon comes from this source. Sediments in the urban area contain measurable levels of PCB, DDT, lindane and heavy metals.

**Sewage:** The effluent from 500 000 Abidjanian inhabitants is collected by a reticulation system and released into Ebrie Lagoon after incomplete primary treatment. It is estimated that the organic waste from at least 20% of the remaining 1.5 million people also enters the lagoon. This organic waste (about 20 000 tonnes/yr) consumes one third of the available oxygen in the lagoon locally. Eutrophication occurs with the increase in minerals and organic matter. Bathing in the area is considered dangerous, with more than 2000 faecal coliform bacteria per 100 ml water.

**Conservation Status:** The left bank of the lower Bandama River and the most westerly bank of Ebrie Lagoon are included in the Azagny National Park which is situated between the Bandama River and Ebrie Lagoon, covering 20 000 ha with an additional small buffer zone. Some 7000 ha of permanent freshwater swamp is included in the park, together with a further 10 000 ha of primary rain and seasonally inundated forest, some 550 ha of seasonally inundated grassland and about 250 ha of tidal forest. Here many locally endangered species survive, including *Cephalophus dorsalis*, *C. sylvicultor*, *Choeropsis liberiensis*, *Colobus polykomos*, *C. verus*, *Felis aurata*, *Hyemoschus aquaticus*, *Loxodonta africana cyclotis*, *Neotragus pygmaeus*, *Pan troglodytes* and *Syncerus caffer nanus* with *Trichechus senegalensis* and all three African crocodiles in the waterways.

Following the collapse of the lagoonal fishing industry in 1981 (in Aby Lagoon only 500 tonnes of *Ethmalosa* compared with 5000 tonnes in 1979), a number of new regulations were implemented. Seine nets are now prohibited in Tadio Lagoon, and their use is limited in Ebrie and Aby Lagoons. In addition the number of fishing licences is restricted, the lengths of the nets controlled, and the mesh size may be no less than 30 mm. The periods of the year during which fishing is permitted are also controlled.

## **(b) The Tadio Lagoon Complex**

**Country:** Cote d'Ivoire

**Coordinates:** 5°09 'N/4°59 '-5°25'W

**Area:** 23 500 ha (19 000 ha open water + 4500 swamps)

**Altitude:** sea level

**Nearest Town:** Grand Lahou (on lagoon)

**General:** This lagoon complex includes the Tagba, Makey, Tadio and Nioumouzou Lagoons, and the estuaries of the Go and Bonou Rivers. It has a permanent natural opening to the sea near the town of Grand Lahou. The principal basin is elongated with an axis oriented E-W, and is 50 km long, parallel to the coast. It has a mean depth of 3 m, and communicates with Ebrie Lagoon via a man-made canal through the intervening swamps. The lagoons are fringed by marshes and there are seasonally inundated zones behind these, the latter best developed at the eastern end between the head of the lagoon and the estuary of the Bandama River. A further 2400 ha of swamp land is situated some 25 km up the Bandama River.

**Hydrology & Water Quality:** The catchments comprise a total of 104 000 km<sup>2</sup>, 93% of which is in the drier zone. Run-off from the land is estimated at a mean volume of 10 billion m<sup>3</sup>/year, 95% of which is contributed by the Bandama River, although there is considerable fluctuation from year to year. Direct precipitation and tidal exchange have not been estimated for this lagoon, but it is thought that residence time of riverine water is about 20 days. Water quality is much the same as that in Ebrie Lagoon.

**Flora & Fauna:** As for Ebrie Lagoon.

**Human Impact & Utilisation:** As for Ebrie Lagoon.

**Conservation Status:** Unprotected.

### (c) The Aby Lagoon Complex

**Country:** Cote d'Ivoire

**Coordinates:** 5°05'-5°23'N/2°05'-3°20'W

**Area:** c. 60 000 ha (41 500 ha open water + 18 500 swamp)

**Altitude:** sea level

**Nearest Towns:** Adiake (on lagoon); Abidjan (84 km W)

**General:** This complex includes the Aby, Tendo and Ehy Lagoons and the Bia and Tano Estuaries. Part of Tendo Lagoon, and the whole of a large subsidiary lagoon, Univaye Lagoon, which constitute the southernmost parts of the system, are situated in Ghana. The complex comprises a main basin in the west oriented N-S perpendicular to the coast. This is 28 km long with a mean width of 8 km. The system opens to the sea at its southwestern extremity, at Assinie, where the Assinie Canal enters from Ebrie Lagoon. From the southeastern tip of the main basin, a broad arm, 3-5 km wide, known as Tendo Lagoon, leads eastwards for 36 km to terminate as Ehy Lagoon. The Tano River enters Tendo Lagoon on its seaward side. The mean water depth of the system is 3.8 m, with a maximum depths of 23 m in the centres of the basins. The lagoons and estuaries are fringed by marshy zones, and some 18 500 ha of seasonally inundated land occurs on the periphery, the bulk in two large blocks, one at the western end towards Grand Bassam, the other at the eastern end along the Tano Estuary and around the head of Ehy Lagoon.

**Hydrology & Water Quality:** The drainage basin of the lagoon is 26 500 km<sup>2</sup>, situated entirely within the wetter zone. Some 30 km<sup>2</sup> of the catchment is situated in Ghana. Two rivers discharge into the lagoon. The Bia supplies a mean annual volume of 1.9 billion m<sup>3</sup> water and the Tano 4.2 billion m<sup>3</sup>, while direct precipitation amounts to an additional annual receipt of 0.9 billion m<sup>3</sup>. Maximum river levels occur in June and July, with

secondary rises in September and October, but there is great variability from year to year. The average residence time of water in the complex has been given as 146 days, but volumetric details of the tidal flux are not known. Water quality is similar to that given for Ebrie Lagoon.

**Flora & Fauna:** As for Ebrie Lagoon.

**Human Impact & Utilisation:** As for Ebrie Lagoon.

**Conservation Status:** Ehotiles National Park comprises a group of five islands situated in Aby Lagoon, which is otherwise unprotected.

## 2. Minor Lagoons

### (a) Petit Digoue Lagoon

**Country:** Cote d'Ivoire

**Coordinates:** 4°42'N/6°46'W

**Area:** 150 ha open water

**Altitude:** sea level

**Nearest Towns:** Menole (6 km W); Sassandra (80 km E)

**General:** This is an open inlet rather than a lagoon, but it is often referred to as a lagoon. It is 3 km long and some 500 m wide. It is protected from high wave energy by low headlands and by the fact that it is branched behind the mouth. It supports some tidal forest, and receives water from the Krenovo/Nema River, and another coastal stream. Patches of swamp forest occur on all three streams.

### (b) Digoue Lagoon

**Country:** Cote d'Ivoire

**Coordinates:** 4°44'N/6°40'W

**Area:** c. 480 ha open water

**Altitude:** sea level

**Nearest Towns:** San Pedro (5 km E); Abidjan (310 km E)

**General:** This is a closed lagoon situated a few kilometres west of San Pedro. It is just over 5 km long, over 2 km wide in the centre, and is oriented roughly E-W parallel with the rocky/sandy coast. It receives water from three local streams. The Baba is the largest of these and rises some 6 km inland at an altitude of 50 m. A watercourse, the Dreganobo Stream, connects the lagoon to the San Pedro River and water flow in this stream is reversible. The southern extremity of the lagoon is very close to the sea beach at Digoue, and at times of high water the sand-bar may be breached. There are permanently marshy zones around the lagoon, and a zone which is inundated periodically. Other small permanent swamps occur in the headwaters of the Baba River.

### (c) Katibo Lagoon

**Country:** Cote d'Ivoire

**Coordinates:** 5°03'N/5°47'W

**Area:** c. 640 ha

**Altitude:** sea level

**Nearest Towns:** Fresco (24 km E); Abidjan (200 km E)

**General:** Katibo Lagoon is a flooded valley system, set in steep coastal hills. The lagoon has two arms, each 4 km long, and each much branched. The arms diverge inland, one oriented NE, the other NW. The valley sides rise steeply from the water along both arms, reaching an elevation of 51 m above the water just 100 m from the shore of the NW arm. Several minor streams enter the arms and their branches, but the lagoon is closed at the seaward end by a sand-bar, which is usually breached during the rainy season. There are no important swamps on the steep shores which are forested down to the water's edge. There are 7 very minor lagoons in the district, 1 west and 6 east of Katibo Lagoon. These are little lakes at the ends of ephemeral streams which become dammed behind the coastal sand-bar.

#### **(d) Fresco Lagoon**

**Country:** Cote d'Ivoire

**Coordinates:** 5°06'N/5°35'W

**Area:** 1700 ha open water

**Altitude:** sea level

**Nearest Towns:** Fresco (on lagoon); Abidjan (180 km E)

**General:** The Bolo and Nioumouzou Rivers discharge into the lagoon, which has a wide mouth open to the ocean. The lagoon shores are marshy in places, particularly along the estuaries, and there are areas subject to seasonal inundation immediately behind the marshes. There are small mangrove stands inside the lagoon mouth, and some swamp forest occurs at the river mouths.

#### **(e) Hebe & Kodioboue Lagoons**

**Country:** Cote d'Ivoire

**Coordinates:** 5°12'N/3°30'W (Hebe); 5°14'N/3°35'W (Kodioboue)

**Area:** c. 1400 ha (total, both lagoons)

**Altitude:** sea level

**Nearest Towns:** Grand Bassam (20 km W); Abidjan (50 km W)

**General:** These are separate closed lagoons, situated some few kilometres behind the beach barrier dunes, almost equidistant from Ebrie and Aby Lagoons. They are surrounded by marshlands, behind which there are small zones subject to seasonal inundation. Some *Avicennia africana* is present.

### **3. Riverine Wetlands**

**General:** As discussed earlier, the great seasonality of the rainfall causes the inundation of narrow strips along the banks of most interior rivers, but there are no major floodplains in Cote d'Ivoire. However, although they are too numerous to deal with individually, many small wetland areas, patches of swamp forest, strips of periodically inundated gallery forest, patches of grassy floodplain, riparian reed swamps and dambos occur throughout

the higher plateau region, north of the parallel 8°N. Wetlands are comparatively scarce south of this parallel, because the rivers flow more steeply down to the coast from this point. Along the western part of the coast small mangrove stands occur at river mouths, many of which are protected from wave action in some way. Many such small wetland areas are protected in National Parks or other reserves. A brief account of some interior wetlands is given here by river system.

#### **(a) Minor Western Rivers**

**Country:** Cote d'Ivoire

**General:** Tidal swamps, grading into freshwater swamps occur in the estuaries of the Houo River (4°30'N/7°12'W), the Ni6gwabo River (4°31'N/7°07'W) and the Dodo River (4°32'N/7°03'W). Swamps extend 7 km upstream on the Dodo, and also occur in a 7 km depression to the east, away from the river.

The Nero (or Mono) River drains the highlands of SW Cote d'Ivoire between Mts. Kop6 (4°59'N/7°26'W) and Nienokouè (5°25'N/7°10'W), and reaches the sea in a sheltered situation behind a promontory in western Cote d'Ivoire (4°39'N/6°55'W). It supports close to 7000 ha of swamp land around its small estuary which grades from tidal (mangrove) forest into freshwater tidal and seasonal swamp forest, with another 1000 ha patch of freshwater swamp forest to the east in a depression. The swamps extend inland for 12 km and reach a maximum width of 18 km across the river 4 km upstream. These forests are unprotected, but presently subject to little disturbance.

#### **(b) The Cavally & Sassandra Rivers**

**Country:** Cote d'Ivoire

**General:** Between them these two rivers drain almost the entire western part of Cote d'Ivoire; they flow directly to the sea and their lower courses are beset with waterfalls and rapids. The Tai National Park, and adjoining game and forest reserves, which in total cover 500 000 ha, are situated between the lower reaches of these streams in an area that contains numerous swamps. The National Park is reputed to contain many endemic plant species, the survival of which, at least in Cote d'Ivoire, probably depends upon the maintenance of these reserves. In addition there are several endangered animals including *Cephalopus jentinki*, *C. zebrae*, *Choeropsis liberiensis* and *Loxodonta africana cyclotis*. Upstream the Sassandra drains other wetland areas in the Mont Peko and Mont Sangbe National Parks. The lower course of the Sassandra was dammed in 1979, at Buyo, a matter dealt with later. The Cavally reaches the sea on the Liberian border at Cape Palmas, its mouth deflected a little eastwards. The Sassandra reaches the sea in a broad island studded estuary at the town of Sassandra. This is tidal for at least 22 km inland and widens to 3.2 km across the island inside the mouth. Mangroves are quite well developed at the Sassandra mouth.

#### **(c) The Bandama River**

**Country:** Cote d'Ivoire

**General:** The two branches of this river, the Bandama Rouge and Bandama Blanc

Rivers, drain the central part of Cote d'Ivoire and discharge into Tagba Lagoon. The river has been dammed at Kossou producing an artificial lake in the Guinean-Soudanian transitional savanna zone. North of this lake the river banks are protected, at least ostensibly, in the Reserve de Haut Bandama, covering 10 100 ha. Farther downstream small areas of riverbank are protected in the Lamto Scientific Reserve, Azagny National Park and several Forest Reserves.

#### **(d) The Komoe River**

**Country:** Cote d'Ivoire

**General:** This river drains the eastern part of Cote d'Ivoire and discharges into the eastern end of the Ebriè Lagoon complex. Formerly it had a natural outlet to the sea but this was closed by road construction in 1980. Almost the entire length of the Komoè is accompanied by riverine and gallery forest, much subject to seasonal inundation. Seasonally inundated areas occur along the river and its tributaries between 8°-9°30'N, in patches and strips which vary from 500-2000 m wide. Rice is grown on the floodplain locally, e.g. around 8°17'N/4°00'W, near the confluence with the Segbono River. About 18 000 ha of the upper valley is protected within the Komoe National Park, which itself has an area of 1 150 000 ha and is considered one of the most important conservation areas of the West African Soudanian zone. This protected stretch of the Komori contains an important population of *Hippopotamus amphibius* in an area where the wide, seasonally inundated alluvial grasslands sustain a great variety of wildlife. There are also a number of permanent and seasonally flooded pans (mares) which provide an important habitat for migratory and other birds, as well as for all three African crocodile species.

The lower course of the Komoe is partly protected in the Mabi-Yaya-Sougan-Tamin Forest Reserve complex, which comprises an area of about 250 000 ha of rain forest. Roth *et al.* (1984) give some account of the large mammal populations in Cote d'Ivoire.

#### **(e) The Granhala, Baoule & Bagoé Rivers**

**Country:** Cote d'Ivoire

**General:** These three rivers rise in, and drain, the northwest part of the country. They all flow northwards and are affluents of the Niger. The Gbanhala forms the border with Guinea for some distance. All these rivers, and their many affluents, have narrow floodplains, north of 9°20'N, and a deal of rice is grown along them.

### **4. Artificial Impoundments**

#### **(a) Lake Kossou**

**Country:** Cote d'Ivoire

**General:** The barrage on the Bandama Blanc River at Kossou was completed in 1972. The lake which developed behind the dam (7°03' - 8°06'N/5°20'-5°49'W) appears from the latest maps to be 155 km long with a mean width exceeding 5 km, thus providing an open water surface of at least 77 000 ha at capacity, but lower figures, c. 40 000 ha, have been cited in some publications. The hydroelectric plant has a potential production of

535 million kWh. The lake is situated in the Guineo-Soudanian transitional savanna zone. It supports a population of *Hippopotamus anzphibius*, is an important habitat for many aquatic and semi-aquatic species and has a progressively diversifying avifauna. A fishery has been developed on the lake in a joint UNDP/FAO project. The lakeshores are unprotected.

**(b) Lake Buyo**

**Country:** Cote d'Ivoire

**General:** The Buyo Dam on the Sassandra River became operational in 1980 and produces 850 million kWh of electrical power. The lake (6°17'-7°04'N/6°53'-7°34'W) is 130 km long, and attains a maximum width of 16 km. It is shaped like a letter U and occupies the valleys of the Sassandra and one of its ephemeral tributaries. It appears to provide an open water surface of approximately 65 000 ha at capacity, although lower figures (c. 35 000 ha) have been quoted.

**(c) Lake Ayame**

**Country:** Cote d'Ivoire

**General:** This impoundment on the Bia River (5°42'-5°57 'N/3°07 '-3°18'W) provides an open water surface of some 30 000 ha in the Guinean Forest zone, behind the dam known as Ayamè I. Some few kilometres downstream there is another dam, Ayame II, and both are used to generate hydroelectric power. The southern side of the western arm of the lake is protected in the N'Zo Faunal Reserve.

**(d) Minor Impoundments**

**General:** There are several, the largest being at Man, Taabo and Ferkessedougou.