



Côte d'Ivoire

Post-Conflict Environmental Assessment

United Nations Environment Programme

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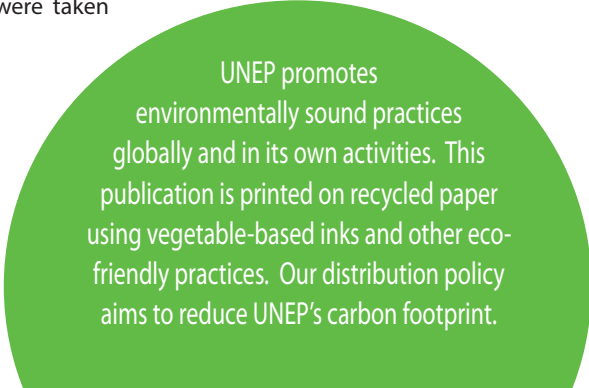
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Côte d'Ivoire

Post-Conflict

Environmental Assessment

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Foreword

Rich in natural resources, Côte d'Ivoire is a country with a strong history of economic prosperity. Using its fertile land for cocoa and coffee production, economic growth of Côte d'Ivoire surpassed any other in the region between 1960 and 1979, a period known as the "Ivorian miracle". However, economic decline and over a decade of internal conflict has rolled back these gains and damaged the nation's environmental resource base.

As Côte d'Ivoire moves towards reconciliation and sustainable development, sound management of the country's natural wealth will be critical for inclusive economic growth, social cohesion and political stability. This multi-disciplinary, environmental assessment aims to help guide the country towards a more prosperous and environmentally sustainable course.

Focusing on critical issues such as forestry, the system of national parks, urban expansion challenges in Abidjan, and the Ébrié Lagoon, this report offers a series of public policy interventions to help reshape the country's environmental situation. It calls for renewed efforts to halt widespread deforestation and for the protection and management of areas with significant conservation value. It also outlines how investments in ecological restoration can help support the country's economic recovery. With a young population, relatively low population density and a favourable climate,



Côte d'Ivoire has the potential to reverse environmental degradation and emerge as a leader on green economy solutions.

UNEP remains committed to supporting Côte d'Ivoire as it moves ahead with implementing the report's recommendations. With a new sub-regional office in Abidjan, UNEP looks forward to future collaboration with Côte d'Ivoire to assist the nation in charting a path to sustainable economic growth.

A handwritten signature in blue ink that reads "Achim Steiner". The signature is fluid and cursive, with a long horizontal stroke at the beginning.

Achim Steiner

Under-Secretary-General of the United Nations
Executive Director
of the United Nations Environment Programme

Foreword

The decade of crisis recently experienced by Côte d'Ivoire and its undoubted impacts on the environment have led the Ivorian Government to embark on such an ambitious environmental assessment exercise for the first time.

This exercise reinforces the vision of the President of the Republic, His Excellency Alassane Ouattara, which is “to ensure a healthy environment for all by anchoring sustainable development in society, so that each citizen is a responsible actor and contributes to harmony between environmental quality, economic dynamism and social equity.”

Besides the will to be acquainted with and analyze the environmental impacts of the 11 years of crisis faced by our country, we thought it appropriate for the Government to have some idea of the changes that have affected the diverse environmental ecosystems of Côte d'Ivoire for more than half a century.

It is in this spirit that the Government of Côte d'Ivoire has called upon the services of the United Nations Environment Programme (UNEP) to provide our country with the required technical assistance to carry out this post-conflict environmental assessment.

We welcome the quality and experience of the multidisciplinary team made available to our country to cover all aspects of the environmental assessment, also taking into account the social and institutional dimensions without which our efforts to manage the environment in a sustainable way would be in vain.

While international experts have played a key role, it is important to emphasize the particularly crucial contribution of national experts to the success of this initiative.

This report is of a high quality in so far as it fulfils the fundamental criteria of a good scientific research based on reliable data and experimentation.

The terrestrial, maritime, lagoonal and aerial techniques as well as remote sensing and other Earth Observation Science used for the assessment are further proof of the rigour of the science-based process which underlies the report's observations and findings.

The articulation of the report along interconnected themes, such as forests and national parks, the Ébrié



lagoon, the mining sector and the urban environment, strengthen our understanding of the interactions between the ecosystems studied and their importance for our country's socio-economic development.

The essence of the report lies in a series of realistic recommendations intended for Ivorian policymakers and particularly the strong correlations between the measures to be taken to sustainably manage our environment and the opportunities available to us to transform our country into an emerging country by 2020, by taking the environment into account.

Three of the recommendations have especially captured my attention. The first one concerns the reform of the forest sector and national parks. We have been delighted to learn that it is possible to partially or totally recover 80 % of the forest coverage lost since independence by implementing a deliberate and rigorous rehabilitation policy of the Ivorian forests, illustrated by the programme “Agriculture with zero deforestation” launched by the President of the Republic at the General Assembly of the United Nations in September 2014.

The second recommendation relates to the reversing of the trend towards the current unsustainable development of the city of Abidjan. Once again, we have been pleased to learn from the report and the wise suggestions of the experts that it is possible to restore the environmental quality of Abidjan, which is home to 5 million people, through the implementation of a true national urban policy.

The third recommendation is related to the Ébrié lagoon, which in its current state symbolizes the decline of a city once compared to the town of Geneva in Switzerland. We are glad to note that the situation is not irreversible and that it is possible to stop spills of all kinds in the lagoon, whose environmental load capacity is currently greatly overburdened. We are of the opinion that the lagoon system of Côte d'Ivoire, unique in the world in terms of its size and functions, can provide opportunities in the areas of trade, fisheries, recreational activities, urban transport, tourism etc., whilst at the same time improving the quality of life of the inhabitants of our economic capital.

As we can see, this report is different from other reports in the sense that it lays the foundations of a radical change in the management of the environmental challenges faced by Côte d'Ivoire,

without which the emergence that we aspire to will not be possible.

I wish to conclude by passing on the Government's sincere thanks to UNEP and all experts involved in the drafting of this report.

We applaud the quality of the relations between our country and UNEP, which has just opened an office in Côte d'Ivoire, hosting the Sub-Regional Office for West Africa and the Secretariat of the Abidjan Convention, which do tremendous work.

We firmly commit to rigorously implementing the post-conflict environmental assessment report's recommendations as part of the drive towards of ongoing socio-economic development, in order to ensure that the Côte d'Ivoire becomes an emergent country by 2020.



Dr. Remi Allah-Kouadio

Minister of the Environment, Urban Salubrity
and Sustainable Development of Côte d'Ivoire

Executive Summary

The Republic of Côte d'Ivoire is located in West Africa and shares borders with Liberia and Guinea to the west, Ghana to the east, and Mali and Burkina Faso to the north; to the south lies the Atlantic Ocean. The country covers an area of 322,463 km², of which 318,003 km² are land and 4,460 km² water. According to World Bank estimates, Côte d'Ivoire has a population of 20.81 million spread across 31 administrative regions, twelve districts, and two autonomous districts.

Côte d'Ivoire gained independence from France in August 1960 and in the two decades that followed, made huge economic progress through growth in the export of various agricultural products, primarily cocoa. When the price of cocoa began to fall in the 1980s, the country fell first into economic decline and then, in the 1990s, into political turmoil. There was a military coup in 1999, and in 2000 conflict became open and widespread. Despite reconciliation efforts on the part of the key political actors, in 2002 a mutiny of disaffected soldiers in Abidjan grew into a full-scale rebellion. The rebels of the Ivory Coast Patriotic Movement (Mouvement patriotique de Côte

d'Ivoire) seized control of the north of the country from the national government and from then on Côte d'Ivoire was in practice governed as two administrative units, with a buffer zone (termed the Zone of Confidence) in the middle. Abidjan continued to be the de facto capital of the National Government, while Bouaké, just north of the Zone of Confidence was the de facto capital of the forces controlling the country north of the zone.

In 2010, after a decade of negotiations, an election was held in which all the major political formations took part and people from all the geographical and social parts of the country voted. The independent election commission of Côte d'Ivoire declared Alassane Ouattara the winner, but the incumbent president, Laurent Gbagbo, did not concede defeat. As a consequence, violence broke out yet again. In April 2011 forces loyal to Alassane Ouattara captured Laurent Gbagbo and in May 2011, Ouattara took up the role of president.

The new government of Côte d'Ivoire, which came into power after the 2010 elections, made a formal request to UNEP for a post-crisis environmental assessment (PCEA). In responding to the request, UNEP conducted a desk study and remote



A number of local experts joined the assessment mission



Ongoing deforestation is a big concern

sensing analyses and a scope of work was agreed with the Government for field work. Fieldwork for the PCEA was conducted in June and August 2013. A number of national experts joined the field work. Chemical analyses of the samples and further remote-sensing studies were conducted between August and October 2013. During 2014, the draft report was prepared and submitted to the government and external peer reviewers.

The report studied the following environmental issues which had direct or indirect linkages with the conflict;

- forests, including national parks and classified forests,
- environmental degradation of Ébrié Lagoon;
- environmental issues related to unplanned urban expansion;
- industrial and artisanal mining and their environmental footprint; and
- risk of oil spill along the Côte d'Ivoire coastline.

In addition, the study also looked at how the institutions overseeing natural resource management and environmental governance were impacted by the conflict.

Key findings

1. There is significant and ongoing deforestation, primarily caused by conversion of classified forests into agricultural lands. The situation is grave and unless addressed comprehensively, it may not be possible to retain ecologically sustainable levels of forests in Côte d'Ivoire.
2. All national parks in the country were affected by the conflict, some more severely than others. The Comoé National Park and Marahoué national park lost significant flora and fauna while the damage to flora in Tai National Park was limited. The animal population in Tai National Park, especially the Chimpanzees, was severely affected with the population dropping about about half.
3. The city of Abidjan has doubled its population during the conflict period while urban service provisions have stagnated or deteriorated. This has resulted in range of environmental issues including water pollution, inappropriate disposal of hazardous and municipal waste and severe land degradation.
4. The Ébrié Lagoon, which was already severely polluted even before the conflict, has been further degraded due to disposal of solid and



Abidjan has doubled in population since 2001

- liquid waste and unplanned land reclamation. There is evidence of heavy metal and pesticide pollution in the fish in the Ébrié Lagoon which needs to be addressed as a matter of priority to better protect the health of the community.
5. The mining sector in Côte d'Ivoire has not gone at a pace similar to its neighbours primarily due to the insecurity caused by the conflicts. There is limited investment in the industrial mines while the artisanal mining sector is flourishing. There are serious health and safety issues in the artisanal mining sector which need to be addressed.
 6. The risk of an oil spill affecting Côte d'Ivoire increased significantly during the conflict period due to expanding oil exploration in the Gulf of Guinea, including in Côte d'Ivoire waters. However, the capacity to deal with an oil spill has in fact deteriorated, making the country doubly vulnerable.
 7. There are number of Ministries and institutions in Côte d'Ivoire who have overlapping responsibility for environmental management. Not all of these departments co-ordinate their activities effectively adding to the environmental challenges facing the country.

Key recommendations

The study has made a number of technical recommendations to deal with the various environmental challenges facing the country. It is clear from all the evidence and analysis presented in this report that Côte d'Ivoire has many environmental challenges. The causes of the environmental degradation of Côte d'Ivoire are complex. Remedial action will have to go far beyond the technical solutions to individual environmental problems that are specified in this report. There are broader actions that need to be taken in order to get the country back on a path of sustainable growth and once again make the country a model for the whole of Africa.

While there are a number of very serious challenges to the country's environmental sustainability, there is also some cause for hope. The population density is still low, about 60 people per km², and only 50 percent of the population still lives in rural areas. Much of the land is suitable for agriculture and being in the tropics, is not subject to extreme weather. The country has plenty of high-value resources (e.g., oil, copper, gold) and owing to its geographical location, could well become the service hub of the region.

Côte d'Ivoire is also fortunate in that the political situation is now more stable, with major hostilities between the two rival formations having ceased and the government now legitimate and internationally recognized. With the exception of a few pockets in the west, there is peace across the country and a mood of growing confidence and security, all of which will help to drive development. Furthermore, even though much of the physical infrastructure has been degraded, the country has retained a core of civil servants and professionals, and more are willing to return to their work if the present peace continues. Lastly, since hostilities have ended and legitimate government has returned, Côte d'Ivoire has begun to regain its status as the economic hub of Francophone Africa—a status that is confirmed

by the return of the headquarters of the African Development Bank, which had left Abidjan during the conflict.

The following recommendations are presented with the anticipation that they will receive attention from individuals and institutions far beyond those within the environmental community:

1. Urgently halt continued deforestation; reforest at a grand scale, adequately protect and manage areas of conservation value

It is clear from the analysis presented in this report that damage to the country's forests is substantial and widespread. Degradation has been the prevailing trend for over a century, but one that has accelerated enormously over the past ten years. The damage will not be reversed by a few well-intentioned actions, be they a few evictions or a program of replantation at a local level. Rather, the government needs to examine the *totality* of forestry and protected areas, considering all the ecological, agriculture, industrial, socioeconomic, and security factors that are involved, and to do so *at once*. Only then will the government be able to envisage the 50-year plan that will be necessary, and to design a sustainable approach to the management of the country's forests and national parks.



Reforestation should be a priority

A strategic approach to forest management in Côte d'Ivoire must balance the need for access to land for a decent and sustainable livelihood with the need to preserve enough contiguous areas of forest so that the integrity of the ecosystem can be guaranteed. This process should start from commitment at the highest level to halt and reverse the forest degradation. This approach should measure the economic value that has been lost in the process of degradation, as well as that which might be generated by emissions trading, payment for ecosystem services, and the reduction of emissions for deforestation. All these must be done at a national scale if there is to be a master plan for the regeneration of the ecosystem and the forests of Côte d'Ivoire.

2. Reverse the unsustainable growth of Abidjan

Most large cities in the developing world have expanded in recent decades, but Abidjan's growth has been explosive. More to the point, it has been unnatural in that it was driven not by aspiration but by fear. As a result, it is unsustainable. The environmental damage caused by that growth is immense: groundwater sources have been depleted, and Ébrié Lagoon is highly polluted. Abidjan no longer offers the quality of life it once did. Its infrastructure from water supply, sanitation and

waste management, to education and health care has suffered.

It is still possible to restore Abidjan's former environmental quality even with its current population of five million, but the resources needed to do so would be vast. More important, it would be neither an efficient nor an appropriate response to this urbanization crisis. The civil war drove large numbers of people to Abidjan over a short period of time, and a brief period of peace will not be enough to persuade them to return to whence they fled. Better economic opportunities, infrastructure, and social services, and the long-term stability of the country, will induce people to return to their former homes. Furthermore, as inertia is often the partner of suspicion in these situations, incentives will need to be offered to encourage people to leave the city.

3. Establish Ébrié Lagoon as an engine for economic revival in Abidjan

At present, Ébrié Lagoon is a foul, unsightly waterbody that does not offer aesthetic or ecosystem benefits to the population. However, the UNEP assessment has shown that only 10 percent of the lagoon is subject to severe anthropogenic impact. The lagoon could recover.



The Ébrié lagoon can become a growth engine promoting tourism and other economic activity

To allow that recovery to happen, the government would need to remove the present accumulation of pollution, prevent further encroachment, and control or stop the use of the lagoon as a dumping ground for solid and liquid waste. Such a recovery would not only make an immeasurable difference to the lives of Abidjan's citizens, it would also drive the city's economic growth. The lagoon could still offer opportunities for commercial and artisanal fishing, recreation, fast and efficient water transport, tourism, and a waterfront worthy of the region's economic hub.

Ébrié Lagoon will not be transformed from its current polluted state into a prime mover of Abidjan's economy by uncoordinated policy initiatives to clean it up or to prevent encroachment. As in the case of forest regeneration efforts, the efforts here need to be long term, coordinated, and substantial. UNEP recommends the formation of an Ébrié Lagoon Authority, to be tasked with long-term planning. Authorities in other countries have managed to ensure effective coordination between the relevant municipalities and government departments so as to implement measures to improve the environmental quality and productivity of bodies of water like the lagoon.

Way forward

Many reports in the past have addressed the individual issues assessed during this survey. For

experts who have been following the story of Côte d'Ivoire, neither the conclusions nor the recommendations found in the report will be entirely new. This report only presents them in a holistic fashion.

The decision makers in Côte d'Ivoire are cognizant of the environmental challenges faced by the country and are aware of potential solutions. However, resources to deal with these issues are severely lacking. With the country coming out of more than a decade of conflict, there are more urgent pressures that require attention, such as job creation and delivery of social services (i.e. education and healthcare). Nonetheless, long-term sustainable development of the country depends on ensuring environmental sustainability, a point that is obvious but not always easy to put into practice.

Côte d'Ivoire would need both significant internal mobilization of funds and external support to deal with environmental issues identified in the report. Luckily, many of these issues have the potential to bring in return on investment in the medium term, such as restoring national parks and promoting tourism, and clean up of Ébrié Lagoon and promoting a range of economic activities therein. The key, therefore, is to bring environmental issues to the forefront, design a number of tangible interventions and create the appropriate market conditions so that capital could be directed towards these efforts.

Introduction

*Economic activity
is returning to Abidjan*



Introduction

1.1 Political backdrop

The Republic of Côte d'Ivoire is located in West Africa and shares borders with Liberia and Guinea to the west, Ghana to the east, and Mali and Burkina Faso to the north; to the south lies the Atlantic Ocean. The country covers an area of 322,463 km², of which 318,003 km² are land and 4,460 km² water. According to World Bank estimates, Côte d'Ivoire has a population of 20.81 million spread across 31 administrative regions, twelve districts, and two autonomous districts. The country's capital city is now Yamoussoukro, which is located in the central-southern part of the country (Map 1). Until 1983 the capital was Abidjan, a coastal city located in the southeastern part of the country and remains the de facto capital of Côte d'Ivoire.

Côte d'Ivoire gained independence from France in August 1960 and in the two decades that followed, made huge economic progress through growth in the export of various agricultural products, primarily cocoa. When the price of cocoa began to fall in the 1980s, the country fell first into economic decline and then, in the 1990s, into political turmoil. Since then the country has been trying to recover from decades of political unrest and to resume a developmental trajectory.

There was a military coup in 1999, and in 2000 conflict became open and widespread. Despite reconciliation efforts on the part of the key political actors, in 2002 a mutiny of disaffected soldiers in Abidjan grew into a full-scale rebellion. The rebels of the Ivory Coast Patriotic Movement (Mouvement patriotique de Côte d'Ivoire) seized control of the north of the country from the national government and from then on Côte d'Ivoire was in practice governed as two administrative units, with a buffer zone (termed the Zone of Confidence) in the middle. Abidjan continued to be the de facto capital of the National Government, while Bouaké, just north of the Zone of Confidence was the de facto capital of the forces controlling the country north of the zone.

In 2010, after a decade of negotiations, an election was held in which all the major political formations took part and people from all the geographical and social parts of the country voted. The independent election commission of Côte d'Ivoire declared Alassane Ouattara the winner, but the incumbent president, Laurent Gbagbo, did not concede defeat. As a consequence, violence broke out yet again. In April 2011 forces loyal to Alassane Ouattara captured Laurent Gbagbo and in May 2011, Ouattara took up the role of president. Since that time Gbagbo has been extradited to the International Criminal Court in the Hague.



Yamoussoukro, the official capital of Côte d'Ivoire

Map 1. Côte d'Ivoire



1.2 Post-conflict environmental assessment

The United Nations Environment Programme (UNEP) has undertaken a post-conflict environmental assessment (PCEA) in a number of countries since 1999.¹ PCEAs in general describe the existing condition of the key environmental sectors that have been impacted by conflict or may have contributed to a conflict in a given country.

However, it should be stressed that the primary focus of a PCEA is on the future: the aim is to offer recommendations on how environmental challenges can be addressed in a manner that would contribute to sustainable development and minimize the potential for future conflict. It is not an objective of the PCEA to establish the benchmark of the environmental situation before the conflict, though when technically possible it is often used as a reference. UNEP conducts PCEAs at the request of a Member State when it is possible to deploy field teams safely after the conflict and when full neutrality of the UN report is assured. Since every conflict is different in its causes, actors, geographical context, and conduct, PCEAs have to be tailored to the specific country context.

The new government of Côte d'Ivoire, which came into power after the 2010 elections, made a formal request to UNEP for a PCEA. In responding to the request, UNEP deployed a multidisciplinary team of experts to Côte d'Ivoire with the intention of building an understanding both of the country's key needs and the expectations of the various stakeholders—from the national government through UN agencies and bilateral donors to the private sector and civil society—regarding the PCEA.

The UNEP mission also served as reconnaissance for the security concerns and logistical challenges that would be encountered when undertaking a country-wide PCEA. Based on the scoping visit, the first step in determining whether an assessment is feasible, UNEP agreed to initiate a PCEA. A plan for the scope of the work involved in the PCEA was prepared and submitted to the government, and the government provided inputs to the scope of work after extensive national consultations. Desk study and remote sensing analyses in preparation of the PCEA were initiated, and the key experts involved and government officials were invited to a consultative meeting in Geneva in April 2013. At that meeting the parties discussed the



The scope of assessment was agreed with the Government

implementation arrangements for the PCEA and finalized both the scope of the assessment and the implementation plan. A further consultative meeting with the regional directors of the Ministry of Environment and Sustainable Development (MINESUDD) took place in June 2013. Fieldwork for the PCEA was conducted in June and August 2013. A number of national experts joined the field work. Chemical analyses of the samples and further remote-sensing studies were conducted between August and October 2013. During 2014, the draft report was prepared and submitted to the government and external peer reviewers.

1.3 Report structure

The main output of the study is the UNEP PCEA report, which is divided into ten chapters.

Chapter 1 introduces the background to the PCEA, describes the structure of the report and gestures towards the thematic results and conclusions contained in the body of the work. Chapter 2 discusses both the environment of the country and the conflict in Côte d'Ivoire. Chapter 3 outlines the assessment's scope and approach, the latter of which includes remote sensing, laboratory work, and institutional analysis.

Chapters 4-9 present the key results from the study of each of the critical areas, provides site-specific recommendations for improvement, and offers several case studies to illustrate the key environmental challenges.

Chapter 10 provides general recommendations for moving forward.

Country Background

*Agriculture has been
the mainstay of the economy*



Country Background

2.1 Geography and ecology

The territory of Côte d'Ivoire is generally flat, but there are some mountains in the north-western part of the country. Côte d'Ivoire is 400 km from the equator and enjoys a climate that is generally hot and humid, ranging from 20°C to 33°C. The country has three major climate zones: subequatorial, humid tropical, and semi-arid. Annual weather variation can be characterized by three seasons: warm and dry from November to February, hot and dry from March to April, and wet from June to October. The latitude and pattern of rainfall have given Côte d'Ivoire three ecological zones: in the north of the country a savanna zone, in the south a dense humid forest zone, and a transition zone between the two.

2.2 Forest cover

The forest zone of Côte d'Ivoire is part of the larger Upper Guinea Forest (UGF) region of West Africa that extends from Guinea to Togo. These forests contain exceptionally diverse habitats rich in plant species—there are 2,800 vascular forest plants, of

which 23 percent are endemic and support one of the highest diversities of mammals in the world. By 2000, however, the UGF region had lost 80 percent of its original size due to timber exploitation and agricultural expansion and is recognized as one of the global hotspots for biodiversity conservation.²

Two main forest types (see Map 2) can be distinguished in the rainforests of the south: evergreen and semi-deciduous. Wet evergreen forest (canopy rising to 30 m) and moist evergreen forest (canopy rising to 40 m and holding fewer species than wet evergreen forest) are poorly stocked with commercial species but still contain *Uapaca* spp., *Guarea cedrata* (bosse, guarea), *Tieghemella heckelii* (makore), *Tarrietia utilis* (niangon) and *Triplochiton scleroxylon* (samba).

The semi-deciduous forests are found in the central and northern parts of the forested zone. They were once rich in valuable timber species, including samba, *Mansonia altissima* (bete), *Nesogordonia papaverifera* (kotibe), and *Khaya ivorensis* (acajou). Moist semi-deciduous forest is the tallest forest type of the region, with the highest density of commercial species, while dry semi-deciduous forest has a canopy rising to 30-45 m but not fully closed.³



Côte d'Ivoire once had the best forests in West Africa

Map 2. Forest classes in Côte d'Ivoire





Forests in Côte d'Ivoire are under multiple pressures

Other forest types, reflecting peculiar ecologies, are also found in Côte d'Ivoire: mangrove forests (8,700 km²), swamp forests (450 km²), and mountain forests in the west of the country (480 km²). These forest types are marginal compared to the lowland forest estimated at 99,200 km².⁴

Forest cover is critical to maintain the ecological conditions necessary for climate control and agriculture. In 1900, Côte d'Ivoire had about 16 million ha of dense forests; by 2000 it had fallen to 6 million ha (FAO 2000). This degradation is attributable to five proximate causes:

- **Population growth.** Between 1988 and 1998 the population of Côte d'Ivoire increased from 10.8 to 15.4 million inhabitants; 78 percent of that increase occurred in the forest zone.
- **Intensive conversion of forests to cocoa and coffee plantations.** Cash crops have been the pillar of the national economy since the 1970s. Areas in which cash crops such as cocoa and coffee are cultivated overlap with the forest zone. Thus there has been an influx of people from all corners of Côte d'Ivoire, as well as from neighboring countries, to the fertile grounds of the forest zone.
- **Commercial timber exploitation.** Timber exploitation began in Côte d'Ivoire in 1880, developed during the colonial era, and was at its most intense from 1970 until the 1980s. The rate of exploitation was 5 million m² in 1977, and is about 2 million m² today. The highest levels of deforestation occurred in the center of the country, in the moist semi-deciduous forests that contain many exploitable species.
- **Firewood collection.** Rural populations rely on firewood and charcoal for cooking. The level of collection was estimated at 14 million m³ in 1995 and has increased in line with population growth.⁵
- **Uncontrolled forest fires.** Fires are used to clear agricultural lands and to regenerate grasses for grazing. Uncontrolled fires, which occur often, are particularly common and especially devastating in the semi-deciduous forest and savanna zones.

2 COUNTRY BACKGROUND

As a consequence, dense primary forest has been largely replaced by a patchwork of secondary forests, cash-crop plantations, timber plantations, food crops, and fallows.

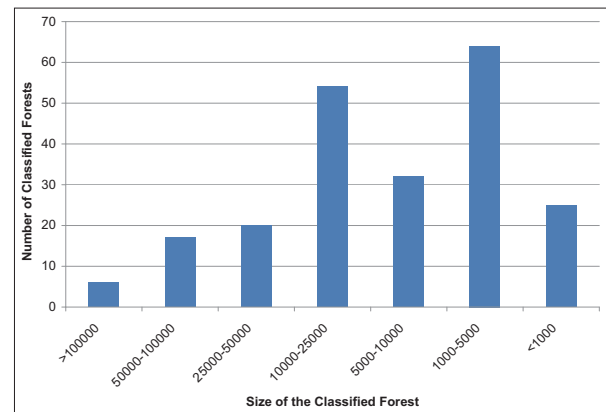
Administratively, the forest sector is divided into the rural zone (domaine rural) and the forest zone, which belongs to the state (domaine forestier permanent de l'état). The forest zone amounts to a de facto protected forest area and comprises the classified forests (forêts classées) and the national parks and reserves. Together, these areas cover 6.1 million ha, which amounts to 19 percent of the national territory.

There are 231 classified forests (forests under government control where timber exploitation is allowed). Not all classified forests are in the forest zone; some are located in the Savanna and transition Forest-Savanna Zones. They occupy 4.2 million ha, which represents 13 percent of the country area, and they vary in size from 90 to 315,000 ha. Figure 1 shows the size distribution of the classified forests, with the exception of Rapides Grah and Haute Dodo, which are con-

siderably larger (315,000 ha and 196,733 ha, respectively).

The principal function of the classified forests is to maintain forest cover while producing wood for the timber industry. Since 1993, the classified forests have been managed by the Forestry Development Agency (SODEFOR), which is currently under the aegis of the Ministry of Water and Forests (MINEF).

Figure 1. Size distribution of the classified forests in Côte d'Ivoire



Some good forest is still remaining

2.3 Economy

With a gross domestic product (GDP) of roughly USD 31 billion and a growth rate of 9 percent in 2013, Côte d'Ivoire is the second largest economy in West Africa after Nigeria, and the largest economy in the West African Economic and Monetary Union.⁶ Approximately 85 percent of all economic activity is concentrated in the southern part of the country.⁷ Small and medium enterprises constitute 61 percent of companies in Côte d'Ivoire.⁸ According to the United Nations Conference on Trade and Development's *World Investment Report*, the stock of foreign direct investment in Côte d'Ivoire as of 2010 was an estimated USD 6.6 billion, the equivalent of 28.9 percent of that year's GDP. In terms of foreign direct investment stock, France is Côte d'Ivoire's leading investor, followed by other European countries and Lebanon. Chinese, Indian, Libyan, Singaporean and Moroccan businesses have begun making significant investments in Côte d'Ivoire.

The national economy is considered to be fairly well diversified. The primary sector—which makes direct use of natural resources through agriculture, forestry, and fishing or hunting—comprises roughly 30 percent of the country's GDP.⁹ The secondary sector, covering industrial and manufacturing activities that produce finished goods, comprises 21 percent of GDP.¹⁰ The tertiary, or service, sector represents 49 percent of the economy.¹¹

Nearly half of Côte d'Ivoire's GDP (44 percent) relies on exports, with cocoa being the leading export.¹² All of Côte d'Ivoire's export products are either directly or indirectly related to natural resources (either raw/processed goods or extraction and processing equipment). There are three main sectors: agriculture, forestry, and extractive industries. This section illustrates the major role of these natural resources for Côte d'Ivoire's recovery and development, and provides a basis for subsequent sections to show why it is essential to address natural resources within post-conflict development plans.

Agriculture

Due to record high prices and availability of fertile forest land for cacao production, Côte d'Ivoire's economic growth surpassed any other in the region

between 1960 and 1979, and it became known as the "Ivorian miracle," with Abidjan dubbed the "Paris of West Africa." The growth was based on export-oriented agriculture. At the time of independence in 1960, Côte d'Ivoire's economy and economic infrastructure were already oriented towards an export-based system that relied on the extraction of raw materials, primarily for export and processing elsewhere. Transportation axes were oriented north-south, with most converging near the two main ports of San Pedro and Abidjan. This colonial development model was continued by the independent administration of Houphouët-Boigny, the first President of Côte d'Ivoire, for the following three decades.

Agriculture, especially cash crops, remains the primary engine of Côte d'Ivoire's economy.

The main cash crops produced and exported include:

- **Cocoa.** Côte d'Ivoire is the largest producer of cacao in the world, representing around 40 percent of global production. It is the dominant sector of the economy, currently accounting for 38 percent of the country's value in exports (USD 4.16 billion),¹³ and contributes 6 percent to the country's GDP.¹⁴
- **Robusta coffee.** Côte d'Ivoire is the largest producer in Africa, though production is declining. It was the fifth-largest producer in the world in 1990.¹⁵ However, current exports now value only USD 50.63 million, making it the twelfth-largest producer worldwide.¹⁶
- **Natural rubber.** Côte d'Ivoire is Africa's largest producer of natural rubber and the seventh largest producer in the world. The sector has grown 9 percent per year since 1995. With the sharp rise in global prices (from USD 1.03 per pound in 2007 to USD 2.18 per pound in 2011),¹⁷ production rose from 289,000 tons in 2007 to 400,000 tons in 2011.¹⁸ Annual production is forecast to reach 600,000 tons by 2025.¹⁹
- **Palm oil.** This is a growing sector that along with rubber is set to be a driver of rural growth and employment in the coming years. Between 2007 and 2011, production of palm oil



Rubber is a growing cash crop

increased from 288,000 tons to 400,000 tons.²⁰ In 2011 production of palm oil was valued at USD 174 million, contributing almost 1 percent to national GDP.²¹ Palm oil is grown for both subsistence and commercial purposes, primarily in the southern part of the country.

- **Cashew nuts.** Côte d'Ivoire is the world's third-largest producer and second largest exporter of raw cashew nuts.²² In 2010 cashews represented 1.5 percent of total Ivorian exports, totaling USD 170 million.²³ Cashews are grown primarily in the north and central parts of the country.
- **Cotton.** Exports for 2010 totaled USD 164 million and accounted for 1.5 percent of total exports.²⁴ Cotton is one of two primary cash crops in the northern and central parts of the country, and output has been steadily increasing since 2009.²⁵
- **Yams.** From 2002 to 2010 yams accounted for 49 percent of domestic food production, surpassing plantain and cassava.²⁶ Yam production is the leading food crop produced in Côte d'Ivoire and is particularly important for farmers to ensure their food security as well as cash income.

Forestry

Côte d'Ivoire's industrial forestry sector has been well developed since the early colonial period due to extensive forest resources, good road infrastructure, and ample energy supplies.²⁷ Between the 1960s and 1970s, the export of timber products was the third most important generator of export revenue after cocoa and coffee. During the 1970s industrial harvesting reached a peak of over 5 million m³ of roundwood equivalent, which dropped to around 4 million m³ per year during the 1980s and to 2 million m³ in 1987 as part of government efforts to combat rapid deforestation.²⁸ In 2006 the total formally extracted log volume amounted to about 1.5 million m³, with 1.3 million m³ from forested areas, 120,000 m³ from protected forests, and 100,000 m³ from teak plantations.

According to the Ministry of Planning and Development statistics cited in a 2008 regional timber trade study, all forestry companies had sawmills, 30 percent also produced rotary veneer, and 10 percent produced sliced veneer.²⁹ As of June 2013 there were 83 active mills.³⁰ Most timber felled and transformed in the formal sector is exported. During 2012, 156,000 m³ of roundwood (logs, valued at USD 72.7 million), 193,000 m³ of sawnwood (valued at USD 102 million), 69,000 m³



The timber Industry is active, though raw timber supplies are dwindling

of veneer (valued at USD 48.3 million) and 14,000 m³ of plywood (valued at USD 9.9 million) were exported. Timber products are exported from the ports of Abidjan and San Pedro.

The formal forest sector is managed through concession processes and management plans. According to MINEF, there were 130 registered forestry companies as of June 2013.³¹ However, 80 percent of the log harvesting and timber processes are conducted by eight companies: Congolaise Industrielle des Bois (CIB), Forest Investment Program (FIP), Inprobois, SIFCI, Scillage & Moulure Côte d'Ivoire (SMCI), STBO, Thanry, and Tropical Bois. Lebanese nationals now dominate management of the industry, followed by French, Italian, and Spanish, although Indian and Chinese nationals are increasingly active in the raw material trade, especially of teak to India and false teak to China and there are indications of consolidation into bigger companies.³² A quarter of the 30,000 employees in the sector were expatriates in 2008.³³

Due to decreasing wood supply, some operators have attempted to source from neighboring countries.³⁴ Recovery rates (percentage of useful

product out of the raw timber used as input) at the various mills range from 30-40 percent for sawn timber to 50-60 percent for rotary veneer depending on the processing method. The market trend is to reduce waste and increase high-value processing in order to maintain the export trade despite the scarcity of timber resources. As a result, operators face increasing pressure to obtain wood from across borders, both legally and illegally.

The 2010-2011 electoral crisis negatively impacted the timber industry, as purchasers sought supplies from alternative African sources.³⁵ Sanctions imposed by the European Union (EU) on the Gbagbo administration, transportation concerns, and boycotts of Côte d'Ivoire shipments by some European importing companies all led to this drop. Political unrest in the country and a lack of supply of certified wood (for sawnwood) has contributed to declining demand. However, ITTO has noted that Côte d'Ivoire experienced a sharp rebound in economic activity after the election-related disruptions of 2011.³⁶ The timber market has since stabilised and is showing recovery in 2014, with considerable increase in exports to China offsetting reductions to other markets.

Extractive industries

The extractive industries in Côte d'Ivoire include oil and gas, gold and diamond mining, as well as some manganese and aggregate mining. In addition to the formal exploration and mining activities, there is also artisanal gold and diamond mining operating on an informal basis.

In 2012 the oil and gas sector constituted over 20 percent of the country's exports, worth USD 2.36 billion,³⁷ and has recently overtaken cacao as the main source of government revenue. There are four oil blocks currently in production: Lion (CI-11), Espoir (CI-26), Baobab (CI-40) and Foxtrot (CI-27) (Table 1). With proven offshore oil reserves of 100 million barrels (global ranking 69th as of

January 2011), Côte d'Ivoire is a relatively small global player in petroleum production. Offshore oil production first began in Côte d'Ivoire in the 1950s; through the mid-1990s production predominantly catered to domestic demand.³⁸ Since the emergence of new technologies in the mid-1990s, the country has increased production, which peaked in 2006 to about 60,000 barrels a day. After the discovery of an estimated 1.8 billion barrels of offshore reserves off the coast of Ghana in 2007, there is significant interest in further study of the Ivorian coastline and shelf.

Proven natural gas reserves were estimated to be one trillion cubic feet in 2011. The country is currently the 59th largest producer of natural gas in the world; in 2010 production reached 57 billion cubic feet.³⁹



Exploration for hydrocarbon is showing promise

Table 1. Oil and gas production fields in Côte d'Ivoire as of 2010^{40, 41, 42, 43}

Field name	Current peak production of oil ^a and gas ^b	Operators and shareholders	Oil quality	Producing since
Espoir (CI-26)	Oil: 25,596 Gas: 13,541	CNR: 58.67% (operator) Tullow Oil: 21.30% PETROCI: 20%	Light	1982–88, 2006-
Baobab (CI-40)	Oil: 23,342 (52,000) ⁴⁴ Gas: 7,692	CNR: 57.6% (operator) Svenska: 27.4% PETROCI: 15%	Moderately heavy	2005-
Foxtrot (CI-27)	Oil: 603 Gas: 78,733	Foxtrot International: 24% (operator) Enerci: 12% PETROCI: 40% Saur Energie Côte d'Ivoire (SECI): 24%	n/a (mainly natural gas)	1999- ⁴⁵
Lion-Panthère (CI-11)	Oil: 1,623 Gas: 39,432	Afren: 48% (operator) PETROCI: 20.1% IFC: 18.94% SK Energy: 13% Société Ivoirienne du Pétrole et des Mines	Very light	1997-

^a barrels per day, ^b million cubic feet per day

Table 2. Commercial gold mines in Côte d'Ivoire

Mine	Company	Location	Year opened	Production details
Yaoure Mine (formerly Angovia Mine)	Amara Mining (formerly Cluff Gold till 2012)	Approximately 40 km northwest of Yamoussoukro	1998	2001: 1,500 kg 2009: 673 kg 2010: 629 kg 2011: 201 kg The mine operated initially between 1998 and 2003, reopened in March 2008, continued until early 2011, reopened later that year, and is currently closed.
Bonikro	Operated by LGL Mines CI SA, (an Ivorian company); 89.89% owned by Newcrest ⁴⁶	South-central Côte d'Ivoire, about 240 km northwest of Abidjan	2008	2008: 1,150 kg 2009: 4,666 kg 2010: 2,651 kg Annual production was expected to average about 3,700 kg during the eight years of projected mine life. ⁴⁷
Ity	Société des Mines d'Ity, a joint venture of La Mancha Resources Inc. of Canada: 45.9%); SODEMI: 44.1%; the government: 10%	90 km southwest of Man	1984	2001: 1,500 kg 2009: n/a 2011: 1,155 kg Planned to produce between 1,900 and 2,100 kg of gold in 2012.
Tongon	Randgold Resources Ltd.: 89%-owned subsidiary; government: 10%; un named Ivorian company: 1%	Northern Côte d'Ivoire about 55 km south of the border with Mali	2010	2010: 875 kg 2011: expected to produce between about 8,100 kg and 8,400 kg ⁴⁸ Mine life is estimated at ten years.



Artisanal gold and diamond mining increased during the conflict

As of 2012, the industrial mining sector in Côte d'Ivoire was well organized and set to expand.⁴⁹ Mineral production included gold and manganese, along with construction materials such as cement, crushed stone, sand and gravel. Undeveloped mineral resources at that time included bauxite, cobalt, copper, iron ore, nickel, and silica sand. Various prospecting and mineral exploration projects were under way, including prospecting and exploration for nickel and cobalt, gold, iron ore, manganese, phosphate rock, and tantalum.⁵⁰ Key gold mines in Côte d'Ivoire are presented in Table 2.

The first diamond discoveries took place in 1927 and 1947 in the Séguéla and Tortiya regions in the north of the country. Diamond exports spiked 50 percent between 1998 and 1999. This dramatic increase was attributed to the inflow of looted conflict diamonds from Liberia and Sierra Leone. Diamond exports from Côte d'Ivoire were banned by the UN Security Council in 2005 and were only lifted in August 2014.

2.4 System of government

Côte d'Ivoire is a republic with an executive branch headed by a president; a legislative body comprising a single National Assembly; a judicial branch consisting of the Supreme Court with three chambers (judicial, administrative, and auditing); and the Constitutional Council.⁵¹ The president is assisted by a council of ministers, led by a prime minister, who is appointed by the president. Federal government ministries have representative offices in regions.

The Ministry of Environment, Urban Sanitation and Sustainable Development (MINESUDD) holds the primary mandate for environmental management. Created by decree in 2012, MINESUDD is responsible for the design and implementation of policy relating to the environment, urban health, and sustainable development in Côte d'Ivoire, with each of the three themes governed by a separate general directorate. MINESUDD is also responsible for the technical supervision of the National Environment Agency (ANDE), the

Ivorian Pollution Control Centre (CIAPOL), the National Urban Sanitation Agency (ANASUR), and the Ivorian Office of Parks and Reserves (OIPR), which all have their own legal status and some financial autonomy. During the conflict, MINESUDD officials had no access to the central, north and west regions of Côte d'Ivoire, and key infrastructure was either looted or destroyed. Today, 15 regional directors and additional staff have been redeployed, but resources remain limited and infrastructure dilapidated.⁵²

The Ministry of Water and Forests (MINEF) also has a mandate to address environmental issues. Created by decree in 2011, it sets and implements national policy regarding water and forests, and works in collaboration with MINESUDD. MINEF has five directorates that cover forest industry, reforestation, wildlife, forest police, and water resources. During the conflict, MINEF representatives also were unable to access the central, northern, and western regions of the country; in fact, most were forced to flee as fighting spread. With 12 regional offices, MINEF has managed to re-establish a presence nationwide. Additional information about the Government agencies, key legislations and Multilateral Environmental Agreements (MEAs) relevant to Côte d'Ivoire are given in Annex 3 and 4.

In addition to the different ministries, there are a number of other bodies with varying degrees of autonomy that have implementing responsibilities for government policies and programs. Some of these, such as the Forestry Development Company (SODEFOR), which is responsible for the management of classified forests, are partly funded by the revenue from their operations.

2.5 Protected areas

The national park system includes eight national parks, one integral reserve, and five Ivorian reserves, which together cover 1.7 million hectares, or 6.5 percent of the geographical area of the country (Map 3 and Table 3). The national parks are located within parts of all the country's ecological zones. The N'Zo Faunal Reserve and Tai National Park (5,187 km²) are in the boundary rainforest zone and the Comoé National Park (11,492 km²) in the the Savanna Zone. Marahoué National Park and Mt. Sangbé National Park are a patchwork savanna/forest, whereas Mt. Peko (1,000 m)

Parks and reserves

National Parks are areas under control of the state where flora, fauna and landscape are totally protected. Their vocation is the conservation of the natural areas and their biodiversity as well as the recreation of the public.

Total Nature Reserves are areas under control of the state where flora, fauna and landscape are totally protected and where any perturbation to the flora, fauna and terrain are prohibited. Hence, it is prohibited to penetrate the area or even to fly over it at low altitude. Scientific research in the area is allowed with authorization. The vocation of Total Natural Reserves is essentially the conservation of the flora, fauna and the natural environment.

Partial Faunal Reserves are areas for the conservation, management and propagation of wild animals and the management of their habitats where hunting and capturing animals is prohibited and where human activities are regulated or prohibited.

and Mt. Nimba (1,762 m) are mountain forest. Azagny National Park is a coastal park containing, among other habitats, coastal swamps.

Some of the protected areas have received international recognition for their conservation value in the form of designation as a World Heritage Site, Biosphere Reserve, or Ramsar Site (see Table 3). Comoé and Tai, with about 11,500 and 5,200 km², are the largest national parks in West Africa. In theory, they ensure the protection of 90 percent of the animals in the region, including significant populations of endemic species of birds, antelopes, and primates.

In general the purpose of the national parks is to conserve the flora and fauna and provide recreation for the public. However, the protection status of the Integral Reserve, Mt. Nimba, which is a fragile mountain ecosystem, is more severe as it excludes the right to move around the site. The Partial Fauna Reserves of Abokouamekro and Haut Bandana are managed areas for the conservation and propagation of the fauna. The Lamto Reserve is a renowned scientific station with long-term research programs in ecology.

Map 3. Protected areas in Côte d'Ivoire

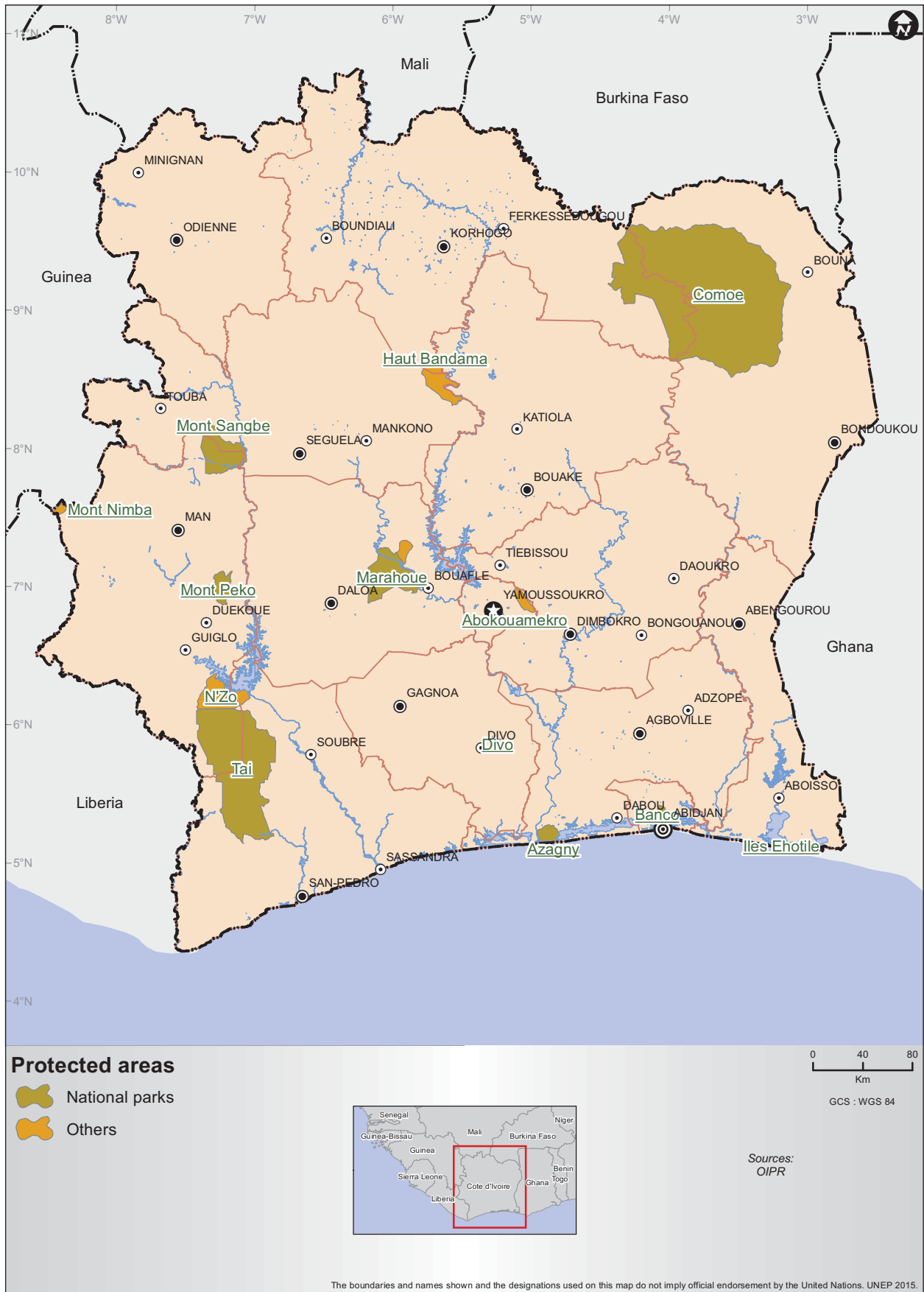


Table 3. National parks and reserves in Côte d'Ivoire

	Status	Area (km ²)	International recognition	Main vegetation type
Mt. Nimba	Integral reserve	50	World Heritage site	Mountain forest
Comoé	National park	11492	World Heritage site and Biosphere Reserve	Wooded savannah
Tai and N'Zo	National park (Tai) and Partial Reserve (N'Zo)	5187	World Heritage Site and Biosphere Reserve	Evergreen forest
Marahoué	National park	1010		Forest and savannah
Mt. Sangbé	National park	960		Wooded savannah
Mt. Peko	National park	280*		Semi-deciduous forest
Azagny	National park	194	Ramsar site	Coastal park; mosaic of habitats
Banco	National park	30		Evergreen forest
Iles Ehotile	National park	6	Ramsar site	Coastal
Haut Bandana	Partial reserve – fauna	1230		Wooded savannah
Abokouamekro	Partial reserve – fauna	204		Mosaic forest, savanna
Lamto	Scientific reserve	25		Savanna
Dahlia Fleurs	Botanical reserve	2		Horticultural

* Incorrectly estimated at 340 km² at the time of creation



Côte d'Ivoire has a network of parks and protected areas

Before the political unrest, the national parks and reserves were already under pressure, mainly from agricultural encroachment and poaching, but also from forest fires, logging, artisanal mining, cattle grazing (in the savanna zone, i.e., Comoé and Sangbé) and to a lesser extent, from the collection of firewood and non-timber forest products.

2.6 Ébrié Lagoon

The Ébrié Lagoon (see Map 4), which lies adjacent to the city of Abidjan, is one of the most important water resources in Côte d'Ivoire. The lagoon extends for approximately 150 km in an east-west direction; its surface area is approximately 550 km², and there is an additional 200 km² of adjacent mangrove swamps and wetland. It is separated from the Gulf of Guinea for almost its entire length by a narrow, mostly sandy, strip of land. Fresh water flows into the lagoon from a number of small creeks and rivers, the most significant being the Comoé and Mé in the east, and the Agnéby and Ira in the central part. The lagoon averages some 4 km in width and 5 m in depth. It was originally connected to the Gulf of Guinea only at the Comoé Estuary, but the opening of the Vridi Canal—a man-made channel 185 m wide and 15 m deep—created a second opening. Changes in

2 COUNTRY BACKGROUND

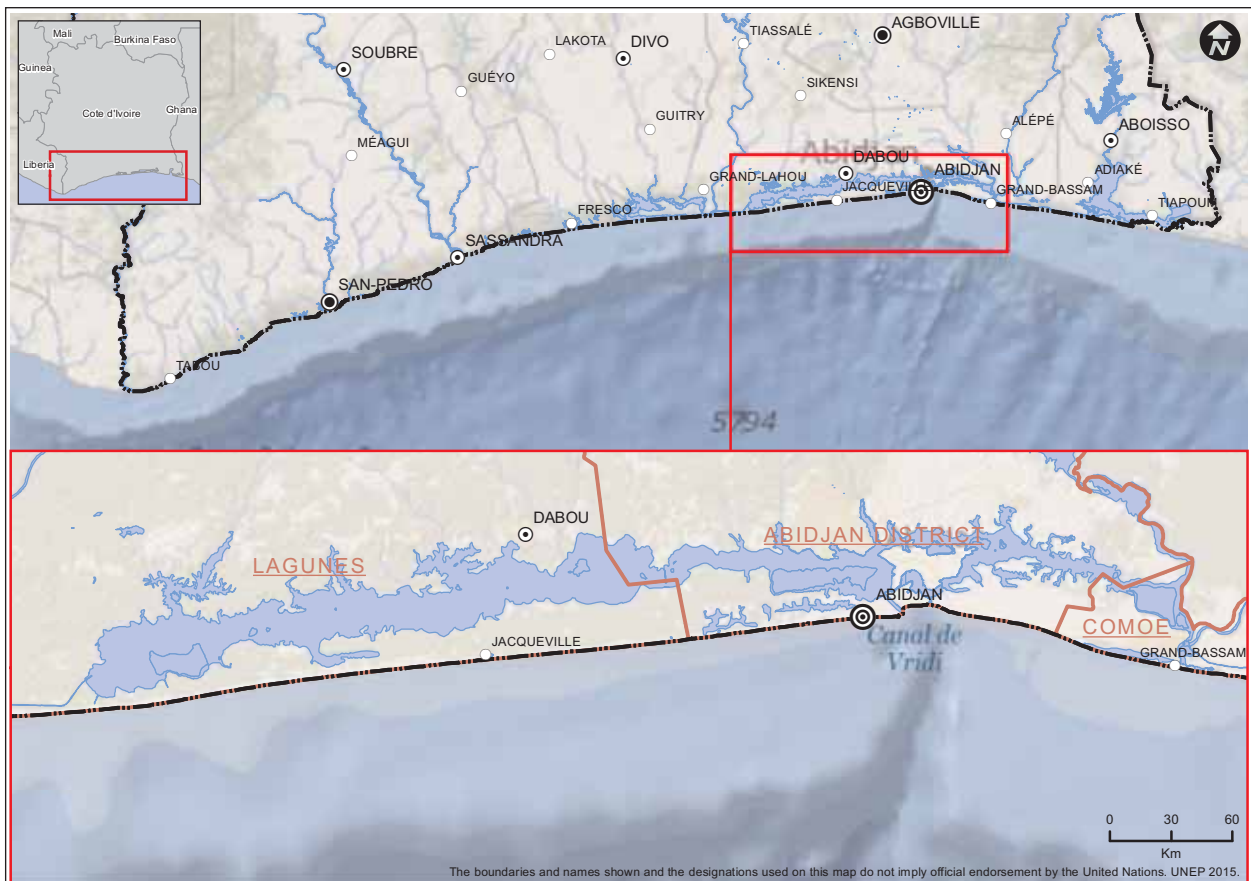


Ébrié Lagoon still supports fishing

the littoral current led to the natural closing of the Comoé Estuary in the 1990s so that, at the time of writing, the Vridi Canal is the only linkage between the lagoon and the Gulf of Guinea.

Historically, the Ébrié Lagoon provided the foundation for Abidjan's social and economic development. Early settlers in the area were fishermen, and fishing remains an important livelihood in the region. The development of the Vridi Canal in 1950 made the lagoon the epicenter of economic activity in Côte d'Ivoire. Following the development of the main harbor—protected from the elements and accessible all day and throughout the year—it became the main port of entry not only for Côte d'Ivoire but also for landlocked West African countries like Burkina Faso and Mali. This change in the status of the port had beneficial consequences for a range of industries, and soon facilities associated with the production and refinement of fuel, chemicals, and food were developed around the lagoon. In general, the change drove the development of the then-capital city.

Map 4. Ébrié Lagoon, showing its full length



2.7 Expansion of Abidjan and related environmental issues

At the beginning of the 20th century, Côte d'Ivoire was an entirely rural country, but in 2011 it was estimated that 51.3 percent of its population lived in urban centers (Map 5). Abidjan, in particular, went through a period of rapid growth: there were fewer than 50,000 people living there in 1948 whereas the last census, in 1998, counted 2,877,948 (current estimates are that it is now about 5 million).

Infrastructure in Côte d'Ivoire is fairly developed in comparison to that of comparable countries around the world—a state of affairs that can in part be attributed to the so-called Ivorian miracle. The country has a network of more than 8,000 miles of paved roads and good telecommunications services, which include a public data communications network, cellular phone system, and Internet access.⁵³ There are two major ports in Côte d'Ivoire: Abidjan, which is the largest to be found between Casablanca

and Cape Town; and San Pedro, a smaller port that mostly handles freight pertaining to the trade in coffee and cocoa.⁵⁴ There are also regular international flights from Felix Houphouët-Boigny International Airport in Abidjan, both to countries in the region and to European destinations. While there are many other airports in the country, at the time of writing the only flights that are scheduled regularly from those airports are for humanitarian purposes. Lastly, it is worth noting that various modern real-estate developments have also been constructed for commercial, industrial, retail, and residential use.⁵⁵

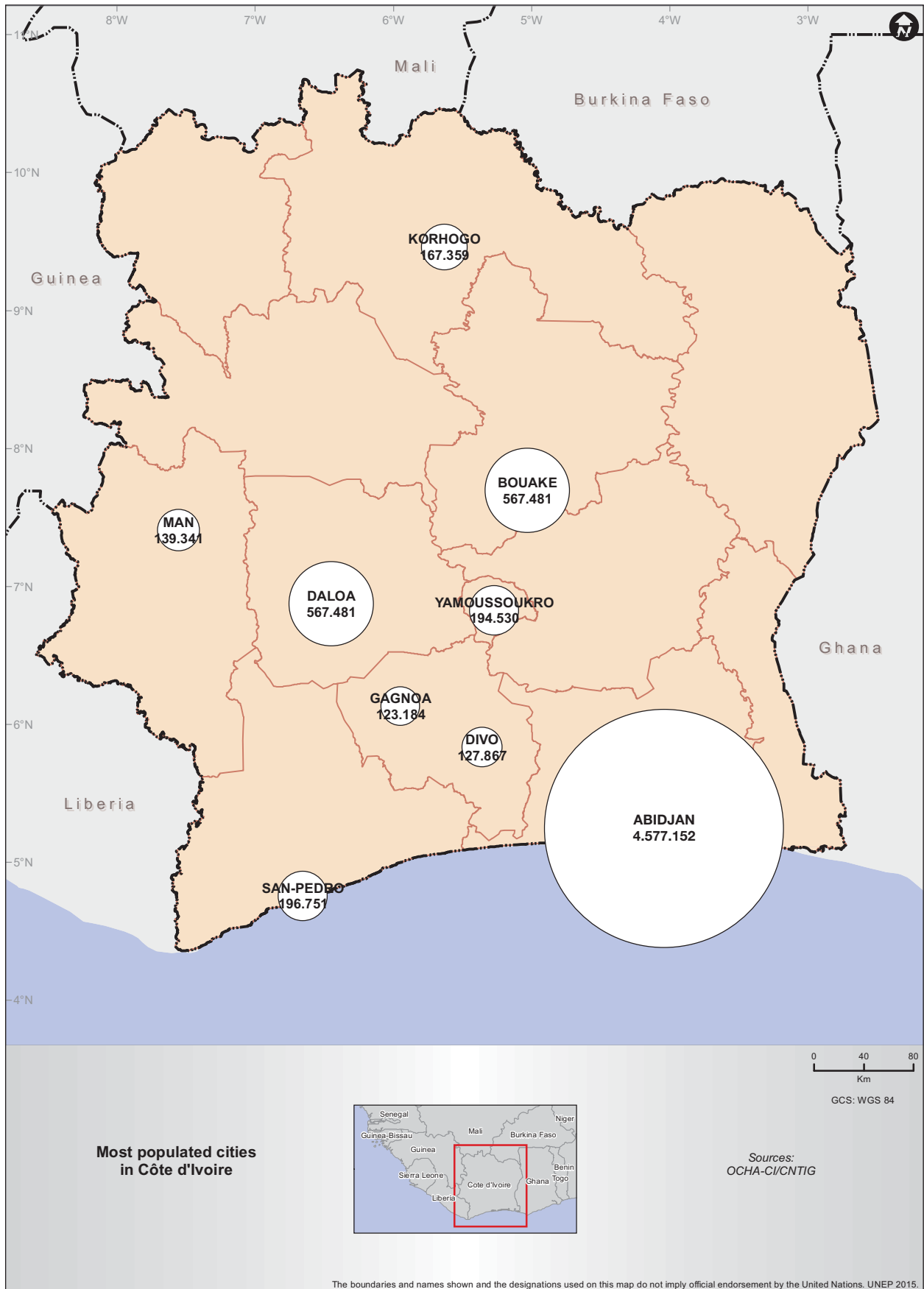
The conflict period of 2002–2011 had a dramatic impact on both the process of urbanization and the infrastructure of Côte d'Ivoire. The population of Abidjan is reported to have doubled between 2002 and 2006 due to large-scale migration from villages and towns. Much of that migration came from the north of the country and was driven by people fleeing the fighting and moving towards Abidjan, where not only security but also economic opportunities and social services like education and health care were easier to come by. This rapid and unplanned growth in the population radically increased pressure on all of Abidjan's services and infrastructure.

Cities to the north of the Zone of Confidence also faced challenges. When the formal government withdrew from the north, the consequences for the population were enormous. All services in northern cities collapsed. Infrastructure was not maintained, property was destroyed by fighting, and markets were severely impacted by insecurity and migration. There were no official systems for the supply of water, sewage management, or the collection of waste. Schools and hospitals became dysfunctional, and most of them became dependent upon nongovernment actors.



Abidjan has well developed road infrastructure

Map 5. Urban areas in Côte d'Ivoire



Objectives, Scope and Methodologies

*Involvement of local experts
was critical to the
assessment process*



Objectives, Scope and Methodologies

3.1 Objectives

Based on the scoping mission and background research, UNEP set the following objectives for the PCEA:

1. study and document the environmental situation in the key sectors that were impacted by the conflict;
2. recommend technical measures to bring about improvement in environmental conditions; and
3. make recommendations to decision makers on institutional changes so as to bring improvements within an overall framework of sustainable development.

3.2 Scope of the study

Côte d'Ivoire has been going through political and economic turmoil for more than two decades. The environmental consequences of that experience are broad and deep, and can be felt across the country in many sectors. The final decision on the sectors to be assessed was made based on a systematic process, which involved the following steps:

1. review of available information about the conflict and the associated environmental damage from the literature, anecdotal evidence and remote sensing;
2. in-country scoping mission and consultation with key stakeholders through a series of structured meetings; and
3. consultation with key government officials through workshops in Geneva and Côte d'Ivoire.

Based on the above process, the following key themes were taken up for analysis:

- forests, including national parks and classified forests, that were impacted by encroachment and lack of administrative oversight;
- environmental degradation of Ébrié Lagoon;
- environmental issues related to unplanned urban expansion;
- industrial and artisanal mining and their environmental footprint; and
- risk of oil spill along the Côte d'Ivoire coastline.

In addition, the study also looked at how the institutions overseeing natural resource management and environmental governance were impacted by the conflict.



Local civil society institutions were consulted on the scope of the study



Field visits were challenging at times

3.3 PCEA process

Background research

UNEP conducted extensive background research by reviewing available information, consulting with experts and assessing past remote-sensing images. From this, the key environmental sectors that were to be assessed and the locations that were to be visited were identified.

Consultations with government and civil society representatives

A scoping mission, which is the first step in identifying the viability, needs, and requirements of a successful project, involved consultations with government and civil society representatives. A series of meetings were held in Abidjan at which the UNEP team met with officials from MINESUDD, various line ministries, key civil society organizations, and UN agencies active in Côte d'Ivoire. This process resulted in the preparation of a final scoping document.

In early 2013 an international team of experts was identified as potential mission participants, and a consultative meeting on the mission scope was

held in Geneva. Officials from the government of Côte d'Ivoire were invited to this meeting, which addressed approaches to be taken in each of the thematic areas and cross-sectoral linkages.

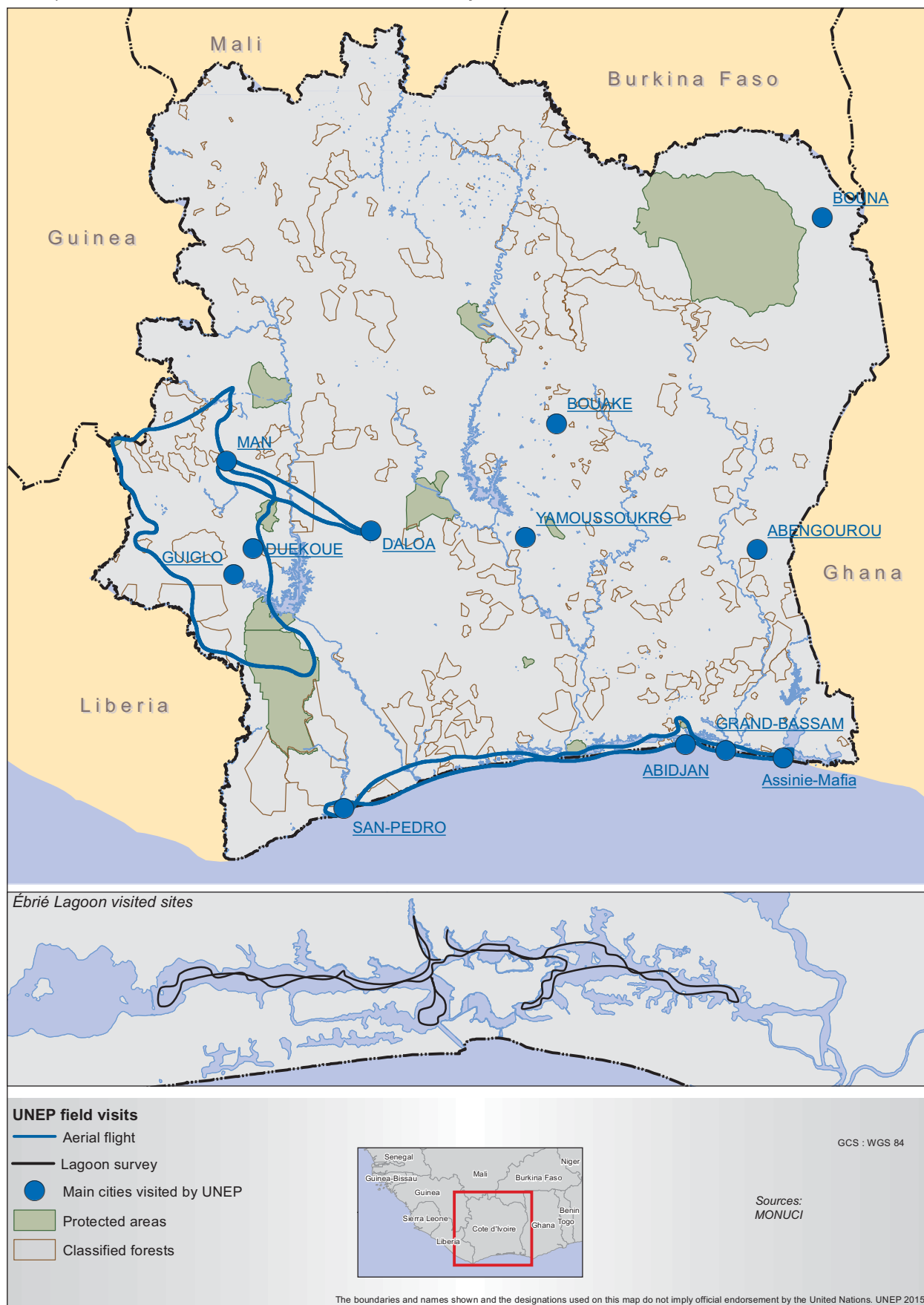
Remote sensing

Remote sensing of the country at large was a key component of the PCEA. It was undertaken using satellite image analysis as well as aerial inspection and photography from a helicopter. Specifically, remote sensing, including a review of satellite images, was used to assess changes in forest cover, encroachment upon Ébrié Lagoon, urban expansion, and the environmental footprint of mining operations.

Field visits

The field missions to Côte d'Ivoire were conducted in June and August 2013. In addition to international experts, UNEP also requested the government to nominate a number of Ivorian experts to participate in the fieldwork along with the international experts. The list of government experts who participated in the visit are given in Annex 5. All government counterparts were duly briefed on the scope of the assessment and planned activities. The field visit locations are indicated in Map 6.

Map 6. Locations in Côte d'Ivoire visited by the UNEP PCEA team



Environmental sampling and analysis of Ébrié Lagoon

The Ébrié Lagoon is an economically and socially important waterbody in Côte d'Ivoire. Over the decades, however, the lagoon has become heavily polluted, primarily due to disposal of solid and liquid wastes from Abidjan. Restoring the lagoon will be an important aspect of restoring quality of life in Abidjan and was therefore the main focus of environmental sampling and analysis during the assessment. Portable equipment was used to collect preliminary data on salinity and water depth, and samples of water, sediment, effluent discharge, and fish were collected and sent to laboratories for detailed chemical analysis.

Questionnaires, interviews, and focus group meetings

The PCEA team conducted a series of interviews with government officials as well as focus group meetings with nongovernmental organization (NGO) representatives and communities. Questionnaires were used as stand-alone instruments and at other times to support face-to-face interviews. The information collected from these exercises was then used to formulate field visit plans, and to triangulate information obtained from other sources.

Preparation of final report

Following the field visits and once laboratory results were received, UNEP experts prepared their technical reports, presenting the results and making specific recommendations. The different sectoral reports were then integrated into a single report that was internally and externally peer-reviewed.

3.4 Methodology

This section presents a brief introduction of the technical methodology applied to collect information on various environmental and institutional segments. Detailed methodologies of chemical analyses, including quality assurance systems, are available at the dedicated website.

Assessment of the forestry and national parks sector

The Côte d'Ivoire PCEA set about obtaining both quantitative and qualitative information about changes in the country's forests and national parks in order to address the following questions:

1. How much forest cover did the country lose during the crisis?



Community meetings were important to get local knowledge

2. How did the crisis impact the country's protected areas? What is the current status of their forest cover and biodiversity? What challenges do they face?
3. What is the status of wildlife in Côte d'Ivoire?

The methodology employed to gather the data combined a review of the literature with satellite image analysis, aerial surveillance by helicopter, and discussions with experts who are familiar with forest management. Field visits were conducted primarily to verify the information obtained from remote sensing and discussions.

Satellite images of the forest zone of Côte d'Ivoire in 2002, 2008, and 2013 were used to evaluate forest degradation, as evidenced by the extent of closed forest canopy, in selected forest classes and national parks.

UNEP experts and a team of national counterparts visited key protected areas identified by remote sensing image, local consultations, and aerial reconnaissance. The scope of this tour included five of the nine national parks and three of the classified forests (Table 4). The team of national counterparts facilitated both access to and contact

at the sites, and provided valuable information to the assessment

In parts of the country that were not accessible due to security constraints, field visits were supplemented by an aerial survey by helicopter. This also provided the team with an overview of Mont Péko National Park, Tai National Park, and N'Zo Faunal Reserve; and the classified forests of Cavally, Goin-Débé, Haut-Sassandra, and Bafing.

UNEP analyzed the state and evolution of the classified forests using data provided by SODEFOR's regional management centers for 2010 and 2012. From the data the team was able to ascertain the area occupied by illegal plantations, the numbers of family units, and a rough estimate of the degradation of the classified forests. It should be noted that the dataset is not complete and is indicative only.

Additional information about Comoé, Tai, Sangbé and Peko National Parks and Mt. Nimba Reserve were obtained from OIPR through a questionnaire survey. The team used the data to assess the following: the pressures and threats to the parks; the specific impacts of the crisis; the state of conservation; the current capacity of OIPR; and the socio-economic context.



Local experts were an important part of the forestry team



Extended field work in the Ébrié Lagoon

Table 4. Sites visited by the UNEP PCEA team for the forestry and protected areas sector

Field visit locations
Classified forest of Haut-Sassandra
Classified forest of Goin Débé
Banco National Park
Tai National Park
Mt. Péko National Park
Mt. Sangbé National Park
Marahoué National Park
Comoé National Park
SODEFOR Management Center in Abengourou
SODEFOR Management Center in Man

Assessment of Ébrié Lagoon

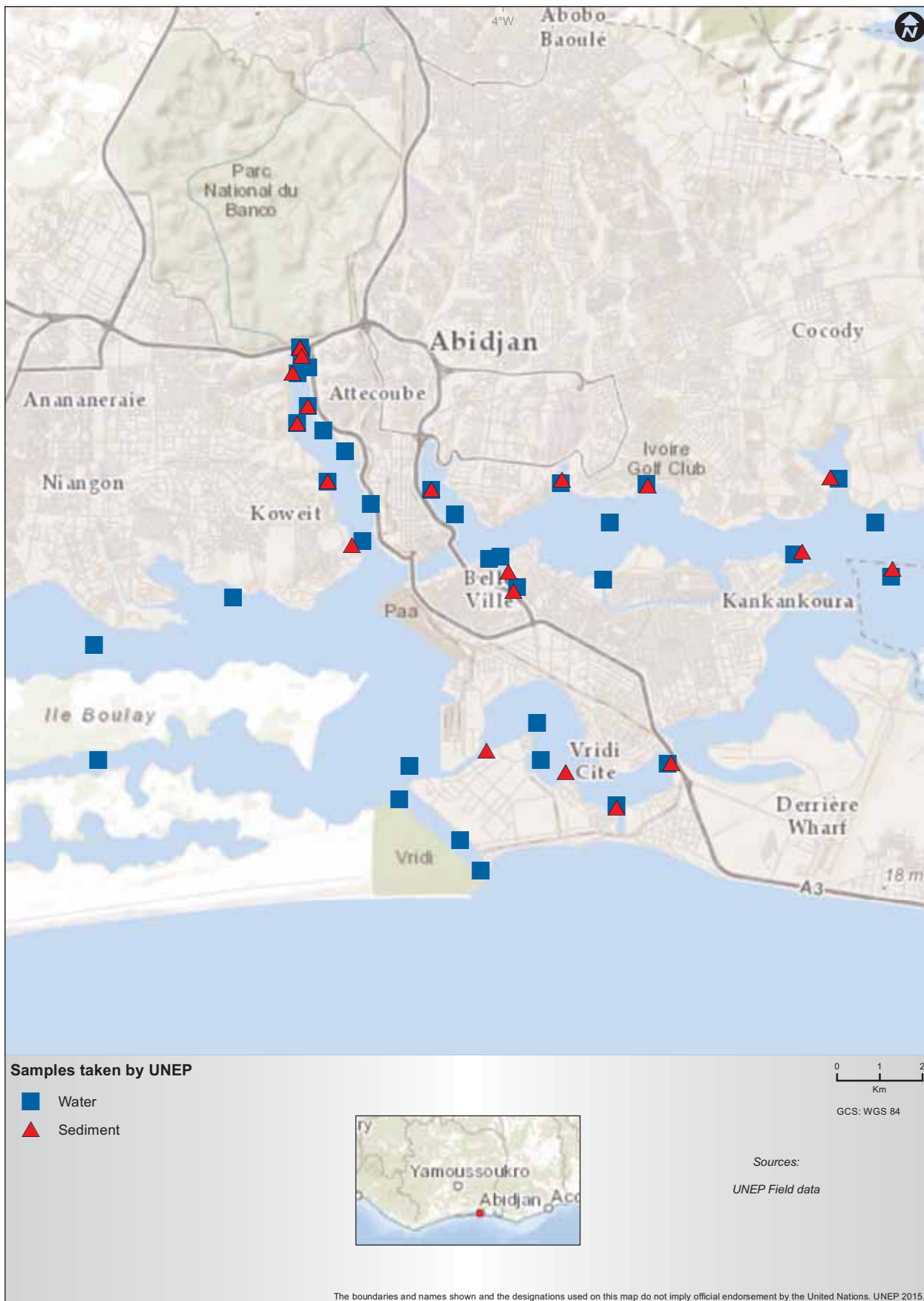
Ébrié Lagoon is one of the biggest lagoon systems in West Africa and a potential economic powerhouse for Côte d'Ivoire. However, the lagoon system is currently highly polluted. The assessment of Ébrié Lagoon addressed the following questions:

1. What are the key pressures contributing to the environmental degradation of the lagoon?

2. How polluted are the water and sediment in the lagoon in locations that are close to Abidjan and impacted by an inflow of sewage and industrial drainage?
3. Are fish caught in the lagoon contaminated with some of the pollutants present in the water and sediments?
4. Is there an accumulation of contaminants of concern in the oysters that are harvested in the lagoon?
5. How does the flow of freshwater affect the salinity within the lagoon given flows of freshwater from the Comoé River on the eastern side and the Gulf of Guinea at the Vridi Canal in Abidjan?

The team used a combination of remote-sensing analysis, verification on the ground, and field sampling to address these questions. Remote sensing was used to determine how land use has changed around the lagoon in recent years. The team undertook field visits in order to identify the types of activity that are damaging the lagoon, such as sewage and waste disposal, landfilling, and the sinking of unwanted ships. The sampling involved monitoring depth and salinity; sampling for sediments, water, and fish; and documenting the geographical coordinates of the sampling points. (See Map 7.)

Map 7. Ébrié Lagoon sampling sites



Salinity profile

The hydraulic regime in the lagoon has changed significantly over the 20 years following the closing of the Comoé Estuary at the eastern extremity of the lagoon. The salinity transect attempted to establish the extent to which salinity in the lagoon varied from east to west, and how a combination of freshwater and seawater inflow influenced salinity. Longitudinal and cross-sectional transects were undertaken, and both salinity and depth were monitored at each of the sampling points.

The longitudinal transect started at the extreme eastern edge of the lagoon where the Comoé River flows into it. This is also the point where the lagoon was once connected to the Gulf of Guinea. GPS, depth, and salinity measurements were taken at this point using portable equipment. Transect points were then taken at intervals of roughly 5 km in a westerly direction to monitor both salinity and depth, until sampling became difficult due to the unevenness of the depth profile. A cross-sectional transect was conducted from the mouth of the Vridi Canal toward the center of the lagoon.

Five parameters were measured using field monitoring equipment:

- geographical coordinates;
- depth;
- water temperature;
- dissolved oxygen; and
- conductivity.

Water, sediment and fish sampling

Water and sediment sampling evaluated the anthropogenic activities around the lagoon, with the objective of capturing typical pollution loads generated by urban activities. The key areas of sampling and the basis for selection are given in Table 5.

Additional samples were taken from other areas of the lagoon in order to establish background concentrations of pollution and to ensure analytical control.

Water samples were collected from the platform of a motorboat. At each location, the geographical coordinates were recorded before samples and measurements were taken.

Table 5. Basis for selection of sample sites

Location of sampling	Reasons for selecting the location
Cocody Bay	Highly polluted and also a priority area for the government due to the presence of key hotels, residences, and offices
Marcory Bay	Highly polluted, including industrial pollution
Banco Bay	Pollution from the largest outdoor launderette in Africa
Billionaires' Bay	Highly regulated area in the lagoon as it is surrounded by housing of wealthy individuals

Four parameters were measured in the field using field monitoring equipment:

- depth of water;
- temperature;
- dissolved oxygen; and
- salinity.

Samples were collected using a bailer and were then poured into sampling bottles, after which the bailers were rinsed. Separate samples were collected for the following analysis:

- bacteriological quality;
- biological oxygen demand;
- nutrients and chemical oxygen demand; and
- other chemical analysis.

The analysis of the bacteriological quality, nutrients, and biological and chemical oxygen demand of the water were conducted in Côte d'Ivoire. All the other chemical analyses were conducted at international laboratories. All samples were stored under suitable conditions prior to their shipment to a local laboratory or to laboratories outside the country.

Sediment samples were also collected from the platform of the boat, using a Van Walt Multisampler with a plexiglas coring tube with an inner diameter of 50 mm. Four samples were taken at each station. The coring tube was pushed into the sediment to a depth of approximately 25 cm. The sampler and its content were then sealed and pulled into the boat. The top 10 cm of the sediment cores from each station were mixed and one sample was collected from the mixture. The sample was stored in an acid-



Many fish samples were collected from local fishermen

cleaned glass jar in a freezer until the analysis could be carried out. During the collection, care was taken to avoid mixing of the sediment or flushing away the light surface floc. The sediment samples were analysed for a range of parameters (Table 6).

Fish samples were purchased from fishermen who were actively fishing in the lagoon. Only freshly caught fish were purchased (Table 7), and the fishermen verified their fishing locations. In most cases, a number of samples of the same species of fish were purchased.

Tissue samples from four to six different fish at any given location were pooled to form a composite sample. Fish tissue was taken by cutting the dorsal muscle from the fish with a scalpel and transferring it into a glass jar. About 50 g of tissue were collected for each sample. All samples were frozen and shipped to the laboratory following standard quality-control procedures.

Oysters (*Crassostrea cf. margaritacea*) were collected by the project team from the mangroves; four to six oysters from each station.

Details of technical methods of analyses, including quality assurance procedures at the laboratory, are

provided at the website along with the raw data of chemical analyses.

Table 6. Analyses of sediment samples taken from Ébrié Lagoon

Parameters analyzed	Detailed list of chemicals analyzed
Heavy Metals	As, Cd, Co, CR, CU, HG, NI, Pb, V and Zn
Pesticides	o,p'-DDT, p,p'-DDT, o,p'-DDD, p,p'-DDD, o,p'-DDE, p,p'-DDE
Hydrocarbons	Total Hydrocarbon, >C10-C12, >C16- C35, >C35<C40, >C10<C40

Table 7. Fish species collected

Mullet (<i>Mugil sp.</i>)
Catfish (<i>Aries sp.</i>)
Shad (<i>Alosa sp.</i>)
Snapper (<i>Lutjanus sp.</i>)
Barracuda (<i>Sphyraenidae</i>)
Sea bream (<i>Sparidae</i>)

Assessment of urban environmental issues in Abidjan

The rapid urbanization of Abidjan has been one of the most significant consequences of the conflict. The UNEP team assessed the process and its consequences using a combination of remote sensing and field monitoring. Three key questions were identified:

1. What are the contours of urban expansion in Abidjan since 2000?
2. How have the city's urban environmental services been impacted by the crisis?
3. What is the current status of urban environmental services, such as water supply and waste management?

The assessment was conducted using a combination of the following approaches:

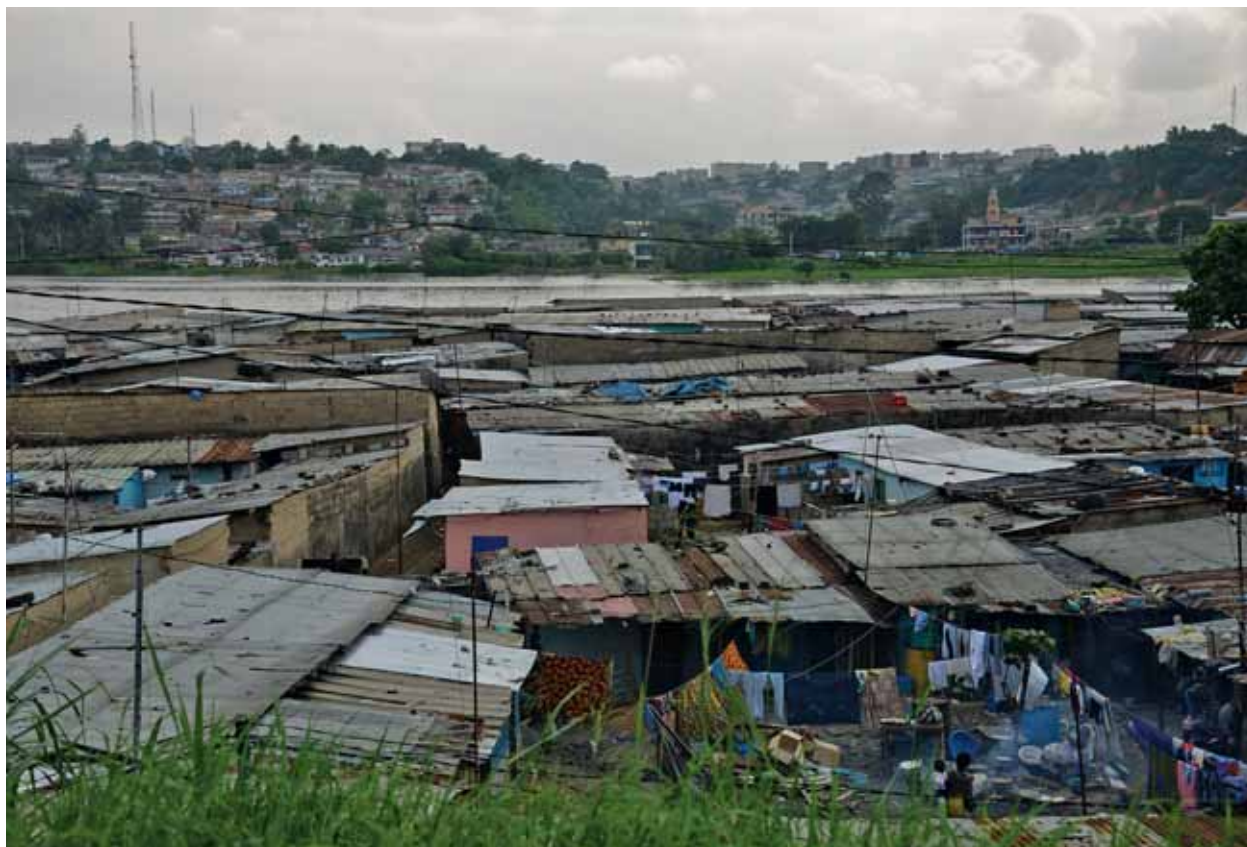
- interviews with key officials and local stakeholders;
- review of key documentation;

- field visit to
 - Waste management/disposal areas
 - Waste collection/treatment operators
 - Wastewater collection/treatment facilities
 - Effluent disposal points.

All interviews were documented along with the name of the interviewee, the date and time at which the interview took place. In cases where a site visit was conducted, the locations were photographed and a note made of their geographic coordinates.

The following government institutions were contacted for data collection and interviews: MINESUDD, Directorate of Water Resources (DRE, under MINEF), and SODECI, as well as the local municipal authorities of Abidjan and Bouaké.

A number of private companies engaged in supporting government efforts, sometimes under contract to the government while at other times working as independent commercial operators.



Rapid urbanization of Abidjan has been one of the most significant consequences of the conflict

Assessment of the mining sector

Mining does not constitute a major component of GDP in Côte d'Ivoire, but there are both industrial and artisanal mining operations in the country. Both sectors were impacted by the conflict. Artisanal mining became a coping strategy for communities' sources of revenue for armed groups. The UNEP team's assessment of the mining sector set out to answer the following questions:

1. What is the status of environmental management in Côte d'Ivoire's mining sector?
2. Has the conflict led to changes in the mining sector that have had an impact on the environment?

The mining sector assessment included the following activities:

- remote-sensing analysis to locate the key areas of industrial and artisanal mining;
- discussions with key government agencies involved in the mining sector, including SODEMI, OIPR, SODEFOR, and MINESUDD; and

- Visits to both industrial and artisanal mining locations (Table 8).

At each of the mine locations the team interviewed the management and workers; observed the key mining processes (cutting, sieving, processing) and the health, safety, and environmental regime under which the mine operates. The team also took GPS coordinates and photographs for further remote-sensing analysis.

Table 8. Mining locations visited by the UNEP assessment team

Name	Location	Type of mine
ITY Mine	Near Danané	Formal
Floleau Mine	Near Zouan Hounien	Artisanal
Yaoure Mine (previously Angovia)	Near Yamoussoukro	Formal
Santé mine	Near Zagouta	Artisanal
No formal name	Near Angovia mine	Artisanal
No formal name	Near Bouna	Artisanal



The mining sector was part of the assessment



ENVAL, a local laboratory did part of the chemical and biological analyses

3.5 Environmental standards used in this report

Samples of surface water, sediment and biota were taken from Ébrié Lagoon and analyzed. In order to assess the degree of pollution in these samples, the analytical results needed to be compared with appropriate environmental standards. Usually the legislation of a country would offer such a standard, but in the case of Côte d'Ivoire no such legislation exists. Presenting the findings without reference to a standard or a reference point would render them meaningless. Therefore, in the absence of the necessary national environmental standards for surface water, sediments, or fish, the team looked to other countries (e.g. Nigeria) or international institutions (e.g. World Health Organisation) for

standards against which to make the necessary comparison.

3.6 Laboratories used in the survey

Two main laboratories were used to assess samples taken during the PCEA: ALS Scandinavia in Taby, Sweden, and ENVAL Laboratory based in Abidjan. ALS Scandinavia, part of a global chain of laboratories and ISO 17025 accredited, was used for the analysis of fish and sediments. Enval Laboratory, a private laboratory used by MINESUDD to undertake samples collected as part of their inspection procedures, was used for the analysis of water.

Forests

*Forests in Côte d'Ivoire
continue to be under threat*



Forests

Forests in Côte d'Ivoire are important not only locally and regionally but also globally. Locally, forests provide both direct benefits to the community, such as timber and non-timber forest products, and indirect benefits such as climate regulation and water security. As Côte d'Ivoire forests have high biodiversity value with many endemic species, these forests also have global significance. It was therefore important to assess the state of the forest after the period of prolonged crisis in Côte d'Ivoire.

4.1 Changes in forest cover during the crisis

The state of forest cover in Côte d'Ivoire was alarming even at the start of the 21st century, and it got progressively worse during the conflict period. The destruction of the forests can be visualized in satellite images (see Figure 2 a-c). In 2002 dense forest cover, defined as the climax vegetation for the forest zone, shown in dark green on the satellite images, was already reduced to very small fragments in the Rural Zone and to a few blocks of unbroken forest in the protected areas. Many of the classified forests were already severely degraded or no longer forested at all even before 2002.

However, during the conflict period there were once again significant impacts on the forest sector. Data derived from satellite imaging (Landsat) suggest a reduction of approximately 660,000 ha of the closed-canopy forest cover of the classified forests between 2000 and 2013: 250,000 ha between 2000 and 2008, and 410,000 ha between 2008 and 2013. In 2013, the closed-canopy forest cover remaining in the classified forests amounted to about 650,000 ha, 15 percent of the total area. The satellite images also show, most dramatically, that the entire 102,400 ha classified forest of Haut Sassandra lost its unbroken forest cover within a few years, between 2008 and 2013 (See Case Study 1).



Forest offices in the North of the country were abandoned and vandalized during the crisis



Large scale settlements inside the park require humane handling

Figure 2a. Forest cover in 2000

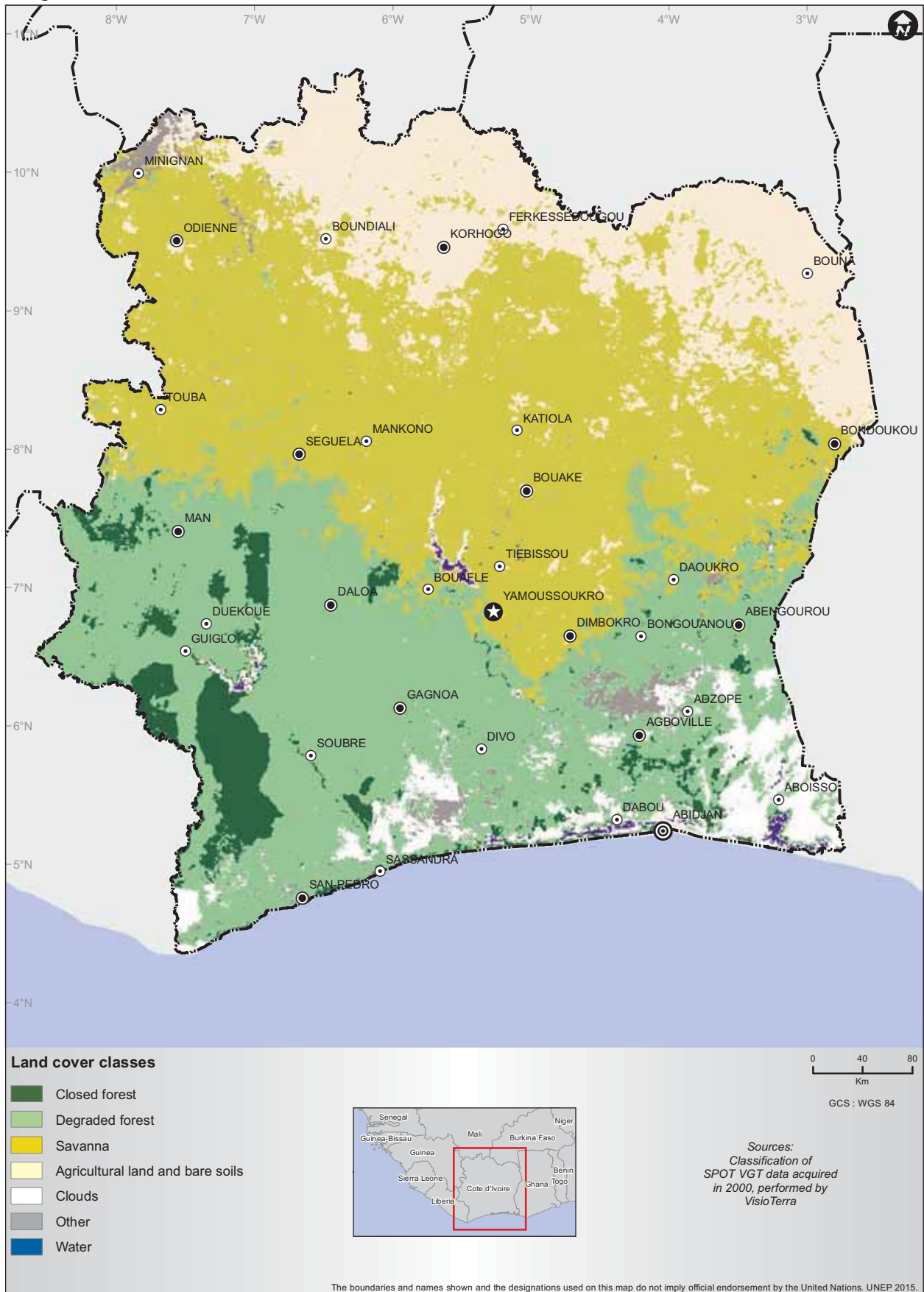


Figure 2b. Forest cover in 2008

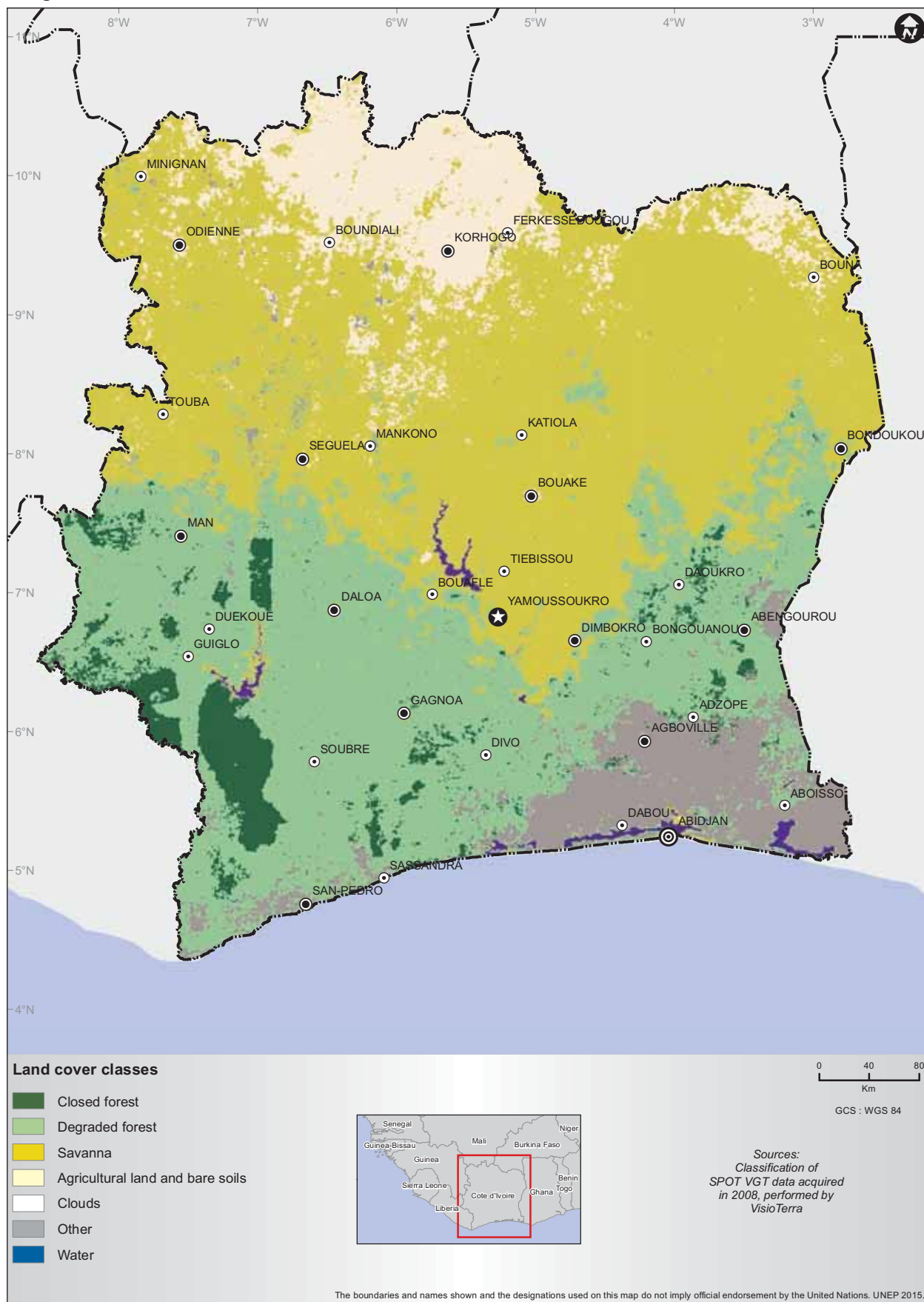
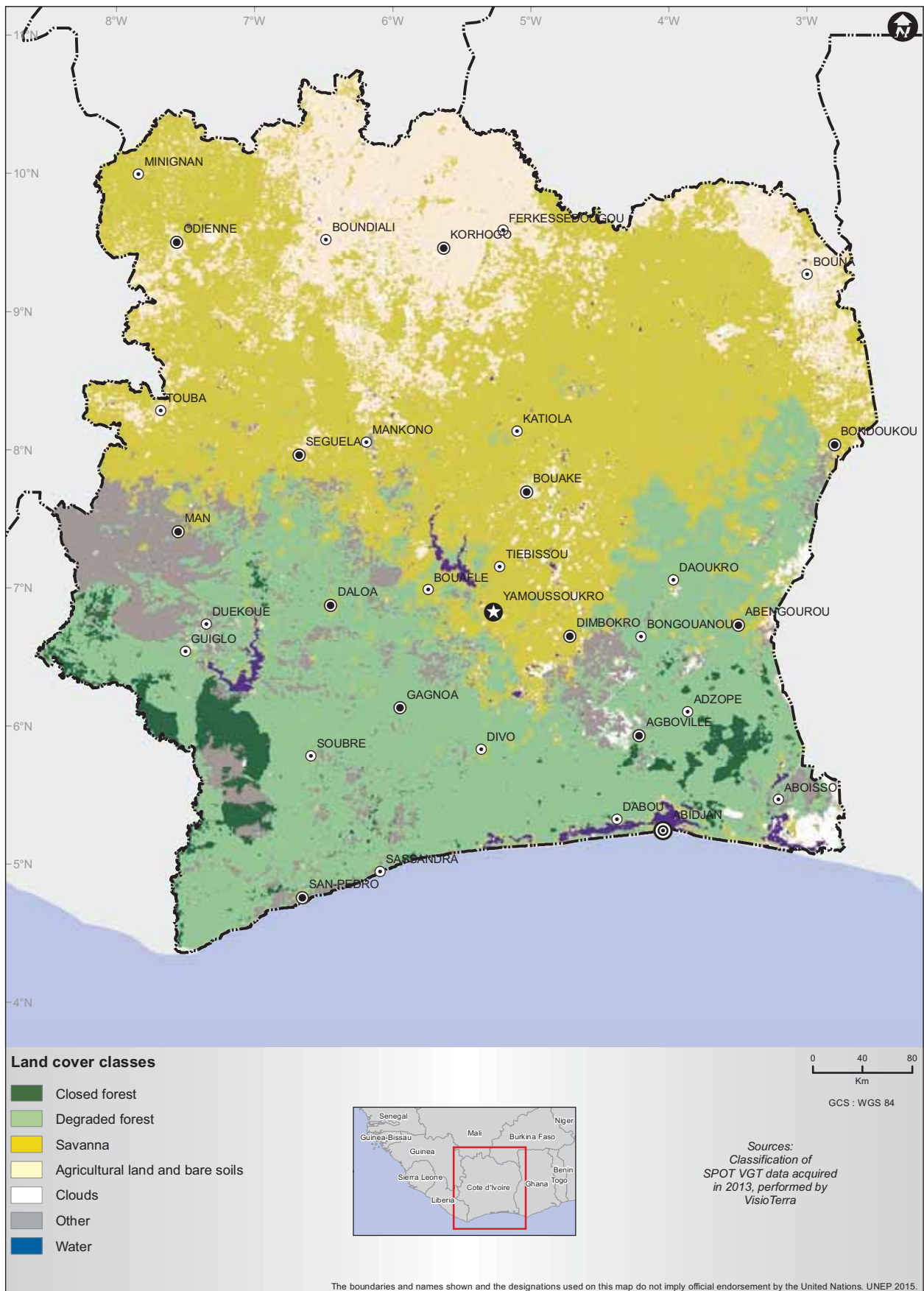


Figure 2c. Forest cover in 2013



Case Study 1. Haut-Sassandra classified forest

The classified forest of Haut-Sassandra is located 60 km west of Daloa. Covering an area of 102,400 ha, it is one of the largest classified forests in Côte d'Ivoire.⁵⁶ It is composed of semi-deciduous forest and characterized by *Triplochiton scleroxylon* (samba) and *Celtis spp.*

Most of the classified forests in the Daloa region have been infiltrated during the past 80 or 90 years by plantation growers who farm cocoa and coffee. Many such areas, like Bouaflé, Dé, or Koba, are no longer forested at all.

The classified forest of Haut-Sassandra was a unique exception. It had been remarkably well preserved, except for two enclaves, one in the southwest corner and the other in the northwest corner of the forest.⁵⁷ Owing to the area's great potential for timber exploitation, it had been under rigorous protection by SODEFOR, and its limits had been clearly marked on the ground since 1974. The forest is divided into three areas: a production area (série naturelle de production) covering 81,144 ha (80 percent of the classified forest); a protection area (la série naturelle de protection) to the west covering 15,954 ha (15 percent); and an agricultural area, corresponding to the agricultural enclaves, covering 4,920 ha (5 percent).

Haut-Sassandra has tremendous conservation value. In 1991, it was estimated to hold up to 400 chimpanzees⁵⁸ and an unknown number of elephants. It was connected through forest corridors to Mont Péko National Park and until 2002, it remained one of the best preserved classified forests in Côte d'Ivoire.

During the crisis, the region was under the control of the FN such that SODEFOR could no longer maintain surveillance of the classified forest. Cacao planters moved in following a similar pattern to that seen in most of the other classified forests: 30-50 individuals assumed ownership of the forest, divided it between themselves, and sold the use of it to incoming cocoa growers.

Illegal settlers were not the only source of deforestation. The timber exploitation company Covalma continued its operations during the conflict as it was licensed to do. However, during this period SODEFOR had no control over the amount of timber extracted by the company or the number of trees planted in return.

As well preserved as Haut-Sassandra was until 2002, SODEFOR estimates that by 2012, 80 percent of it had been degraded. Satellite images show that its closed forest cover was fairly well maintained between 2002 and 2008 (dropping from 89 percent to 80 percent) but that it had dropped dramatically, to 14 percent, in 2013 (Table 9). The adjacent classified forest of Mont Tia followed the same pattern.

During two helicopter overflights, the UNEP team confirmed the advanced state of degradation of the forest, occasional patches of closed forest canopy, numerous small settlements of one and five roofs, cocoa plantations, food crops, fires, and evidence of logging.

The UNEP team also visited the forest to ground-truth the observations made from satellite-image analyses and aerial reconnaissance. The conclusion was very clear: Haut-Sassandra classified forest is probably the single biggest causality of the crisis between 2008 and 2012 (see Figure 3).

Table 9. Changes in the classified forests of Haut-Sassandra and Mont Tia, 1992-2012

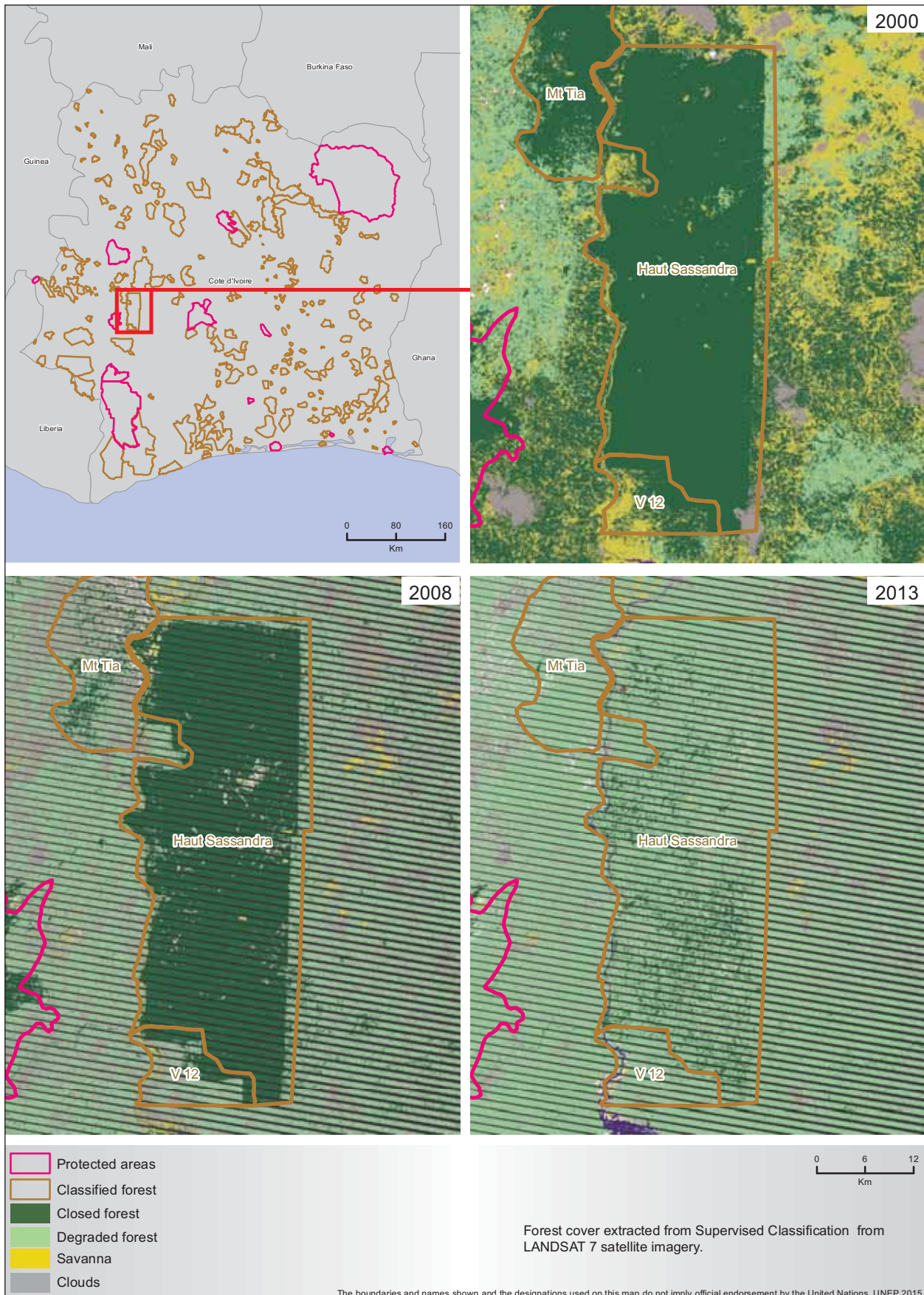
Source	Area (km ²)	Forest cover (%)	Conservation estimate (%)			Dense forest cover (%)		Conservation estimate (%)	Heads of exploitation	
			SODEFOR	UNEP	UNEP	UNEP	SODEFOR		SODEFOR	SODEFOR
		1992	2002	2002	2008	2013	2012	2002	2012	
Haut Sas-sandra	1,024	68	100	89	80	14	20			
Mont Tia	250	x	80	56	0	0	10	1,000	4,400	

* Chatelain C., Dao H., Gautier L., Spichiger R. 2004. Forest cover changes in Côte d'Ivoire and Upper Guinea. In: Biodiversity of West African Forests, p. 15-32. CABI Publishing, Oxford UK.



Hautassandra lost 80 % of its forests after the election crisis

Figure 3. Change in forest cover in Haut-Sassandra classified forest, 2000, 2008 and 2013



The boundaries and names shown and the designations used on this map do not imply official endorsement by the United Nations. UNEP 2015.

According to data on the state of degradation of the classified forests provided by SODEFOR for 2002 and 2012, of the 4.2 million ha of classified forests, a very conservative estimate of 1.05 million ha were degraded during the crisis;⁵⁹ the estimated area of classified forests remaining nondegraded in 2013 would be over 1.3 million ha as the evaluation included only 80 percent of the classified forests' area.

The classified forests of the forest zone that were most affected by the crisis are situated in the west of the country, in the regions of Man, San Pedro, and Daloa. Based on forest degradation data provided by SODEFOR, the seven classified forests of Haut Sassandra, Duékoué, Goin-Débé, Scio, Haute Dodo, Monogaga, and Niégré together lost 4 million ha in the ten years of conflict.

Table 10 and Table 11 show the classified forests that were most affected by the crisis based on the

criteria “that during the crisis they lost more than 50 percent of the area, or an area greater than 30,000 ha.” The estimates of degradation of the classified forests in 2000 and 2012 shown in the table are based on data provided by SODEFOR.

According to data on the classified forests from SODEFOR regional management centers, from 2002 to 2012 there was a sharp increase both in the area under agricultural cultivation and in the number of families that have established agricultural plots (Table 12). These figures are indicative only, and considered an underestimation because the land area occupied by farms and the number of plantations have not been assessed for all classified forests. In essence, well over one million people have encroached upon protected forests and currently depend on them for subsistence, with half of these incursions occurring between 2002 and 2012.

Table 10. Estimated levels of degradation in Côte d'Ivoire's classified forests in 2000 and 2012

SODEFOR Regional Management Center	Classified Forest	Area (ha)	Estimated level of degradation (%)		Estimated area degraded (ha)		Estimated degradation during the crisis (%)		Remaining non-degraded area in 2012 (ha)	Estimated number of heads of exploitation	
			2002	2012	2002	2012	(%)	(ha)		2002	2012
Abidjan	Audoin	6,600	22%	90%	1,452	8,940	68%	4,488	660	194	500
Daloa	Dé	13,051	45%	99%	5,873	12,920	54%	7,048	131	1,080	3,240
Daloa	Haut-Dé	7,448	0%	95%	0	7,076	95%	7,076	372		
Daloa	Haut-Sassandra	102,400	0%	80%	0	81,920	80%	81,920	20,480		
Daloa	Moyenne Marahoué	38,800	30%	90%	11,640	34,920	60%	23,280	3,880	310	350
Man	Duékoué	52,679	23%	90%	12,116	47,411	67%	35,295	5,268	1,271	9,000
Man	Goin - Débé	133,170	39%	80%	51,936	106,536	41%	54,600	26,634	2,500	10,000
Man	Kouin	5,395	9%	60%	486	3,237	51%	2,751	2,158	100	700
Man	Mont Tia	24,990	20%	90%	4,998	22,491	70%	17,493	2,499	1,000	4,400
Man	Scio	88,000	24%	75%	21,120	66,000	51%	44,880	22,000	2,440	30,000
San Pedro	Haute Dodo	196,733	16%	60%	31,477	118,040	44%	86,563	78,693	2,674	15,000
San Pedro	Monogaga	39,986	18%	95%	7,197	37,987	77%	30,789	1,999	663	15,000
San Pedro	Niegre	92,500	15%	80%	13,875	74,000	65%	60,125	18,500	1,631	12,000
San Pedro	Monts Kourabahi	3,350	20%	80%	670	2,680	60%	2,010	670	80	250
Total		805,102			162,841	624,158		458,317	183,944	13,943	100,440

Notes:

1. Degradation is defined as loss of more than 50 percent of area or an area greater than 30,000 hectares.
2. Forests that lost more than 30,000 ha during the crisis are shown in red.

Table 11. Estimated levels of degradation in Côte d'Ivoire's classified forests in 2000 and 2012

SODEFOR Regional Management Center	Classified Forest	Area (ha)	Estimated level of degradation (%)		Estimated area degraded (ha)		Estimated degra- dation during the crisis		Remaining non-degrad- ed area in 2012 (ha)
			2002	2012	2002	2012	(%)	(ha)	
Bouake	Akouma	90	10%	90%	9	81	80%	72	9
Bouake	Bamoro	2,280	5%	70%	114	1,596	65%	1,482	684
Bouake	Bandama blanc	50,000	0%	50%	0	25,000	50%	25,000	25,000
Bouake	Boli	5,330	30%	90%	1,599	4,797	60%	3,198	533
Bouake	Bossia Mori	220	10%	90%	22	198	80%	176	22
Bouake	Boyakro	2,510	30%	90%	753	2,259	60%	1,506	251
Bouake	Kafaka	1,800	0%	70%	0	1,260	70%	1,260	540
Bouake	Kinkené	48,200	0%	80%	0	38,560	80%	38,560	9,640
Bouake	Konhoukro	2,340	0%	90%	0	2,106	90%	2,106	234
Bouake	Koumo	4,000	0%	90%	0	3,600	90%	3,600	400
Bouake	Loho	89,150	0%	60%	0	53,490	60%	53,490	35,660
Bouake	Niellépuo	1,500	0%	70%	0	1,050	70%	1,050	450
Bouake	Niellépuo	64,370	0%	50%	0	32,185	50%	32,185	32,185
Bouake	Péoura	4,000	0%	90%	0	3,600	90%	3,600	400
Bouake	Pyerrhé	53,460	0%	60%	0	32,076	60%	32,076	21,384
Bouake	Suitoro	21,950	0%	70%	0	15,365	70%	15,365	6,585
Bouake	Toutekoté	250	0%	75%	0	188	75%	188	63
Total		351,450			2,497	217,411		214,914	134,040

Notes:

1. Degradation is defined as loss of more than 50 percent of area or an area greater than 30,000 hectares.
2. Forests of the savanna zone that lost more than 30,000 ha during the crisis are shown in red.

Table 12. Area under agriculture and number of families in the classified forests, 2002 and 2012

	2002	2012
Estimated area occupied by agricultural exploitation (ha)	575,347	1,312,128
Percentage of the total area of classified forests under agricultural exploitation	14	32
Estimated number of families in the classified forests	90,615	229,560
Estimated population based on five people per exploitation	453,075	1,147,800

The authorities on site, governmental sources, and the media all ascribe the general pattern of current agricultural infiltration to the organized sale of parcels of land in the classified forests by some individuals to farmers. The process of forest degradation by people planning to establish cocoa plantations is subtle—at least at the outset—and precedes the human settlements and more visible and widespread damage that follow. Typically, forest undergrowth is cleared at night by a large group of people, after which cocoa seeds are planted. The parcel of land is then left unattended for six months to a year before the farmers return to clear vegetation growth from around the young plants and to kill the surrounding trees by setting fire to them at the base. In general, SODEFOR becomes aware of these actions only after the damage to the forest has already been done.

Some of the settlers are armed, or at least believed to be armed. They are often provided cover by those who sold them the parcel of land. Conflict routinely arises between the illegal occupants of the forest and members of the local population, as well as between the illegal occupants and SODEFOR agents. Security is poor in the classified forests and SODEFOR lacks the means to establish a strong presence in them. The incidence of infiltration by farmers rose significantly during the post-electoral crisis and continues even though the period of conflict is over.

At present, SODEFOR appears to have insufficient personnel, equipment, and funding to exercise effective surveillance and control over the forest resources under its supervision. For example, only two agents and one vehicle are designated for the surveillance of the 102,400 ha of classified forest of Haut Sassandra, while there were 32 agents before the crisis. SODEFOR equipment was pillaged during the conflict and in the north of the Zone of Confidence, their buildings were occupied by the Forces Nouvelles (FN) and are now generally occupied by the Armed Forces of Côte d'Ivoire (FRCI).

Other causes of degradation of the classified forests arose during the crisis:

- illegal logging on a commercial scale in the natural forests and the plantations north of the Zone of Confidence;
- legal industrial exploitation of the forest by concession holders north of the Zone of Confidence that continued without SODEFOR's supervision and without a guiding concept of sustainability;
- destruction of reforested areas in plots converted to agriculture;
- artisanal gold mining in small areas scattered through the forest, such as in Goin-Débé; because the gold miners are sometimes armed, their presence prevents effective surveillance of the forest; and
- poaching of wildlife.

Table 13 lists the remaining large blocks of forest with closed cover, where the forest is less than 35 percent degraded and has a remaining area of dense forest greater than 15,000 ha. These figures are based on estimates of degradation of the classified forest provided by SODEFOR regional management centers, and closed forest cover data from SPOT satellite imagery analysis.



After the small saplings start to grow, surrounding trees are deliberately burnt

Table 13. Forests with lower estimated rates of degradation, 2002 and 2013, including SPOT satellite data for closed forest cover in 2013

SODEFOR Regional Management Center	Classified Forest	Area (ha)	Estimated level of degradation (%)		Estimated degradation during the crisis (%)		Closed forest cover, in % (SPOT satellite data)			Remaining undisturbed in 2012/2013 (ha)		Estimated number of heads of exploitation	
			2002	2012	(%)	(ha)	2000	2008	2013	SODEFOR	VG-SPOT	2000	2012
Man	Cavally	64,200	4%	20%	16%	10,272	95%	96%	93%	51,360	59,706	<100	10000
Man	Tiapleu	28,000		30%			95%	91%	x	19,600	x		
Abengourou	Mabi	56,363	20%	x			x	x	76%	x	42,836		
Agboville	Yapo-Abbé	28,790	7%	12%	5%	1,440	x	x	96%	25,335	27,638	434	543
Abidjan	Yaya	23,879	6%	6%	1%	191	x	x	96%	22,375	22,924	300	300
Gagnoa	Tene	29,700	20%	30%	10%	2,970	0%	0%	1%	20,790	297		

Only six classified forests of the forest zone greater than 15,000 ha maintained their integrity during the crisis. Two forests (Cavally and Tiapleu) are in the west of the country; three (Mabi, Yapo-Abbé, and Yaya) are in the east; and one (Tené) lies in the center. However, the data from satellite imaging does not seem to confirm continuing dense forest cover for Tené. The classified forest of Cavally is known for its biodiversity and has a high conservation value (see Case Study 2).

Of these six forest areas, Cavally is the most threatened, and SODEFOR reports that this has occurred through recent massive encroachment by as many as 10,000 farmers. If urgent action is not taken, Cavally is likely to share the fate of the adjacent classified forest of Goin-Débé which is now 80 percent degraded. Tiapleu, meanwhile, seemingly owes its good condition to the fact that the local population has chased away the infiltrating farmers.



Charcoal production is prevalent in Cavally though less rampant than other areas

Case Study 2. Cavally and Goin-Débé classified forest

The seven classified forests of Haut-Dodo, Goin-Débé, Cavally, Scio, Duékoué, Krozalié, and Cavally Mont Sainte remained under governmental control throughout the crisis. Infiltration by illegal settlers for agriculture, poaching, and to a lesser extent artisanal gold mining had started before the crisis but intensified after 2002 due to SODEFOR's lack of surveillance capacity. In 2013 the classified forests of Scio, Duékoué, Krozalié, Cavally, Mont-Sainte, and Goin-Débé were severely damaged (Table 14).

The classified forest of Cavally is a regional exception as it has been well preserved (Table 14). Data from satellite images confirm that the dense forest cover was minimally affected by the crisis. Cavally is known for its high biodiversity of flora and fauna, which includes endangered species.⁶⁰ Approximately 50 chimpanzees are resident in the forest,⁶¹ and it is one of the last remaining elephant refuges in Côte d'Ivoire. According to SODEFOR, in 1996 there was no agricultural encroachment or settlement in Cavally; rather, the threat at the time was posed by illegal exploitation of timber.⁶²

A combined biomonitoring team comprised of personnel from the Wild Chimpanzee Foundation (WCF) and SODEFOR reported that limited infiltration had started in the classified forest in 2008-2009 but had not affected the chimpanzee population.⁶³ Although still remarkably conserved, Cavally is at risk: agricultural encroachment is ongoing and poses a real threat to the forest. SODEFOR estimates that there were 10,000 farmers operating in the forest in 2012. Three armed groups are reportedly fighting over ownership of the forest, and the insecurity created by that conflict prevents any effective control of agricultural infiltration.

SODEFOR, in partnership with WCF, is currently working towards a program of sustainable forest exploitation in the classified forests of Cavally and Goin-Débé.

In Cavally, most of the forest had a closed canopy. There was, however, evidence of human activity, past and present: commercial logging, although not recent; fires; food crops; and plantations. There were no signs of settlement other than one thatched roof.

Urgent action is required to ensure that one of the last remaining forest blocks—and the largest after Tai National Park—does not disappear entirely. Given its high biodiversity value and its large size (50,000 ha of closed canopy), Cavally may be a good candidate for promotion to the status of national park.

Table 14. Estimated classified forest degradation in the west of Côte d'Ivoire during the crisis

Source	Area (km ²)	Forest cover (%)	Conservation estimate (%)	Dense forest cover (%)			Conservation estimate (%)	Heads of exploitation	
				UNEP 2002	UNEP 2008	UNEP 2013		SODEFOR 2002	SODEFOR 2012
		1992	2002	2002	2008	2013	2012	2002	2012
Haute Dodo	1,967	66	84	31	19	4	40	2,674	15,000
Goin - Débé	1,331	69	61	66	72	23	20	2,500	10,000
Cavally	642		96	95	96	93	80	<100	10,000
Scio	880	60	76	47	24	x	25	2,440	30,000
Duékoué	526	58	77	30	0	0	10	1,271	9,000
Cavally Mont Sainté	141	x	60	1	x	x	30	1,000	2,000
Krozalié	93	85	100	56	69	34	90		

* Chatelain C., Dao H., Gautier L., Spichiger R. 2004. Forest cover changes in Côte d'Ivoire and Upper Guinea. In: Biodiversity of West African Forests, p. 15-32. CABI Publishing, Oxford UK.

Note: Conservation estimates provided by SODEFOR; dense forest cover assessments from VG-SPOT satellite imaging.

Since the 1990s, the authorities have taken measures to address reductions in forest cover and of continued encroachment on the classified forests by cocoa plantation growers. Since 1994, companies holding concessions for exploitation of forest timber (CPEF) are required to undertake reforestation activities in order to promote a sustainable harvest of forest timber. Logging companies are legally bound to reforest 1 ha for every 150 m³ of timber extracted from the forest zone. SODEFOR is responsible for the control of such reforestation in the classified forests. The area reforested by logging companies for the period 1997-2000 was approximately 40,000 ha.⁶⁴

In 2000, SODEFOR's commercial plantations, in classified forests, of teak, Gmelina, and Terminalia, as well as a few local species, were estimated at 120,000 ha.⁶⁵ During the crisis, most logging companies opted to pay a fine rather than comply with their reforestation obligations. And many of the reforestation efforts of SODEFOR were reversed by agricultural encroachments and clear-cutting of commercial plantations.

There have been significant efforts from the government to initiate reforestation programs. The farmer-forest contract, a scheme by the government, aims to promote agroforestry. In 2005, Ivorian forestry experts adopted the National Reforestation Programme for 2006-2015, with the goal of reforesting 150,000 ha of forest within that period. However, the program (estimated to cost FCFA 72 million) was not carried out due partly to lack of funds and partly to the post-electoral crisis. This plan was updated in 2011. The government also created the National Forest Agency (ANDEFOR) for the purpose of reforestation in the rural areas. ANDEFOR is a limited liability company in which the private sector is allowed to hold up to 34 percent of the shares.

4.2 Recommendations for the classified forests

Arrest ongoing encroachment. The forest cover of Côte d'Ivoire now forms just 3 percent of the national territory and continues to decrease rapidly. If the current trend is not slowed, halted, and then reversed, in the near future the country's forests will no longer be sufficient to fulfil their ecosystem or economic functions. The protection of the remaining forests and the restoration of forest cover should be

a priority. Although the government has identified protection of forests as an important problem to be addressed, at this point SODEFOR does not have the personnel, equipment, or funding to ensure proper surveillance of the country's forests. Because the perpetrators of illegal activities are sometimes armed and so pose a threat to SODEFOR's agents and work program, providing better support to the government agency to undertake its surveillance task is critical to arresting the ongoing encroachment.

Conserve the few remaining intact primary forest blocks and their biodiversity. The flora and fauna of the forests are under threat from habitat loss and poaching. Blocks of primary forest large enough to act as sanctuaries for West Africa's flora and fauna are now rare. In Côte d'Ivoire an estimated 120,000 ha of the national parks and reserves network have been severely degraded. The following measures to alleviate this crisis are recommended:

1. Raise the remaining large blocks of dense forests to the status of national parks. They already support a wide diversity of flora and fauna; six blocks have been identified as potential candidates through analysis of satellite imagery. The 50,000 ha classified forest of Cavally, currently under threat, is a prime candidate for restoration.
2. Identify within the classified forests those areas of high conservation value and limit all exploitation activities hostile to wildlife and its habitat.
3. Halt illegal hunting in the forests and monitor the recovery of large mammals and sensitive species.
4. Prioritize the areas (i.e., classified forests and forest patches in the rural domain) to be protected according to their remaining conservation value; their size and intactness; their contiguity with other protected areas; and their potential as wildlife corridors linking protected areas.

Reduce or halt commercial forest exploitation. The timber industry currently needs about 2 million m³ of timber each year. It is unlikely that that demand can be met sustainably in the future. Reducing or halting the commercial exploitation of forests should therefore be considered. At present, the timber industry consists predominantly of sawmills and plywood manufacture for both the national market and export. The socioeconomic

impacts associated with reducing sawmill activities can be lessened by promoting the export of manufactured products with timber imported from elsewhere as raw material.

Reduce the agricultural expansion that is compromising forest cover.

In general, Ivorian farmers still use slash-and-burn techniques to clear land for agriculture. This practice is destructive and lays waste to large amounts of land and undermines reforestation efforts. If the technique were to be replaced by a static, intensive, and efficient form of agriculture, the pressure exerted on the forests by farmers would be greatly reduced. New methods could ensure the long-term sustainability of the agricultural system and conserve not only forest but also soil. To achieve this, the following recommendations are made:

1. Establish pilot and demonstration plots showing sustainable sedentary agricultural systems (e.g., agroforestry and improved fallows).
2. Encourage research on agroforestry techniques and adapt them to the context of Côte d'Ivoire.
3. Strengthen agricultural extension services to enable them to provide the technical support necessary for the sustainable production of both cash and food crops.
4. Provide incentives to encourage farmers to adopt suitable sedentary alternatives to slash-and-burn agriculture and educate them on sustainable soil fertility management.

Develop a humane strategy for those settled in a forest. Close to a million settlers currently reside in areas that technically belong to forests in Côte d'Ivoire.



Large-scale timber exploitation is unsustainable

If the forest cover has to be reestablished, these settlers need to be managed. The current approach to resettling, however, is somewhat aggressive and has led to incidents of violence. A more humane strategy in which the settlers have access to livelihoods needs to be developed. Moving the settlers to the outskirts of the forest boundaries and establishing a reforestation program where the settlers will play an active role in planting and surveillance, with some shared benefits for the community in the long term, would increase acceptability of resettlement efforts.

Increase forestry revenue for the government.

One of the main challenges facing the forestry sector in Côte d'Ivoire is the lack of adequate financial resources to manage the forestry sector. This is further compounded by the fact that SODEFOR, one of the key agencies dealing with the forestry sector, is partly financed by revenue from timber harvesting. In order to improve forest management and guide it towards more sustainable path, it is important that nonconsumptive use of the forest is promoted and harnessed to increase revenue. This could include bioprospecting for genetic resources, ecotourism, and animal ranching. International funding opportunities such as REDD+ and carbon trading also must be considered.

National Parks

*Luckily, some good quality
forests remain within
the boundaries of
protected areas*



National Parks

Prior to the conflict, Côte d'Ivoire had designated a number of areas as national parks and had established a specialized agency, the Office for Parks and Reserves (OIPR). The parks existed in all parts of the country and in various ecological zones. During the conflict, however, all parks suffered impacts of varying degrees. During the assessment, three national parks were studied. They were selected as representative of different ecosystems as well as stages of damage, based on consultation with national and international experts.

5.1 Comoé National Park

Comoé National Park is situated in the northeast of Côte d'Ivoire, a few kilometers from the Burkina

Faso and Ghana borders. At 11,500 km², it is by far the largest park in Côte d'Ivoire and is one of the largest protected areas in West Africa. It is one of the few remaining areas in the region that is large enough to ensure the population viability of the species that live within it and therefore presents a rare and precious refuge for a number of West African species. In 1983 it was declared a Biosphere Reserve and a UNESCO World Heritage Site.

Although the park lies entirely in the savanna zone, it is home to a diversity of habitats, including shrub and wood savannas, gallery and fluvial forests, and riparian grasslands. This ecological wealth can largely be credited to the variety of the park's topography. The Comoé River crosses the park from north to south for 230 km, and rocky, green inselbergs form isolated massifs and small chains reaching 500-600 m high.



Comoé park still supports some faunal diversity

This diversity of habitats is home to a rich variety of plant species (620 on record), mammals (135 species, including 11 primates, 11 carnivores, and 21 ungulates), 35 species of amphibians, 60 species of fish, and 500 species of birds. A number of these species are quite rare and have garnered international interest, the yellow-casqued hornbill (*Ceratogymna elata*), brown-cheeked hornbill (*Bycanistes cylindricus*), and saddle-billed stork (*Ephippiorhynchus senegalensis*) among others.

The flagship species, some of which are included in the International Union for Conservation of Nature (IUCN) Red List of Threatened Species, are lion (*Panthera leo*), hippopotamus (*Hippopotamus amphibius*), African forest elephant (*Loxodonta africana cyclotis*), West African chimpanzee (*Pan troglodytes verus*), lycaon (*Lycaon pictus*), and dwarf crocodile (*Osteolaemus tetraspis*).

Toward the end of the last century, poaching caused a dramatic decrease in the density of the park's population of large mammals. Between 1978 and 1988, 80 percent of Buffon's kob (*Kobus k. kob*) disappeared, along with 75 percent of the elephants and 40-50 percent of African forest buffalo (*Syncerus caffer nanus*), hartebeest (*Alcelaphus buselaphus*), hippopotamus, West African bushbuck (*Tragelaphus scriptus scriptus*), roan antelope (*Hippotragus equinus*), and olive baboon (*Papio anubis*).

Impact of the crisis

Even before the crisis, there was pressure on Comoé National Park, with poaching and overgrazing. In 2003, when difficulties were exacerbated by a lack of management, Comoé National Park was added to the list of World Heritage Sites in Danger.

The park was essentially left without management during the crisis. Rebel forces occupied more than two-thirds of the park area, and OIPR had little influence over the rest. The park's buildings and equipment were pillaged, and vehicles stolen. OIPR only regained full control in 2011 and started its surveillance activities with the support of international funds (Protected Area Management Project [Projet d'appui à la reliance de la conservation des parks et réserves de Côte

d'Ivoire], or PARC-CI⁶⁶ financed by the Global Environment Facility, GEF). These measures suffered a setback, however, when the six vehicles that were acquired with PARC-CI funds were stolen during the post-election crisis.

During the crisis, poaching, which was conducted on both a small subsistence scale and a large and organized commercial level, intensified. It seems that the poachers were a mixture of Lobi hunters, who operated individually or in groups, and foreigners. Allegedly, groups of up to 40 poachers (including women and children), equipped with all-terrain vehicles and assault weapons, established camps inside the park and lived there for up to two months at a time. Meat was smoked on site and then moved out of the park via a network of women. Various species were hunted, among them Buffon's kob, duikers (*Cephalophus* spp.), primates, and even lions. A combined survey team from OIPR and the NGOs Panthera and WCF, which stayed in the park for a month in order to search for lions, encountered 88 poachers' campsites.⁶⁷

Poachers have not been the only threat to the park. Pastoralist farmers have also caused significant damage. Peuhl herders from north of Korhogo or from Burkina Faso cross the region with their cattle during the dry season, on their way to the southern cities. Seasonal incursions into the park by herds of cattle took place before the crisis but intensified during it. Herders, each with 100-200 head of cattle, remained in the park for several weeks, some even establishing settlements for up to three years.

Aerial biomonitoring of the park in 2010⁶⁸ confirmed that the density of wildlife was low, with animal populations having decreased by 80 percent in 30 years. And the composition of the mammal population and the park in general was changing. Of the 8,477 mammals counted during the monitoring, 90 percent were domestic. In theory, the park should have had the largest population of elephants in the country, yet none were observed during the monitoring that traversed 3,000 km of aerial transects. Similarly, a survey designed to count lions concluded that the species had probably disappeared from the park altogether (See box, "Reintroducing lions in Comoé").⁶⁹



Re-introducing lions in Comoé

The lion was once the mascot of Comoé, the national park with the species' most suitable habitat. Lions are now thought to be entirely absent from the park. A joint effort by Panthera, OIPR, and WCF to locate lions in Comoé in 2010 yielded signs of leopards and the widespread presence of spotted hyenas (*Crocuta crocuta*), as well as 16 groups of poachers and four groups of pastoralists. In one of the 88 campsites used by the poachers, there was a large gin trap, evidence of the targeting of large carnivores. The pastoralists that were interviewed had not heard or seen lions in recent years; indeed the last credible observation dates back to 2004.⁷⁰

According to OIPR park rangers, lions were specifically targeted by the Dozos poaching in the park during the crisis. The Dozos are members of a fraternity of traditional hunters who use lion parts as amulets that they believe give them special powers.

Since there is no known resident population of lions in the adjacent protected areas across the border in Ghana⁷¹ or Burkina Faso,⁷² the chances of lions returning to the park of their own accord are slim. However, given adequate surveillance, and if the pressure from poaching eases, the numbers of those species that serve as natural prey for the lion should return to levels that would eventually allow the reintroduction of lions to the park.

Fires associated with poaching and grazing have done significant damage in the park. Setting fires in December and January is a common technique for the management of the savanna as an ecosystem. However, so-called late fires set with the intention of promoting new growth of grass are damaging to the process of vegetation regrowth and subsoil fauna and ultimately to the diversity of plant species.

Encroachments into the park by subsistence and cash-crop farmers growing rice, yam, and cashew trees, have also occurred. Their settlements were cleared once OIPR returned to the park.

Through education of the local populations and the surveillance strategy of OIPR, the pressures from poaching and seasonal grazing have decreased and the animal populations are recovering. In a pedestrian monitoring of the park in 2012[1], 88 % of the records were ungulates. Hartebeest were the most observed animal followed by Bushbuck and then Duikers. Buffalo, antelope and waterbuck were also observed, although in small numbers. Only 4% of the records were evidences of human activities, mostly poaching. OIPR has achieved this with the aid of 2010 World Heritage Centre (WHC) Rapid Response Facility (RRF) grant of USD 30,000 to assess the status of the threat posed to the park by poaching and to control that threat by reinforcing OIPR's authority.

Observations during the UNEP mission

Surveillance in the park is greatly hampered by the poor condition of the 980 km of tracks, which have not been subject to regular maintenance since 2002. The UNEP team only drove the 90-km transect from the guard post at Bania to the Comoé River crossing at Gawi, a journey that covers more than two-thirds of the width of the park. The following observations were made:

- The track from the guard post at Bania to the Comoé River has been rehabilitated and is in good condition. Reportedly, poachers avoid this area, and as a consequence wildlife has returned.
- On the western limit of the park, bordered by the road to Bouna, the physical limits of the park have recently been clearly demarcated with boards and white poles.
- Animals recorded along the track included several groups of patas monkeys (*Erythrocebus patas*), several groups of baboons, oribi (*Ourebia ourebi*), duikers, and hartebeest.
- The savanna and the Comoé River side have great visual appeal.
- Signs of fire were obvious on tree trunks, but the impact of fires on plant biodiversity was difficult to judge.
- The buildings of the Gawi surveillance post, which provide accommodation for OIPR personnel, had recently been rehabilitated.
- OIPR personnel were well informed and motivated.

Conclusions on Comoé National Park

Comoé National Park has maintained the integrity of its landscape and habitat. During the crisis, the main pressure exerted on the park came from intense poaching, grazing by cattle, and late fires. Those threats have significantly abated but should be considered in abeyance rather than extinct. Although the densities of animal populations are low, the diversity of the park's fauna has been less impacted. If the remaining animals and their habitats can be kept safe, their populations may yet recover. Species that have totally disappeared from the park, such as the lion and African forest elephant, could be reintroduced. Elephants currently in the Rural Zone at the exterior of the park, which causes community-animal conflicts, could be led back into the park. Reintroducing lions from captive stock is theoretically feasible but technically challenging and costly. In general, the pressure on and damage to the park can be alleviated if there are adequate resources for surveillance and management.

Recommendations for Comoé National Park

Restrict uncontrolled grazing. This could be done by creating a transhumance corridor for cattle during the dry season and encouraging herders to find alternative grazing areas for cattle in the dry season.



Tai National Park has the best preserved forest in Côte d'Ivoire

Encourage the return of animal populations.

The ecological value of the park can be increased by reintroducing some of the animal species that used to be present. Elephants may be reintroduced from nearby areas and by extending the park's boundaries to Mounts Gorowi and Kongoli, providing elephants in particular with suitable habitat and also enabling the protection of other important species.

Involve the local population in surveillance and management of the park. Côte d'Ivoire has good examples of the Community-Based Natural Resources and Wildlife Management Project (GEPRENAF, financed by the World Bank). Two conservation zones under the GEPRENAF project, which are managed by local communities, are in a good state and provided refuges for some animal species during the crisis.⁷³ Communities may be involved in day-to-day surveillance and ecotourism programs that provide livelihood support.

Review and update the park's management plan.

The management plan should include provisions for increased resources needed for protection and scientific biomonitoring and other research activities needed to follow up on ecological recovery. As Comoé was one of the most visited parks in the country prior to the conflict, the need

to rebuild the tourism infrastructure also should be included in the plan.

Improve the financial situation. The park management plan can be implemented effectively only if there are adequate resources available to the park management. Multiple opportunities should be explored to increase revenue for park management. This includes obtaining support from international agencies, finding potential corporate sponsors for the park, and increasing revenue from tourists.

5.2 Tai National Park and N'Zo Faunal Reserve

Tai National Park and the contiguous N'Zo Faunal Reserve cover 5,400 km² of the southwest corner of Côte d'Ivoire, close to the Liberian border. When seen in the context of the rampant deforestation that West Africa has suffered in recent years, it is clear that the park has regional as well as national significance. It holds 20 percent of all Ivorian forests, is the largest and best-preserved remnant of the Upper Guinea rainforest, and represents more than half of the West African forests under high protection status. The park's flora and fauna are so diverse that it received Biosphere Reserve status in 1978 and became a World Heritage Site in 1982.

The park is almost entirely covered by forest: moist evergreen in the southwest, and moist semi-evergreen in the north and southeast. Much of the forest is unlogged, mature old-growth with emergents rising to 60 m. There is some swamp forest in the northwest of the park and in N'zo, and a large number of granitic inselbergs, which support an open savanna-like vegetation with grasses and deciduous trees.

The flora of Tai is estimated at more than 1,800 species, of which 80 to 150 are thought to be endemic to the Upper Guinea region. The mammal fauna is rich: 140 species, including 12 endemic species, are found in the park, representing 93 percent of the mammal species of the West African forests. It is one of the last strongholds of the chimpanzee (*Pt. verus*); the Sooty mangabey (*Cercocebus atys*), as well as several species of colobus monkeys, Diana monkey (*Cercopithecus diana*), Liberian mongoose (*Liberiictis kuhni*), Pel's flying squirrel (*Anomalurus pelii*), pigmy hippopotamus (*Hexaprotodon l. liberiensis*), giant forest hog (*Hylochoerus meinertzhageni ivoriensis*), African forest buffalo, bongo (*Tragelaphus euryceros*), several rare duikers, and the royal antelope (*Neotragus pygmaeus*). The African forest's elephant population is estimated to be 200 individuals. There are two species of crocodile that are of conservation concern, as well as Home's hinge-back tortoise (*Kinixys homeana*). In all, nearly 1,000 species of vertebrates are known to live here.

The human population around the park has increased sharply in the last 30 years, to a total of almost one million people, due largely to a massive influx of migrants from the central and eastern regions and from Sahelian countries. As a consequence, what was once forest at the fringes of the park is now agricultural land used for growing cocoa, coffee, and rice. The land is cultivated right up to the boundary of the park, as is vividly illustrated by aerial and satellite imagery.

Since 1993, Tai National Park has received international assistance from German Federal Enterprise for International Co-operation, World Wildlife Fund, Wild Chimpanzee Foundation for management, surveillance, and biomonitoring; for pilot conservation projects with local people; and for research.

The park has great potential for tourism, including the opportunity to see habituated chimpanzees in the wild. The park's tourism facilities had been improving at the time of the crisis. In 2000 the

locally run Touraco Ecotel⁷⁴ opened on the park's eastern border. The Ecotel is a 20-bed lodge built in a traditional style and designed to minimize the building's environmental impact; it has solar panels and a wastewater treatment system, and uses environmentally sound waste disposal practices. In building the facility, the park's management aimed for a carefully chosen target of 1,500 tourists annually.

Impact of the crisis

Tai National Park is situated south of the Zone of Confidence, so OIPR had been able to maintain its activities there throughout the period of unrest, except for the duration of the post-election crisis and during part of 2010 when there was a disruption in its international funding. In April 2011, during one of its brief periods of absence, OIPR's buildings and equipment were ransacked.

Satellite image analysis provided evidence of the remarkably healthy state of the park's forest cover at the end of the crisis, and this was confirmed by aerial inspection and ground-truthing. While there has been, and still is, some farming toward the eastern limit of the park and in N'Zo Faunal Reserve, 97.6 percent of the park (5,323 km²) is still under forest cover, compared to 97.7 percent in 1998. The rest of the park consists of natural non-forest vegetation that is not the result of human activity or damage of any kind, with a further 0.9 percent (45 km²) being used for agriculture.

However, the park's animal population did not weather the crisis as well as the tree cover. Biomonitoring, carried out in collaboration with the WCF, has taken place every year since 2005 and has clearly identified poaching as the main pressure on the park. Poaching decreased between 2005 and 2010,⁷⁵ but a reduction in surveillance towards the end of 2010 and in 2011 led to an increase in poaching and a decrease in the animal population. Monkeys and chimpanzees were particularly affected. The population of chimpanzees, the flagship species of the park, dropped dramatically, from a stable population of about 550 adults in the previous years to 250 adults in 2012 (See box, "Chimpanzees in Tai Forest"),⁷⁶ while the monkey population fell by one-third in the same period. Monitoring statistics for 2012 indicate the still-significant threat posed by poachers, who accounted for 91 percent of all acts of aggression against the park that year, the remaining 9 percent coming from agricultural encroachment and artisanal gold mining.^{77,78}

Chimpanzees in Tai Forest

The survival of the West African chimpanzee is in danger.

Based on surveys in 1989-1990, Côte d'Ivoire, one of the last strongholds of the endangered chimpanzee, was estimated to support between 8,000 and 12,000 individuals, which would have amounted to nearly half of the world population.⁷⁹ A survey in 2007 revealed a 90 percent decline in the total nest encounter rate over the 17-year period.⁸⁰

In Marahoué, the chimpanzee population, once estimated to be 900, had dropped to less than 50 in 2007,⁸¹ a change that is undoubtedly linked to the 93 percent decrease in vegetation cover that occurred between 2002 and 2008.

In Tai National Park, one of the country's main refuges for chimpanzees, there are an estimated 480 individuals, one-tenth of the previously assumed population size.⁸² In this case, the decline in numbers must be attributed to poaching, as the park went through the ten years of crisis with hardly any damage to its forest cover. These numbers indicate that the decline in chimpanzee numbers is alarming and that urgent action is needed.

On returning to the park, following the post-conflict break in surveillance, OIPR discovered a 400 ha clearing with a four-month old cocoa plantation 3 km inside the eastern edge of the park near the village of Djapaji. The plantation has since been destroyed while other similar attempts have been thwarted thanks to a network of informants drawn from local villages.

The consequences of violating the park can be serious, and many people are caught. Shortly after their intrusions into N'Zo Faunal Reserve, 60 people were caught by OIPR and brought to the tribunal in Man, where they were sentenced to three months in prison. In the first half of 2013, OIPR arrested 190 individuals for illegal activities: 27 for poaching, 101 for artisanal gold mining, and 62 for clearing land for agriculture. The arrests led to 81 convictions.⁸³

The Touraco Ecotel, the park's sole tourism infrastructure, was pillaged during the early part of the crisis but has since been rehabilitated.⁸⁴

Observations during the field visit

The UNEP team entered the park from the west, close to Tai village, and took the 11-km track leading to the Tropical Ecology Research Station. The following observations were made:

- The park boundary is clearly marked by a corridor 4 m wide that is maintained twice a year and runs along the 368-km extent that has neither natural nor man-made boundaries such as a waterway or a trail.
- The 11-km track leading to the research station requires a four-wheel drive vehicle. It does not run through primary forest but rather through an old plantation, now secondary forest, that was included in the park at the time of its creation.
- The Tropical Ecology Research Station consists of six buildings that can house 20 researchers. The station was not in use at the time of the visit.

Aerial transects by helicopter covered 58 km of Tai National Park from east to west, over the park's northeast boundary, and 34 km from north to south, with one north-south transect of 22 km over N'Zo Faunal Reserve.

The survey revealed an unbroken closed canopy of primary forest extending 56 km along the east-west transect, with a distinct boundary between the Rural Zone (crops, settlements) and the park, and some agricultural encroachment into the eastern edge of the park. Unbroken closed canopy dominates in N'Zo Faunal Reserve, although one large settlement was noted.

Conclusions on Tai National Park

The boundaries of Tai National Park were barely breached during the crisis and superficially, it appears the chaos that engulfed the rest of the country had little affect on the park. However, indications of illegal activity, mostly poaching, are visible everywhere. Chimpanzee and monkey populations have suffered alarming decreases in the very recent past—as much as a 65 percent fall in the number of chimpanzees in the Tai sector between just 2010 and 2011—caused by the sharp spike in poaching that occurred during the post-election crisis.⁸⁵ It is clear from this that surveillance is of paramount importance.

The park has been well managed since it was created in 1977. Its management plan was revised in 2006, and since then the park has undergone yearly biomonitoring. The surveillance capacity of OIPR personnel and factors associated with it have made all the difference to safeguarding the park in the face of significant pressures and threats, among them the movement of people towards the

Liberian border. Several factors are involved in that success:

- The park remained under government control, and OIPR maintained its surveillance and management through most of the crisis.
- The park has partners for funding, biomonitoring, and management—the German Organization for Technical Cooperation, World Wide Fund for Nature, World Chimpanzee Foundation, World Bank, and Global Environment Facility—enabling its surveillance capacity to be the best of all the Ivorian national parks (e.g., 40 well-equipped people in groups of 4 to 8 carrying out surveillance duties at any one time).
- The park's boundaries are clearly defined, and its legal conservation status is well known by the local population.
- A network of local informants helps OIPR in its surveillance work, which strengthens its capacity tenfold.



Community settlement close to the park

Recommendations for Tai National Park

1. **Ensure continuous surveillance.**⁸⁶ The Tai National Park managed to withstand much of the impact of the conflict due to the continuous presence of researchers in the area during most of the conflict period. It is important that sustainable systems are put in place for continued surveillance of the park to stop illegal activities and target particular zones where sensitive animal populations (e.g., chimpanzees) are at risk. At the same time, authorities should develop and formalize the local informant network, and ensure that people who are arrested for illegal activities are tried and where convicted, sentenced.
2. **Promote tourism within the park.** The unique stature of Tai National Park in West Africa would justify an ambitious international promotion of tourism once the structures needed to receive tourists are in place. Income generated by tourism should directly benefit local communities and the park. The presence of tourists and researchers also acts as a deterrent to poachers and contributes towards surveillance.
3. **Encourage research and biomonitoring.** Both are essential to acquire a better understanding of the challenges to the park's biodiversity and management needs. Research activities should be run in such a way that they raise income, for example from the issue of research permits (including to international researchers) and accommodation fees.



Regular surveillance using modern technology could reduce encroachment

4. **Support local communities.** Raise awareness among the general public of the value and conservation needs of the park, especially within those communities known to carry out illegal activities. Develop income-generating activities for the local population in order to decrease pressures on the park caused by poverty and the shortage of animal protein. Examples of rural microprojects that are already being piloted are grass cutter farm or fish and poultry farming. Other potential forms of employment include surveillance and maintenance of the park, tourism work (as ecoguides), and research assistants.
5. **Develop the proposed Tai-Grebo elephant corridor between Liberia and Côte d'Ivoire along the Hana River.** Tai National Park holds the largest African forest elephant population in Côte d'Ivoire, estimated at 200 individuals. A corridor allowing exchange with other populations is required for the long-term genetic health of the elephants.
6. **Improve the financial situation.** Tai is one of the national parks that has received continued financial support through the years. It is also well known both locally and internationally. There are multiple possibilities for further revenue generation by bioprospecting, chimpanzee adoption, and carbon offsetting.

5.3 Marahoué National Park

Marahoué National Park is located in south-central Côte d'Ivoire, in the Bouaflé region near Lake Kossou, 275 km northwest of Abidjan. It covers 1,010 km² of the transition zone between dense humid forest and the mosaic forest-savanna; a quarter of its area is savanna and three-quarters are semi-deciduous forest.

Marahoué was once known not only for its remarkably rich fauna—the product of its diverse habitat—but also for tourism. The park's animals included African forest elephant, hippopotamus, African forest buffalo, Buffon's kob, bushbuck, mongoose, bongo, leopard (*Panthera pardus*), olive baboon, and chimpanzees. The park was also rich in birds, with 360 species, including some rare or remarkable. Easily accessible from urban centers, the park also had a small amount of tourism infrastructure.



Marahoué National Park is mostly settled by farming communities

Impact of the crisis

The story of the degradation of Marahoué National Park began in the 1970s with several waves of intrusion, primarily for cocoa farming but also poaching and exploitation of the forest in general. Encroachment intensified between 2002 and 2012 as agricultural exploitation grew significantly. In 1986 agriculture covered 12 percent of the entire park area.⁸⁷ That proportion grew steadily at first, to 30 percent in 2003,⁸⁸ and then exponentially, to 60 percent in 2006, 70 percent in 2007, and 82 percent in 2011.⁸⁹ According to the NGO Africa Nature International, in 2011 the entire forested area had disappeared, with the exception of a few remnants of open forest and savanna patches in the southeast that had not yet been exploited.⁹⁰ In the vegetation analysis shown in Figure 2, the 41 percent of closed forest cover that was there in 2000 had disappeared by 2008.

Encroachment brought permanent settlements, some with large infrastructures including schools

and plantations growing cocoa, coffee, cashew nuts, and other crops. OIPR recorded close to 50 settlements in 2013. The current number of occupants is not known but is estimated to be in the vicinity of 30,000. Some settlements are estimated to have as many as 700 houses.⁹¹ OIPR limits its presence to those areas that remain less affected, partly because of its lack of resources and partly because of hostility from settled farmers.

The consequences of these settlements for the park's fauna have been severe. Habitat has been lost to agriculture, and poaching has been rife. The number of elephants decreased by 70 percent between 2002 and 2007 (see accompanying box).⁹² In 2012 the only evidence of the 50 individuals that had been observed in 2007 was four carcasses.⁹³ General opinion in the park is that there are no elephants left, and that the last ones moved to Daloa on the periphery of the national park, where they have destroyed crops and caused human deaths.

Conflicts between people and elephants around Marahoué

The elephant, which is the symbol of Côte d'Ivoire and was present in hundreds of thousands at the beginning of the twentieth century, has been heavily hunted for its ivory. The population was estimated at less than 2,000 in 1992⁹⁴ and may now be on its way to extirpation.

The habitat of the forest elephant has long been encroached upon by the spread of agriculture. Increased deforestation and poaching during the crisis have also taken a heavy toll on the species.

Besides being visually appealing, the elephant plays an important role in the forest ecosystem, in particular the dispersal and germination of the seeds of important tree species.⁹⁵ The secondary consequence of the loss of habitat has been to drive the elephant toward conflict with people. Those agencies responsible have neither the expertise nor the operational capacity to manage this situation.

Marahoué National Park, for example, used to harbor a healthy population of elephants, but it is now almost completely covered by agriculture. The last traces of elephants found in the park were four carcasses, the animals killed by poachers.⁹⁶ Three small groups of nine elephants in total are believed to have left the park and taken up residency in the vicinity of Daloa, where their cohabitation with people has cost three human lives and the recorded destruction of 187 plantations.

To address the situation, the government reached out for international expertise. The International Fund for Animal Welfare (IFAW) is due to carry out a transfer of the elephants from Daloa to Azagny National Park, which has suitable habitat, where the elephants will be under surveillance. The cost of the transfer, IFAW, is USD 250,000. The Ivorian government in turn is required to resurface the roads along the transfer route.

The long-term survival of the elephant in Côte d'Ivoire depends not only on the control of poaching and the conservation of habitat, but also on the creation of corridors between protected areas that would allow freedom of movement to the animals as well as genetic exchange between groups. Two potential corridors are presently under consideration: one to the west of the country linking Tai National Park with Sapo National Park via the Grebo National Forest in Liberia, and one to the east through the Bia-Songan Riverine vegetation linking the classified forest of Bossematié with Goaso and Bia in Ghana.

Biomonitoring by WCF and OIPR⁹⁷ in 2007 yielded more records of illegal human activities. Animals under threat and lacking habitat had concentrated in a small area of the park, while primates had nearly disappeared. In 2012 a very small number of Kobes remained, in the extreme northeast of the park, along with a few other species such as buffalo and African golden cat (*Caracal aurata*).⁹⁸ In the 2012 bird census, although 44 percent of the park's known species were recorded, some forest birds, such as the large hornbills, once common and characteristic of the park, were absent, reflecting the decrease in the forest's avian population.

Observations during the UNEP mission

The following observations were made by the UNEP team:

- Evidence of past tourism was found at the front entrance of the hotel in Daloa, where a faded board with information about Marahoué was clearly aimed at visitors. It was evident from the information that there had been a visitor center, trails, four miradors, and two picnic areas with barbecue facilities. Visitors could choose circular tours that took from two hours to a full day. The tourism facilities no

longer exist, and some of the species enjoyed by tourists in years past, such as elephants, have left the park entirely.

- On the track that leads to the park entrance, there were several roadblocks manned by people in uniform. Some road blocks were unofficial, and the people manning them seemed to be collecting tolls. Crops such as bananas were openly transported out of the park on trucks and motos. Insecurity and corruption are such that the OIPR staff accompanying the UNEP team were visibly ill at ease; they mentioned that there had been attacks against OIPR personnel inside the park.
- When visiting the well-established settlement of Yao N’Gorankro, which has roughly 500 houses, the UNEP team was met by the village elder and a few other representatives, with some 150 men, women, and children looking on. The exchanges mostly touched upon the living conditions in the park. The village is probably more than 15 years old and has its own school. There was a large patch of cocoa beans drying on the ground, and domestic animals (goats and dogs) were visible.
- On the track leading to the settlement and around the settlement itself, crops such as maize and cassava, and plantations growing cashew nuts and cocoa, as well as some fallows, were evident. No natural habitat was to be seen.

Conclusions on Marahoué National Park

Marahoué National Park presents a serious challenge. If OIPR is to regain effective management of the park, around 30,000 settlers need to be managed. The habitat and animal resources of the park have been damaged to such an extent that, if left to regenerate on its own, the park would turn into a secondary forest with poor biodiversity and undeserving of the status of national park.

Recommendations for Marahoué National Park

1. **Detailed ecological mapping.** The park has been significantly degraded, and before a management plan can be prepared, it will be necessary to carry out a detailed study of the park to determine if there remain areas of significant ecological value that provide refuge habitat for fauna. If such areas are identified, it would be urgently important to take measures to adequately protect them.
2. **Maximize research opportunities.** As a conservation area, the value of the park is currently limited because the damage to the flora and fauna is severe and for the most part irreversible. The park, however, retains some value simply by being a national park and as such, a location for research, education and eventually, tourism, given its location close to urban centers. Alternative uses, both in the short term and the long term, could be considered for the area: for example, as an experimental station for agroforestry practices; as a location for wild-animal ranching or habitat rehabilitation trials; or as a cultural village, a national botanic garden, a zoo, or an endangered animal breeding center, with the remaining natural areas of value protected in its midst.
3. **Regain operational control.** If the park is to regain its ecological significance, government agencies have to regain control over the area, manage the communities that are currently settled in the park, and establish a management plan for park restoration and recovery.
4. **Improve the financial situation.** Due to the park’s ecological degradation, there is very little opportunity for local revenue generation from tourism or other activities. However, a restoration plan can be implemented only if there are adequate resources available to the park management. Opportunities should be explored to increase revenue for park management, such as obtaining support from international agencies, finding potential corporate sponsors for the park by tapping the potential for carbon trading, and seeking support under REDD+.

Urban Environmental Issues in Abidjan

*The conflict saw unplanned
explosion of housing in Abidjan*



Urban Environmental Issues in Abidjan

Abidjan, the commercial center and de facto administrative capital of Côte d'Ivoire, was severely impacted by the conflict. While the population of Abidjan has been increasing ever since independence in 1960, that process was radically accelerated by the crisis as ethnic division, insecurity, and poverty drove large numbers of people away from their homes and toward the city. At the same time, also due to the conflict, investment in urban infrastructure did not catch up, leading to major environmental issues in the city.

Satellite image analyses of Abidjan were conducted for the period 2000-2013, and the urban expansion is visible in the images presented in Figure 4a. Much of the expansion has taken place in the east along the shores of Ébrié Lagoon, some of it occurring on land reclaimed from the lagoon itself (Figure 4b). However, what is most revealing from the quantitative data presented in Table 15 is that the total increase in land area is less than 10 percent while the population is estimated to have doubled. This partially explains the severe pressure on urban services and the deterioration in urban environmental quality.

6.1 Wastewater and rainwater management

Abidjan once had a well-designed wastewater and rainwater collection system. Wastewater was collected in underground sewers that led to main collection points and thence to the treatment facility. Rainwater was collected in open channels that fed into large open-air collectors and then overflowed directly into Ébrié Lagoon.

The city has 710 km of separate wastewater sewers; 150 km of mixed wastewater/rainwater

sewers; 555 km of subterranean rainwater drains; 490 km of open-air rainwater drains; 8 primary mechanical wastewater treatment facilities, each with a capacity of 300 m³ per day; 23 secondary biological treatment stations with a capacity of 600 m³; and 2 physicochemical stations with a capacity of 200 m³ per day. None of the biological and physicochemical treatment stations are currently working, mainly due to a lack of funds for maintenance and repair.⁹⁹ Before the crisis, with the exception of Yopougon, the city's most populated commune, and some areas of the adjacent suburb of Abobo, most parts of the city were connected to the wastewater sewage system.

The influx of people into Abidjan began in 2002 and gradually intensified, reaching a peak in 2011.¹⁰⁰ The wastewater collection network simply could not cope with this massive increase in demand. Migration led to an estimated doubling of the city's population and the creation of many new residential areas, both legal and illegal. The illegally constructed settlement areas are not connected to the underground sewage network, and people use makeshift connections to the open rainwater channels or discharge their wastewater directly into the open in hollows, valleys, or the lagoon. The World Bank's Emergency Urban Infrastructure Project (PUIUR) estimates that 37,500 m³ of wastewater is produced daily, of which 70-80 percent is discharged without being treated.¹⁰¹ Since waste collection services are not provided for many of the illegal settlements, many of the open rainwater drains are not only polluted by sewage water but also jammed with solid waste. This is the case for both secondary drains and main collectors; the rainwater collector ending in Cocody Bay can scarcely be distinguished from an open sewer, and a large amount of waste is caught in the protective grid.

A large part of Abobo, with a population between 500,000 and 600,000 people, is situated within the basin of the Banco River. Rainwater from the basin

Table 15. Land area increase versus population growth in Abidjan

	2000	2008	2013
Total areas (N in ha)	266,704.11	190,873.08	272,704.32
Urban built up area	18,826.37	20,722.65	22,331.85
Gain between years (ha)		+1,796.28	+1,609.20
Gain between years (%)		+9.49%	+7.77%

6 URBAN ENVIRONMENTAL ISSUES IN ABIDJAN

Figure 4a. Satellite imagery showing urban growth in Abidjan between 2000 and 2013

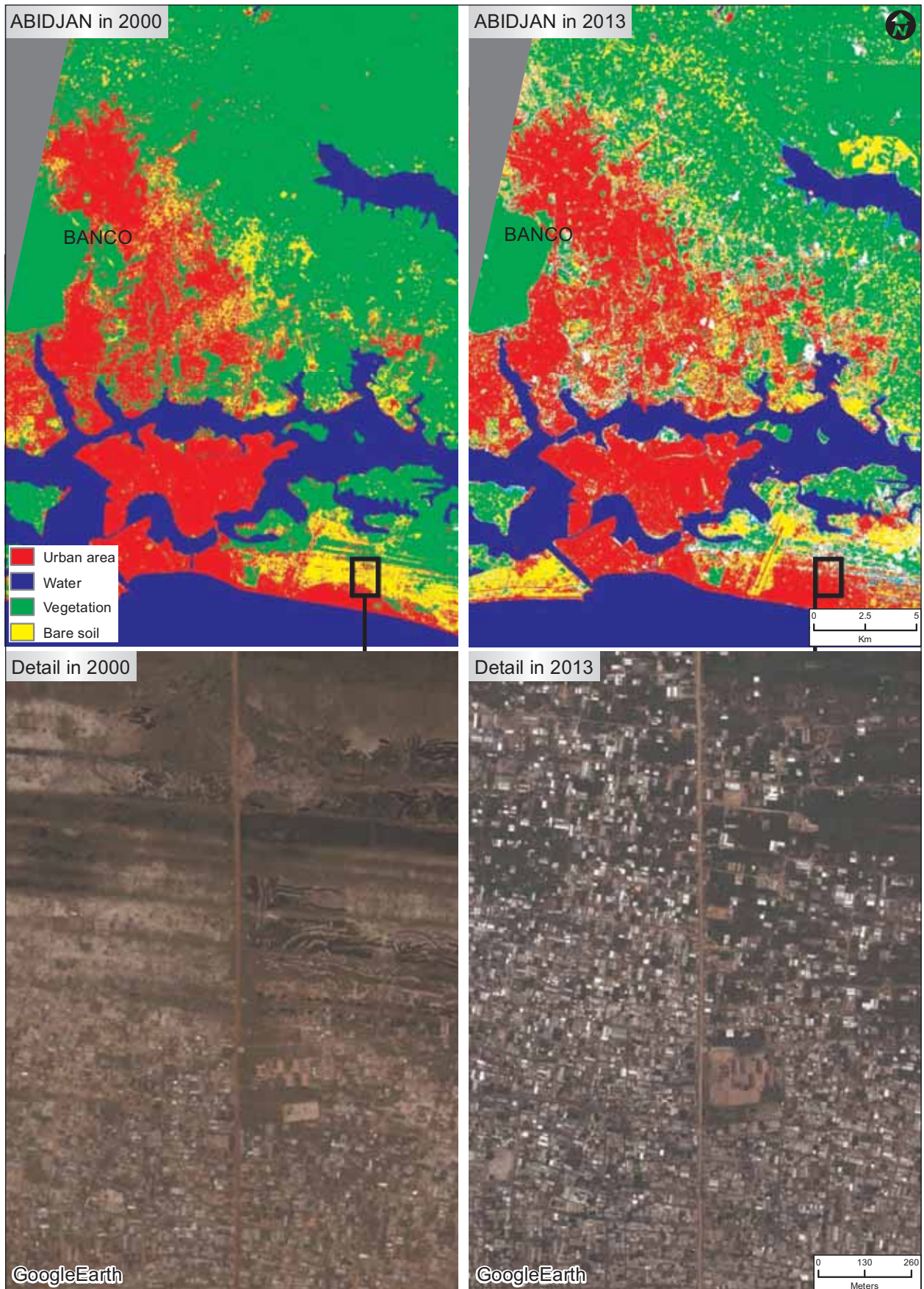


Figure 4b. Land Reclamation in Ébrié Lagoon





When proper sewage and solid waste management system are absent, gullies get filled with both

collects in a large drain that passes the forest and discharges into the Banco River. During the crisis, a large number of people settled in the northern part of Banco National Park as well as adjacent to it. Wastewater from many of the houses in the area runs into the main rainwater collector, adding a significant load to the rainwater drain and reducing the natural filtration capacity of the soil by sealing it with fine particles. This situation has led to serious erosion and flooding in the park, both at the park entrance and at the point of discharge into the Banco River. MINESUDD intends to build a dam in order to protect the park from seasonal floods.

Another case in point is the main wastewater collector at Yopougon, which was to be built as part of a project of the Japan International Cooperation Agency (JICA). The collector takes in wastewater from the Yopougon industrial zone and household wastewater from approximately one million people. However, construction was abandoned after the

military coup of 1999, and the collector now ends downstream of the industrial zone. Wastewater from the collector and from the adjacent areas is discharged into the open, and over time that process has carved a deep valley. In the rainy season, the valley fills completely with water and erodes the edges of the valley still further. Houses that have been built on the banks of the valley collapse and are swept away by the flood. Sometimes people fall into the sewer and drown, their corpses found in the lagoon. Water pipes laid underground by SODECI, which used to carry drinking water, now hang suspended in the air, the ground under them having been eroded by rivers of sewage.

Two major projects are now underway to improve wastewater collection. A project financed by the African Development Fund targets the Gourou Basin and the associated communes of Adjamé, Abobo, Cocody, Plateau, and the Bay of Cocody.¹⁰² The other, financed by PUIUR, targets the Abidjan communes of Abobo, Adjamé, and Treichville.¹⁰³



Informal recycling in landfills is part of the waste management system

Industrial wastewater

Industrial companies are obliged by legislation to clean their wastewater before discharging it into the sewage network or into surface waters. However, only large companies, usually those that have certification (such as ISO 140019) and are supervised by the Classified Installation Inspection Service (SIIC),¹⁰⁴ observe this regulation. Indeed, only 35 installations report to SIIC on their environmental performance; the great majority of companies do not provide any information on their liquid and gaseous effluents or solid waste.¹⁰⁵ Even those companies that do treat their wastewater do so incompletely or have dysfunctional systems. As a consequence, the treated wastewater that is discharged into Ébrié Lagoon often has pollutant values considerably higher than the limits stipulated in the relevant environmental permit.¹⁰⁶

An environmental profile report in 2006¹⁰⁷ referred to an investigation by the Office of Scientific and Technical Research Overseas (ORSTOM) and its successor the Institute for Research into Development (IRD) in 1983, when the discharge of liquid industrial waste into the lagoon was estimated to be 4.4 million m³ per year. This amount

has probably increased in the last few years, but no reliable data are available. The most significant quantity of wastewater is produced by textile factories and tanneries, and by the process of cleaning tanks used in the chemical industry. SIIC, which is run by CIAPOL, estimates that the amount of waste oil generated by the transport sector is around 20,000 tons per year. Some of this oil is re-used as fuel, but an unknown amount is discharged into the sewer system or directly into the lagoon. Car repair workshops are often located close to the lagoon or an estuary, and discharge waste directly into the surface waters.

6.2 Solid waste management

The term *waste sector* is used here to refer to the prevention, reuse, recycling, treatment, and disposal of residential and hazardous waste. *Residential waste* means waste produced by households and to assimilated industrial, commercial, and hospital waste with characteristics similar to household waste. *Hazardous wastes* are usually industrial and chemical, or infectious and medical wastes. Hazardous household wastes are of minor importance in quantity and are treated as residential waste in the context of this assessment.

6 URBAN ENVIRONMENTAL ISSUES IN ABIDJAN

There are several important actors involved in the collection, treatment, and disposal of household waste, and their roles and responsibilities have changed over the years. Until 2003 waste management services were organized by municipalities; the 2003 decree on transfer of responsibilities to local governments¹⁰⁸ established communes and districts that shared responsibility for financing and organizing waste collection and disposal. Communes were made responsible for the pre-collection of waste, and districts for the transport and dumping of waste.

In 2007 the government established both the Ministry of Urban Sanitation, which is responsible for household waste collection, and the National Agency for Urban Sanitation (ANASUR), an executive agency under the ministry, which was tasked with organizing household waste collection and disposal. Two decrees legally determined the distribution of competence between the different responsible ministries and the establishment of the new executive agency ANASUR.¹⁰⁹ The responsibility for strategic planning and legislation in the waste sector remained with the Ministry of Environment, Water and Forests. So too did responsibility for the planning, monitoring, and enforcement of industrial hazardous waste management. The Ministry of Health was responsible for medical waste management. Despite the decrees, the new situation led to confusion because the distribution

of responsibilities was unclear and the different ministries disputed the attribution of mandates.

In June 2011, ANASUR was merged with the Ministry of Environment, which is now MINESUDD. This merger also brought together the relevant competences in the waste sector. However, medical waste management remained under the purview of the Ministry of Health and Public Hygiene.

Collection, treatment, and disposal of solid waste is also organized differently for the three main waste streams: household waste and assimilated waste, hazardous industrial waste, and hazardous medical waste.

In cities, household waste is collected at two levels: pre-collection, and collection and transfer. Pre-collection in many cities is organized by citizens or by small, local NGOs. Citizens organize the transfer of solid waste from their residence to local collection centers, from where that waste is transported to the final disposal site. The NGOs are often associations working with unemployed youths, allowing them to gain a very modest income through the manual door-to-door collection of waste. In Abidjan, it is common for the pre-collection of waste to be tendered to specialized companies. Pre-collection is paid for by households, and many families do not use the service as fees are considered too high. Fees vary between FCFA 50 and FCFA 500 per household per month.



Fires are common in the existing landfill

The collection and transfer of household waste is organized by ANASUR. The agency does not carry out collection and transport services itself but outsources this task by tender to private companies, which are paid by the ton via the household waste tax (TEOM) and ANASUR subsidies.¹¹⁰ The TEOM is FCFA 2.5 per kWh for households, and FCFA 1.5 per kWh for companies, a difference that is linked to electricity consumption. Prior to 2007, subsidies were paid to the private companies by the local government. However, the payment system does not run smoothly. The TEOM is cashed in by the Ivorian Electricity Company (CIE) and should be transmitted to the local governments or, later, ANASUR, after a deduction of 5 percent for administrative costs. In reality, a large part of the tax is kept by CIE for financing street illumination. Moreover, the consultants preparing the strategic waste management plan for Abidjan estimate that a TEOM of FCFA 10 per kWh would be sufficient to cover collection and final disposal costs.¹¹¹ Communal financing is done via a tax on real estate and on markets; however, this is largely insufficient to cover the costs of pre-collection if it is not directly financed by the citizens.

Financing of ANASUR is done via a specific fund for urban sanitation that was established in 2007.¹¹² In fact, ANASUR is largely underfinanced, which causes a problem for its contractors, who are also often paid only after long delays.¹¹³ Despite this problem, the waste collection market is quite dynamic. Currently there are contractors in Abidjan competing for the collection tenders, all of them with reasonably modern equipment. Visual observation of vehicle parks gave the impression that approximately half the vehicles are of the modern compacting type, the rest consisting of outdated tractors, trucks, or other less-adapted vehicles. The modern equipment gets overused as a result.¹¹⁴

Waste treatment goes no further than informal recycling. Waste pickers work in the streets and at the Akouédo dump in Abidjan. In the other cities, recycling activities are very limited due to a lack of market opportunities. All recoverable material is collected and recycled in small workshops; there is no large-scale recycling industry active in the country. Recyclers do not make any distinction between hazardous and nonhazardous waste; the main issue for them is the sales value of the material.

Collected waste is transferred to dumping sites. Most dumps are constructed with little or no engineering provision to mitigate environmental impact. Dumping sites in cities generally use waste compactors, but these tend to be light bulldozers rather than heavy equipment. The norms of waste management—construction of impermeable bottom layers, gas collection, draining and treatment of leachate—are not practiced. The Akouédo dump has a waste entrance register with a manual weighbridge. In the dump sites of other cities, the operators generally know the size and number of entering trucks and can estimate the amount of waste coming in daily or seasonally (in Yamoussoukro, the amount increases considerably when national events are organized in the city).

The total amount of waste collected in Abidjan is currently around 3,000 tons per day. Most areas of the city have waste collection services except those difficult to access. Moreover, in areas with many valleys and hollows, people routinely throw their waste into the valley even when waste containers are available. During the rainy season that waste is then swept away to Ébrié Lagoon.

ANASUR works with the military to supervise waste collection. In turn, the military observes the population and exacts penalties of FCFA 10,000 for illegal littering. However, the weak enforcement is insufficient to prevent littering and the disposal of waste into the open air or into the lagoon.

During the crisis period, or at least until 2009, waste was not well managed, and there was an accumulation of waste across the country. In 2008 the World Bank supported an emergency program targeting solid waste management, and approximately 500,000 tons of waste were removed as a result.¹¹⁵ The program continued until the presidential election in October 2010 but was interrupted by the post-election violence. In general, waste collection did not really work during the crisis. Street sweepers had to pull cadavers out of the sewer system, and the systems were completely disrupted. At one point waste was not properly collected for five months, and people threw their waste into ditches and hollows. In April 2011 funds were again available, and since that time the city has been cleared of the backlog of waste.¹¹⁶ ANASUR restarted its work in December 2011, and at the time of writing, waste collection was functioning in most parts of the city.



During the election crisis, solid waste collection systems collapsed leading to local dumping of garbage

Currently the main destination for waste collected in Abidjan is Akouédo dump. This site has been operational since 1965 and is currently managed by the company Pisa Impex, under the supervision of the Mission for the Conduct of Municipal Operations (MACOM). The operating company uses a manual weighbridge for the registration of waste, and compacts incoming waste regularly. This is an old-fashioned dump site with no impermeable lining at the bottom, no draining and treatment of leachate, and no gas collection and recovery. The leachate is mostly likely flowing into the Ébrié Lagoon and to the aquifer below it, but so far there have been no systematic studies to confirm it.

In 2008 a decision was made to close the Akouédo dump site, but it has not been implemented.¹¹⁷ Private investors have proposed two new landfill sites in Attiékoï and Kossihouen. However, at the time of writing neither had permission to build a dump site. The construction of the Kossihouen site has been suspended by the government, and a new environmental impact assessment (EIA) for

the Attiékoï site raises problems with leachate and the aquifer.¹¹⁸ The strategic plan for household waste management in Abidjan recommends the introduction of separate collection in some areas of the city (Cocody, Marcory, and Plateau) and the construction of a sorting plant. The private company Eoulé is engaged in the construction of a sorting and composting plant near the Akouédo landfill, a project that has been endorsed by the Global Environmental Facility.

The recycling of household waste remains in the hands of the informal sector. Separation and recycling of household waste is done at all levels by street scavengers and by informal waste pickers on the Akouédo dump. Between 200 and 1,000 waste pickers work on the dump,¹¹⁹ in very poor health and safety conditions; children, even babies, are allowed access to it. This is a long-term practice and was not affected by the crisis. Women play an important role in waste management in Abidjan (see Case Study 3). Waste pickers sell the material to artisans; there are no large industries recovering paper, plastic, or glass.

Case Study 3. Plastic Recycling in Côte d'Ivoire

In Abidjan, widespread use of plastic, coupled with low public awareness about waste segregation and recycling options, has given rise to a robust informal economy of plastic waste collection. This industry, which involves an intricate network of collectors, washers, and transporters, operates in concert to recover discarded plastic for financial remuneration. Entire families work in plastic waste collection, women comprising the majority of workers.¹²⁰ Families also organize into groups that collect and wash the plastic, which is later resold to recycling companies. Collectors earn FCFA 100 for every kilogram of plastic bags delivered. For many this is their sole form of income.¹²¹ Plastic collected around Abidjan used to be washed in public areas near the Ébrié Lagoon. Recent evictions from the lagoon, however, have driven women involved in these collection networks to operate in more marginal washing points in waterways off Banco Bay, near the Yopougon industrial site. At these locations, women can be found waste deep in polluted water cleaning discarded bags.

These scenes are replicated around the city, employing thousands of people. Estimates from Interpack, a local recycling and plastics company, indicate that the plastics industry supports about 10,000 jobs directly in more than 40 plastics manufacturing companies in Côte d'Ivoire, and some further 20,000 informal jobs. While plastic waste is a source of livelihood to some, in particular women, many people view the discarded plastic as both an environmental and health hazard that can cause problems for wastewater and contribute to flooding.

In May 2013 the government issued decree No. 2013-327, which bans the production, import, marketing, possession, and use of plastic bags. The decree is in its infancy and implementation arrangements are still being determined. Application of the ban will require careful scrutiny of its social, economic, and environmental implications. Critics of the decree argue that an outright ban on plastic will result in a shift to wood-based products, as well as eroding an income base for many. Moreover, prohibition of collection activities could cause current collection activities to migrate further into the periphery.

As the government seeks to formalize the recycling sector and begin implementation of the ban on plastic bags, viable alternatives to it should be identified. The implications of such regulations on public health and the livelihoods of those working in plastics collection must be taken into account. In addition, risks to the health of women and children who are heavily involved in the collection process need to be assessed and mitigated.

These provisos aside, the regulation of plastic waste—if done properly—presents an opportunity to transform this informal sector into a formal one, address waste collection, and promote employment opportunities for both men and women.

Hazardous waste treatment and disposal

Most of the industrial hazardous waste is produced by the petrochemical and pharmaceutical factories in Abidjan; some small quantities of hazardous waste are also produced by laboratories. The industries in other cities—food processing, textiles, and so on—generally do not produce hazardous waste. The exception to this is the mining industry, which is active in the center and north of the country and produces significant quantities of hazardous waste, most notably from the use of mercury in gold mines.

In 2007, consequent to the disposal of shipborne hazardous waste in Abidjan, referred to as the Probo Koala incident, the government of Côte d'Ivoire asked UNEP to design a hazardous-waste management plan for Abidjan. This plan proposed various measures to promote cleaner production and strengthen the capacities of CIAPOL. It also recommended investments in infrastructure for the treatment and disposal of hazardous waste. The plan for Abidjan has now been adopted by the government and integrated into the 2010-2015 National Development Plan. It has still not been financed, and the government lacks the means to implement the measures set

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out in the plan. However, the crisis had two main effects on hazardous waste treatment and disposal in Abidjan:

- Destruction of the CIAPOL building and laboratory, which weakened CIAPOL's control capacity; compliance with norms could not be enforced at the necessary level
- Suspension of investment in treatment infrastructure.

Independent of the measures proposed in the waste management plan, private companies started several initiatives for treatment and disposal of hazardous waste. The most significant of the companies, Envipur, cleans the tanks of the large petrochemical companies and treats waste electrical and electronic equipment (WEEE) at a rate of 5-6 tons per day, waste oil (10 tons per week), and transformers contaminated by polychlorinated biphenyls (PCB). Envipur works partly in Abidjan in its own premises and partly in cooperation with two French companies. The company is flourishing, but several rounds of investment have been delayed due to the crisis, mainly because banks are unwilling to give credit and does not support investments of this type. In addition, the capacity of hazardous waste treatment installations is sometimes insufficient for

the demand, a situation that is also a consequence of financial difficulty.¹²² For example, the phytosanitary company RMG operates an incinerator for waste pesticides and similar chemical products. Before the post-electoral crisis, the company planned to replace it with a larger, up-to-date incinerator, but this project has not yet been implemented.

There is considerable involvement of the informal sector in hazardous waste treatment. The most striking example is the Biafra area bordering Ébrié Lagoon. Named after refugees from the Biafra war, people make a living here recycling oil barrels. The contents are emptied into the lagoon or onto the shore, and the remaining traces are burned.

Treatment of waste electrical and electronic equipment by the informal sector is also a problem in Côte d'Ivoire, albeit not at the same level as in Ghana or Nigeria. There are several sites where informal recyclers are grouped: in Marcory on the shore of the lagoon, and in Abobo, Koumassi, and Adjamé. MINESUDD intends to regulate imports of second-hand electrical and electronic equipment and their recovery, collection, and transport, the objective being to create specialized enterprises in this field. The government estimates the annual production of WEEE at about 10,000 tons.



The private sector is active in waste oil management

Neither recycling of oil barrels nor WEEE recycling can be properly ascribed to impacts of the crisis; rather, these are generic problems that have been experienced by many countries. The only effect that can be linked to the crisis is the weakening of the government's control and enforcement capacity.

Port waste

Neither of the international ports at Abidjan or San Pedro accept hazardous waste from ships because they have no facilities for treatment. Until 2008 the company ITE had been treating waste covered by the International Convention for the Prevention of Pollution from Ships, (MARPOL I) in the port of Abidjan, but in the aftermath of the Probo Koala catastrophe, the company's neighbors requested its relocation. Since then, a

restart of activities at another site has been under discussion; the company has acquired a site in the port area, prepared the design of the facility, and submitted it for an EIA, but construction is still pending. The port of Abidjan also had its own project for the construction of a reception facility, but during the crisis, all programs were blocked. The fact that there are no facilities for the treatment of hazardous waste is definitely a problem for the port of Abidjan. With better reception facilities, more ships would dock there. Instead, ships prefer to use the port of Tema in Accra, Ghana, or even Dakar, Senegal, both of which have such facilities.¹²³

The port of San Pedro does not have reception facilities for processing liquid waste. There have been talks with a private enterprise to manage liquid waste, but those discussions are in the initial stages.



Port waste management still has challenges



Some waste streams have no proper outlet

Both Abidjan and San Pedro accept nonhazardous solid waste from ships. The waste is collected by private companies and transported to the local dumping site. In fact, the collection companies also accept hazardous wastes, current controls being insufficient to prevent this practice. From time to time, hazardous waste cargoes are discovered by chance, but there is no systematic supervision.

San Pedro has a project to install a reception facility for hazardous solid waste from industries working in the port area, where electronic waste, waste oil or batteries can be unloaded for transportation to appropriate treatment facilities.

In 2009 the Basel Convention and the MARPOL Convention carried out an assessment of the Autonomous Port of Abidjan and made a series of recommendations for the re-establishment of adequate reception facilities for MARPOL I and IV wastes.¹²⁴ These included training on how to identify and distinguish hazardous waste from

commercial goods; the development of legislative provisions; training on legal framework and information exchange between stakeholders (such as customs, CIAPOL); and best practices on port waste management.¹²⁵ Due to the crisis, none of these recommendations have yet been implemented. However, the port authority decided to apply for an International Organization for Standardization (ISO) 14001 certificate, and the preparatory phase of that application is now in process. If it is to be successful, the bid requires significant improvement to the environmental management system.¹²⁶

Accumulation of hazardous chemicals and obsolete products

During the crisis, control over imports slackened. Some borders were less controlled than others, but the border with Ghana was certainly not sufficiently protected. The north of the country was not under government control, so banned pesticides were brought in. Organochloride products and Paraquat,

used as herbicides but banned in Côte d'Ivoire, were both smuggled in from Ghana. The Ministry of Agriculture (MINAGRI), which is responsible for the licencing and control of pesticides, has carried out joint operations with customs officers and seized several large quantities of illegal pesticides. These pesticides are now stockpiled in Abidjan, with an unknown quantity handed over to the Ministry of Commerce in 2012. More illegal pesticides seized during control operations have been stored in rural areas. MINAGRI had intended to incinerate the captured stocks in the RMG incinerator, but the cost of doing so was prohibitive.

Pesticide smuggling has decreased since the government's return. MINAGRI provides information and awareness building for customs officers, to enable them to identify contraband and be knowledgeable about which products are approved for movement to Côte d'Ivoire and which are not, and about how those products should be labelled.

Medical waste treatment and disposal

Hospitals are obliged to separate infectious waste from nonhazardous waste, and are responsible for the final disposal of infectious waste. In general, most hospitals have small-scale incinerators, while some have more advanced models and others bury infectious waste.

The International Clinic of St. Anne-Marie wanted to construct an incinerator with the capacity to deal with all the medical waste of Abidjan. The post-electoral crisis effectively froze the funding for the project, so the clinic will now build an incinerator solely for its own use. CIAPOL tried to obtain funding from the government to complete what was a private sector project, but the government declined.¹²⁷

In 2009 the Ministry of Health and Public Hygiene (MSHP) drew up a plan that envisaged a transition to a centralized system of hospital waste management. However, the plan was suspended for six months during the post-election crisis. MSHP had had no control over health-care waste management in the northern cities between 2002 and 2011. When the crisis ended, the government began updating the plan and it is now being implemented in 2013-2015, the main focus being

the purchase of medical waste incinerators. The MSHP initially wanted to purchase one incinerator per district, but settled for a total of ten. Most are destined for districts in the interior of the country, but one has been installed in Port Bouet, Abidjan.¹²⁸ No information on the capacity of these incinerators could be obtained.

Envipur is currently constructing an incinerator with the capacity to deal with one ton of hospital waste per day in Abidjan. The company wanted initially to construct a larger system but found that the university hospitals preferred to continue using their own small-scale incinerators.

In summary, it can be said that the post-election crisis has slowed investment in processes of modernization and centralization of infectious medical waste treatment, but MSHP continues to implement its policy nonetheless. The commitment of private hospitals and companies to progress in this field is also promising. It is worth noting, however, that when the hazardous waste management plan was suspended, so too were complementary training and awareness-building programs.

6.3 Recommendations

In order to avoid duplication, the following recommendations have been prepared taking into consideration measures already taken:

Improve waste collection. Currently, some parts of the city are not connected to the formal waste collection system. This not only results in difficulties with solid waste in those areas but also clogs the rainwater drains, creating water logging and landslides. All parts of the city, regardless of their legal status, should be covered by waste management systems.

Prevent land reclamation by waste dumping. Recovering land from the Ébrié Lagoon by depositing solid waste into it is an ongoing practice. This creates multiple environmental issues. Farming, playing, or building houses on land reclaimed by waste deposition expose communities to health hazards; at the same time, the lagoon gets polluted by waste leachate. Waste dumping in the lagoon, including for land reclamation should be prevented.

Establish hazardous waste management infrastructure. Currently facilities are inadequate to deal with hazardous wastes, including e-wastes. However, market-linked waste management facilities show that there is a demand for such services, which could even generate profit. So it is important that government create the right regulatory framework for the establishment of private hazardous waste infrastructure.

Expand the sewage collection network. The sewage network has not kept up with the rapid expansion of the city and growth in population. The capacity of the system needs to be increased, including with booster pumps in most areas, and new areas need to be connected.

Restart the sewage treatment facilities. Currently, sewage from the city, even when collected, is not

treated properly before being discharged. This is causing a high degree of pollution in the Ébrié Lagoon. The existing treatment facilities, including their design capacities, need to be reevaluated and upgraded.

Seek financing for waste management. Urban waste management is a service that will require significant resources from the city, and unless the city finds a way to recover it from the population, such services will deteriorate, causing a loss of quality of life. Communities are often willing to pay for such services so long as efficient systems exist. It is important that a way of finding capital to establish the system is found with adequate policies to recover investment. The private sector can be incentivized to play a role in building urban environmental infrastructure so long as companies can be assured of a return on their investment by collecting user charges.

Ébrié Lagoon

*Pollution of Ébrié Lagoon
needs to be arrested for
ecosystem recovery to begin*



Ébrié Lagoon

Ébrié Lagoon is the biggest lagoon system in West Africa and an important cultural and economic feature of Côte d'Ivoire. Evidence collated from the remote sensing assessment indicates that not only has the city of Abidjan expanded around the lagoon, it has expanded into it. The lagoon is the main recipient of urban wastes, both solid and liquid, from the city. There are reports indicating that the lagoon was very polluted even in the 1980s, though the degree of pollution cannot be understood in retrospect by remote sensing, unlike in the case of urban expansion or deforestation. Some anecdotal evidence, however, indicates that sporting activities such as water skiing were present in Abidjan up to the 1990s.

As discussed in the previous section, Ébrié Lagoon has been the recipient of solid, liquid, and industrial waste from Abidjan. With the rapid expansion of the city and closure of the sewage treatment facilities, the waste load into the lagoon exceeded its own self-cleansing capacity, leading to the current situation. In addition to urban wastes, the lagoon also receives discharge from rivers from inland carrying agricultural chemicals, including pesticides.

The PCEA team looked at water quality, sediments, and the fish being caught from the lagoon.

7.1 Water quality

Remote sensing observations indicated that most anthropogenic activities in the lagoon were concentrated around the city of Abidjan, so the water quality assessment focussed on this area. However, samples were also collected from places some distance from Abidjan, where the water quality is more sheltered from anthropogenic activities. The sampling details are presented in Map 7, and the significant results are given in Table 16. The entire set of analyses conducted for this exercise is available on the website that accompanies this report.

The assessment yielded several highlights from the analytical results:

- Biological oxygen demand (BOD) is an indicator of the presence of organic pollution in the bay, which in an urban context can be seen as an indicator of pollution by sewage. The BOD in the water samples taken ranged from 2.59 mg/l to 31.7 mg/l (milligrams per liter). Environmental quality standards for healthy water bodies will typically stipulate a BOD value between 3 mg/l and 9 mg/l. Increased BOD in the water body increases the risk of depletion of dissolved oxygen content in the water, which is a direct threat to biological life.



Water sampling in Ébrié Lagoon

- Higher levels of oxygen are needed to support healthy biological life in an aquatic system. As oxygen levels decline, the composition of the ecosystem changes and only certain kinds of fish and biota can survive. Eventually, if the water is devoid of all oxygen due to high organic loading, anoxic conditions can prevail and fish will die. The resulting anoxic decomposition of organic matter produces hydrogen sulphide and other foul-smelling products. An internationally graded scale is used to assess the dissolved oxygen values. The dissolved oxygen levels obtained from the lagoon shows oxygen stress (values below 6 mg/l) in many locations which corresponds well with the high biological oxygen demand values.
- The biological pollution of the lagoon shows viable microorganism values ranging from 9,800 to 160,000. It is well known that sewage is discharged directly into the lagoon, so these values are not surprising.

Table 16. Analysis of water quality in Ébrié Lagoon

Sample	Location	COD ^a	BOD ^b	Salinity	Viable microorganisms at 36 degrees (U/ml)	Coliform bacteria (U/100ml)	Oxygen (mg/l)
101-SW-130626	Cocody Bay	97.9	27.4	6.7	5,3.10 ⁵	3,4.10 ³	1.32
111-SW-130626	Banco Bay	59.5	16.7	9.5	2.10 ⁵	9,5.10 ²	8.36
112-SW-130626	Banco Bay	74.9	19.5	9.5	7,2.10 ⁴	2,2.10 ²	16.7
113-SW-130626	Banco Bay	88.3	25.6	10	6,6.10 ⁴	1,6.10 ²	15.51
114-SW-130626	Banco Bay	127	31.7	10	2,1.10 ⁵	6,5.10 ²	5.52
115-SW-130626	Banco Bay	67.2	18.8	12	5,2.10 ⁴	2,6.10 ²	3.3
116-SW-130626	Banco Bay	96	25	11	2,5.10 ⁴	7,2.10 ²	3.65
118-SW-130626	Banco Bay	80.6	21.8	12	4,7.10 ⁴	9,2.10 ²	5.24
102-SW-130626	Cocody Bay	69.1	18	9.6	1,1.10 ⁵	5,9.10 ²	4.72
201-SW-130627	Marcory Bay	73	19	8	3,1.10 ⁵	1,2.10 ³	4.25
202-SW-130627	Marcory Bay	53.8	13.4	6.9	1.10 ⁵	7.10 ²	4.13
211-SW-130627	North of Marcory	61.4	17.2	10	4,9.10 ⁴	5,5.10 ²	4.46
212-SW-130627	North of Marcory	51.8	13.5	9.7	1,4.10 ⁵	9,8.10 ²	4.9
213-SW-130627	North of Marcory	42.2	11.4	4.5	6,5.10 ⁵	2,7.10 ³	4.45
221-SW-130627	Bay M'Badou	64.3	16.7	1.9	2,4.10 ⁵	1,1.10 ³	5.76
214-SW-130627	North of Marcory	53.8	15.1	3.1	2,5.10 ⁴	8,7.10 ²	5.31
231-SW-130627	Bay Koumassi	39.7	11.5	2.2	6,2.10 ⁴	5,8.10 ²	4.51
215-SW-130627	North of Marcory	46.1	12.9	3.5	1,1.10 ⁵	6,9.10 ²	5.4
301-SW-130628	North of Vridi Channel	64.2	18	13	3,2.10 ⁴	7,5.10 ²	5.73
311-SW-130628	Bietri Bay	52.9	13.8	11	1,2.10 ⁴	2,5.10 ²	9.17
312-SW-130628	Bietri Bay	78.4	19.6	12	2,4.10 ⁵	4,9.10 ²	7.99
313-SW-130628	Bietri Bay	89.9	25.2	11	3,3.10 ⁵	1,8.10 ³	8.9
314-SW-130628	Bietri Bay	66.9	18.1	7.8	3,6.10 ⁴	5,6.10 ²	3.39
321-SW-130628	Yopougon Bay	76.5	18.1	11	1,1.10 ⁵	5,2.10 ²	5.24
401-SW-130629	Azito						5.01
411-SW-130629	Vridi Channel	106	29.7	14	1.10 ⁵	7,5.10 ³	5.96
412-SW-130629	Vridi Channel	96	25	13	1,4.10 ⁴	9,6.10 ³	5.32
413-SW-130629	Vridi Channel	110	30.8	16	1.10 ⁴	6,6.10 ³	5.85
421-SW-130629	Billionaires' Bay	106	25.4	15	9,8.10 ³	6,1.10 ³	7.59
501-SW-130629	Attécoubé Boribana	86.4	22.5	9.5	3,5.10 ⁴	9,9.10 ³	
502-SW-130629	Centre de tri Attécoubé	67.2	18.8	3.6	1,4.10 ⁶	9,8.10 ³	
503-SW-130629	Marcory Canal	62.4	16.2	8	6,8.10 ⁴	9,2.10 ³	
504-SW-130629	Marcory Quartier Biafra	19.2	5.38	12	8,7.10 ³	9,5.10 ³	
601-SW-130701	Outdoor Laundrette, Banco	9.6	2.59	0	1,2.10 ⁴	8,5.10 ³	5.96
621-SW-130701	Outdoor Laundrette, Banco	72	18.7	0	9,6.10 ⁴	9,7.10 ³	3.07
611-SW-130701	Far east of the lagoon	33.6	9.07	0.3			4.05
631-SW-130701	Western reference	43.2	12.1	3.8			8.05
632-SW-130701	Same as 631	33.6	9.41	3.8			
603-SW-130701	Blank sample	4.8	1.34	0.1			

Notes: ^a COD = chemical oxygen demand. ^b BOD = biological oxygen demand.

In the absence of national standards for water quality in lagoons, the observed values cannot immediately be used as a basis for policy advice. However, according to the World Health Organization (WHO) *Guidelines for safe recreational water environments*, water quality in the lagoon is unfit for all recreational activities that involve contact with water.

Standards are also set for the dissolved oxygen levels in the lagoon which, among other things, indicate the type of fish able to survive in these waters. Values of dissolved oxygen above 7 are considered good for supporting normal aquatic life, while those below 2 are those in which only limited fish and aerobic aquatic life is possible. The theoretical dissolved oxygen level in brackish water at 30° C is 9.8 mg/l, and the values of oxygen reported above this value are an indication of algal growth, yet another indication of water pollution.

7.2 Sediment samples

Analysis of water quality provides a snapshot of the pollution at the time of sampling. Such analysis is therefore very unreliable in coastal waters that are influenced by tide and hence in perpetual flux. Tidal influx causes a significant disturbance of the body of water, so samples taken at different times of the day could yield very different concentrations of pollutant. Sediments, on the other hand indicate the accumulated pollution within a water body over a period of time. Thus sediment measurements taken from Ébrié Lagoon are probably more accurate and more representative of the condition of the lagoon in general than the water samples.

Sediment samples were collected from a number of locations, targeting the most polluted parts of the lagoon, while reference samples were taken from a location far beyond the Abidjan metropolitan area. The sampling points are shown in Map 7.

Sampling sediment in many areas of the lagoon was difficult to conduct due to the accumulation of trash. Plastic bags and bottles were especially prevalent in the shallow bays of Cocody and Marcory, limiting access to sediment. The sampler had to be moved around the location to collect enough sediment to conduct the analysis.

From the results obtained, two sets of chemical parameters are of interest: heavy metals and hydro-

carbons (Table 17). Heavy metals are usually carried in industrial waste or domestic sewage (traces), but in this case other possible sources are the discarded, rusting hulks of ships that litter the lagoon. Heavy metals in sediments not only impact biological life in the sediment, but they can also accumulate in the biota and ultimately reach humans. As there are no national standards on heavy metals in sediments, no further action can be initiated based on law. However, it is helpful to compare these results with the reference value for heavy metal pollution in sediments in Nigeria (Table 18), which has comparable geology, geography, and ecosystems. Cadmium, mercury, and lead all show values exceeding the Nigerian reference values, indicating both localized pollution and potential for bioaccumulation.

Hydrocarbons are also a concern. The traces of hydrocarbons in the lagoon are likely to have come from workshops in the catchment area and from leaks in small boats used in and around the lagoon. During the field visit it was also observed that one of the drum-cleaning companies was disposing of effluent directly into the lagoon. Samples were selected from around the lagoon, including from the point adjacent to the drum-cleaning operation.

The hydrocarbon pollution of the lagoon's sediment, measured as total hydrocarbons, ranged from 184 mg/kg to 11,600 mg/kg. To understand the implication of those figures, we can rely on a number of investigations into petroleum hydrocarbons in coastal sediments that have been conducted around the world. These studies show that sediment concentrations of total petroleum hydrocarbons are usually below 50 mg/kg in coastal areas that are not directly subjected to chronic petroleum hydrocarbon contamination or where the conditions are favorable to the degradation of low levels of contamination (i.e., where the temperature is high and the water and sediment is well oxygenated). Environmental effects of oil contamination start to occur among more sensitive organisms in the 50-100 mg/kg range, which is why many countries set their clean-up targets at 50 mg/kg.

In the absence of a national standard in Côte d'Ivoire, UNEP compared the sediment pollution with the standard set taken from the similar climatic and ecological regime in Nigeria. The Nigerian standard for hydrocarbon pollution stipulates two concentrations: target value (5000 mg/kg) and intervention value (50 mg/kg).

Table 17. Analysis of sediments from Ébrié Lagoon

		TS_105°C	Arsenic (As)	Cadmium (Cd)	Mercury (Hg)	Lead (Pb)	Vanadium (V)	Hydrocarbons >C10-<C40
Sample	Location	%	mg/kg TS	mg/kg TS	mg/kg TS	mg/kg TS	mg/kg TS	mg/kg TS
111-SED-130626	Banco Bay	63.9	2.62	0.0852	0.343	20.5	28.6	280
112-SED-130626	Banco Bay	73.9	2.17	0.0946	0.124	24.6	13.7	93
113-SED-130626	Banco Bay	82.4	1.65	0.0316	<0.04	5.32	11.8	56
115-SED-130626	Banco Bay	75.5	0.618	0.0123	<0.04	4.82	4.22	<20
117-SED-130626	Banco Bay	77.7	3.39	0.0213	0.0407	22	8.54	<20
201-SED-130627	Marcory Bay	18.7	5.52	1.84	7.34	137	74.3	15200
202-SED-130627	Marcory Bay	75.7	1.78	0.0748	0.291	27.8	9.96	1340
211-SED-130627	North of Marcory	60.5	9.8	0.142	0.361	48.5	132	126
213-SED-130627	North of Marcory	56	4.74	0.0858	0.38	23.7	60.8	559
221-SED-130627	M'Badou Bay	77.3	0.296	<0.01	0.0517	2.05	2.4	<20
231-SED-130627	Koumassi Bay	76.1	0.472	<0.01	<0.04	1.26	3.99	<20
215-SED-130627	North of Marcory	74.6	0.681	0.0132	0.041	3.74	5.82	<20
312-SED-130628	Bietri Bay	75.8	0.822	0.0122	<0.04	3.33	6.79	120
313-SED-130628	Bietri Bay	76.4	0.634	0.032	<0.04	4.39	4.15	33
314-SED-130628	Bietri Bay	79.8	1.01	0.0851	0.176	16.7	6.6	63
315-SED-130628	Bietri Bay	77.4	5.15	0.0952	0.0604	551	10.6	124
501-SED-130629	Attécoubé Boribana	77.7	1.29	0.0237	0.0448	8.82	8.82	70
504-SED-130629	Marcory, Quartier Biafra	67.4	2.52	0.302	0.0843	437	132	4040
601-SED-130701	Outdoor Laundrette, Banco	79.2	1.22	0.0957	<0.04	11.6	9.34	48
602-SED-130701 (soap)	Outdoor Laundrette, Banco							2190
621-SED-130701	Outdoor Laundrette, Banco	78	1.93	0.324	<0.04	20.8	9.29	91
611-SED-130701	Far east of the lagoon	82.3	0.556	<0.01	<0.04	1.54	4.73	<20

Table 18. Heavy metal values for sediment samples from Ébrié Lagoon compared with Nigerian reference values

Heavy metal	Range of pollution	Nigerian target values (mg/kg)
Arsenic (As)	0.296-9.8	29
Cadmium (Cd)	0.0123-1.84	0.8
Mercury (Hg)	<0.04-7.34	0.3
Lead (Pb)	1.26-551	85

If the measured concentration of a sample exceeds the *intervention value*, the Nigerian standard mandates action to rectify the situation. *Target value*, on the other hand means the concentration of total hydrocarbons is below the threshold for environmental impacts and as such is the aim for any corrective action. When the concentration in a location is below intervention value and above target value, the sediments can be left to the natural process of attenuation, but continued monitoring of the sediment is recommended until the pollution levels have dropped below the target value.

For Ébrié Lagoon, just one sample had concentration levels around the intervention value. However, all the other samples had values above the target value. The location with high hydrocarbon pollution is the one nearest the drum-cleaning unit, so the cause is local and evident.

The actions to be taken when sediment chemical contamination exceeds a stipulated standard are manifold and complex. First, more samples need to be analyzed in order to delineate the extent of the contamination. Second, a risk assessment

needs to be done to ascertain whether the heavy metals present are likely to constitute actual harm to public health, and to assess whether there are additional, interim measures—such as banning the consumption of fish from that area—that could be taken to protect the public. Third, a projected comparison would need to be made between the environmental consequences of cleaning up the contamination and disturbing the sediments, which could worsen the situation, versus simply allowing nature to take its course and ultimately solve the problem. In cases of acute pollution, countries increasingly choose to dredge the sediment and

treat it *ex situ* in a controlled environment, rather than to leave the job to nature.

In the case of Ébrié, however, the decision is somewhat more straightforward. Layers of plastic waste have accumulated in many of the acutely polluted areas of the lagoon, especially those where tidal currents are slow. Plastic is not biodegradable; if the lagoon is to recover, the plastic trash will need to be trawled and removed. If such a project were initiated, it would be relatively easy to remove severely contaminated sediments along with the plastic waste.



Until the plastic debris is removed, the Ébrié Lagoon cannot recover

7.3 Fish samples

Due to the acute pollution of the lagoon, it is not used for recreation such as swimming. Therefore the main risk to public health comes from eating fish from the lagoon. In order to assess that threat, fish were collected for analysis. Samples were analyzed for a range of pollutants. The results are presented in Table 19.

Mercury

In terms of mercury concentrations, two findings are of concern. The first is the concentration of mercury in fish. The accumulation of mercury in the food chain is a well-documented phenomenon, which led to the establishment of the Minamata Convention on Mercury. As a neurotoxin, mercury affects the nervous system. This means that people—especially children—who consume fish contaminated by mercury risk an accumulation of the element in their systems that might lead to a disruption or breakdown in the function of their nervous systems. In the absence of a local standard for mercury in fish, the following simplified recommendations made by

the Natural Resources Defense Council (NRDC) can be referred to as an indicator (Table 20).



Fish is an important part of the Ivorian diet and economy

Table 19. Analyses of pesticides and heavy metals in fish and oysters in Ébrié Lagoon

Sample	Species	Mercury (Hg) mg/kg	Dieldrin (mg/kg)	p,p'-DDT mg/kg	o,p'-DDD mg/kg	p,p'-DDD mg/kg	o,p'-DDE mg/kg	p,p'-DDE mg/kg
111-AT-130626	Mullet (Mugil sp.)	0.0805	<0.001	<0.0001	0.00048	0.0015	<0.0001	0.0015
112-AT-130626	Catfish (Aries sp.)	0.0487	0.0081	0.0011	0.00013	0.0043	<0.0001	0.0065
113-AT-130626	Shad (Alosa sp.)	0.0614	<0.001	0.00024	<0.0001	0.00079	<0.0001	0.0015
211-AT-130627	Snapper (Lutjanus sp.)	0.932	<0.001	0.00031	<0.0001	0.0012	<0.0001	0.0024
212-AT-130627	Catfish (Aries sp.)	0.717	0.0011	0.00022	<0.0001	0.00096	<0.0001	0.0032
601-AT-130701	Barracuda (Sphyraenidae)	0.418	<0.001	<0.0001	<0.0001	0.0002	<0.0001	0.0004
613-AT-130701	Seabreams (Sparidae)	0.105	<0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
213-AT-130627	Oyster	0.0825	0.002	0.0028	0.0016	0.0092	0.00049	0.01
214-AT-130627	Oyster	0.0986	0.0025	0.003	0.0018	0.0099	0.0005	0.011

Table 20. Natural Resources Defense Council recommendations on levels of mercury in food

Concentration	Less than 0.09 mg/kg	From 0.09 mg/kg to 0.29 mg/kg	From 0.3 mg/kg to 0.49 mg/kg	More than 0.5 mg/kg
Mercury levels	Minimal mercury	Moderate mercury	High mercury	Very high mercury
Recommendation	No restrictions	Six servings or less per month	Three servings or less per month	Avoid eating
Number of samples in Côte d'Ivoire	5	2	1	2

(one serving is 6 oz = 170 grams)

In the case of Côte d'Ivoire, in the absence of legislation or national standards on the issue, no recommendation that could be enforced by law can be made. More detailed and systematic sampling, along with socioeconomic and legal considerations, is needed before this can be translated into a food advisory notice. However, the results suggest the urgent need for such a study.

Dichloro-diphenyl-trichloroethane (DDT)

The second subject of interest is pesticides. The results of testing in the lagoon show the presence of dichloro-diphenyl-trichloroethane (DDT) and its degradation products. DDT is known to be very persistent in the environment; it will accumulate in fatty tissues and can travel long distances in the upper atmosphere. Since the use of DDT was discontinued in large parts of the world almost 40 years ago, its concentration in the environment and animals has decreased, but because of its persistence, residues of concern still remain.

The analysis of fish and oysters from the lagoon shows the presence of detectable levels of DDT and its metabolites Dichloro-diphenyl-dichloroethane (DDD) and Dichloro-diphenyl-dichloroethylene (DDE). The concentrations are not alarmingly high and may be a reflection of regulated use of DDT for the control of insects indoors. However, the sources of DDT in the lagoon should be established, and a wider study is recommended in order to assess levels of DDT in important food items, predatory fish, and human blood.

Dieldrin

Dieldrin is an insecticide and a by-product of the pesticide aldrin. It is a persistent, bioaccumulative, and toxic (PBT) pollutant, and is usually seen in the form of a white or tan powder. From the 1950s, dieldrin was widely used to control insects on cotton, corn, and citrus crops; to control locusts, mosquitoes, and termites; and as a wood preservative. This pesticide, listed as a persistent organic pollutant (POP) was banned in the 1980s in North America and Europe due to its harmful effects on fish and wildlife. Known human effects are a decrease in the effectiveness of the immune system, cancerogenicity, and impacts on

reproduction and kidneys. Humans are exposed to Dieldrin by eating contaminated fish and shellfish. Infants are exposed from breast milk.

Dieldrin levels in the samples taken from the lagoon were generally low—below or slightly above the detection limit. One sample of catfish contained quantifiable concentrations, though the value was still fairly low. However, it should be noted that the tested fish were young, and would not have been exposed to the water for a long period of time. Concentrations in the range of 1-100 parts per billion were often found in fish in North America during the 1980s when Dieldrin was still in use. The fact that levels above the detection limit were found in the lagoon may indicate that the substance is still in use in the country.

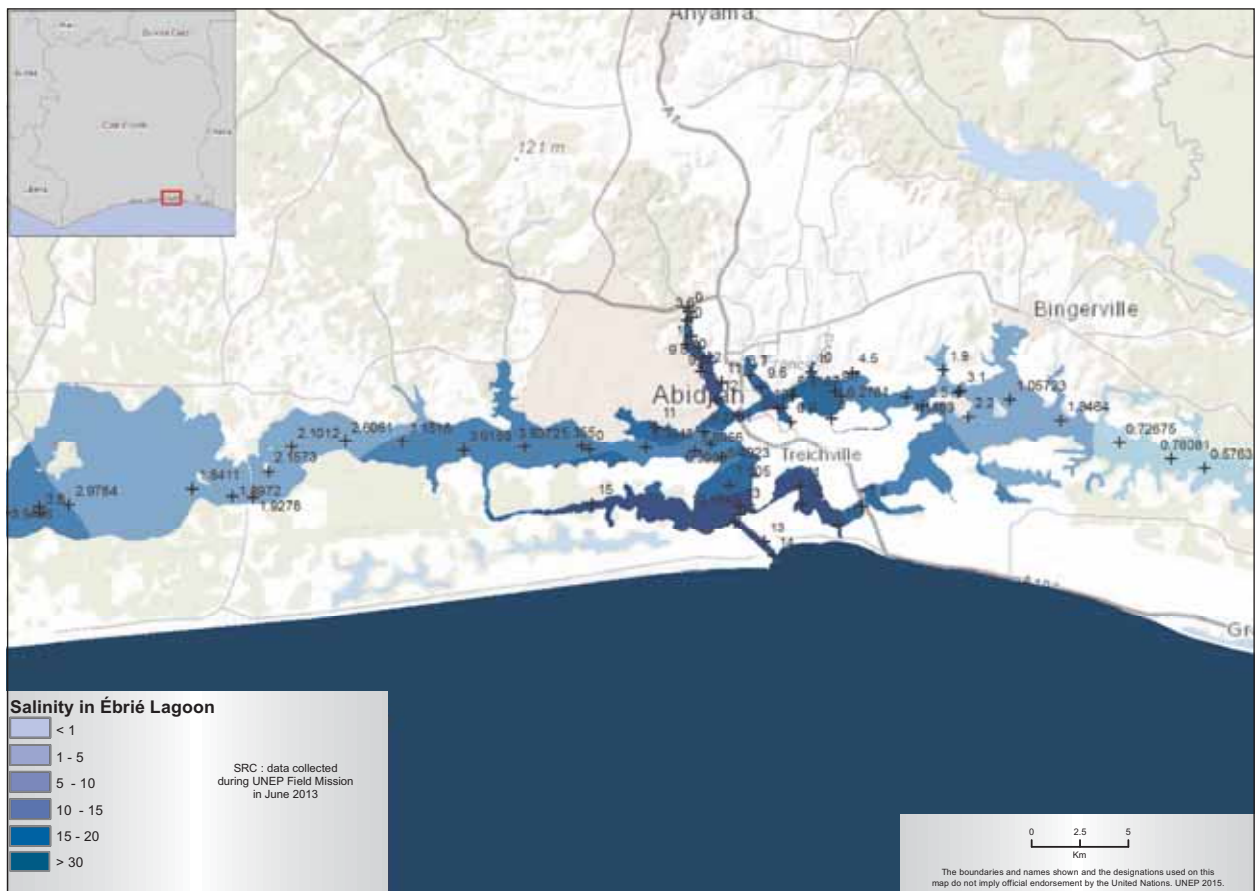
7.4 Salinity profile of Ébrié Lagoon

Evidence gathered to date reveals extensive pollution within the Ébrié Lagoon; however, there are three factors that should be taken into account:

- The lagoon receives an influx of freshwater from the Comoé River; the influx is significantly larger during the rainy seasons. Throughout the year, however, there is a natural process of dilution taking place in the lagoon.
- Because the lagoon is open to the Gulf of Guinea by way of the Vridi Canal, it receives clean seawater that acts as a natural flush.
- With an average depth of just 5 m, the lagoon is very shallow, so the effects of dilution and flushing exerted on this volume of water ensure that there is no stagnant pool of water in the lagoon for an extended period.

A salinity profile shows the relative influences of the river and the sea over a body of water. The salinity profiling for the lagoon was done only once, and the samples were taken at different times of the day. Tidal influence being diurnal, the exact salinity values will vary depending on time of day. However, the values obtained can still provide a general indication of the salinity regime in the lagoon. The salinity profile of the lagoon is presented as a contour in Figure 5 .

Figure 5. Salinity values in Ébrié Lagoon



Salinity and ecology of the Ébrié lagoon is largely dependent on the Vridi Canal

The following observations can be made from the data:

- In the eastern end of the lagoon, where it meets the Comoé river, the water is entirely fresh. This observation is corroborated by the aquatic biota in that part of the lagoon where water lily, a freshwater plant, is widely present. (See the case study 4 on the closing of the Comoé estuary.)
- Closer to the Vridi Canal, on either side of the Bay, the influence of the saltwater influx is obvious.
- To the west of the canal, salinity gradually drops to 3.61 mS/cm as the influence of the saltwater influx from the Vridi Canal opening reduces but does not have a freshwater regime. One possible explanation is that the extreme west end of the lagoon is influenced only by the tidal influx through the Vridi Canal, whereas the eastern parts are influenced by both the river and

the sea. The water exchange in the western end is therefore less frequent. Additional studies will be needed to verify this hypothesis.

Other relevant observations made during the profiling process:

- Beyond kilometer 15 to the east of Vridi Canal, the signs of urbanization are minimal, and the water loses not only its foul smell but also the floating garbage and other visible signs of pollution.
- A healthy section of mangroves is growing along the shore of the lagoon.
- Artisanal and recreational fishermen are active in the lagoon.
- While there is less pressure from urbanization towards the western end of the lagoon, there appeared to be some small settlements along this section.

Case study 4. Closing of the Comoé Estuary

Ébrié Lagoon is separated from the Atlantic Ocean by a thin strip of land. Prior to 1952, when the Vridi Canal was opened, the only link between the lagoon and the ocean was the estuary of the Comoé River. Current satellite images show clearly that the estuary is now blocked (Figure 6). The Comoé River flows into the lagoon but the only link between the lagoon and the sea is the Vridi Canal. The salinity profile offers further support to this reading of events. Where the Comoé River flows into the lagoon the water is entirely fresh, and the river's influence over the salinity regime stretches to 35 km.

Estuaries are one of the most productive ecosystems. A functional estuary provides both productive and regulatory services. By mixing freshwater and seawater, estuaries support biodiversity, including fish. The closure of this estuary has redirected the silt, which would have ended up in the sea, into the lagoon. Indeed, following the closure of the estuary, fishermen who regularly worked the lagoon noticed that the quantity and variety of fish decreased dramatically. In addition, fishing boats could no longer access the sheltered water of the lagoon via the estuary.

In response, the government initiated a project to reopen the channel in 1998. However, this was undertaken simply as an engineering project that treated the symptoms (by dredging) but not the causes, and so was doomed to failure. The sandbar is still there and is now over 300 m wide. No scientific data are available, but anecdotal evidence gathered during the field visit and from conversations with government officials and fishermen suggests that fish stocks have declined in the area of the lagoon that is close to the sandbar and what was once the estuary. That conclusion is supported by the observation that while there were hundreds of fish traps on the western part of the lagoon, there were none in the eastern part, where a freshwater regime dominates.

The closure of the estuary was not a consequence of the civil war. However, the government's ability to adequately respond to the issue was in part hampered by the toll taken by the conflict.

UNEP recommends that an assessment of the factors resulting in the closure of the Comoé Estuary be undertaken. The study should examine the ecological and economic consequences of this geological change. An informed decision can then be made as to whether to reopen the estuary. The feasibility of any plan to do so would depend largely on the probable environmental impact of the change. Interventions to force modifications to coastlines often lead to unintended consequences, and those would need to be estimated and assessed thoroughly before going ahead with reopening the estuary.

Figure 6. Closed Comoé estuary





Outside Abidjan, the Ébrié Lagoon also sustains good ecosystems such as healthy mangroves

7.5 Recommendations

An inspection of Ébrié Lagoon and its catchment, and some chemical analysis of sediment and fish, offers a good base on which to build an understanding of the current environmental status of the lagoon. Despite the gloomy picture presented here, the assessment offers hope for the future of the lagoon, both by addressing the key environmental challenges and by creating new lagoon-based economic activities. It must be clear, however, that the environmental problems manifested in the lagoon are a consequence of the socioeconomic situation in the surrounding areas. Efforts to address pollution must therefore consider the broader environment near the lagoon. For example, a comprehensive plan for the lagoon should encompass the entire lagoon catchment. A number of measures are suggested:

Initiate quarterly monitoring to assess environmental quality of the lagoon. The current analysis provides a snapshot of the lagoon's environmental status. The study needs to be extended in scope and periodically repeated so that a more comprehensive

picture of the environmental issues can be assembled and changes tracked over time.

Establish recreational water-quality criteria. Scientific information and advice about the recreational use of the lagoon should be provided to the community.

Stop the disposal of raw or partially treated sewage and the dumping of wastes. The disposal of raw or partially treated sewage, industrial and domestic waste, both liquid and solid, and the reclamation of land using waste materials are polluting the lagoon. This situation should be addressed at two levels:

- Take immediate action, backed by effective enforcement, to stop activities such as land reclamation by solid waste dumping and disposal of industrial waste.
- In the long run, construct adequate treatment facilities so that wastewater from the city is either reused or disposed of in the sea, in a regime backed up by environmental studies.

Recover floating and submerged solid waste that has accumulated in the lagoon. The removal of highly contaminated sediments should also be included in such a project.

Establish a framework for evaluating contaminants in the lagoon's fish, and issue statutory warnings where necessary. The presence of heavy metals and pesticide residues in fish is a matter of concern that should be monitored and further assessed. Public should also be informed about the results.

Consider opportunities to make full use of the lagoon to maximize livelihood opportunities and

economic return while preserving the quality of the water. The lagoon has tremendous potential for tourism and sports, which can bring in revenue and employment opportunities once the pollution has been brought down. Future plans for the lagoon should take into account that a large part of the lagoon does not have the types of anthropogenic pressure that are currently exerted closer to Abidjan and hence can be opened up for tourism operations.

Initiate an awareness campaign to reduce the amount of pollutants disposed of in the lagoon. The future of the lagoon will largely depend on the public's awareness of its status, value, and potential.

Mining

*Large-scale mining
in Côte d'Ivoire
is relatively rare*



Mining

Côte d'Ivoire has huge potential for mining. More than 30 percent of West Africa's Birimian Greenstone Belt—a massive mineral and gold-rich geological formation stretching from Ghana to Senegal—lies within its borders. Yet its neighbor to the east, Ghana, which is home to just 19 percent of the belt, is consistently one of the world's leading gold producers and outperforms Côte d'Ivoire by a factor of 14. Burkina Faso, Guinea, and Mali all produce more gold than their Ivorian neighbor.

There are two types of mining: industrial and artisanal. In industrial mining, a company establishes a mine with a large footprint, often tens of hectares, and mining is carried out with mechanical earth-moving equipment. Such a mine may have the capacity to fully concentrate the ore and process it further to a pure metal, or it may stop at processing the ore and then export the concentrates to another country for processing. Industrial mines are always established based on concession agreements that are given to the mine operator by the government. Those mines could be owned by the government, by the private sector, or jointly between the two. An industrial mine may employ anywhere from a few hundred to a few thousand people directly and many more indirectly.

Industrial mining operations are often capital- and technology-intensive, and may take many years to become established and even more to become profitable. The experts needed in an industrial mine—geologists, instrumentation engineers, metallurgists, and so on—are sought after all over the world and are not normally found in local labor pools. The sheer financial and technological difficulty of the business means that it is unusual for industrial mines to operate in areas that are afflicted by conflict. Put simply, the mine cannot operate without capital and a credit line, and it is not an attractive bet for a backer or a bank if it is in a conflict zone. Neither can a mine operate without expertise, and it is not a desirable destination for an expert with other options. Furthermore, mines in conflict areas are often targeted by both governments and rebels as a source of revenue. Major operators, therefore, prefer to operate in areas where there is political stability and security.

In artisanal mining, individuals or small groups use crude processes to extract or otherwise access valuable resources such as metals or diamonds. These operations are labor-intensive but require minimum capital investment. The work is almost always done by local people, often with entire families being involved in the process of digging, crushing, sieving, and chemical treatment. Conflict



Industrial mining has better controls and systems for environmental management

situations can facilitate the proliferation of artisanal mining because, in the absence of government regulators, people are free to mine. Indeed the economic hardship that is so often a consequence of conflict often forces people who once had another occupation into artisanal mining as a coping mechanism. As with industrial mining, both rebel groups and the government often extract protection money from artisanal miners in conflict areas.

The UNEP assessment covered both industrial and artisanal mines, although more focus was on artisanal mines, which proliferated during the crisis and operate with no government surveillance or environmental control.

8.1 Ity gold mine

The Ity mine is situated in western Côte d'Ivoire, 700 km northwest of Abidjan, on the Liberian border. The geomorphology of the Ity area is typical of rainforest areas. The landscape is often referred to as “half-orange type” due to its succession of rounded hills with convex slopes separated by a well-developed drainage system. Elevation ranges from about 225 m to over 400 m, and vegetation consists of secondary forest found on hilltops and scrubland with cultivated farmland on the slopes. The Cavally River is located about 1 km from the mine operations.

Copper and gold were discovered in places near the village of Ity in the 1950s, but systematic geological estimations were only made in 1970. The concession was granted in 1987, and mining operations started in 1991. Since then, 600,000 ounces of gold have been extracted. There are three open pits at the mine: Flotouo, Zia, and Mt. Ity. Ownership of the mine is split between Compagnie Minière Or (COMINOR, with a 45.9 percent stake), SODEMI (44.1 percent) and the government of Côte d'Ivoire (10 percent). At the time of the survey, it employs some 400 staff and 200 contractors, and is operated by La Mancha, a Canadian company that is 21 percent Ivorian-owned.

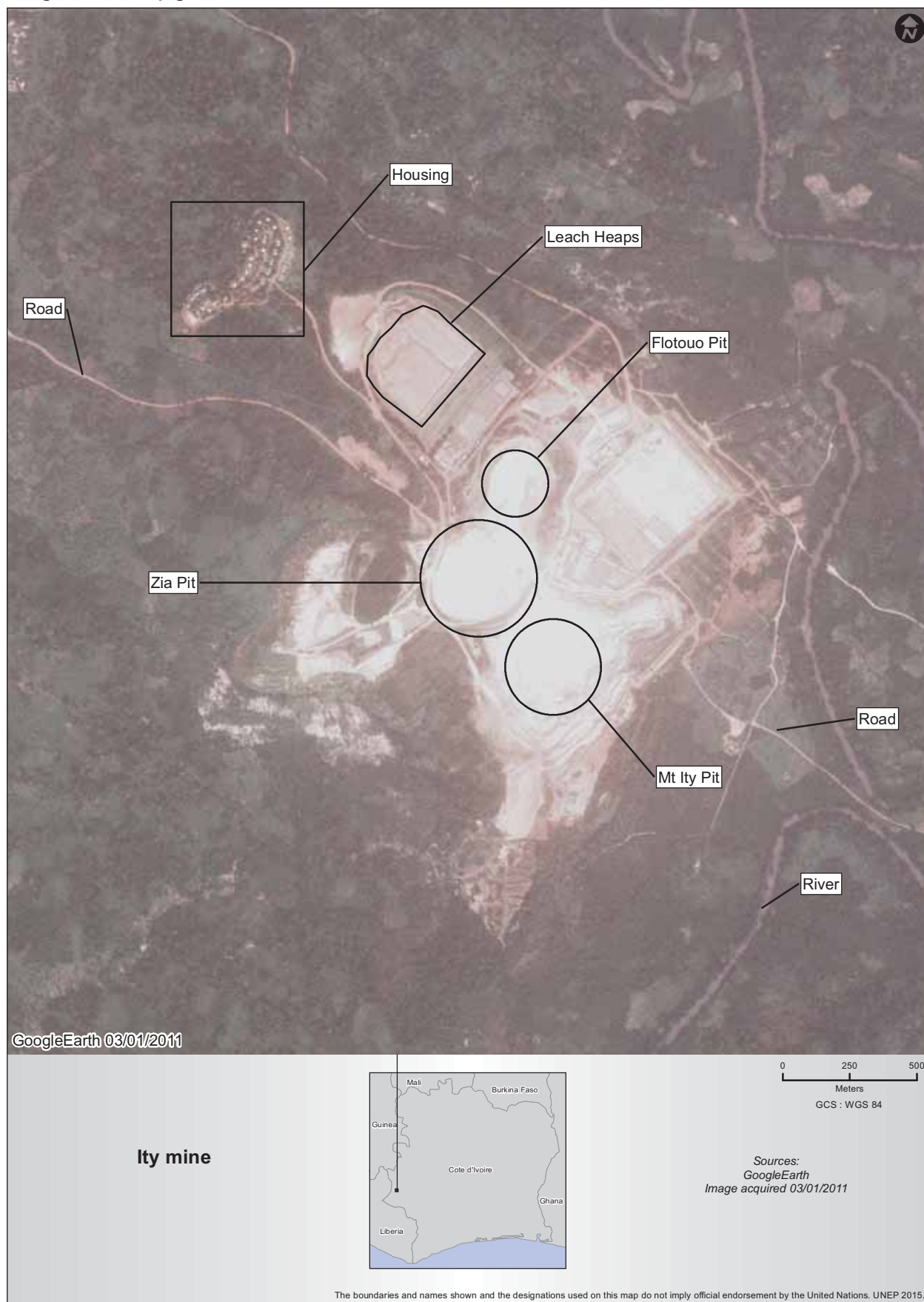
The mine's footprint of 25 km² is distinct and can be seen from satellite images (Figure 7). The mine uses the typical open-cast approach, where the top vegetation and soil (referred to as overburden in mining terminology) is first removed to reach the soil strata bearing the precious materials.

The ore—the soil that constitutes commercially recoverable quantities of the precious metal—is then removed by excavation, or blasting if needed. Once the ore is extracted, it is moved to a separate area for processing. Valuable metals in ore are typically less than 2 percent and hence 98 percent of the excavated materials are then disposed of as tailings. The Ity mine was established prior to the requirement for an environmental impact assessment, so no basic document is available illustrating the environmental baseline or impacts. However, from international experience, there are several environmental impacts associated with open-cast industrial mines:

- creation of access to the mine, especially when the mine is in remote or sensitive areas;
- deforestation and land clearance to create the mine and associated facilities;
- disposal of overburden and waste tailings;
- chemical pollution of air, land and water from the processing of the mine and tailings;
- noise and dust pollution from explosion, transport, and crushing of ores;
- issues associated with offices and staff quarters (waste management, sewage, water supply); and
- social impacts associated with establishment of camps

As the Ity mine is more than two decades old and the physical environmental footprint is already well established, the UNEP assessment focused on the ongoing environmental challenges at the site, the most important of which are those associated with ore processing. Ore is processed by heap leaching. In this process, cyanide solution is sprinkled on the top of the pile; gold in the ore reacts with the cyanide and is carried in liquid form and trapped by an impermeable membrane. The cyanide solution containing the gold is then collected in a pond. The gold is recovered from the cyanide leachate using adsorption onto activated carbon, leaving most of the cyanide back in the solution. This solution is again pumped onto the top of the leaching pile and the process continues for 45-90 days until the commercially recoverable gold has been leached out. The ore heap is then topped up with fresh ore, and the process continues. The gold desorbed from the activated carbon is then recovered by an electrolytic process to produce pure gold bars.

Figure 7. Ity gold mine



Sodium cyanide is an extremely toxic solution, and managing the life cycle of cyanide at the mine is of utmost importance from an environmental and safety point of view. According to the mine's environmental management plan, standard practices are in place to deal with the cyanide. Both the ore and the cyanide solutions are stored on land protected by an impermeable polyvinyl chloride lining, with systems in place to detect leakages. Wastewater from the ore processing is put through a cyanide destruction pond using sodium hypochlorite, and is tested prior to its release back into the environment. Groundwater is monitored regularly. One of the challenges during heavy rainfall seasons is to ensure that the cyanide pits and wastewater treatment plant do not overflow. To facilitate this, the process is regulated and 24-hour, seven-day-a-week monitoring takes place at the site during the rainy periods.

The UNEP team visited the mine and main facilities at the site. The key facilities, including the offices and staff quarters, are marked on the satellite image (Figure 7). The primary environmental issue visible at the mine is the size of its physical footprint, which is steadily expanding. The mine is located within the boundaries of a classified forest, and the function and use of the land has changed completely due to the mining operations. The mine pit (from where ore is extracted), the processing facilities, access roads, office facilities, and staff quarters have all altered the land use and landscape. In addition, the dumping of overburden and tailings has occupied additional land thereby altering the original land use.

Based on the site inspection, the overall house-keeping appeared to be in good order, with all operations on an industrial scale being carried out in a professional manner. The heap leaching has a capacity of 440,000 tons per year. Testing of wastewater is reportedly undertaken twice a week within the site's own laboratory, which tests for numerous parameters including acidity/alkalinity, cyanide, and arsenic. Duplicate samples are tested within a certified laboratory belonging to a third party, in this case ENVAL in Abidjan. The data generated by analysis are then routinely shared with a number of government regulators, including CIAPOL and SODEMI. However, UNEP could not obtain copies of these reports from any of the sources.

One of the biggest challenges presented by industrial mines is decommissioning. At some point in the future, when economically recoverable resources have been extracted, the mine will need to be decommissioned. The issue of a large open pit, processing facilities, and stockpiles of overburden and tailings needs to be addressed. Leaving them alone will not only permanently alter the original landscape and land use, but also leave potential hazards such as a major wash out of the tailings dam and landslides within the ore pit. The mine will have to prepare a comprehensive decommissioning plan to ensure that all contaminated sites are assessed and cleaned up, and distortions to the landscape are assessed and addressed. However, it is often the case that by the time a mine reaches its commercial end point, the funds necessary to deal with the mine's legacy are nonexistent, leaving the local community, as well as the natural environment, to deal with the consequences. International best practice in mining calls for the creation of a fund during the operational period of the mine in order to address the closure issue. According to some sources, an annual amount of EUR 200,000 is being set aside for decommissioning of the Ity mine, though UNEP could not find out where these funds are held, and on what basis the amount is estimated.

Industrial mines leave a clear physical footprint and often large open holes, as is the case at the Ity site. It is true to say that there are quantities of tailings and overburden large enough to fill the hole. To the casual observer it might seem sensible to fill the hole with the two types of spoil and level it. However, it would take a massive amount of work to fill the hole and regrade the site. The cost of such an undertaking would be prohibitive, and companies do not normally factor such an operation into proposals, business plans, or budgets. It is therefore unrealistic as an expectation and unlikely as an outcome that the Ity mine operators will solve this problem alone, leaving the state with the enormous challenge of having to deal with a vast area of forest or agricultural land the opportunity cost of which has been lost or postponed. It is also important to consider that the tailings can themselves become a hazard; artificial hills can collapse, destroying life and property. The Ity mine is still operating, but it is important to look ahead to the time when the mine will close and the site will be decommissioned, taking into account the requirements of the Environmental Audit Decree.¹²⁹

8.2 Artisanal mining

Two main processes can be used in the artisanal mining of gold, and the choice of which one to use will depend on the nature of the geological formations within which the gold is found. When gold is found as pure strands or nuggets within sediment deposits, it can be recovered by washing large quantities of the sediment soil and panning for the gold. Where gold is attached to other rock material, it can only be extracted by using chemicals, usually mercury. Both processes exert pressure on the environment: they clear land, make it unsuitable for agriculture, and increase sediment load in the runoff water, which may in turn affect the health of bodies of water downstream. The use of mercury magnifies the health and environmental impacts significantly, exposing people to elemental mercury during the amalgamation stage and vaporized mercury during the final stage of the process. Some of the mercury will pollute waterbodies and will be taken up by biota, bioaccumulated in the food chain, and eventually reach human beings and cause health problems. Some mercury-related health effects are shown in accompanying box, "Mercury-induced health effects."

The UNEP team visited a number of artisanal mining sites across the country where both of the above processes are practiced (Table 21). Two of the site visits are described in detail, while information on other mines are presented in tabulated form.

In an effort to implement a permit system for artisanal diamond miners, the Ministry of Industry and Mines (MIM) has documented 797 diamond workers, 174 team leaders, and 65 small companies active as of 31 July 2013.¹³⁰ SODEMI, the Ivorian parastatal mining company, is in the process of issuing permits and registering diamond miners, as witnessed by the UNEP team in Séguéla.

Floleu artisanal mine

The Floleu artisanal mine is located near the village of Zouan-Hounien in the western part of Côte d'Ivoire. It comprises an operational footprint of some 3 ha, the majority of which is waterlogged due to the stiff nature of the surface clay. There are some 50 deep, vertical shafts that penetrate to a

Mercury-induced health effects

- Elemental or metallic mercury primarily causes health effects when it is breathed in as a vapor and absorbed through the lungs. Symptoms include tremors, emotional changes (e.g., mood swings, irritability, nervousness, excessive shyness), insomnia, neuromuscular changes (such as weakness, muscle atrophy, twitching), headaches, disturbances in sensations, changes in nerve responses, and performance deficits on tests of cognitive function. At higher exposures there may be adverse kidney effects, respiratory failure, and death.
- When mercury is taken up through the food chain it affects fetuses, infants, and children. The primary health effect is impaired neurological development.
- The most documented case of uptake of mercury through the food chain is from Japan, where mercury from a chlor-alkali plant reached the local community through food from the Minamata Bay.
- The international community has decided to control the use of mercury and its release to the environment through a multilateral environmental agreement, which is now referred to as the Minamata Convention. Côte d'Ivoire is a signatory.



Gold produced is sold locally



The mine in Bouna had more improvised shafts

depth of 10 m or more through the clay. Each shaft has a team of three or four men, one digging in the shaft and the others hauling buckets of material to the surface or channelling away the accumulated surface water.

When UNEP visited the site, some 200 people were working there, mostly men, many of whom said they were from neighboring countries, including Liberia, Ghana, Mali, and Burkina Faso. The women at the site were engaged in washing, sieving, child care, and cooking. The site was very well organized, with a frequent motorcycle taxi service from the nearest village and a range of outlets for hot food. The site seemed to be run by the community; there was no evidence of an armed militia of any kind.

For several reasons, the site did not present major environmental issues. It is relatively small, mature trees have been left in place, the gold is extracted by sieving and panning sediment, and no toxic materials such as mercury or arsenic are used. Hence there is no danger of the mine contaminating water or soil with hazardous waste. Nevertheless, the cumulative environmental impact of large numbers of such mines might be significant.

The real concern at this site is safety. The shafts are very deep and have no form of structural support, and because of the impervious quality of the surface there is a good deal of flooding. The risk of the shafts collapsing is high. It was recently reported in the international press that one such collapse at this site resulted in the death of up to seven miners.¹³¹ However, the real death toll from the incident may have been considerably higher as some of the bodies will probably never be found.

Artisanal mine near Bouna

Located some 30 km southeast of Bouna in the northeast of the country, this site lies just a few kilometers from the border with Ghana. This was by far the largest artisanal mining site that the team visited, with an operational footprint of up to 10 ha and a temporary residential camp that is estimated to house as many as 2,000 people. Here, gold is extracted from solid igneous rock which is mined by hand from large shafts and then manually crushed and sieved. This technique differs from that used at the other artisanal mines visited, where gold deposits are extracted from loose, unconsolidated, alluvial material.



Mercury is still used for extracting gold

The team saw a number of large mine shafts within the confines of the camp. The shafts were hand-dug and were typically 10 m deep by 3 m wide. The shafts were shored up with timber, and structures had been erected over the opening of each shaft in order to minimize the infiltration of rainfall and to mitigate the risk of the mine flooding. All of this seems to indicate that some of the people involved have a reasonable understanding of the fundamental engineering principles of mining. However, these measures are very rudimentary and it seems that shafts have indeed collapsed or suffered rock falls in the past. These incidents have caused injuries, the team was told, but as yet no deaths.

At the time of the UNEP visit, the camp, and all site operations associated with it, were clearly under the control of an armed militia that claimed to be working with the knowledge and permission of the local prefect. Operations at the camp were observed to be extremely well organized, albeit in a somewhat military fashion. In simple terms, a person buys a ticket to mine from the militia; that ticket number is then tagged to all material excavated by the holder, who contracts other people to crush, sieve, and process the material. After being paid by a middle man for the gold, the ticket holder then pays a fee to

his contracted employees in line with an agreed local tariff. The task of excavating, removing and carrying the indigenous rock fell to men, while both men and women were involved in the extremely arduous job of manually crushing the rocks.

The team was told by an armed guard at the site that that no chemicals at all, including mercury, were used at the site, but it was clear that liquid mercury was indeed being used in the final stages of the process. Gold-bearing sediments were mixed with liquid mercury and then water before being poured down a ramp with a sedimentation medium, such as plastic matting, in which the mixture of gold and mercury was captured. The water was then reused. This is the probable pathway to environmental contamination as mercury leaches from the unlined holding basin into the adjacent watercourse. This product is then an amalgam of mercury and gold. The mercury has to be burned off with a blowtorch before the gold can be weighed and sold. The people involved in the latter stages of the process appeared to have some degree of awareness of health risks: the person wielding the torch was wearing a face mask, but one that would be wholly inadequate for preventing the inhalation of mercury fumes.

Table 21. Artisanal mines visited by UNEP PCEA team

	Location of the mine			
	Zouan-Hounien	Zagouta	Yamaussoukro	Bouna
Mineral being mined	Gold	Gold	Gold	Gold
Area	3 ha	2 ha	1 ha	10 ha
Number of people working	200	20	20	2,000
Surface or subsurface	Subsurface, 10 m	Subsurface up to 10 m	Surface, digging up to 3 m	Subsurface, up to 10 m
Is there a labor camp?	Not on site, but many immigrants		No	Yes
Are women employed?	Yes	Yes	Yes – only women employed	Yes
Are children employed?	Yes	Yes	No	Yes
Is mercury used?	No	No	No	Yes
Key environmental issues	<ul style="list-style-type: none"> · land clearing · waterlogging · increased sediment load in runoff 	<ul style="list-style-type: none"> · land clearing · waterlogging · increased sediment load in runoff 	<ul style="list-style-type: none"> · land clearing · increased sediment load in runoff 	<ul style="list-style-type: none"> · land clearing · increased sediment load in runoff · camp-related issues: wastewater, solid wastes
Are armed militia present?	No	No	No	Yes

A significant number of people, including women and children, live at the camp, which has no sanitation or waste management systems. The team was told that people simply “relieve themselves in the bushes.” Solid waste accumulated in numerous large piles, which appeared to be periodically burned. These inadequate practices harm both public health and the environment in a number of ways. Perhaps most importantly, the waste piles offer breeding grounds for numerous disease vectors such as rats, flies, and mosquitoes; and when the piles are burned, they produce toxic fumes.

A temporary medical clinic is operating at the camp, but at the time of the visit it was short of all basic supplies. A number of people who spoke to the team said that they have no formal contact with the government authorities and no services of any sort are provided by them. The sheer size of the site—the scale of the operations, the number of trees being cut down for firewood, the number of people and the conditions in which they live and work—are worrying. Those issues, coupled with the widespread use of liquid mercury and possibly other toxic chemicals that were not seen by the team, mean that this artisanal mining site has the potential to cause major environmental and health impacts.

8.3 Conclusions

As observed from the site visits, the impacts of artisanal mining at the individual sites are not massive, and the primary concern is for the health of those engaged in the mining activities. Because these operations are undertaken without any formal training for the miners and no official oversight, environmental impacts in the form of deforestation, water pollution, and chemical contamination occur. The cumulative impact from dozens and possibly hundreds of artisanal mines operating in the country, including in national parks and classified forests, needs to be considered.

In addition to the environmental concerns, artisanal mining also has a number of well-documented health and social impacts. While the UNEP team did not focus on these impacts, there is no reason to believe that the following issues are not a real and present concern in Côte d’Ivoire:

- exposure to very dangerous working environments, especially for those working in the mine shafts;

- exposure to high levels of dust and heat, as well as to toxic materials such as mercury and cyanide;
- unregulated working hours and no norm of best practice, such as for work breaks;
- employment of children whose parents are involved in artisanal mining, preventing them from attending school;
- prostitution in general and the exploitation of women and children in particular;
- absence of basic services (e.g., access to toilets, running water, waste management) within the large labor camps; and
- lack of basic medical facilities and services.

8.4 Recommendations

Leverage expertise to improve the environmental management of the mining sector across the country. The large-scale mine visited during the assessment appeared to be self-regulated, yet had good environmental practices. The people working there seemed to have both the technology and the technical knowledge to run their operations with reasonable control. Some of this expertise can be made available to those who are managing artisanal refining and even government agencies. By establishing cooperation between the industrial mines and artisanal mines, government can improve the environmental management in the mining industry.

Develop capacity to visit and inspect mines, both big and small, more regularly and to offer advice to the mine operators. Government institutions currently do not have adequate training and resources to regularly inspect the mining operations. Strengthening the capacity of the Ministry of Environment, by providing training on inspection protocols and portable equipment, will be necessary to improve the surveillance of the mines.

Implement measures to decriminalize artisanal mining activities as an interim measure. Artisanal mining underpins the livelihoods of tens of thousands, possibly hundreds of thousands, of people across Côte d’Ivoire and should be recognized. Proper licensing and regulation,

rather than a ban on artisanal mining altogether, is the only sustainable solution. It is not realistic to expect bans on gold mining to be respected when poverty is endemic and individuals are in search of a livelihood to support themselves and their families.

Encourage industrial mines to offer technical assistance to nearby artisanal mines in order to promote sustainable practices.¹³² This measure would not only improve mining operations and techniques, but also would help to manage and mitigate the socioeconomic risks common to artisanal mining.

Introduce technologies that can reduce environmental and health risk in the artisanal mining sector. These could include:

- Use retorts when burning off mercury. A retort is a container in which the gold and mercury amalgam are placed and heated. The volatile mercury then travels up a tube and condenses in an adjacent cooler chamber, capturing up to 95 percent of the mercury, significantly reducing the amount of mercury discharged into the environment.

- Introduce flotation, a process that can significantly concentrate fine gold while simultaneously reducing the volume of material that will need to be amalgamated with mercury or treated with cyanide.
- Enhance waste management by using simple settling ponds or tanks to assist with the segregation of potentially toxic tailings and to promote the reuse of water.

Establish processing centers to service a number of artisanal mines with shared equipment and technology. Such centers can also provide training and support for planning, operations, health and safety, and environmental issues. A number of examples of this type of approach exist: for example, the Shamva Mining Centre in Zimbabwe¹³³ and others in Ghana, Burkina Faso, and Mali.

Implement a program to improve the condition of sanitation and health-care facilities within the larger artisanal communities. Health improvements directed at reducing exposure to mercury should be paired with investments in material goods such as a medical center. Such investments are more visible and will help garner goodwill and support from surrounding communities.

Oil Spill Threat to Côte d'Ivoire

*Oil spill risk along Côte d'Ivoire's
coastline has increased*



Oil spill threat to Côte D'Ivoire

Oil production in general, and offshore drilling in particular, are growing exponentially in West Africa. The coast of West Africa that faces the Gulf of Guinea stretches over 5,500 km from the Bissagos Archipelago in Guinea-Bissau to the mouth of the Congo River. Some of the countries along this coast, particularly Nigeria and Gabon, are established oil producers, while others—Angola, Ghana, Guinea Bissau, and Côte d'Ivoire—have only recently started producing oil. Indeed, many oil analysts believe Africa to be one of the new frontiers of oil exploration, and major discoveries are expected. A significant number of those finds, and therefore of growth in the sector, will take place offshore. Some countries, Nigeria, Angola, and Côte d'Ivoire among them, are already producing oil from offshore sites in the Gulf of Guinea, and others are beginning to explore and prospect in the area. By some estimates, West Africa already has up to 547 major offshore oil and gas structures. Some of the hydrocarbon that is extracted and refined here will go to the growing regional market. West and Central African countries already provide 12-15 percent of U.S. oil demand and Angola is now China's top supplier.

However, the significant increase in the volume of oil and gas that is discovered, extracted, refined and exported will also increase the risk of an oil spill or offshore blow-out in the Gulf of Guinea. Like the other West African countries that share this coastline, Côte d'Ivoire is very vulnerable. However, the country is further at risk because its coastline lies adjacent to the route along which ships commonly carry stolen, or bunkered, oil to their destinations. Such ships are more likely to cause a spillage than one regulated by law. Additional risk is also anticipated as the Ivorian economy recovers and the Port of Abidjan becomes busier with guest tankers or more stored oil.

9.1 Key exposures

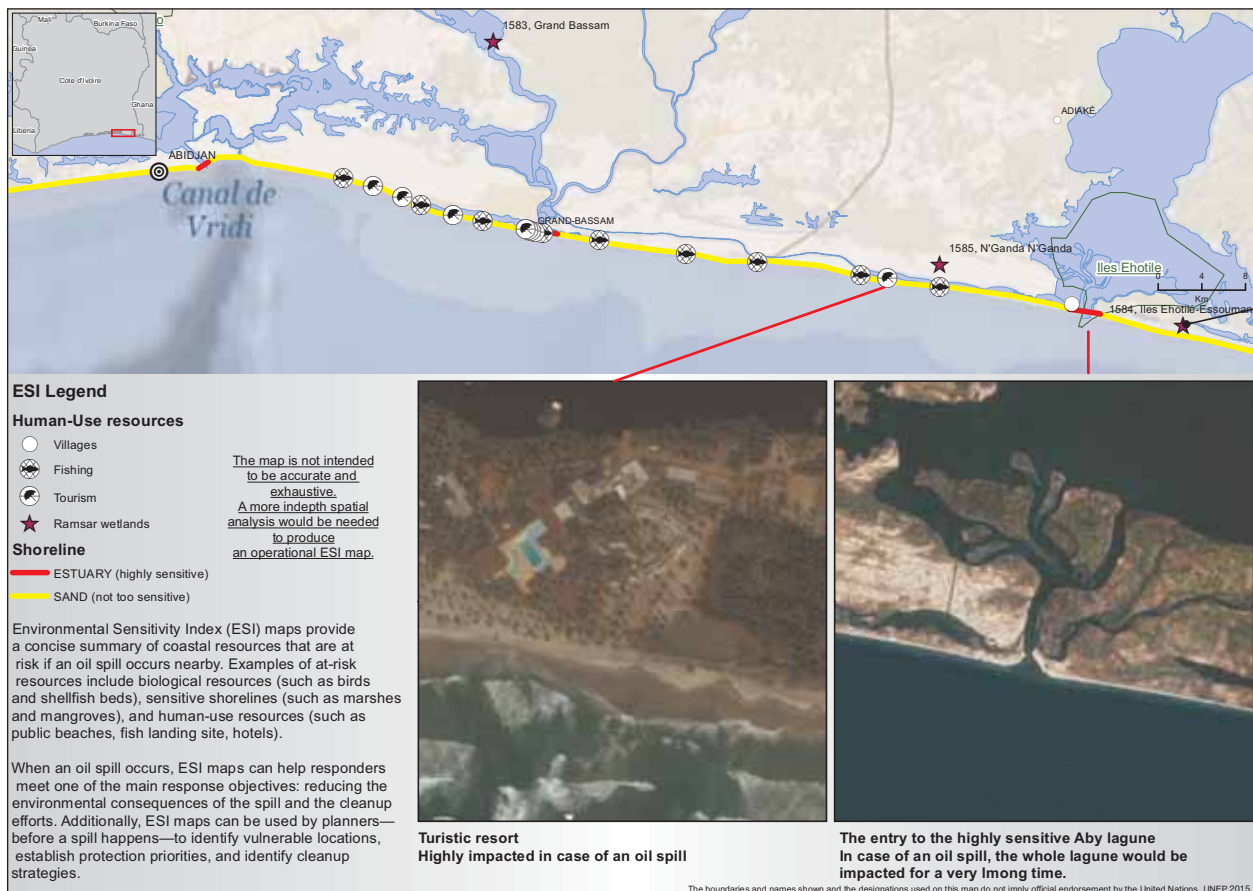
The coastline of Côte d'Ivoire is 560 km, and is home to more than half of the country's population and a significant proportion of its economy. An oil spill on the coastline could have a crippling effect on the national economy by impacting the following sectors:

- tourism, along the coast and coastal lagoons;
- port activities in Abidjan;
- fishing in the coastal waters and lagoons; and
- communities that live on the beaches and the shores of the lagoons



Oil spill risk in Côte d'Ivoire has grown during the crisis

Map 8. Oil spill sensitivity map for the area from Grand Lahou to Grand Bassam



Significant ecological damage would also occur if oil finds its way into the lagoons, which still retain mangrove forest and wetland habitats.

Most countries with coastlines that are vulnerable to oil spills prepare a coastal environmental sensitivity map. Such maps are created based on the Environmental Sensitivity Index (ESI) methodology developed by the International Maritime Organisation (IMO) that ranks the various features along the coastline on a subjective sensitivity scale. Environmental sensitivity is not the same as ecological sensitivity. Rather, environmental sensitivity is a concept that integrates the ecological and economic characteristics of a given resource. The sensitivity of coastal areas can then be ranked based on their ecological features (e.g., mangroves, turtle nesting habitats, estuaries) and their commercial interests (ports, tourist beaches). The ranking process also takes account of strategic interests, such as industrial facilities and military installations, and public or general interests such as beaches or settlements.

International guidance on determining environmental sensitivity is available, but that determination will ultimately be made by the sovereign state concerned, usually in consultation with the various stakeholders. Of specific interest with respect to planning for and response to oil spills is the potential use of dispersants. ESI maps can guide the identification of areas where ecological sensitivity would rule out the use of dispersant chemicals.

At the time of writing, Côte d'Ivoire has no environmental sensitivity map. Some officials believe that there was an environmental sensitivity map at CIAPOL but was destroyed during the post-election crisis (See Case Study 5). As mentioned above, the development of a coastal Environmental Sensitivity Index map should be a consultative and iterative process led by national authorities. Map 8 should be seen as starting point to identify key exposures close to Abidjan. This work needs to be expanded to other parts of the country.

9.2 Recommendations

While the risk of a major oil spill and the resources exposed to it have increased over the past decade, the capacity to deal with one has not. On the contrary, that capacity has been eroded. The country's National Oil Spill Contingency Plan dates to 1997 and has not been revised or updated since then. CIAPOL, which was once the custodian of the plan and the repository of the relevant equipment, was severely affected by the post-election crisis, losing all of its records, equipment, and facilities.

Rebuilding national capacity for oil-spill response must be one of the priorities of the National Committee for Disaster Management. Adequate resources should be allocated and time taken to build institutional capacity. However, there are things that can be done immediately to reduce or mitigate the effects of a large oil spill:

1. Review the existing capacity to respond to an oil spill with all stakeholders, including the port authorities in Abidjan and San Pedro and the refinery in Abidjan. The review should include an assessment of staff capacity and equipment.
2. Investigate the capacity of nearby countries, including their private sectors, to help in the event of a spill during the period in which Ivorian capacity to respond is being rebuilt.
3. Investigate existing systems for regional and international cooperation in the event of a spill, as well as Côte d'Ivoire's membership or eligibility for membership of those systems.
4. Update the National Oil Spill Contingency Plan to include the measures recommended in this assessment, and prepare an Environmental Sensitivity Index map.

Case study 5. Damage to CIAPOL

The Ivorian Pollution Control Centre (CIAPOL) is also the nodal agency for dealing with oil spills, as defined in the 1997 National Oil Spill Contingency Plan (NOSCP). However, CIAPOL's lack of physical and financial resources illustrates one of the fundamental challenges faced by many government institutions.

CIAPOL is financed by fees paid by industries and the state budget. In the past, when the Ivorian economy was in better shape and overheads were lower, the agency was able to implement its mandate in a reasonable manner. However, during the post-election crisis of 2011, CIAPOL's headquarters were attacked and its laboratory and office facilities destroyed. Moreover, all the chemicals, sampling equipment, office furniture, and archives were lost. In the aftermath of the crisis, as part of the peace agreement, what remained of CIAPOL's office facilities were taken over by paramilitary forces. Consequently, CIAPOL now has to rent office facilities and no longer has a laboratory or access to sampling equipment. Instead, the agency has to depend on private laboratories, which do not have sufficient competencies and which have higher costs than CIAPOL's inspection fees. The agency thus runs at an operational loss and is able to undertake fewer than half of the target number of inspections.

A further and equally serious concern is CIAPOL's role as the nodal agency responsible for responding to oil spills. The NOSCP stipulates both the resources CIAPOL should be given and the actions it must take in the event of a spill. However, along with everything else, CIAPOL has also lost the equipment with which to combat oil spills, and the relevant skills of its staff have not been updated in a decade. There is also no coastal Environmental Sensitivity Map that could help to prioritize those areas that need to be protected. It is clear that Côte d'Ivoire is now doubly exposed to an oil spill: from the increased risk of a spill occurring along its coastline, and from CIAPOL's lack of capacity to respond. Furthermore, this lack of capacity could adversely affect Côte d'Ivoire in any litigation regarding compensation in the event of a spill.

There are, however, positive aspects for CIAPOL. The quality of the agency's leadership is good, and the core of the civil service, including its technical personnel, has stayed with the institution throughout the crisis and beyond. What CIAPOL really needs now is training to update skills and the physical resources—offices, laboratories, vehicles, and communications equipment—in order to execute its mandate.

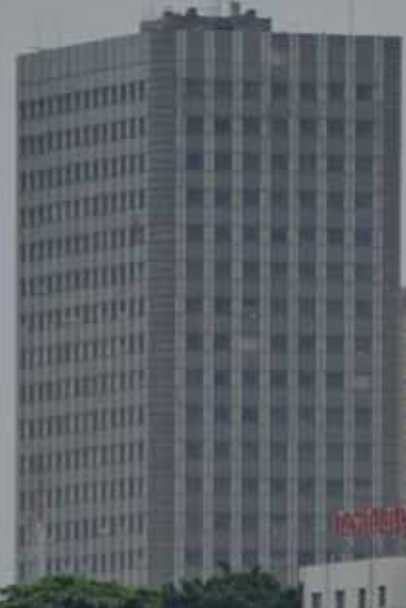
9 OIL SPILL THREAT TO CÔTE D'IVOIRE



CIAPOL headquarters was taken over during the election crisis and its capacity undermined

Conclusions and Recommendations

*The Ébrié Lagoon
has the potential to be
a key driver of
the revival of Abidjan*



Conclusions and Recommendations

It is clear from all the evidence and analysis presented in this report that Côte d'Ivoire has many environmental challenges. The causes of the environmental degradation of Côte d'Ivoire are complex. Remedial action will have to go far beyond the technical solutions to individual environmental problems that are specified in this report. There are broader actions that need to be taken in order to get the country back on a path of sustainable growth and once again make the country a model for the whole of Africa.

While there are a number of very serious challenges to the country's environmental sustainability, there is also some cause for hope. The population density is still low, about 60 people per km², and only 50 percent of the population still lives in rural areas. Much of the land is suitable for agriculture and being in the tropics, is not subject to extreme weather. The country has plenty of high-value resources (e.g., oil, copper, gold) and owing to its geographical location, could well become the service hub of the region.

Côte d'Ivoire is also fortunate in that the political situation is now more stable, with major hostilities between the two rival formations having ceased and the government now legitimate and internationally recognized. With the exception of a few pockets in the west, there is peace across the country and a mood of growing confidence and security, all of which will help to drive development. Furthermore, even though much of the physical infrastructure has been degraded, the country has retained a core of civil servants and professionals, and more are willing to return to their work if the present peace continues. Lastly, since hostilities have ended and legitimate government has returned, Côte d'Ivoire has begun to regain its status as the economic hub of Francophone Africa—a status that is confirmed by the return of the headquarters of the African Development Bank, which had left Abidjan during the conflict.

The following recommendations are presented with the anticipation that they will receive attention from individuals and institutions far beyond those within the environmental community:

1. Urgently halt continued deforestation; reforest at a grand scale, adequately protect and manage areas of conservation value

It is clear from the analysis presented in this report that damage to the country's forests is substantial and widespread. Degradation has been the prevailing trend for over a century, but one that has accelerated enormously over the past ten years. The damage will not be reversed by a few well-intentioned actions at local level. Rather, the government needs to examine the *totality* of forestry and protected areas, considering all the ecological, agriculture, industrial, socioeconomic, and security factors that are involved. Only then will the government be able to envisage the 50-year plan that will be necessary, and to design a sustainable approach to the management of the country's forests and national parks.

A strategic approach to forest management in Côte d'Ivoire must balance the need for access to land for a decent and sustainable livelihood with the need to preserve enough contiguous areas of forest so that the integrity of the ecosystem can be guaranteed. This process should start from commitment at the highest level to halt and reverse the forest degradation. This approach should measure the economic value that has been lost in the process of degradation, as well as that which might be generated by emissions trading, payment for ecosystem services, and the reduction of emissions for deforestation. All these must be done at a national scale if there is to be a master plan for the regeneration of the ecosystem and the forests of Côte d'Ivoire.

2. Reverse the unsustainable growth of Abidjan

Most large cities in the developing world have expanded in recent decades, but Abidjan's growth has been explosive. More to the point, it has been unnatural in that it was driven not by aspiration but by fear. As a result, it is unsustainable. The environmental damage caused by that growth is immense: groundwater sources have been depleted, and Ébrié Lagoon is highly polluted. Abidjan no longer offers the quality of life it once did. Its infrastructure—from water supply, sanitation and waste management, to education and health care—has suffered.



Other parts of Côte d'Ivoire should be developed to attract people to settle outside of Abidjan

It is still possible to restore Abidjan's former environmental quality even with its current population of five million, but the resources needed to do so would be vast. More important, it would be neither an efficient nor an appropriate response to this urbanization crisis. The civil war drove large numbers of people to Abidjan over a short period of time, and a brief period of peace will not be enough to persuade them to return to whence they fled. Better economic opportunities, infrastructure, and social services, and the long-term stability of the country, will induce people to return to their former homes.

3. Establish Ébrié Lagoon as an engine for economic revival in Abidjan

At present, Ébrié Lagoon around Abidjan is currently a foul-smelling, unsightly waterbody that does not offer aesthetic or ecosystem benefits to the population. However, the UNEP assessment has shown that only 10 percent of the lagoon is subject to severe anthropogenic impact. The lagoon could recover.

To allow that recovery to happen, the government would need to remove the present accumulation

of pollution, prevent further encroachment, and control or stop the use of the lagoon as a dumping ground for solid and liquid waste. Such a recovery would not only make an immeasurable difference to the lives of Abidjan's citizens, it would also drive the city's economic growth. The lagoon could still offer opportunities for commercial and artisanal fishing, recreation, fast and efficient water transport, tourism, and a waterfront worthy of the region's economic hub.

Ébrié Lagoon will not be transformed from its current polluted state into a prime mover of Abidjan's economy by uncoordinated policy initiatives to clean it up or to prevent encroachment. *As in the case of forest regeneration efforts, the efforts here need to be long term, coordinated, and substantial.* UNEP recommends the formation of an Ébrié Lagoon Management, to be tasked with long-term planning. Authorities in other countries have managed to ensure effective coordination between the relevant municipalities and government departments so as to implement measures to improve the environmental quality and productivity of bodies of water like the lagoon.

Appendices

Appendix 1

Acronyms and abbreviations

International organizations, institutions, and terms

ADB	African Development Bank
CCC	Coffee-Cocoa Regulatory, Stabilization and Development Council Le Conseil du Café-Cacao > Le Conseil de Régulation, de Stabilisation et de Développement de la Filière Café-Cacao
CIAPOL	Ivorian Pollution Control Centre Centre Ivoirien Antipollution
CNDD	National Commission on Sustainable Development Commission Nationale du Développement Durable
DDT	Dichloro-diphenyl-trichloroethane
DRR	Disaster risk reduction
EIA	Environmental impact assessment
FLEGT	Forest Law Enforcement, Governance and Trade (European Union)
GEF	Global Environment Facility
GTZ	German Organization for Technical Cooperation Deutsche Gesellschaft für Technische Zusammenarbeit
IRD	Institute for Research into Development Institut de recherche pour le développement
ISO	International Organization for Standardization
IWAF	International Fund for Animal Welfare
JICA	Japan International Cooperation Agency
MARPOL	International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto.
MEA	Multilateral environmental agreement
MEF	Ministry of Economy and Finance Ministère de l'Économie et des Finances Côte d'Ivoire > de Côte d'Ivoire
NRDC	Natural Resources Defense Council
NGO	Nongovernmental organization
OIPR	Ivorian Office of Parks and Reserves Office Ivoirien des Parcs et Reserves
ONEP	National Drinking Water Office Office Nationale de l'Eau Potable
PBT	Persistent, bioaccumulative, and toxic (pollutant)
POP	Persistent organic pollutant
PUIUR	World Bank's Emergency Urban Infrastructure Project
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNOCI	United Nations Operation in Côte d'Ivoire

WCF	Wild Chimpanzee Foundation
WEEE.....	Waste electrical and electronic equipment
WHO	World Health Organization
WHS	World Heritage Site
WWF	World Wide Fund for Nature

Ivorian organizations and institutions

AIPH.....	Association of Palm Oil Professionals of Côte d'Ivoire Association Interprofessionnelle de la filière Palmier à huile de Côte d'Ivoire
ANADER	Agency for Rural Development and Support Agence Nationale d'Appui au Développement Rural
ANASUR	National Agency for Urban Sanitation Agence Nationale de la Salubrité Urbaine
ANDE.....	National Environment Agency Agence Nationale de l'Environnement
APROMAC	Association of Natural Rubber Professionals of Côte d'Ivoire Association des Professionnels du Caoutchouc Naturel de Côte d'Ivoire
ARECA	Cotton and Cashew Regulatory Authority Autorité de Régulation du Coton et de l'Anacarde
CCC	Coffee-Cocoa Regulatory, Stabilization and Development Council Le Conseil du Café-Cacao
CIAPOL	Ivorian Pollution Control Centre Centre Ivoirien Antipollution
CIE	Ivorian Electricity Company Compagnie Ivoirienne d'Electricité
CNDD	National Commission on Sustainable Development Commission Nationale du Développement Durable
CPEF.....	Concessions for exploitation of forest timber Concessionnaires d'Exploitations Forestières
DGRE.....	General Directorate for Water Resources Direction Générale des Ressources en Eau
DRE.....	Directorate of Water Resources Direction des Ressources en Eau
FCFA.....	West African franc Franc de la Communauté Financière d'Afrique
MACOM.....	Mission for the Conduct of Municipal Operations Mission d'Appui à la Conduite des Opérations Municipales
MEF.....	Ministry of Economy and Finance Ministère de l'Economie et des Finances Côte d'Ivoire
MIM	Ministry of Mines, Petroleum and Energy Ministère de l'Industrie et des Mines
MINAGRI.....	Ministry of Agriculture Ministère de l'Agriculture
MINEF.....	Ministry of Water and Forests Ministère des Eaux et Forêts

MINESUDD	Ministry of Environment, Urban Sanitation and Sustainable Development Ministère de l'Environnement et du Développement Durable
MIRAH	Ministry of Animal Resources and Fisheries Ministère des Ressources Animales et Halieutiques
MPE	Ministry of Petroleum and Energy Ministère du Pétrole et de l'Energie
MSHP	Ministry of Health and Public Hygiene Ministère de la Santé et de l'Hygiène Publique
NOSCP	National Oil Spill Contingency Plans
OIPR	Ivorian Office of Parks and Reserves Office Ivoirien des Parcs et Reserves
ONEP	National Drinking Water Office Office Nationale de l'Eau Potable
PETROCI	National Company of Oil Operations of Côte d'Ivoire Société Nationale d'Opérations Pétrolières de la Côte d'Ivoire
SIIC	Classified Installation Inspection Service Service d'Inspection des Installations Classées
SODECI	Classified Installation Inspection Service Société de Distribution d'Eau
SODEFOR	Forest Development Company Société de Développement des Forêts
SODEMI	Mining Development Company Société pour le Développement Minier
TEOM	Household waste tax Taxe d'Enlèvement des Ordures Ménagères

Geographical term

UGF Upper Guinea Forest

Military formations

FN Forces Nouvelles
Generic term for rebel forces

FRCI Armed Forces of Côte d'Ivoire
Forces Republicaines de Côte d'Ivoire

Appendix 2

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Appendix 3

Institutional framework governing the environment and natural resources in Côte d'Ivoire

The following institutions and structures in Côte d'Ivoire are deemed the most relevant by the UNEP assessment for governing the environment and natural resources.

Category	Name	Description
Environment	Ministry of Environment, Urban Sanitation and Sustainable Development (MINESUDD)	Created in 2012 by decree, MINESUDD is responsible for the design and implementation of policy relating to the environment, urban health, and sustainable development in Côte d'Ivoire; each of those areas is governed by a separate general directorate. MINESUDD, which works closely with MINEF, is also responsible for the technical supervision of ANDE, CIAPOL, CNDD, ANASUR, and OIPR, which all have their own legal status and some financial autonomy. During the conflict, MINESUDD officials had no access to the central, northern, and western regions of the country, and key infrastructure was looted or destroyed. Today all 15 regional directors and other staff have been redeployed, but resources remain limited and infrastructure dilapidated. This ministry has changed names several times in recent years: from 2005 to 2011 it was the Ministry of Environment, Water and Forests; from 2011 to 2012 it was the Ministry of Environment and Sustainable Development. The Ministry of Urban Health, created in 2011, was merged with the environment and sustainable development portfolios of MINESUDD in 2012.
	National Environment Agency (ANDE)	Created in 1997 by decree, ANDE is in charge of implementing environmental projects and programs. Specifically this entity coordinates environmental development projects, manages environmental investment projects, and oversees the creation and management of a national environmental information system. ANDE is also responsible for environmental assessments, including environmental impact assessments, environmental audits, and strategic environmental assessments. ANDE is under the technical supervision of MINESUDD.
	National Commission on Sustainable Development (CNDD)	Created in 2004 by decree, the CNDD implements national sustainable development policy by establishing sectoral and regional commissions (although these commissions have yet to be established). CNDD is under the technical supervision of MINESUDD and works closely with the General Directorate of Sustainable Development (DGDD), one of the three MINESUDD general directorates. DGDD is charged with driving national sustainable development policy by promoting a green economy.
	Ivorian Pollution Control Centre (CIAPOL)	Created in 1991 by decree, CIAPOL is responsible for pollution control of natural waters (marine, lagoon, river, underground, and meteoric), waste (solid, liquid, and gas) and residue. It is also mandated to carry out regular surveillance of the coastal and lagoon areas, and is the first responder after pollution accidents in the sea, lagoon, or coastal areas. CIAPOL is under the technical supervision of MINESUDD.
	National Urban Sanitation Agency (ANASUR)	Created in 2007 by decree, ANASUR is responsible for nonhazardous urban waste management (industrial and domestic), including coordinating the activities of waste collection companies and preparing legislation related to waste. ANASUR is under the technical supervision of MINESUDD and the Ministry of Economy and Finance.

Category	Name	Description
Forests/ National Parks/Natural Reserves	Ministry of Water and Forests (MINEF)	Created in 2011 by decree, MINEF sets and implements national policy regarding water and forests, and works in collaboration with MINESUDD. The ministry has five directorates that cover the forest industry, reforestation, wildlife, forest police, and water resources. Like MINESUDD, the ministry suffers from a lack of resources. During the conflict, MINEF representatives had no access to the central, northern, and western parts of the country, and most were forced to flee as fighting spread. With 12 regional offices in the country, MINEF has managed to reestablish a presence nationwide, but only four of the regional offices have been rehabilitated (funded by ADB) since the conflict, leaving eight offices in a state of disrepair and dysfunction. From 2005 to 2011 there was a Ministry of Environment, Water and Forests; this was subsequently divided and the environment portfolio merged with sustainable development, and later urban health.
	Forest Development Company (SODEFOR)	Created in 1966 by decree, SODEFOR manages the country's 231 classified forests (over 4 million ha). It is mandated to assist in elaborating and implementing government policy on developing the national forest heritage and forestry production, adding value to forest products and conserving forest zones. SODEFOR is under the technical supervision of MINEF and has ten management centers nationwide.
	Ivorian Office of Parks and Reserves (OIPR)	Created in 2002 by decree, OIPR is responsible for protecting and sustainably managing the flora and fauna in parks and reserves in perpetuity, including wild flora and fauna resources, both terrestrial and aquatic. OIPR's remit includes regulating forestry use at the boundaries between protected areas and neighboring zones, disseminating information, and promoting research and tourism activities. OIPR is under the technical supervision of MINESUDD.
Water	Ministry of Water and Forests (MINEF)	MINEF is the Government entity that implements and monitors water policy and implements the Water Code.
	National Drinking Water Office (ONEP)	Created in 2006 by decree, ONEP is responsible for ensuring access to drinking water and managing drinking water supplies in rural areas of Côte d'Ivoire. ONEP is under the technical supervision of the Ministry of Economic Infrastructure and the Ministry of Economy and Finance.
	Water Distribution Company of Côte d'Ivoire (SODECI)	SODECI is a private utility company responsible for the public water service in the framework of a 20-year concession contract (renewed on 12 December 1987), with exclusive drinking water production and distribution rights in urban areas (but not in rural areas). The company comes under the authority of the Ministry of Economic Infrastructure. The state retains ownership of the infrastructure, sets the national water policy and monitors SODECI's activities. SODECI is responsible for the fixed assets it is given charge of, for the use and maintenance of all the installations placed under its responsibility according to the concession contract, and for the quality and the continuity of the products and services provided.

Category	Name	Description
Mines	Ministry of Industry and Mines (MIM)	Created in 1989 by decree as the Ministry of Planning and Industry, this ministry has since restructured on several occasions. Responsible for developing industry, the private sector and small and medium enterprises. The Ministry of Industry absorbed the mining portfolio – previously lodged with petroleum and energy – in July 2013.
	State Company for the Mining Development of Côte d'Ivoire (SODEMI)	State company established in 1962, responsible for mining exploration and exploitation in Ivorian territory, usually in partnership with other companies.
Oil & Gas	Ministry of Petroleum and Energy (MPE)	Responsible for the implementation and monitoring of government policies in the oil & energy sector. Until July 2013, this ministry also included the mining portfolio; this was absorbed at this time by the Ministry of Industry.
	National Company of Oil Operations of Côte d'Ivoire (PETROCI)	Established in 1975, PETROCI is responsible for the exploration and exploitation of gas and oil in Côte d'Ivoire in partnership with international companies. Also in charge of the transport, storage and trade of oil and gas products and sub-products.

Appendix 4

Multilateral environmental agreements and voluntary initiatives

In addition to domestic legislation, Côte d'Ivoire has also signed and ratified a plethora of multilateral environmental agreements (MEAs) and voluntary initiatives relating to the environment and natural resource governance. These international and regional agreements all have an impact on national policy, as stated under the Ivorian Constitution: "Treaties that are regularly ratified are, from the time of publication, a superior authority to the law." In addition, if a matter is not treated in national law, the country can resort to international agreements. The following are some of the key MEAs and related voluntary initiatives with year of entry into force in Côte d'Ivoire.

Major MEAs

1. World Heritage Convention, 1981
2. Abidjan Convention, 1984
3. Bamako Convention, 1991
4. Montreal Protocol, 1993
5. Vienna Convention, 1993
6. Basel Convention, 1994
7. Convention on Biological Diversity, 1994
8. Convention on International Trade in Endangered Species of Wild Fauna and Flora, 1995
9. United Nations Framework Convention on Climate Change, 1995
10. Ramsar Convention, 1996
11. United Nations Convention to Combat Desertification, 1997
12. International Treaty on Plant Genetic Resources for Food and Agriculture, 2001
13. Convention on Migratory Species, 2003
14. African Convention on the Conservation of Nature and Natural Resources, 2003
15. Rotterdam Convention, 2004
16. Stockholm Convention, 2004
17. International Convention for the Prevention of Pollution from Ships, 2005
18. Kyoto Protocol, 2007
19. International Convention on Oil Pollution Preparedness, Response and Co-operation, 2008
20. Nagoya Protocol (under CBD Agreement), 2012
21. African-Eurasian Waterbird Agreement, 2013

Additional agreements on natural resources

1. International Coffee Agreement, 1999
2. International Cocoa Agreement, 2001
3. Grains Trade Convention, 2002
4. International Tropical Timber Agreement, 2008

International voluntary initiatives

1. Extractive Industries Transparency Initiative (EITI). Compliant since 22 May 2013
2. Forest Law Enforcement, Governance and Trade (FLEGT). Signature expected in 2017
3. Kimberley Process (KP) Certification Scheme. Currently non-compliant. KP review mission scheduled for November 2013

Additional nonbinding agreements

1. Memorandum of Understanding concerning the Conservation of the Manatee and Small Cetaceans of Western Africa and Macaronesia (concluded under CMS)
2. Memorandum of Understanding concerning Conservation Measures for the West African Populations of the African Elephant (*Loxodonta africana*) (concluded under CMS)
3. Memorandum of Understanding concerning Conservation Measures for Marine Turtles of the Atlantic Coast of Africa (concluded under CMS)
4. Partner to the UNEP-led Great Apes Survival Partnership

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Further technical information may be obtained from the UNEP Post-Conflict and Disaster Management Branch website at: <http://www.unep.org/disastersandconflicts/> or by email: postconflict@unep.org

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The Government of Côte d'Ivoire, which came into power after the 2010 elections, made a formal request for UNEP to undertake a post-crisis environmental assessment. In response, UNEP carried out a Post-Conflict Environmental Assessment (PCEA) which examined a range of environmental issues that had direct or indirect linkages with the conflict, including forests, national parks and urban environmental issues.

The study documents environmental challenges in all areas assessed. The forests of Côte d'Ivoire, which were already severely impacted, continue to be under threat of encroachment, which could lead to irreversible damages. The infrastructure of national parks suffered substantial losses, especially in parts of the country which were not accessible to the central government during the conflict. Ébrié lagoon, which has economic, aesthetic and cultural significance to Abidjan, is degraded as a result of pollution and land reclamation. The study also identified that the risk of an oil spill along the Ivorian coastline has increased in the last decade, while at the same time the capacity of the Government to deal with oil spills has deteriorated.

While there are a number of very serious challenges to achieving environmental sustainability in the country, there is also some cause for hope. The population density is still low at approximately 60 inhabitants per km², and only 50 percent of the population still live in rural areas. The country has plenty of high-value resources (e.g., oil, copper, gold) and, owing to its geographical location, could well become the service hub of the region. Côte d'Ivoire is also fortunate in that the political situation is now more stable, with major hostilities between the two rival formations having ceased and the Government now considered legitimate and recognized by the international community.

The study outlines a series of recommendations which, if implemented, can put Côte d'Ivoire on the track towards sustainable development.

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