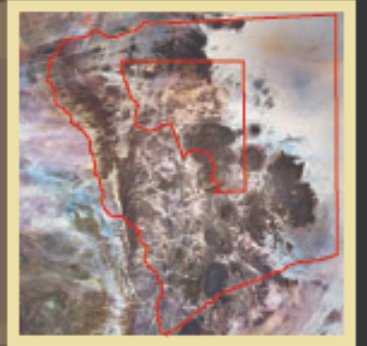


FROM SPACE TO PLACE

An Image Atlas of World Heritage Sites on the 'In Danger' List



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75352 Paris 07 SP France

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ISBN 978-92-3-104227-0

Cover Design: Carly Morganwalp

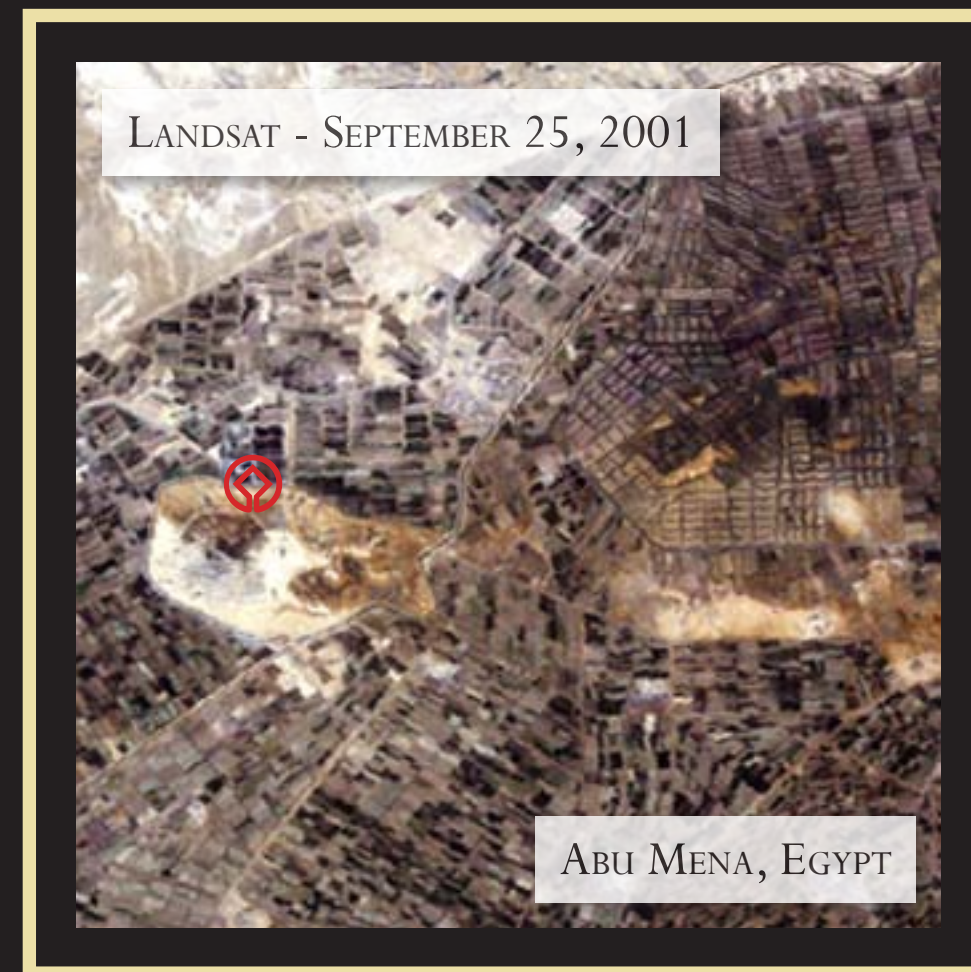
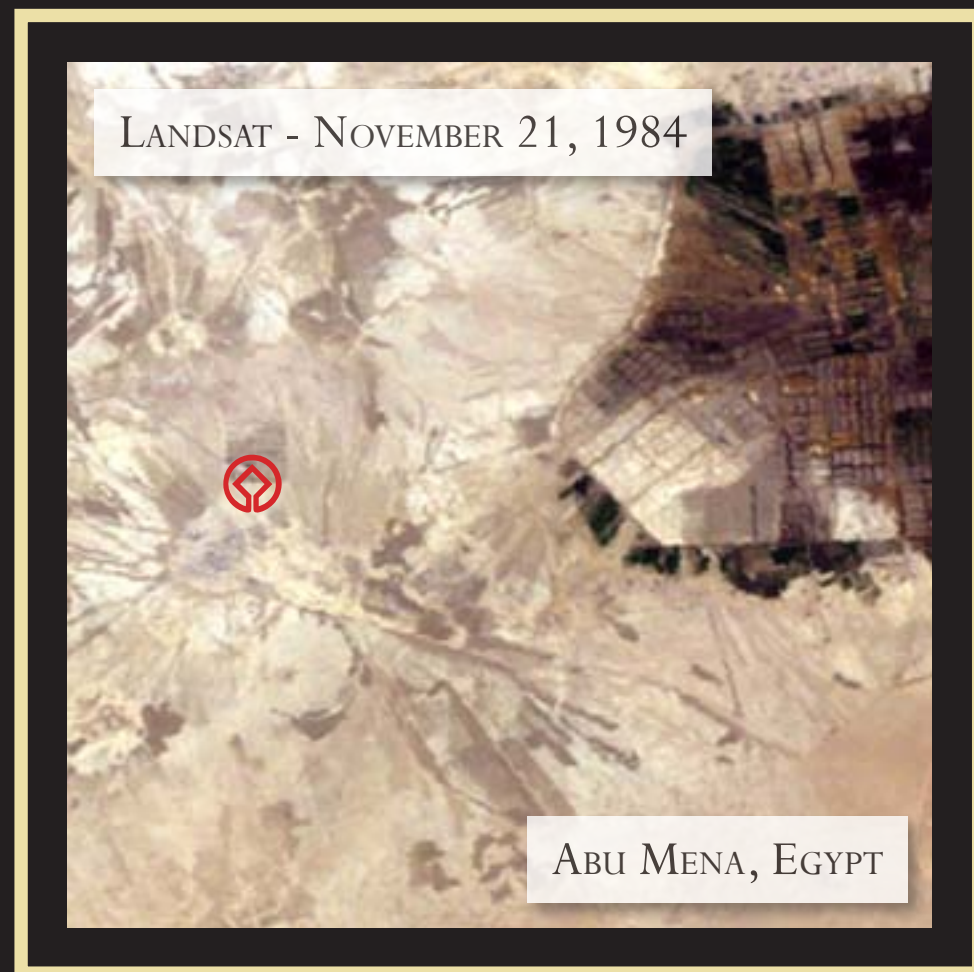
Citation:

Sayre, R., Hernandez, M., Spencer, D., Cecere, T., Morganwalp, C., Hamann, S., Fox, C., Benson, L., Cook, S., Bunning, J., Alvarado, S., and Cardenas, M. 2011. *From Space To Place – An Image Atlas of World Heritage Sites on the ‘In Danger’ List*. UNESCO Publishing, Paris, France.



FROM SPACE TO PLACE

An Image Atlas of World Heritage Sites on the 'In Danger' List



A Collection of Satellite Images for Improved Understanding and Management of World Heritage Sites



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DEDICATION

We illustrate herein a modern support tool based on satellite imagery and geospatial technologies that can assist researchers and site managers to better assess and manage World Heritage sites. To these individuals, and to all who work for the conservation of World Heritage sites, we dedicate this Atlas. They are working to ensure that these natural areas and cultural antiquities may persist for future generations. Under sometimes difficult and dangerous situations, many park staff and conservation authorities have worked tirelessly to protect these sites. Some have even given their lives in this pursuit. May their efforts not be in vain, and may all World Heritage sites, and the treasures they contain, endure always.



© IFAW the International Fund for Animal Welfare/J. Cumes

This photograph shows a threatened Asian greater one-horned rhinoceros (*Rhinoceros unicornis*) being re-introduced into the Manas Wildlife Sanctuary in India in 2008. The rhino had disappeared from this UNESCO World Heritage site following periods of civil unrest, lack of management, widespread poaching, and habitat alteration. For these same reasons, the Manas Wildlife Sanctuary was inscribed on the List of World Heritage In Danger in 1992. Since that time, efforts to improve the conservation of the sanctuary have been fruitful, and in 2011 Manas Wildlife Sanctuary was removed from the List of World Heritage Sites In Danger. The return of the rhino to Manas, and the removal of the sanctuary from the Sites In Danger roster is illustrative of an abiding hope and strong passion for the conservation of World Heritage sites.

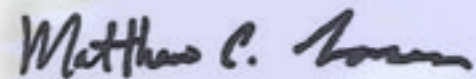
FOREWORD

In 1970, while still in high school in Philadelphia, I attended one of the first global events of what is now celebrated internationally, Earth Day, a concept that is at least partly attributed to a 1969 UNESCO conference in San Francisco. Global awareness of environmental challenges facing our planet had reached new heights, and just two years later, in 1972, the UNESCO General Conference met in Paris from 17 October to 21 November and adopted the historic Convention Concerning the Protection of the World Cultural and Natural Heritage.

That Convention notes that “cultural heritage and the natural heritage are increasingly threatened with destruction not only by the traditional causes of decay, but also by changing social and economic conditions which aggravate the situation with even more formidable phenomena of damage or destruction”. The Convention includes in its definition of cultural heritage: “works of man or the combined works of nature and man, and areas including archaeological sites which are of outstanding universal value from the historical, aesthetic, ethnological or anthropological point of view.” What made this Convention so historic was the connection it made between the protection of both cultural and natural heritage. The concept of world heritage forced us to think beyond our regional, national, and geographic boundaries.

This volume presents a stunning collection of moderate and fine resolution imagery from some of the most culturally and naturally important places on Earth. The images are just a small example of an untapped and potentially large analytical capability that is available to managers of World Heritage sites. Our purpose in presenting images and maps of the 31 World Heritage sites in this volume is to show the utility of imagery for improving understanding of the landscape context for these sites, and the threats they face, as a tool for their improved management.

The U.S. Geological Survey is proud of our rewarding and mutually beneficial collaboration with UNESCO in the creation of this volume. We are hopeful that the increased awareness that all of us gain from observing the beauty and wonder of our planet from above, will continue to lead to improved management of our fragile natural and human-made treasures.



Dr. Matthew C. Larsen,
Associate Director Climate and Land Use Change, USGS

In 2012, we will celebrate the 40th anniversary of the Convention concerning the Protection of the World Cultural and Natural Heritage, adopted by the General Conference of UNESCO.

Groundbreaking in 1972, this Convention remains revolutionary today, because it proposes a new way to see the world. The World Heritage convention provides us with an atlas that blurs the boundaries between states and peoples and that reminds us of the ties we hold in common. By regarding heritage as both cultural and natural, the Convention highlights also the ways in which people interact with nature, and the fundamental need to preserve a balance between the two.

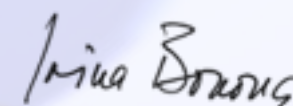
Unfortunately, our heritage is in danger. Armed conflict and war, earthquakes and other natural disasters, pollution, poaching, deforestation, uncontrolled urbanization and unchecked tourist development -- all of these are posing major problems to the common heritage of humanity.

This publication provides unique insight to these threats. These satellite images give us a new way to see the dangers arising to 31 sites on the List of World Heritage in Danger (as of 2009) and to understand their impact. The result is a remarkable new view of these sites.

This builds on the strong partnership UNESCO has developed with the United States Geological Survey. This publication benefits tremendously from its unique expertise in space technologies, and especially remote sensing (satellite imagery processing). Across the world, national authorities are working to preserve their natural and cultural heritage. They do not always have access to the most suitable technologies to observe the threats to World Heritage sites as they emerge. This is where space technologies can play such a valuable role.

2011 marks the tenth anniversary of the European Space Agency–UNESCO Open Initiative on the use of space technologies to support World Heritage. UNESCO has today over 60 space partners, bringing the benefits of space technologies to developing countries in the area of cultural and natural heritage.

I hope this atlas will encourage the further use of science and technology across the world for the preservation of our heritage. Only the combined effort of all sources of expertise and all actors will allow us to preserve our common heritage for future generations to enjoy.



Irina Bokova, Director General, UNESCO



PREFACE

The concept for this book, and the partnership to produce it, were born during conversations held at an international workshop in Campeche, Mexico, in late November of 2005. The workshop was entitled “The Use of Space Technologies for the Conservation of Natural and Cultural Heritage”, and featured speakers from United Nations organizations, space agencies, universities, and conservation groups. Two of the keynote speakers, Mario Hernandez, Senior Program Specialist for Remote Sensing for the United Nations Educational, Scientific and Cultural Organization (UNESCO), and Barbara Ryan, then Associate Director for Geography at the United States Geological Survey (USGS), were inspired to extend the outcomes of the conference to include a collaboration to develop this book. They shared a vision for the production of an atlas of satellite imagery for the set of World Heritage sites on the ‘In Danger’ list. The atlas would emphasize the utility of satellite imagery for assessing and managing these endangered protected areas.

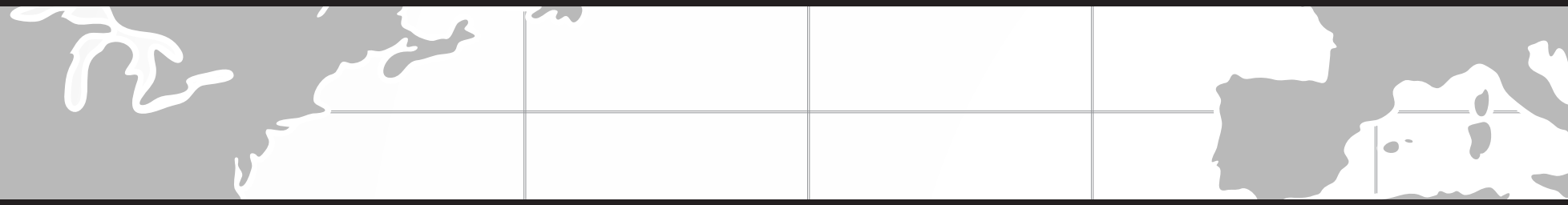
The new collaboration between UNESCO and USGS originally produced an atlas of change pairs. A change pair is a pair of images for the same location, but separated in time, and showing the change on the landscape over the intervening time period. Change pairs are frequently used to show urbanization. While some of the sites were suffering from encroachment by expanding human settlement, other sites were suffering from pressures that were not visually evident in change pair assessments. The atlas began to evolve into a collection of satellite images which “told the best story” for each site. Sometimes, the best image for a site, especially the smaller ruins and monuments, was a crisp, high spatial resolution image showing maximum detail of the site and its landscape context.

This atlas represents the fruition of the collaboration. It contains a remarkable collection of images, some visually stunning, which characterize the sites and their surrounding landscapes. It contains images which could be quite useful for site management, and in the end, is an affirmation of the role that space technologies and imagery can play in the conservation of global natural and cultural heritage.

We acknowledge and offer our most sincere appreciation for help from many kind and generous individuals during the planning and development of this book, including Barbara Ryan, Jonathan Smith, Douglas Muchoney, Bryant Cramer, Lone Taylor, Cindy Cunningham, Ruth Linke, Ryan Bannon, Christian Bongard, Monica Bass Corwith, Brenda Ellis and Linda Jonescheit. For helpful review comments we thank Matthew Larsen, Jonathan Smith, Ashbindu Singh and Susan Stitt.

While the atlas is intended primarily for park management and remote sensing professionals, it was developed and presented in an easily accessible format and style, and has much to offer to the larger scientific community and interested public. The satellite imagery contained in this book represents a rich source of digital information that can be analyzed in different ways to address research questions and support resource assessments and monitoring.

TABLE OF CONTENTS



Development and Production Team	iii	Kahuzi-Biega National Park	24
Dedication	iv	Okapi Wildlife Reserve	26
Foreword	v	Salonga National Park	28
Preface	vi	Virunga National Park	30
Table of Contents	vii		
Locations of World Heritage Sites 'In Danger'	ix		
Introduction	x		
Afghanistan		Ecuador	
Cultural Landscape and Archaeological Remains of the Bamiyan Valley	2	Galápagos Islands	34
Minaret and Archaeological Remains of Jam	6		
Belize		Egypt	
Belize Barrier Reef Reserve System	8	Abu Mena	38
Central African Republic		Ethiopia	
Manovo-Gounda St. Floris National Park	12	Simien National Park	42
Chile		Georgia	
Humberstone and Santa Laura Saltpeter Works	14	Historical Monuments of Mtskheta	44
Colombia		India	
Los Katíos National Park	16	Manas Wildlife Sanctuary	46
Côte d'Ivoire		Iran (Islamic Republic of)	
Comoé National Park	18	Bam and its Cultural Landscape	48
Côte d'Ivoire and Guinea		Iraq	
Mount Nimba Strict Nature Reserve	20	Ashur (Qal'at Sherqat)	52
Democratic Republic of the Congo		Samarra Archaeological City	54
Garamba National Park	22	Jerusalem (Site Proposed By Jordan)	
		Old City of Jerusalem and its Walls	58
		Niger	
		Air and Ténéré Natural Reserves	60



TABLE OF CONTENTS (CONTINUED)

Pakistan	
Fort and Shalamar Gardens in Lahore	62
Peru	
Chan Chan Archaeological Zone	66
Philippines	
Rice Terraces of the Philippine Cordilleras	68
Senegal	
Niokolo-Koba National Park	72
Serbia	
Medieval Monuments in Kosovo	74
United Republic of Tanzania	
Ruins of Kilwa Kisiwani and Ruins of Songo Mnara	76
Venezuela (Bolivarian Republic of)	
Coro and its Port	80
Yemen	
Historic Town of Zabid	82
Contributing Organizations	84

LOCATIONS OF WORLD HERITAGE SITES 'IN DANGER'



Afghanistan:

1. Cultural Landscape and Archaeological Remains of the Bamiyan Valley
2. Minaret and Archaeological Remains of Jam

Belize:

3. Belize Barrier Reef Reserve System

Central African Republic:

4. Manovo-Gounda St. Floris National Park

Chile:

5. Humberstone and Santa Laura Saltpeter Works

Colombia:

6. Los Katíos National Park

Cote d'Ivoire:

7. Comoe National Park
8. Mount Nimba Strict Nature Reserve

Democratic Republic of the Congo:

9. Garamba National Park
10. Kahuzi-Biega National Park
11. Okapi Wildlife Reserve
12. Salonga National Park
13. Virunga National Park

Ecuador:

14. Galápagos Islands

Egypt:

15. Abu Mena

Ethiopia:

16. Simien National Park

Georgia:

17. Historical Monuments of Mtskheta

Guinea:

8. Mount Nimba Strict Nature Reserve

India:

18. Manas Wildlife Sanctuary

Iran:

19. Bam and its Cultural Landscape

Iraq:

20. Ashur (Qal'at Aherqat)
21. Samarra Archaeological City

Jerusalem:

22. Old City of Jerusalem and its Walls

Niger:

23. Air and Tenere Natural Reserve

Pakistan:

24. Fort and Shalimar Gardens in Lahore

Peru:

25. Chan Chan Archaeological Zone

Philippines:

26. Rice Terraces of the Philippine Cordilleras

Senegal:

27. Niokolo-Koba National Park

Serbia:

28. Medieval Monuments in Kosovo

Tanzania:

29. Ruins of Kilwa Kisiwani and Ruins of Songo Mnara

Venezuela:

30. Coro and its Port

Yemen:

31. Historic Town of Zabid

INTRODUCTION

WORLD HERITAGE IN DANGER

The List of World Heritage Sites In Danger is designed to inform the international community of conditions which threaten the very characteristics for which a property was inscribed on the World Heritage List, and to encourage corrective action. It alerts the international community to these situations in the hopes that actions to save these endangered sites will be implemented. Those restorative efforts are aimed at the removal of the site from the List of World Heritage Sites In Danger as soon as possible.

THREATS TO WORLD HERITAGE SITES

There are many types of human-caused and natural threats faced by World Heritage sites. For the set of Natural Sites, those areas inscribed into the network due to outstanding natural value, the biggest threat is frequently habitat alteration from human activity (e.g. deforestation) or natural forces (e.g. hurricanes). Habitat alteration involves degradation of the natural integrity of an area's landscape/seascape, resulting in loss of species, natural vegetative cover, and ecosystems. Other threats to natural areas include poaching of wildlife or illegal extraction of other natural resources, introduction of exotic species, environmental contamination, and increasingly, climate change.

For the Cultural Sites like ruins, monuments, buildings, other structures, and sacred cultural areas, many threats relate to weather- and age-related structural decay, and lack of restoration efforts or site stewardship. Illegal removal of artifacts is a threat at several sites, and willful destruction of sites due to ideological contradiction, or civic unrest, is not uncommon. Pollution affects several sites, and excessive tourism can be problematic for frail properties. The graphic at right lists the kinds of threats encountered at the sites on the In Danger list, and the symbology in the following pages to indicate the presence of a threat at a site:

- | | |
|--|--|
|  AGRICULTURE |  POLLUTION |
|  FIRE |  EXCESSIVE TOURISM |
|  INVASIVE SPECIES |  RESOURCE EXTRACTION |
|  LIMITED MANAGEMENT |  SETTLEMENT |
|  LOSS OF AUTHENTICITY |  SPECIES DECLINE |
|  LOOTING |  STRUCTURAL INSTABILITY |
|  NATURAL HAZARDS |  TRANSPORTATION |
|  POACHING |  WAR/CIVIL UNREST |
|  DAMS & WATER | |

SATELLITE IMAGERY AS A MANAGEMENT TOOL FOR SITE MANAGERS

Satellite imagery can be a useful tool for site managers. A satellite image of a site provides a bird's-eye view of the area and often conveys a big-picture sense of the geographic context in and surrounding the site. Studying satellite images usually results in an increased familiarity of the natural and man-made features of the site. Moreover, threats to sites are often detectable in satellite images. Habitat loss and conversion is frequently both detectable and quantifiable in satellite images, and the source of this landscape change (agricultural intensification, human settlement, etc.) may also be identifiable in the image. For large natural areas, moderate resolution (30 - 250 m) satellite imagery is useful for detecting encroachment into the park around its perimeter, and large scale cultivation inside and surrounding the area. For smaller, Cultural Sites like monuments and ruins, higher resolution imagery (4-10 m) is necessary to detect threats. Not all threats to World Heritage sites are detectable using imagery analysis. Poaching, for example, is a major threat in most African natural World Heritage sites, but this threat is generally not detectable in satellite imagery.

In addition to spatial resolution, or grain size, of the satellite image, spectral properties can also be useful for interpreting imagery. Some satellite image sensors collect information from different wavelengths. Light reflected from different objects has different spectral properties, which allows, for example, forests to be distinguished from grasslands. Image analysts are trained in using variation in spectral reflectances to delineate and distinguish features in the satellite image. There are many satellites in space actively sensing the environment. The graphic below lists the different types of sensors/imagery used in this Atlas, and the symbology used to identify the source of the satellite image:



INTRODUCTION (CONTINUED)

THE IMAGE ATLAS OF WORLD HERITAGE SITES ON THE 'IN DANGER' LIST.

Textual, photographic, and satellite image information is provided for each site depicted in the Atlas. The details of a site's inscription into the World Heritage List are given, along with a brief description of the cultural or natural values for which the site was inscribed. The threats to the site are then described, followed by a brief explanation of what is discernable in the satellite imagery that was selected for each site. The 'stories' told in the satellite imagery provide numerous examples of the utility of satellite image analysis for World Heritage site management. In certain cases the main threats that put a World Heritage site in danger are not identifiable in the satellite imagery (e.g. reduction of the number of individuals of a species, etc.). In these cases we have selected imagery which provides an improvement in the general understanding of the site.

SOURCES OF INFORMATION

All textual information about the sites was obtained from official UNESCO-sourced documentation available at the World Heritage webpage at <http://whc.unesco.org>. Sites included in this Atlas are the sites that were inscribed on the List of World Heritage Sites In Danger in 2009. New sites have since been added. In 2010, Galápagos Islands, Ecuador was removed from the list, and in 2011 Manas Wildlife Sanctuary was removed. Although they are no longer on the list, we decided to include these two sites in the Atlas anyway, for the education value they offer. For those two sites we made a special notation of the year they were removed from the Sites In Danger list.

The documents provided on this web site include Site Nomination Forms, Advisory Body Evaluations, State of Conservation Reports, UNESCO Mission Trip Reports, and Records of Decisions from World Heritage Committee Meetings.

The polygon boundaries and/or point locations for the sites are for illustration purposes only, and do not necessarily represent official boundaries. The polygon boundaries used herein were obtained from the World Conservation Monitoring Centre's (WCMC) World Database on Protected Areas (WDPA), a public domain resource available from <http://www.wdpa.org/>. A red polygon boundary always represents the area and location of a site. A red World Heritage symbol depicts the point location(s) of sites or antiquities which comprise a site. In a few cases site boundaries were approximated by the authors using other maps or best available information. For each site, efforts were made to obtain satellite imagery at spatial resolutions which illustrated the threats to the sites.

These images were obtained by USGS through partnerships and license agreements with vendors. In many cases public domain Landsat satellite imagery was used.

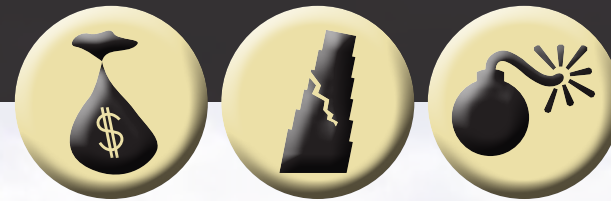
WORLD HERITAGE SITES 'IN DANGER'



Landscape conversion and steep slope farming adjacent to Virunga National Park, Democratic Republic of the Congo. © Kim Gjerstad



CULTURAL LANDSCAPE AND ARCHAEOLOGICAL REMAINS OF THE BAMMIYAN VALLEY



Afghanistan

Year of Inscription as World Heritage Site: 2003
Year of Inscription on Sites In Danger List: 2003
Bamiyan Province, Bamiyan District
N34 50 49 E67 49 31

The Buddhist Kingdom of the Bamiyan served for centuries as a thriving spiritual and commercial center, connecting China and Central Asia with India and the west along the historically important Silk Road trade routes. The Bamiyan Valley is linked to the spread of Buddhism and the influence of Buddhist art from the 1st to 13th centuries. The cultural landscape contains ancient monastic ensembles and sanctuaries, decorated cave paintings, and fortified settlements from the Islamic period.

There are a number of reasons why the site was inscribed as a World Heritage site. Bamiyan's Buddhist statues and cave art are outstanding examples of a particular Buddhist artistic expression called the Gandharan school. Gandharan art features Indian, Hellenistic, Roman, and Sasanian influences, with subsequent Islamic influence.

Bamiyan is also important because it represents a significant period in the development of Buddhism, as well as a cultural tradition which has been lost. In past centuries, the area has been the site of a pilgrimage for many.

In March 2001, the Taliban destroyed two monumental 2000 year old Buddha statues carved from the Bamiyan Valley cliffs. Today, the site is in a vulnerable state of conservation. The most pressing dangers include the risk of imminent collapse of the Buddha niches, deterioration of mural paintings, looting, and illicit excavation.

International restoration efforts are underway at the site. Protective boundaries and buffer zones have been delineated to improve the management of surrounding development pressures, including housing, military, and mining activities.

The satellite image on the facing page shows the location and extent of the fertile Bamiyan Valley, immediately surrounded by cliffs and mountains. The World Heritage site complex includes eight specific cliffs, caves, and fortifications, two of which are depicted in the image using the World Heritage symbol. While agricultural development is extensive, and clearly visible in the imagery, the cultivation of land is not the primary threat to the site.

Agriculture in the Bamiyan Valley has always existed, and contributes to the natural beauty of the location.

Most of the primary threats, such as looting, excavation, abandonment, deterioration of cave paintings, etc., are not discernible in the image. The image is useful in depicting the larger geographic context of the site.



These pictures show the site in its landscape context of valley bottom, conglomerate sedimentary rock cliffs, and surrounding mountains. There are approximately 1000 man-made caves in the cliffs, some of which are large well-decorated sanctuaries and assembly halls, others of which are simple, small, monastic cells. The regrettable destruction of the giant Buddhas is evidenced by their conspicuous absence from the niches in which they were contained. The empty niches are shown below. Although the Buddhas are gone, their colossal size can be appreciated from the enormity of the empty niches which framed them. Also depicted below is an example of an ancient painted decoration within one of the monastic caves. Many of the Afghan treasures from Bamiyan are no longer present at the site due to systematic theft, neglect and lack of maintenance, and deliberate destruction for ideological reasons.



CULTURAL LANDSCAPE AND ARCHAEOLOGICAL REMAINS OF THE BAMIYAN VALLEY, AFGHANISTAN

QUICKBIRD - SEPTEMBER 02, 2004



The image on this and the following pages is a high spatial resolution (2.5m), natural color QuickBird image from DigitalGlobe. Irrigated agricultural systems appear as red, green, gray, and black parcels throughout the Bamiyan Valley. The surrounding mountains are generally devoid of vegetation, and appear as hues of red and gray based on their geochemistry.




0 1 2 Kilometers



© 2004 DigitalGlobe
Licensed Under NextView

CULTURAL LANDSCAPE AND ARCHAEOLOGICAL REMAINS OF THE BAMIYAN VALLEY, AFGHANISTAN

QUICKBIRD - SEPTEMBER 02, 2004

 LOCATIONS OF GIANT BUDDHA NICHES



CULTURAL LANDSCAPE AND ARCHAEOLOGICAL REMAINS OF THE BAMIYAN VALLEY, AFGHANISTAN

QUICKBIRD - SEPTEMBER 02, 2004



On these pages, the same QuickBird image is used as on the previous spread, but zoomed in to the locations of two of the specific antiquities. The left hand page shows the Bamiyan Cliffs sites, where the niches of the 38 and 55 meter Buddhas are located. On this page, a zoomed in image of the fortress of Shahri-i-Ghulghulah is presented.





MINARET AND ARCHAEOLOGICAL REMAINS OF JAM



Afghanistan

Year of Inscription as World Heritage Site: 2002
Year of Inscription on Sites In Danger List: 2002
Shahrak District, Ghur Province
N34 23 48 E64 30 58

The Minaret of Jam, constructed in the 12th century, stands 65 meters tall and is the second tallest brick tower in the world after the Qutub Minar in New Delhi. The tower is located in a remote mountainous region at the confluence of two rivers, the Jam River and the Hari Rud River. The tower is covered in lace-like brick work which is considered an exceptional example of Islamic architecture.

Sultan Ghiyath al-Din Muhammed commissioned the minaret, a palace, and fortifications to commemorate the Ghurid Dynasty, which ruled Afghanistan from 1148 to 1214. Remarkably, the Minaret remains standing after years of war and destruction in Afghanistan. Moreover, the minaret sits in a very active earthquake zone. It is thought that wooden reinforcement beams in the brickwork may help stabilize the structure and support the minaret. The minaret has three tapered cylindrical tiers, and the surface is covered with inscriptions and a variety of geometric and floral patterns.

The site was inscribed on the World Heritage List in 2002, as an outstanding example of

Islamic architecture and ornamentation, and as a testimony to the power of the Ghurid civilization. The Minaret of Jam was placed on the List of World Heritage Sites In Danger in the same year due to a number of threats which could contribute to its demise. The threats at the site are both human-caused and natural.

The most significant natural threat to the Minaret is a weakening of its structural foundation caused by water. Situated between the Hari and Jam rivers, the water table under the tower is quite high, and water infiltrates into and erodes the octagonal foundation. Human-caused threats to the site include construction of a nearby road, and the theft of artifacts. Many bricks have already been stolen from the site. Illegal excavations and theft of cultural assets has been identified as the most immediate and irreversible threat facing the site today.

The satellite image on the facing page shows the location of the site at the confluence of the two rivers. The rugged, mountainous landscape surrounding the site is discernible in the image

as brown, red, purple, and gray rock surface. The Minaret itself is clearly visible, along with its shadow, at the confluence of the two rivers. The proximity of the tower to the water courses is clear in the satellite image.

Another threat to the structures, road network expansion, is also visible in the imagery. Roads are discernible in the image to the east of the Minaret, on both the northern and southern sides of the east-west flowing Hari Rud River. Vibration and pollution from vehicle traffic in proximity to the Minaret could cause irreversible damage to the structure and accelerate its decay.



This photograph shows the ornate brickwork which covers the surface of the Minaret. The baked brick decorations are three dimensional, and often organized into vertical panels. Inscriptions made of small terra-cotta bricks for lettering are common, and include, for example, the entire Sura of Maryam, the 19th chapter of the Koran. Geometric and floral patterns are also common. Some inscriptions appear with a turquoise-colored glaze, while most decorative bands are unglazed brick.

The Minaret has a high level of authenticity. Since it was first constructed, no major reconstructions have taken place. However, clandestine excavations and looting of artifacts is recognized as a major threat to the integrity of the site. Therefore, in addition to engineering-based solutions for excluding water from the property, a system of regular monitoring and protection of the site would contribute to its long term conservation.

MINARET AND ARCHAEOLOGICAL REMAINS OF JAM, AFGHANISTAN

QUICKBIRD - JULY 05, 2008



The image on this page is a high spatial resolution (2.5 m) natural color QuickBird image. The Minaret of Jam is visible in the center of the image, along with other antiquities such as the ruins of a fortification. The Hari Rud River, green in color, runs east-west, and the smaller Jam River is black and runs south-north, with the confluence of the two rivers just to the west of the Minaret.





BELIZE BARRIER REEF RESERVE SYSTEM

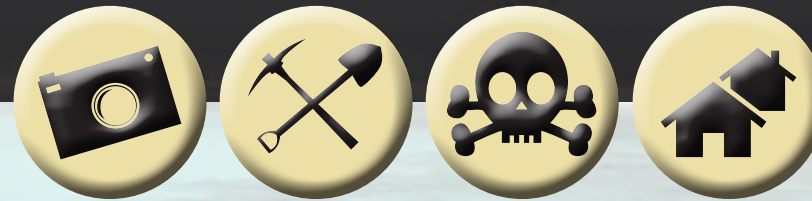


Photo taken by Olivera Rusu, www.oliverarusuphoto.com

The photograph above is a picture of the Blue Hole, one of the seven protected areas that make up the Belize Barrier Reef Reserve System. A blue hole is a unique ecosystem which is essentially an underwater sinkhole, a deep limestone depression down to the sea floor. The walls of blue holes often contain caves and overhangs, as well as interesting assemblages of fish, making them an attractive underwater destination for scuba divers. The boat exiting the Blue Hole in this photograph is likely one of many dive excursions operating in the area. The fragility of blue hole ecosystems under increasing tourism pressure is a management concern. A high resolution satellite image of the Blue Hole is also shown in the following page spread. Fish such as the squirrelfish (below) frequent the Belize Barrier Reef.



Photo taken by Bruce Avera Hunter, U.S. Geological Survey



Belize

Year of Inscription as World Heritage Site: 1996
Year of Inscription on Sites In Danger List: 2009
Belize, Stann Creek, and Toledo Districts
N16 45 00 W87 03 30

The 250 km long Belize Barrier Reef System is the world's second largest reef system after the Great Barrier Reef of Australia. The reef hugs the Belize coastline and extends from the northern border with Mexico to the southern border with Guatemala. Outside the barrier reef there are three large atolls. The coastal system of Belize is an outstanding natural ecosystem with several hundred mangrove or sand/shrub cayes, coastal lagoons and estuaries. The Belize Barrier Reef Reserve Systems contains seven separate sites, all of which are decreed protected areas. These seven sites illustrate the evolutionary history of reef development, and are a significant habitat for threatened species, including marine turtles, manatees, and the American marine crocodile. Many of the sites harbor major colonies of seabirds and waterbirds.

The site was included on the World Heritage List as a Natural Site for several reasons. It contains several examples of fringing, barrier, and atoll reef types and is therefore an example of on-going ecological and biological processes related to reef development. It is a relatively pristine system, with exceptional beauty and

aesthetic importance. Finally, it contains very important habitat for several internationally threatened marine species, as well as many endemic and migratory bird species.

A large part of the Belizean economy is dependent on fishing and tourism in the Barrier Reef, and these two industries represent a major source of over-exploitation of reef resources today. Another significant threat to the reef is habitat alteration caused by coastal development, particularly mangrove cutting and damage to shallow water benthic communities from boat traffic. Coastal development also causes nutrient enrichment from sewage discharge and surface runoff of agrochemicals. Dredging and mining of sand causes siltation, which chokes corals. For these reasons, the Belize Barrier Reef is becoming increasingly damaged, and recognition of this impairment led to the site being inscribed on the List of World Heritage Sites In Danger in 2009.

The satellite image on the facing page shows a regional view of Central America which includes the nation of Belize and its offshore

reefs and island systems. In the southern half of Belize, the Mata Mountains appear as a dark green band which extends in a northeast to southwest direction. These mountains are covered with tropical rainforests. The border between Belize and Guatemala is visible in the imagery owing to the greater deforestation on the Guatemala side.

The Great Barrier Reef System is also seen in the image, with each of the seven sites depicted as red polygons. Shallow waters appear as shades of turquoise, and both the submarine shelf and the three atolls are visible as relatively shallow areas.

BELIZE BARRIER REEF RESERVE SYSTEM, BELIZE

MODIS TERRA - MARCH 27, 2009



This satellite image was collected by the NASA MODIS (Moderate Resolution Imaging Spectrometer) sensor onboard the Terra satellite. It is a moderate spatial resolution (250 m) image using three of the 36 spectral bands. The Terra satellite views the entire Earth's surface during daylight hours every 1-2 days on a north to south orbit. A "twin" satellite on a different trajectory, the NASA Aqua satellite, also carries a MODIS sensor.

The reef and shallow waters appear as light blue and light purple areas off the coast. On land, tropical forests appear as dark green areas.



0 75 150 Kilometers

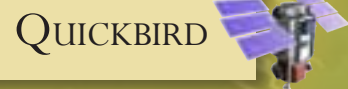




The imagery on this page is a high resolution (2.5 m) multispectral QuickBird image of Belize City, the capital of Belize. Belize City sits mainly on a peninsula, but has expanded to include northern and southern coastal development as well. Where this development occurs, coastal mangroves have been cut. Mangrove remnants are discernible in the imagery as dark green patches of vegetation in-between developed parcels. Mangrove cutting is a threat throughout the barrier reef coastal system. Also visible in this image are a number of boats. Overfishing is another serious threat to the site. Although Belize City is not part of the World Heritage site, it is a source of many of the human activities which threaten the Barrier Reef.

BELIZE BARRIER REEF RESERVE SYSTEM, BELIZE

QUICKBIRD - FEBRUARY 18, 2007



BELIZE BARRIER REEF RESERVE SYSTEM, BELIZE

IKONOS - APRIL 12, 2001



The image on this page is a high resolution (4 m) multispectral Ikonos image of the Blue Hole. The 4 m multispectral image was pan-sharpened using the 1 m panchromatic image. The pan-sharpening allows the viewer to discern wave patterns in and around the Blue Hole, and provides additional detail in the land and submerged bottom features. Variation in water depth is depicted in shades of blue, with shallow waters and reefs appearing as turquoise, and deepest waters as dark blue to black. The Blue Hole itself appears as deepwater, as it is essentially a vertical tunnel to the seafloor through the limestone reef platform. Emergent terrestrial systems appear as white/brown/orange areas.





MANOVO-GOUNDA ST. FLORIS NATIONAL PARK



The primary natural heritage value at this site is its biodiversity, both in terms of abundance of many species, and degree of endangerment for others. The variety of ecosystems within the site provide habitat for many large mammals, including hippopotamus, duiker, waterbuck, hartebeest, oribi, topi, reedbuck, water buffalo, and warthog. Roan antelope, lion (above), giraffe, and giant eland are also noteworthy in the park. Baboons are the most common primate. Ostrich are common on the plains, and some 320 species of birds have been identified.

The site contains several species of conservation concern, chief among them black rhinoceros, elephant, leopard, cheetah, hunting dog (below), shoebill, and crocodile. Poaching is the primary threat to several of these species.



Central African Republic

Year of Inscription as World Heritage Site: 1988

Year of Inscription on Sites In Danger List: 1997

Bamingui-Bangoran Province

N09 00 00 E21 30 00

The Manovo-Gounda Saint Floris National Park was inscribed as a Natural Site due to its rich diversity in ecosystems, flora and fauna. The Park encompasses three river basins, and includes excellent examples of wetlands, woody savannas, grassy floodplains, gallery forests, and a sandstone massif. The park also contains important examples of dry forests, which are threatened throughout their range.

This site is the largest park in West and Central Africa. The savannas are home to black rhinoceroses, elephants, cheetahs, leopards, wild dogs, red-fronted gazelles, buffalo, and other fauna. The northern floodplains are important for many types of waterfowl.

While many animals are abundant in the park, it is also a shelter for eight threatened species: the black rhinoceros, elephant, cheetah, leopard, wild dog, red-fronted gazelle, hoe bill, and crocodile.

The wildlife in the park is primarily threatened by large-scale poaching, bush fires, and illegal grazing of livestock. Poaching by heavily armed

poachers increased in the late 1990s, and in 1997 four park staff were shot by poachers. The park was added to the List of World Heritage Sites In Danger in that same year. The park has a small staff, and at the time there was no anti-poaching force.

A general state of deteriorating security has hindered regional development projects and tourism to the area. It has been estimated that as much as 80% of the park's wildlife may have been harvested.

The incidence of fire in the park is increasing. Whether started by poachers, illegal grazers, or others, fires are a cause for concern as they destroy important habitat. Illegal grazing is also increasing in the park, impacting the extent and composition of grasslands.

The World Heritage Committee has encouraged the definition of the boundaries of the management zones and the development of a trans-boundary wildlife migration corridor with Burkina Faso and Ghana to provide important habitat for elephants, rhinos and other species.

The satellite imagery could be useful in assisting park authorities to define the park boundaries.

The satellite image on the facing page is a moderate spatial resolution natural color image which shows the park in its regional context. The northern part of the park is a low-lying flood plain. The southern part of the park is a large sandstone massif with considerable forest cover in green. In between these two landscapes is a savanna transition zone, dissected with river systems and associated gallery forest. The image is most useful in showing the general landscape features within the park, and in general the threats are not readily discernible in the image. A fire, however, is visible in the western middle section of the park, with a smoke plume blowing from east to west.

MANOVO-GOUNDA ST. FLORIS NATIONAL PARK, CENTRAL AFRICAN REPUBLIC

MODIS TERRA - JANUARY 05, 2010



This satellite image was collected by the NASA MODIS (Moderate Resolution Imaging Spectrometer) sensor onboard the Terra satellite. It is a moderate spatial resolution (250 m) image rendered in false color using a particular combination of three of 36 spectral bands. Upland vegetation is shown in dark green and lowland vegetation is shown in purple and light green. The image includes the area of the World Heritage site (red boundary), and shows the variety of ecosystems in the park (plains, mountain forests, aquatic, etc.).

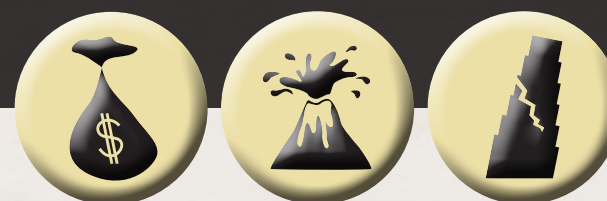


0 50 100 Kilometers





HUMBERSTONE AND SANTA LAURA SALTPETER WORKS



The Humberstone site contains three structural elements that remain today: industrial equipment (as pictured above), living quarters for mine workers, and the main town square and community buildings. These structures were constructed out of lightweight, local materials including timber frames, corrugated metal sheets for roofs, and stucco or metal walls. The buildings functioned well with regular maintenance but have fallen into disrepair since the site was abandoned in 1960.



Chile

Year of Inscription as World Heritage Site: 2005

Year of Inscription on Sites In Danger List: 2005

Iquique Province

S20 12 21 W69 47 39

The abandoned towns and derelict machinery of Humberstone and Santa Laura are important vestiges of Chile's great saltpeter industry. In 1870, thousands of workers from Chile, Peru, and Bolivia were brought together to work in the Atacama Desert of northern Chile, one of the driest deserts in the world. In this harsh climate, they forged a distinct communal "pampinos" culture, possessing unique customs, language, creativity, and solidarity.

The Humberstone and Santa Laura saltpeter works consist of two mining camps located 1.5 kilometers apart from one another. For over 60 years, the industry employed Chileans, Peruvians, and Bolivians to mine and process saltpeter, a potassium nitrate compound, for the production of nitrate fertilizer. This fertilizer fueled global agricultural advancement at that time, and generated enormous wealth and prestige for Chile.

Over the next 60-70 years the saltpeter mines, the largest natural saltpeter works in the world, were extremely productive.

During this time, the thousands of mine workers created a unique culture, and the mining towns became centers of progressive thinking about labor, injustice, and social equality. However, as the technology to produce synthetic fertilizers advanced, the mines were abandoned and the camps became ghost towns. The Humberstone and Santa Laura saltpeter were inscribed as Cultural Sites in 2005, in recognition of their profound and globally-reaching agricultural and sociocultural influences.

Post-abandonment, the towns have suffered from a lack of conservation attention. The fragile wood and metal structures have deteriorated from wind and rust, and the wood has been plundered. The greatest threat to the site is looting and associated demolition of structures. Moreover, the site is located in a seismically active region of Chile where earthquakes are not uncommon. The site was placed on the List of World Heritage Sites In Danger in July 2005 after a strong earthquake (7.8 on the Richter scale) hit northern Chile, increasing the vulnerability of the saltpeter works to collapse.

Most of the threats to the site are not detectable in satellite imagery. Nevertheless, imagery is useful in providing a contextual view of the site in its surrounding physical environment. On the facing page is a high resolution image of the site. The two mines are clearly visible as irregular scalloped patterns. The mining town of Humberstone, now a museum, is visible as a set of structures just south of the easternmost mine. Roads to and around the site are visible, as is a portion of a modern mineral extraction plant to the south, with square blue mineral deposit pans.

HUMBERSTONE AND SANTA LAURA SALTPETER WORKS, CHILE

QUICKBIRD - AUGUST 02, 2007



This image is a high resolution (61 cm) pan-sharpened QuickBird image in natural color. The image shows the two mines and their associated tailings, and the old mining town of Humberstone just south of the easternmost mine. Also discernible in the lower right image is a modern, operational mineral extraction plant.



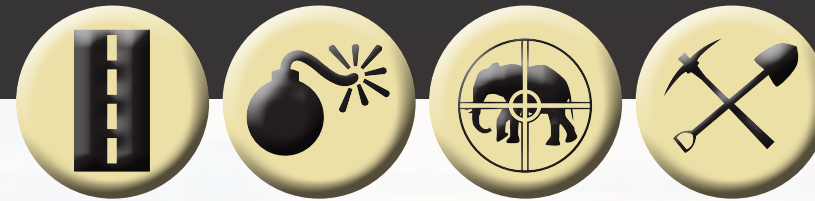
0 0.5 1.0 Kilometers



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LOS KATÍOS NATIONAL PARK



© Government of Colombia/UNESCO

Illegal logging and deforestation are a major threat to the site. The picture above shows the remains of a hardwood tree that was felled and hewn into logs at the same spot. The logs were removed by floating them out along a watercourse. The picture below shows the logs ready to be floated.



© Government of Colombia/UNESCO



Colombia

Year of Inscription as World Heritage Site: 1994
Year of Inscription on Sites In Danger List: 2009
Antioquia and Chocó Provinces
No7 40 00 W77 00 00

Los Katíos National Park was created in 1974, and was expanded to its present size of over 72,000 hectares in 1980. It is a vast trans-frontier park, adjacent to the Darién National Park, itself a World Heritage site, in Panama. The park comprises the Serranía del Darién Mountains in the west, and the floodplain of the Atrato River in the east, and is largely forested with tropical rain forests and lowland swamp forests.

The park was included as a Natural Site for its biological importance. The site contains an incredible assemblage of faunal and floral diversity, largely owing to its biogeographic development as a bridge between the Americas. The park has been and remains a filter or barrier to the interchange of plants and animals through evolutionary time. It contains spectacular waterfalls and extensive wetland formations. The park is home to many threatened animal species, as well as many endemic plants. Several typical Central American species, not found elsewhere in South America, are found in Los Katíos. Los Katíos is the only protected area in this region of Colombia, and

is a refuge for many species which might not persist if the area was not protected.

Los Katíos has been relatively well conserved since its creation, and has benefitted from the acquisition of private land within the park and considerable funding from international development projects. However, Los Katíos National Park was placed on the List of World Heritage Sites In Danger in 2009. The site is now threatened by deforestation, illegal fishing and hunting. The deforestation is occurring in and around the park, and is primarily motivated by illegal extraction of timber. The increasing deforestation is associated with growing settlement of the region in general. At times during its history as a World Heritage site, various areas within Los Katíos have been occupied by paramilitary and guerilla factions, leading to temporary closures of the park to staff and tourists.

The Panamerican Highway, which stretches from Alaska to Argentina, is complete except for an approximately 100 mile segment in the Darién and Los Katíos parks. Plans to complete

that last section have been in existence for decades. For a variety of reasons, however, the road has never been completed, and this area has come to be known as the Darién Gap. Agricultural (prevention of transmission of foot and mouth disease) and environmental (irreplaceable loss of species and habitats) concerns have halted the construction of the road on numerous occasions.

The satellite image on the facing page shows the park and its main physical features. A large river, the Atrato River, is located in the eastern lowlands of the park, flowing in a south to north direction. Extensive wetlands, the Ciénegas of Tumaradó, constitute the eastern edge of the park. The border between Colombia and Panama constitutes the boundary of the park from its westernmost to northernmost extent. Deforestation and development are discernible in the area to the north of the park.

LOS KATÍOS NATIONAL PARK, COLOMBIA

LANDSAT - MARCH 21, 1991



This satellite image is a Landsat 5 image in false color, using bands 7, 4, and 2. It has a spatial resolution of 30 m. The upper left and lower right portions of the image are somewhat obscured by "popcorn" clouds, but the area comprising the park is relatively cloud free. The mountains and hills in the western and central area of the park are easily distinguished from the lowland swamps of the eastern portion. The pink areas around the water bodies are swamp vegetation. The extensive and biologically important Tumarado swamplands are situated east of the region's major river, the Rio Atrato.



0 10 20 Kilometers





COMOÉ NATIONAL PARK



Côte d'Ivoire

Year of Inscription as World Heritage Site: 1983
Year of Inscription on Sites In Danger List: 2003
Bouna and Ferkessedougou Prefectures
No9 00 00 W04 00 00

Comoé National Park is a large Natural Site, notable for its variety of vegetation types. Initially established as a national park in 1968, it is now one of the largest protected areas in West Africa. The park has a rich floral diversity, primarily owing to the presence of the Comoé River. Some of these vegetation types, such as shrub savannas and dense rainforest, are not normally found this far north, but are well developed in the park. A number of different savanna habitats and savanna/forest transition types are found, and these support a great diversity of animals. Ecologically, the park was designed to contain whole watersheds and ecosystems, and due to this design and its large size, has remained relatively intact since its creation. This ecological integrity has been critical for the maintenance of a rich faunal diversity.

Wildlife in the park is abundant, and includes elephants, lions, leopards, chimpanzees, hippos, anubis baboons, black and white colobus monkeys, buffalo, roans antelopes, and over many species of wading birds and raptors. Reported numbers of species include 11

monkeys, 11 carnivores, 21 grazers, and 3 species of endangered crocodiles.

The park has been zoned for management purposes into a core zone where tourism is prohibited, and a buffer/tourism zone. A conservation management plan has been produced, which includes a patrol regimen, but an effective management presence has not been achieved.

The site was inscribed on the List of World Heritage Sites In Danger for three reasons: 1) increasing civil unrest in the region was threatening the integrity of the park, 2) the populations of many large mammals were decreasing due to increasing and uncontrolled poaching, and 3) an effective management presence was lacking. Illegal logging, poaching, and agricultural incursion, particularly cotton, have led to the deterioration of the site. Poaching has been targeted primarily at elephants and roan antelope. Poachers are also a source of fire, an increasing threat to the integrity of the park. Although the civil unrest has declined since the end of the Côte

d'Ivoire civil war in 2007, and the government has re-committed to improving management effectiveness, the poaching has not lessened. Moreover, mining concessions have recently been granted over the entire property.

The moderate resolution satellite image shows the park extent and the physical geography of the region. The Comoé River is the main feature discernible in the imagery, running north-south through the western third of the park. Forests appear as darker brown and green shades, while savannas are seen as lighter green and tan areas.



© Lauren Brent

Comoé National Park is rich in faunal diversity, including the charismatic colobus monkey (top), and the roan antelope (bottom). The roan antelope is particularly targeted by poachers.



Photo Taken By Rajarshi Dutta, <http://picasaweb.google.com/rajarshi/TripToComoeNationalPark#>

COMOÉ NATIONAL PARK, CÔTE D'IVOIRE

LANDSAT MOSAIC - APRIL 09, 2007 & FEBRUARY 02, 2000



The image on this page is a mosaic of two moderate resolution (30 m) Landsat images rendered in natural color. The various vegetation types are represented in shades of green. Moister rainforest and gallery forests along watercourses appear as darker shades of green and brown, while savanna types appear as lighter green shades with tans. Wet areas are dark black and light blue.

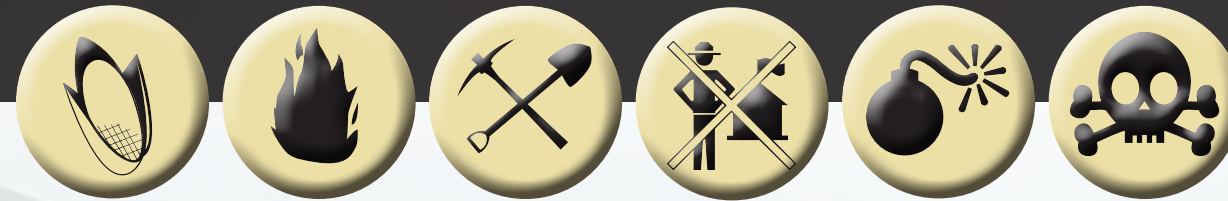


0 25 50 Kilometers





MOUNT NIMBA STRICT NATURE RESERVE



Côte d'Ivoire and Guinea

Year of Inscription as World Heritage Site : 1981
Year of Inscription on Sites In Danger List: 1992
Lola Region
No7 36 11 Wo8 23 27

Mount Nimba is a transfrontier reserve which spans the border between three African countries: Guinea, Liberia, and Côte d'Ivoire. It was first established as a nature reserve in Guinea and Côte d'Ivoire in 1944. Mount Nimba is an iron ore mountain with a high grade iron deposit. It rises 1000 m above the surrounding flat plains, and lies in a southwest to northeast transect. The ridgeline along the mountain constitutes part of the international border between Guinea to the north and Côte d'Ivoire to the south. There is great topographic variety in the area, with mountains, cliffs, hills, plateaus, valleys, bare granite blocks, and rock outcrops.

Mt. Nimba is a biogeographical barrier to evolutionary movements, and the region is therefore home to a great number of endemic plants and animals found nowhere else. This high level of endemism is one of the reasons why Mt. Nimba was established as a Natural Site. Mt. Nimba contains rich montane forests on its flanks which give way to extensive montane grasslands at higher elevations. The forests vary from moist and gallery forests to dry forests. Savanna habitat surrounds the mountain at

the lower elevations. The montane grasslands, forests, and savanna plains all contain endemic flora, and the area has been designated by the International Union for Conservation of Nature (IUCN) as a Centre of Plant Diversity.

There are also more than 200 endemic animal species, including a rare viviparous toad, which gives birth to fully developed offspring. Mammalian diversity is high, and includes bushbuck, several species of duiker, buffalo, warthog, pygmy hippopotamus, pangolin, leopard, lion, several civets and genets, otter, otter shrew, and several monkeys, including red Colobus, black and white Colobus, Diana monkey, chimpanzee, and lesser bushbaby. Certain chimpanzee groups are notable in their use of stones and other objects as tools. There are numerous rare and endemic birds, and a similarly high diversity of reptiles, amphibians, and invertebrates.

Threats to the integrity of the site are related to extraction of its rich mineral and biological resources. The major threat to the site has been habitat alteration from slash and burn agriculture

and mining operations. Over many years of mineral extraction, roads, wells, mineshafts, and even villages have been built inside the park. Mining has led to the removal of soil from the area, and many streams have been polluted with heavy metals. Mining concessions inside the park continue to operate even though many of these have been revoked. Civil unrest in the region has resulted in the emergence of several Liberian refugee camps in proximity to the site. Poaching and habitat conversion for agriculture continue, and there is a lack of an effective management presence, partly due to the general insecurity in the region. For these reasons the site was inscribed on the List of World Heritage Sites In Danger in 1992.

The satellite image on the facing page shows the extent of the site as it lies along the mountain ridge. Outside the park, development is discernible as a patchwork of cultivated areas. Inside the park, the tropical montane forests (dark green) and tropical montane grasslands (light green) are evident, and habitat conversion appears as tan colored parcels. The satellite imagery could prove useful in assisting authorities to improve boundary demarcation.



The chimpanzee pictured above is one of the many species of animals found in the site. The park is home to hundreds of plant and animal species, over 200 of which are only found in the Mount Nimba area.

In the high resolution satellite image below, smoke plumes originating from presumed slash-and-burn agriculture are evident.



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0 1 2 Kilometers

MOUNT NIMBA STRICT NATURE RESERVE, CÔTE D'IVOIRE AND GUINEA

LANDSAT - APRIL 14, 2007



The satellite image shown here is a moderate resolution (30 m), natural color Landsat 5 image. Dense tropical forests on the flanks of the mountain chain appear as a darker green, while at higher elevations, tropical montane grasslands are evident as a lighter green color. Disturbances to both vegetation types appear as tan colored parcels. In the lowlands around the mountains, a patchwork of different colored parcels indicates human settlement and agricultural development.



0 5 10 Kilometers





GARAMBA NATIONAL PARK



Democratic Republic of the Congo

Year of Inscription as World Heritage Site: 1980
Year of Inscription on Sites In Danger List: 1996
Oriental Province
No4 00 00 E29 15 00

Garamba National Park, established in 1938, is one of Africa's oldest protected areas. The park was inscribed as a Natural Site in 1980. The park contains many large and intact examples of a variety of habitat types, including savannas, grasslands, woodlands, wetlands, and forests. There are also three large hunting reserves on the eastern, western and southern boundaries, which serve as buffer zones for the park. Garamba is home to endangered populations of African elephant, giraffe, and hippopotamus. The site has been the location of the last remaining northern white rhinoceros population, and was originally inscribed as a World Heritage site largely for this reason. In the 1960s there were some 1000 individuals in the park. The endangered white rhino population has been declining steadily since that time from about 500 in 1976, to 23 in 1984. The site was placed on the List of World Heritage Sites In Danger in 1996 due to the poaching situation for the white rhino and other species like the African elephant. Effective anti-poaching measures were implemented and large-scale poaching was halted for a time.

There has been a recent breakdown in security in the northeastern area of the park due to general unrest in the region and in neighboring Sudan. Armed refugees have become an increasing problem and threaten biological and human resources. Anti-poaching efforts have been unable to control poaching, and park guards have been killed in some conflicts.

Recent searches for living white rhinos have not been able to document the persistence of the species, and it is feared to be extinct in the wild. For the past several years, the World Heritage Committee has been urging the adoption of measures to control and eradicate the human settlement and armed insurgency in and around the park. The situation has not materially improved, and the site continues to be maintained on the endangered list.

The satellite image on the facing page shows the park extent and the variety of multicolor habitats it contains. The park is dissected by many ribbon-like watercourses. The reddish and brown areas are savanna grasslands and shrublands, and the shades of green are

different forest types ranging from open woodlands to dense, closed forests. The threats to the site from poaching and civil unrest are not discernible in the imagery.

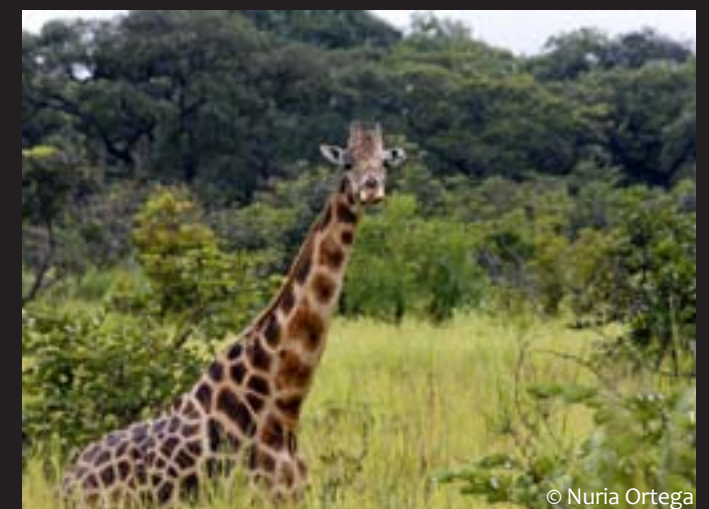


© Kes and Fraser Smith

The park's immense savannas, grasslands and woodlands, interspersed with gallery forests along the river banks and the swampy depressions, support an abundance of wildlife. Pictured here are three of many of Garamba's charismatic mammal species: the lion (middle), the endangered northern white rhino (top), and the giraffe (below).



© Nuria Ortega



© Nuria Ortega

GARAMBA NATIONAL PARK, DEMOCRATIC REPUBLIC OF THE CONGO

LANDSAT MOSAIC - APRIL 09, 2002 & JUNE 05, 2002

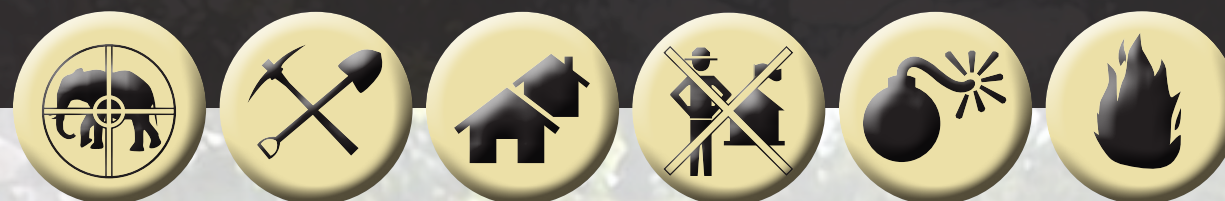


The satellite image shown on this page is a natural color mosaic of two moderate resolution (30 m) Landsat 7 ETM+ satellite images from the year 2002. Mosaics made by combining adjacent images are helpful when the location of interest spans multiple images. In this image, the diversity of colors represents the great diversity of habitat types. Watercourses are blue black, and are usually surrounded by dark green gallery forests. Lighter greens represent open broadleaf deciduous forests. Shades of tan and red represent mixtures of grasslands and shrublands.





KAHUZI-BIEGA NATIONAL PARK



Democratic Republic of the Congo

Year of Inscription as World Heritage Site: 1980
Year of Inscription on Sites In Danger List: 1997
South-Kivu and Maniema Provinces
502 30 00 E28 45 00

Kahuzi-Biega National Park is one of several Natural Sites in the Democratic Republic of the Congo. It is near the Great Rift Valley and neighboring country of Rwanda. The site is named for two extinct Rift Valley volcanoes, Mt. Biega and Mt. Kahuzi. The park has two sections, an older mountain section first established in 1970 to protect gorillas, and a newer lowland section established in 1975 to expand the protection of the gorilla habitat. Kahuzi-Biega was inscribed on the World Heritage List in 1980 for its exceptional diversity and endangered species.

The mountainous section of the park contains many types of tropical moist forest, including montane rainforest, cloud forest, bamboo forest, and swamp forests, as well as heather and peat bogs. The western lowlands section mainly contains equatorial rainforest. These different forest types support a rich diversity of mammals and birds, including 194 mammal species, and 224 species of birds. The area is within one of BirdLife International's global Endemic Bird Areas, with 42 endemic bird species. Forest

elephants, hippos, buffalo, leopards, bongos and duikers are all found in the park.

Kahuzi-Biega National Park is located in a densely populated area and is subject to a variety of threats. Poaching for bushmeat and ivory has diminished gorilla and elephant populations to alarming levels. Slash and burn farming is common along the forest edges, and tea and banana cultivation is common. An influx of Rwandan refugees, primarily seeking to mine for coltan (a mineral ore used to produce tantalum for cell phone capacitor manufacture) and gold, has had a disastrous effect on the landscape integrity of the park. Associated military invasions have exacerbated the problem, and the corridor connecting the mountain and the lowland sections has effectively been closed to animal migration. General insecurity and civil unrest in the region led to the park's inscription on the List of World Heritage Sites In Danger in 1997.

The satellite image on the facing page shows the boundary of the park, with the two sections clearly distinguishable from each

other. The older, mountainous section is the smaller, relatively narrow eastern portion, which is obscured by clouds. The newer, larger section lies to the west, and is connected to the mountainous area by a narrow corridor. The gorillas inhabiting the park are found in both lowland and montane (2100-2400 m above sea level) habitats. The satellite imagery could assist authorities to improve park boundary demarcation along ecological features.



© Kahuzi-Biega National Park/Congolese National Parks Institute

Kahuzi-Biega National Park was established to protect the endangered eastern lowland gorilla (top). The park is home to a number of other primates as well, including Anubis baboon (bottom), eastern chimpanzee, three colobus species, and five other species of monkey.



© Kahuzi-Biega National Park/Congolese National Parks Institute

KAHUZI-BIEGA NATIONAL PARK, DEMOCRATIC REPUBLIC OF THE CONGO

MODIS TERRA - MARCH 27, 2009



This satellite image was collected by the NASA MODIS (Moderate Resolution Imaging Spectrometer) sensor onboard the Terra satellite. It is a moderate spatial resolution (250 m) image rendered in natural color using a particular combination of three of 36 spectral bands. The Terra satellite views the entire Earth's surface during daylight hours every 1-2 days on a north to south orbit. A "twin" satellite, the NASA Aqua satellite, also carries a MODIS sensor, but orbits in a different trajectory.

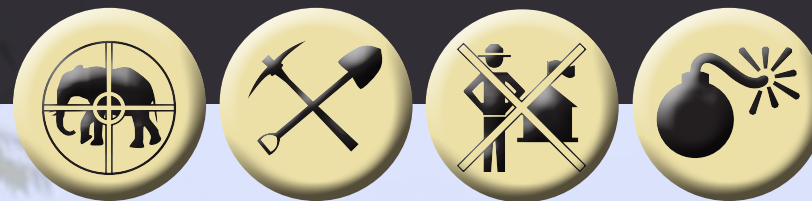


0 25 50 Kilometers





OKAPI WILDLIFE RESERVE



Democratic Republic of the Congo

Year of Inscription as World Heritage Site: 1996

Year of Inscription on Sites In Danger List: 1997

Oriental Province

No2 00 00 E28 30 0

Okapi Wildlife Reserve is a large protected area in the Congo Basin in the northeast region of the Democratic Republic of Congo. Two major rivers, the Ituri and the Epulu, drain the reserve. There are waterfalls on the rivers, and other dramatic scenery in the park, including granitic inselbergs that emerge through the canopy tops in some hilly areas. A variety of different vegetation types support abundant biodiversity, including the okapi, the namesake of the park. This member of the giraffe family is only found in this part of the world, and some 5000 of the estimated 20,000 to 30,000 remaining individuals are found in the reserve.

Over 90 mammals have been recorded from the reserve, including 17 primates. The bongo, the largest of the African forest antelope species, is at home in the reserve, as are elephants, leopards, buffalo, crocodiles, and an astonishing variety of birds. The area is also occupied by two forest dwelling, semi-nomadic hunting tribes, the Mbuti and Efe. The protected area status is reserve, rather than national park, to allow these indigenous tribes to maintain their traditional way of life.

The Okapi Wildlife Reserve was placed on the List of World Heritage Sites In Danger in 1997 in response to a deteriorating security situation in which conservation management was increasingly difficult to implement. In the 1990s, during an era of civil war, the reserve was occupied by military groups, itinerant miners, agriculturalists, and traders. An industry of trafficking in illegal timber, bushmeat, and ivory significantly impacted many species, particularly the elephant. The situation has improved considerably since 2007, with increasing governmental controls, but the reserve remains on the List of World Heritage Sites In Danger.

The satellite image on the facing pages shows the limits of the reserve. At this relatively coarse spatial resolution (250 m), only four features are easily distinguished: rivers as blue/black ribbons, clouds, vegetation (darker, olive green), and developed/altered landscapes (lighter green). A road bisects the reserve running in an east-west direction in the lower third of the reserve. It is discerned as a narrow swath of lighter green running east-west, and

where it crosses the river, the village of Epulu is located. Epulu is also shown in a higher resolution in the adjacent inset image. The satellite imagery could assist authorities to improve park boundary demarcation along ecological features.



© Kim S. Gjerstad

The photograph above captures the elusive and lesser-known okapi, the animal for which the reserve is named. Of the less than 30,000 okapi remaining in the wild, some 5000 are contained in the reserve. Although the okapi has markings similar to the zebra, it is actually one of two members of the giraffe family, along with the charismatic and universally recognized camelopard giraffe.

The picture below is a high resolution satellite image of the village of Epulu, which was a center of conflict during the recent civil war. Epulu is located along the Epulu River, and is near the center of the reserve. Visible in the image is an airstrip which served Epulu, a major jumping off point for miners, military groups, and agriculturalists to enter the forests.



Ikonos © 2002 GeoEye
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OKAPI WILDLIFE RESERVE, DEMOCRATIC REPUBLIC OF THE CONGO

MODIS AQUA - JANUARY 06, 2009



The image on this page is a MODIS Aqua image. This satellite image was collected by the NASA MODIS (Moderate Resolution Imaging Spectrometer) sensor onboard the Aqua satellite. It is a moderate spatial resolution (250 m) image rendered in natural color using a particular combination of three of 36 spectral bands. The Aqua satellite views the entire Earth's surface during daylight hours every 1-2 days. A "twin" satellite, the NASA Terra satellite, also carries a MODIS sensor, but orbits in a different trajectory.

The image in the inset on the opposite page is a high resolution, pan-sharpened Ikonos image zoomed in to the village of Epulu. An airstrip, the village extent, and forest clearing in the surrounding countryside are all discernible at this high resolution.



AQUA



0 50 100 Kilometers



SALONGA NATIONAL PARK



Democratic Republic of the Congo

Year of Inscription as World Heritage Site: 1984

Year of Inscription on Sites In Danger List: 1999

Equateur, Bandundu, Kasai Oriental and Occidental Provinces

S2 00 00 E21 00 00

Salonga National Park is the largest tropical rainforest reserve in Africa. There are two very large blocks of forest that make up the park, a northern property and a southern property. The two sections are separated from each other by a large tract of non-park land. Salonga National Park is primarily composed of lowland rainforest intermixed with swamp and gallery forest, and forest/savanna mosaics in the southern region. Several large rivers traverse the park.

More than 50 mammal species have been recorded, including nine primates. Some of these primates, are endemic to the region, including bonobo monkey, marsh monkey, and Salonga monkey. One of the reasons why the park was inscribed as a World Heritage site in 1984 was for the protection of the bonobo. The Congo peacock is another rare endemic in the park. It is one of over 150 species of birds. Freshwater fish diversity is poorly known, but probably exceeds 600 species.

Managing this park is a challenge due to its enormity and remote location. Travel in the

reserve is by foot or boat; most trips require multiple days in transit. The region is highly underdeveloped and poverty is widespread.

A network of navigable rivers provides access to most areas of the park. Illegal fishing on a commercial scale has been identified as one of the principal threats to the park, and is practiced throughout the riverine networks. Slash and burn agriculture is also widespread. Satellite imagery can be very useful in monitoring activities in such a large and remote location as Salonga National Park. There has been a proliferation of armed inhabitants, many of whom are engaged in the trafficking of bushmeat and fish.

There are at least 17 permanent settlements inside the park. Some are occupied by Kitwalistes that sought refuge in the northeastern area of the northern property in the 1970s, and have remained there since. In the southern property, the Iyaelema people, indigenous to the park area, live in 8-10 villages.

The satellite image on the facing page shows the two properties of Salonga National Park. Both properties are characterized by extensive river systems which generally drain the area in a southeast to northwest direction. These river systems are recognizable as blue and black dendritic networks throughout the park, and they indicate the areas that are most subject to poaching and habitat destruction.



Salonga National Park is dissected by numerous rivers, like the one pictured above, which furnish the primary access to the park, and provide fish for both low impact artisanal fishing and, increasingly, illegal commercial scale fishing.

The picture below is a high resolution image showing development near the northern boundary of the northern property. A road is evident as is clearing of the forest for agriculture and structures.



WORLDVIEW 1 - FEBRUARY 10, 2008



Worldview 1 © 2008 DigitalGlobe
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All Photos © Kim S. Gjerstad

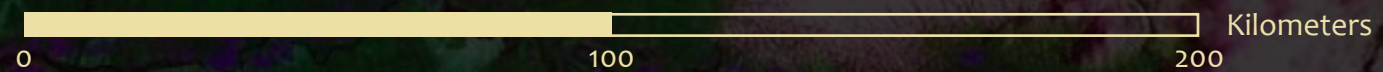
SALONGA NATIONAL PARK, DEMOCRATIC REPUBLIC OF THE CONGO

LANDSAT MOSAIC - JUNE 24, 2002 & OCTOBER 24, 1999



This image is a mosaic of two Landsat 7 ETM+ images displayed with a 7, 4, 2, false color band combination. The image shows the dendritic river networks in both the northern and southern properties.

The image in the inset on the previous page is a zoomed-in portion of a Worldview 1 high resolution (60 cm) panchromatic satellite image. This photograph depicts infrastructural development inside the park.





VIRUNGA NATIONAL PARK



Democratic Republic of the Congo

Year of Inscription as World Heritage Site: 1979
Year of Inscription on Sites In Danger List: 1994
North Kivu and Orientale Provinces
No0 55 00 E29 10 00

The Virunga National Park in the northeastern region of the Democratic Republic of the Congo is situated along the Albertine Rift, and is contiguous with six other national parks in neighboring countries. It was first established in 1925 to protect the habitat of the mountain gorillas of the Virunga volcanoes, and is the oldest park in Africa. It was established as a Natural Site in 1979.

Virunga National Park contains an astonishing variety of landscapes unequalled elsewhere on the continent. These habitats include active volcanoes, lava fields, snow-capped mountains, tropical alpine meadows, bamboo forests, heath ecosystems, montane and lowland tropical forests, savannas, dry forests, and freshwater lakes and watercourses.

This incredible landscape diversity supports an associated rich diversity and endemism in flora and fauna as well. The park is famous for its well-studied, highly endangered mountain gorilla population, currently numbering about 700 individuals. 2077 plant species have been recorded in the park, with 230 of these endemic to the Albertine Rift region. Over half (218) of the mammals found in the whole country (415) are located in Virunga. There are 1094 recorded bird

species, of which 25 are endemic to the region. Most of the fish are also endemics. In addition to the primates, also notable in the park are elephants, buffalo, many species of antelope, and hippos.

Unfortunately, most of these species are in decline due to tremendous poaching pressure. The bushmeat trade in this region is considerable, as armed poachers are increasingly entering the park. The decade long civil war in the region has created an atmosphere of general insecurity, which has hindered conservation efforts. Populations of hippos are in decline, as are elephant, buffalo, and antelopes. Populations of fish are also in decline from overfishing.

High population densities in the region are associated with increased resource extraction from the park. Slash and burn agriculture is increasingly evolving into permanent agriculture, and fishing villages are growing in size and number. A demand for fuelwood and charcoal in the neighboring city of Goma has led to the clearing of many forests inside the park. In addition to the local populace, some military groups and local authorities are engaging in the deforestation. Early efforts to implement conservation management were not adequate

to the task, and the site was placed on the List of World Heritage Sites In Danger in 1994.

The satellite image on the facing page is a moderate resolution image which shows the location of the park in the Albertine Rift. Dark green areas in the image indicate the location of remaining blocks of tropical forest, lighter green and brown areas are largely cultivated landscapes or pasture. The Virunga volcanoes, enshrouded in clouds, are located in an appendage-like section of the northeastern region of the park. This area abuts a park in Rwanda, and is home to many of the remaining mountain gorilla groups.

The lake in the middle of the park is Lake Edward, which extends into Uganda. The eastern shore of the lake, while clearly inside the park, is an area with many new fishing villages. The rapidly growing town of Goma is situated near the southern tip of the park, on the northern shores of Lake Kivu. A plume of smoke in the southern part of the park indicates a fire, probably started for charcoal or fuelwood extraction, forest clearing for agriculture, or both. Due to the lack of resources available for the management of Virunga National Park, satellite imagery represents an important resource for park rangers.



© Kim S. Gjerstad

The photographs above depict some of the striking physical geography of the park. It contains mountains (top) and active volcanoes (middle).

Two mountain gorillas are shown below, including a juvenile. Virunga National Park, the oldest national park in Africa, was first established in 1925 to protect these magnificent creatures.



© Kim S. Gjerstad



© Juan Pablo Moreiras/Fauna and Flora International

VIRUNGA NATIONAL PARK, DEMOCRATIC REPUBLIC OF THE CONGO

MODIS TERRA - JULY 06, 2010



This satellite image was collected by the NASA MODIS (Moderate Resolution Imaging Spectrometer) sensor onboard the Terra satellite. It is a moderate spatial resolution (250 m) image rendered in natural color using a particular combination of three of 36 spectral bands. The Terra satellite views the entire Earth's surface during daylight hours every 1-2 days on a north to south orbit. A "twin" satellite, the NASA Aqua satellite, also carries a MODIS sensor, but orbits in a different trajectory.

Much of Lake Edward is contained in the middle section of the park. The lakes lie in the Albertine Rift, and the Virunga volcanoes are enshrouded in clouds in the northeastern part of the park.



0 75 150 Kilometers



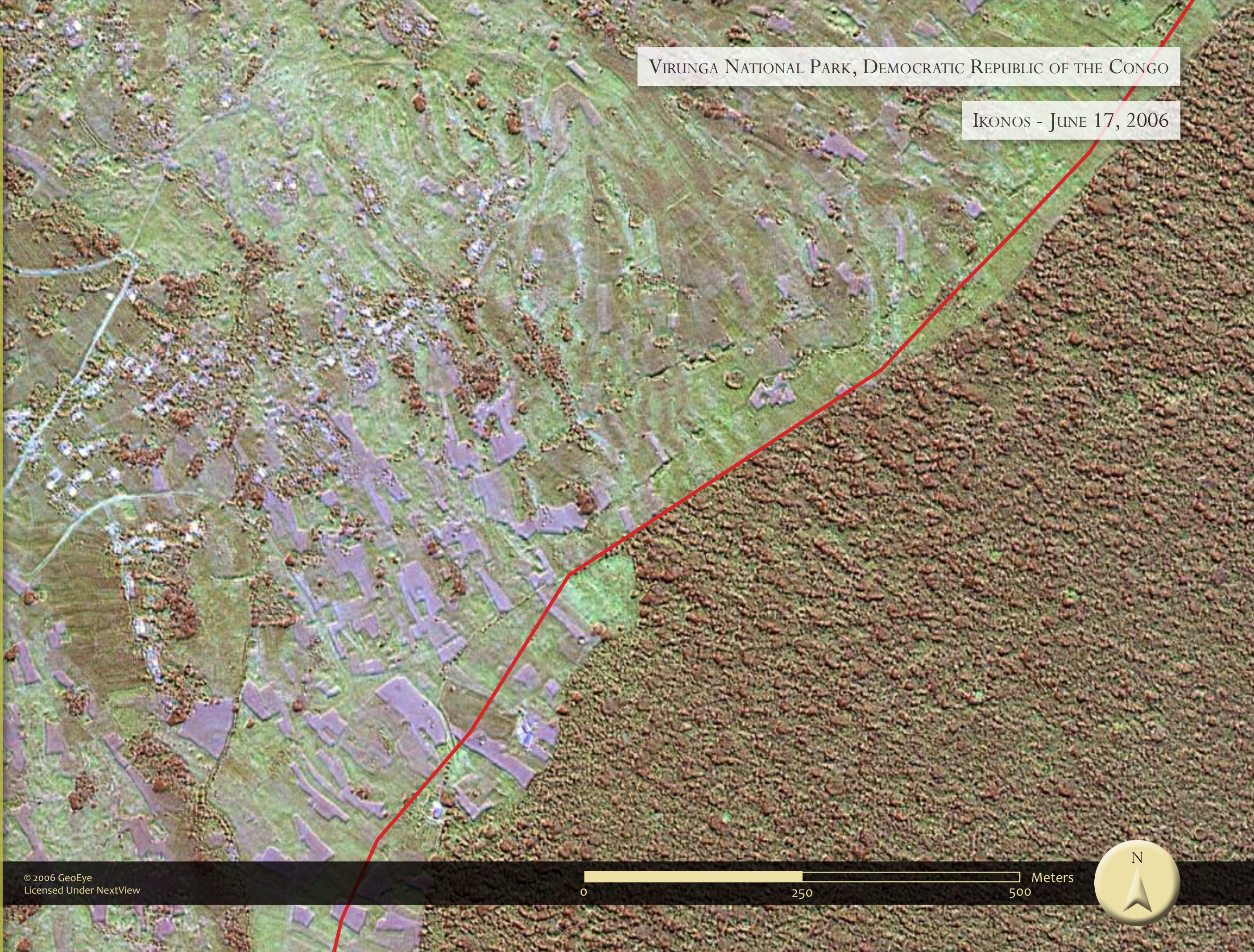


VIRUNGA NATIONAL PARK, DEMOCRATIC REPUBLIC OF THE CONGO

IKONOS - JUNE 17, 2006

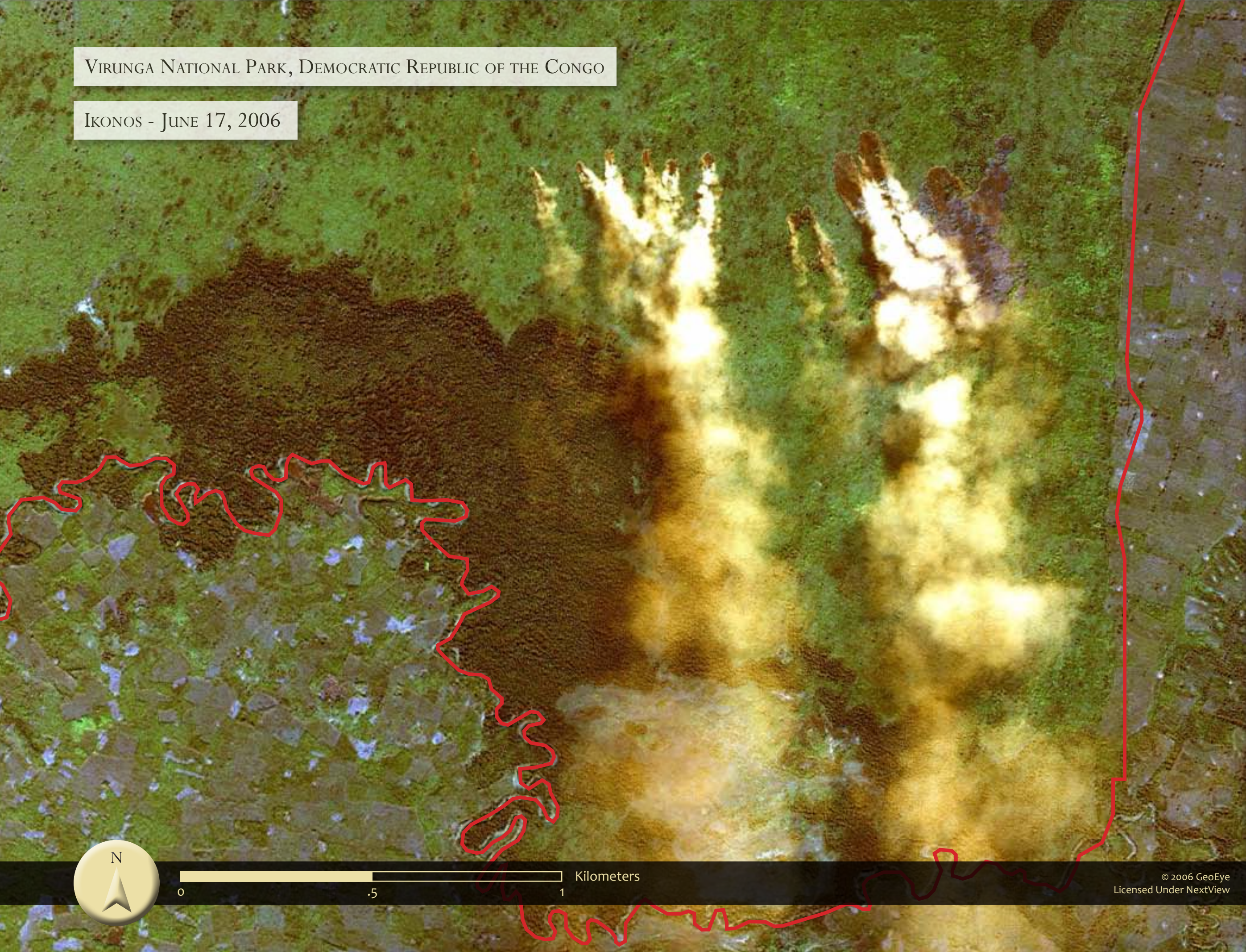
This is a high resolution (4 m) Ikonos multispectral image showing a portion of the park boundary (red) for a small area of the park along the southeastern border. The distinction between the park boundary and the surrounding countryside is dramatic. Inside the border, the area is largely dense, continuous forest, while outside the border the forest has been completely removed and the landscape transformed into agricultural development. This image dramatically illustrates the advance of the agricultural frontier right up to the park boundary.

There also appears to be some clearing of land inside the park along the forest periphery. However, misalignment of boundary lines is often observed when coarse resolution linework is overlain on high resolution imagery. Either intrusion into the park occurred, or the boundary demarcation in the image is inaccurate. Field verification can resolve these matters.



VIRUNGA NATIONAL PARK, DEMOCRATIC REPUBLIC OF THE CONGO

IKONOS - JUNE 17, 2006



This is the same Ikonos image shown on the previous page, but with another area of the border shown farther to the north along the eastern boundary. A number of fires are evident in this image, and they appear to be burning several patches of remaining dense forest in an area which is undergoing a transformation to agriculture. This type of deforestation and subsequent agricultural development within the park constitutes a major threat to its biodiversity and ecological integrity. A major road is evident outside the park in the southeast part of the image. The boundary of the park in the southern portion of this image follows a watercourse, as is evident from the meander of the line.



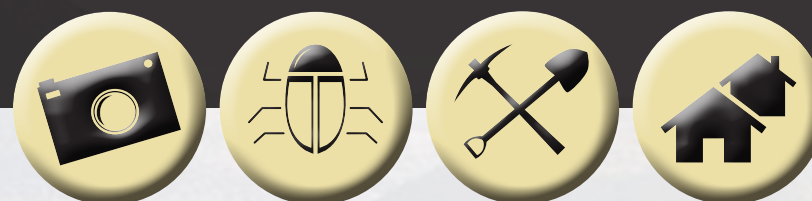
0 .5 1 Kilometers



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GALÁPAGOS ISLANDS



© UNESCO/Evergreen

The famous Galápagos giant tortoise (above), and the Galápagos land iguana (below), are endemic to the islands, as are all land dwelling reptiles found there. These charismatic creatures attract increasing numbers of visitors each year.



© UNESCO/Francesco Bandarin



Ecuador

Year of Inscription as World Heritage Site: 1978

Year of Inscription on Sites In Danger List: 2007

Year Removed from Sites In Danger List: 2010

Galá Province

Noo 49 00 W91 00 00

The Galápagos Islands are a cluster of 19 volcanic islands, some of them active, located nearly 1000 km off the coast of Ecuador. These islands, and their surrounding marine environments, exhibit a remarkable diversity of flora and fauna owing to their geographic isolation and diverse biophysical setting. The archipelago was visited by Charles Darwin in 1835, and inspired his theory of evolution and natural selection. The islands sit in the confluence of three major ocean currents, resulting in a diverse mixture of marine species, more than any other ocean islands.

The terrain is mainly uplifted marine lava flows with poor soils and limited freshwater. Habitats include rocky shoreline, vertical rock walls, sandy beaches, mangroves, upland arid zones with xerophytic and cactus species, and a higher humid zone with shrublands and grasses. These habitats contain a great many endemic species. Almost all of the reptiles are endemic, including the famous Galápagos giant tortoise, and the terrestrial and marine iguanas. There are just a few species of indigenous mammals, including seals, sea lions, rats, and bats. Of the 57 native

bird species, 28 are endemic. Marine life is rich and abundant, with relatively high levels of endemism in fishes, and sharks and rays. Dolphins, sea lions, and fur seals are abundant, and several whale species inhabit the area.

The Galápagos National Park was established by the Ecuadorian government in 1936, and was in the first group of sites inscribed on the World Heritage List in 1978. The site was inscribed as a Natural Site for its geological, ecological, and evolutionary diversity. A marine reserve, extending 40 nautical miles out to sea from the islands, has been established by the government, and was added as an extension of the World Heritage site in 2001.

The site is increasingly under pressure from the burgeoning tourist industry. Tourists come in great numbers to view exceptionally interesting animals with no or little fear of human beings. A lack of facilities to accommodate all of these tourists is a major problem, and there is little or no area remaining on the island for new development. Overfishing and illegal fishing are identified as a major threat to the resource base.

Perhaps the worst threat to the native plants and animals on the islands is the introduction and proliferation of exotic species.

The site was placed on the List of World Heritage Sites In Danger in 2007 due to concerns about increasing access points to the islands, insufficient resources and processes for quarantine and inspection, illegal immigrants, illegal fishing, unregulated numbers of visitors beyond accommodation capacity, overfishing, and lack of education reform and employment strategies for residents.

The satellite image on the facing page is a moderate resolution natural color image of the archipelago. Volcanic craters are visible on a number of the islands when not obscured by clouds. The marine environment surrounding the islands, to a distance of 40 nautical miles, is protected as the Galápagos Marine Reserve. Due to improved management efforts on behalf of Ecuadorian conservation authorities, the site was removed from the List of World Heritage Sites In Danger in 2010.

GALÁPAGOS ISLANDS, ECUADOR

MODIS AQUA - MARCH 02, 2009



The image on this page is a MODIS Aqua image. This satellite image was collected by the NASA MODIS (Moderate Resolution Imaging Spectrometer) sensor onboard the Aqua satellite. It is a moderate spatial resolution (250 m) image rendered in natural color using a particular combination of three of 36 spectral bands. The Aqua satellite views the entire Earth's surface every 1-2 days. A "twin" satellite, the NASA Terra satellite, also carries a MODIS sensor, but orbits in a different trajectory. The larger islands of the archipelago, many with volcanic craters, are visible in this image.



AQUA



0 50 100 Kilometers



This image is a 4 meter, multispectral Ikonos high resolution image of Genovese Island, one of the most remote islands in the northeastern part of the archipelago. Due to its distance from the main islands, Genovese is relatively pristine, and contains many undisturbed nesting colonies of frigate birds and boobies, as well as four of the Darwin finches. The crater of the volcano is relatively low and accessible, and is filled with saltwater. The horseshoe shaped bay on the southern end of the island, Darwin's Bay, is itself a collapsed crater. Despite long travel times, several tourist boats are seen in the bay.

GALÁPAGOS ISLANDS, ECUADOR

IKONOS - FEBRUARY 24, 2007

IKONOS



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0 .75 1.5 Kilometers



GALÁPAGOS ISLANDS, ECUADOR

IKONOS - NOVEMBER 10, 2002



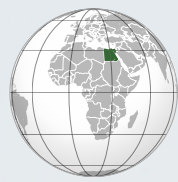
This image is a 4 meter multispectral Ikonos high resolution image of Puerto Villami on Isabela Island. This is one of the permanent settlements in the Galápagos Islands. A road leaving the southeast part of the main village leads to the main dock, located in a large block of mangroves. Mangroves are ecologically important as keystone habitats for many marine and terrestrial species. The cutting of mangroves is illegal, and has been identified as a serious threat to the integrity of the area. High resolution imagery collected in a temporal sequence can be a powerful tool for the detection of mangrove clearing.

More than a dozen boats ranging in size from small watercraft to larger cargo vessels are visible in the area around the dock. Boats can be a vector for the introduction of invasive exotic species, and overfishing is a major threat to marine habitats.

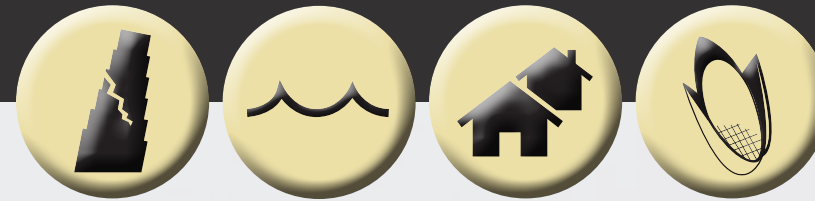


0 .3 .6 Kilometers

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ABU MENA



Egypt

Year of Inscription as World Heritage Site: 1979
Year of Inscription on Sites In Danger List: 2001
Burg al-Arab District
N30 51 00 E29 40 00

The Abu Mena Archaeological Area is the site containing the remains of an early Christian holy settlement in the northwestern portion of the Nile River Delta in Egypt. Abu Mena is situated 50 km to the southwest of Alexandria. The site started as a church built in AD 296 over the tomb of the Christian martyr, Abu Mena of Alexandria. Over the years the site was expanded, and grew to contain a baptistery, basilica, houses, streets and public buildings.

The site was a center of Christian pilgrimage during the 4th through 7th centuries. Many of the Christians came to the shrine of the famous Egyptian saint seeking healing and miracles. Abu Mena was a fine example of Alexandrian architecture, and was characterized by many marble sculptures and decorated mosaics. The site was inscribed as a Cultural Site in 1979 as an outstanding example of a type of architecture which illustrates a significant stage in human history.

The site has become a historical island surrounded by human settlement and agricultural production. Prior to the 1970s, Abu

Mena was in a relatively undeveloped area on the periphery of the Nile Delta. The advancing agriculture frontier over the last 40 years has overtaken Abu Mena, which is now completely embedded in an agricultural landscape transformed by irrigation.

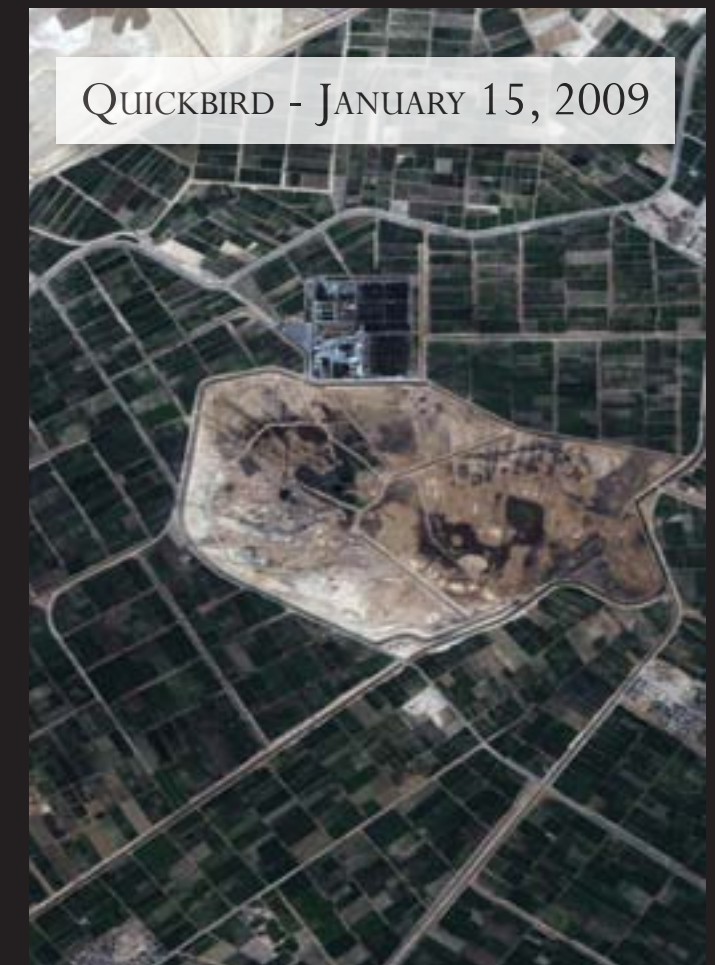
Irrigation has changed the long term hydrology in the region, resulting in a rise in the water table such that subsurface water is now much closer to the surface. The clay soil in the region is hard and compact when dry, and capable of supporting buildings and other infrastructure. However, the soil becomes soft and unstable when wet. The excess of water in the soil from the rising water table has impacted the structural stability of the site. Clay is washing away, leaving large cavities in the soil. Buildings are collapsing as the soil becomes sodden and unable to support the weight of the structure. Much of the site is in danger of collapse from structural instability. This dangerous situation has led to the site being placed on the List of World Heritage Sites In Danger in 2001. The government has implemented trenching and other hydrological diversion projects in an attempt to dry out the

area and avoid structural deterioration. The foundation of the tomb of St. Menas has been filled with sand in an attempt to add some structural integrity. These measures, however, have been inadequate, and the site remains threatened by the pressures of irrigation.

The satellite image on the facing page is a moderate resolution image taken of the Nile Delta. In this image, the locations of two World Heritage sites, Abu Mena and the Pyramids (Memphis and its Necropolis) are noted. Both sites are in proximity to development. These sites were originally in desert locations, but now are essentially historical islands within built and irrigated landscapes. The colored lines in the northwestern part of the delta indicate the approximate extents of the advancing agricultural frontier. Abu Mena was outside of the agricultural development in the 1970s, but by the 2000 era has become embedded in the irrigated landscape. The inset image on this page illustrates the historical island nature of Abu Mena today. On the following pages, the proximity of urban development to the Pyramids is shown, and a change pair (older image and newer image) for Abu Mena is presented.



The top image shows some of the remaining foundation walls of a structure in Abu Mena. The image below is a high resolution image of the site, which is completely surrounded by irrigated agricultural development.



0 2 4 Kilometers

Quickbird © 2009 DigitalGlobe
Licensed Under NextView

ABU MENA, EGYPT

MODIS AQUA - MARCH 26, 2009



— 2009 ESTIMATED EXTENT OF DEVELOPMENT
— 1973 ESTIMATED EXTENT OF DEVELOPMENT



The image on this page is a MODIS Aqua image. This satellite image was collected by the NASA MODIS (Moderate Resolution Imaging Spectrometer) sensor onboard the Aqua satellite. It is a moderate spatial resolution (250 m) image rendered in natural color using a particular combination of three of 36 spectral bands. The Aqua satellite views the entire Earth's surface every 1-2 days. A "twin" satellite, the NASA Terra satellite, also carries a MODIS sensor, but follows a different trajectory.

The regional image shows the desert (tan and brown), irrigated, riverine, and deltaic areas (green and blue), and developed and urban areas (grey).



AQUA



0 100 200 Kilometers



The Pyramids of Giza (Memphis and its Necropolis), another World Heritage site in the upper Nile region, are seen here in this high spatial resolution (2.5 m) QuickBird image. As is the case with Abu Mena, development has proceeded to the property's boundary. This site, however, is not on the List of World Heritage Sites In Danger. In spite of its proximity to dense urban development, the management of this iconic World Heritage property has been able to ensure that the Pyramids remain well conserved.

MEMPHIS AND ITS NECROPOLIS, EGYPT

QUICKBIRD - JANUARY 16, 2008



NOTE: THE PYRAMIDS OF GIZA (MEMPHIS AND ITS NECROPOLIS) ARE NOT ON THE LIST OF WORLD HERITAGE SITES IN DANGER



ABU MENA, EGYPT

LANDSAT - NOVEMBER 21, 1984



LANDSAT - SEPTEMBER 25, 2001



This page contains a change pair of moderate resolution (30 m), natural color Landsat images of the area around Abu Mena. The first image of the change pair was acquired in 1984, the second in 2001. The 2001 image shows the considerable advance of the agricultural frontier over the seventeen year period from 1984 to 2001. By 2001, the site has become completely surrounded by irrigated agricultural development. A change pair, with an older and a more recent characterization of the same area, allows an accurate quantification of land use and land cover change. The change pair shows that the problems of irrigation and development are complex and regional in nature.



0 5 10 Kilometers





SIMIEN NATIONAL PARK



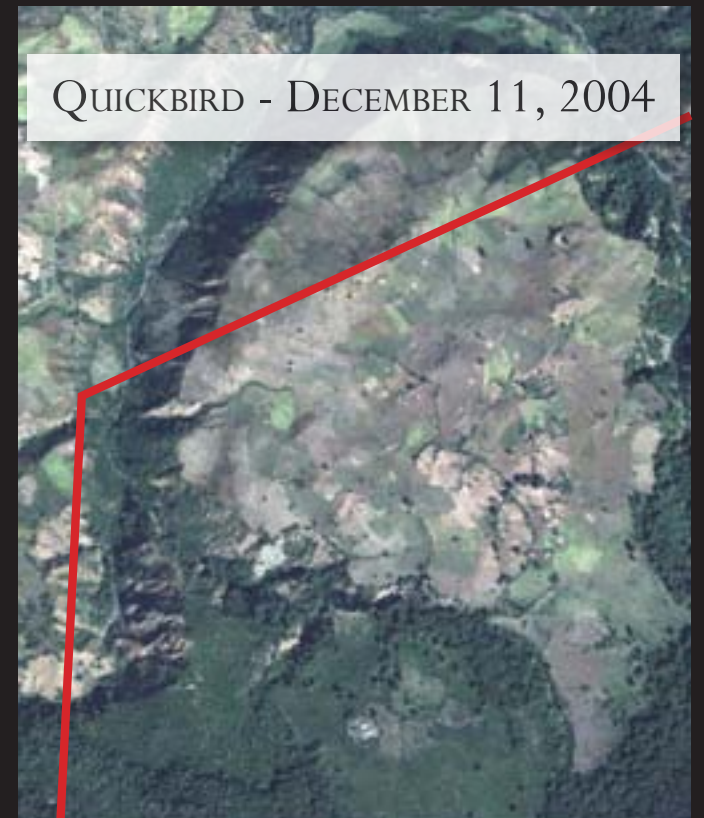
© Christof Schenck



© Christof Schenck

The Walia ibex (top), a rare and endangered mountain goat, is endemic to the park. A highly endangered Simien fox (middle), also known as the Ethiopian wolf, is endemic to the Ethiopian highlands.

The high resolution QuickBird image (bottom) shows the encroachment of human settlement into the park, a major threat to its integrity.



QUICKBIRD - DECEMBER 11, 2004

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Ethiopia

Year of Inscription as World Heritage Site: 1978
Year of Inscription on Sites In Danger List: 1996
Gondar Region
N13 10 60 E38 04 00

Simien National Park is a high plateau and mountain ecosystem in northern Ethiopia. It was one of the first World Heritage sites, inscribed in 1978. Over the past 25 million years, the plateau has eroded in many places to form sheer cliffs and deep mountain gorges which are extensive and very rugged. A great topographic variety is found here, which supports a number of vegetation types including Afro-alpine woods, heath forests, high montane vegetation, montane savannas and montane moorlands. These diverse landscapes in turn support a number of rare and endemic animals. These animals include the Walia ibex, a rare and endangered mountain goat not found elsewhere in the world. Also found here and endemic to the Ethiopian highlands is the rare and endangered Simien fox (also known as the Ethiopian Wolf) and the Gelada baboon.

In addition to these three endemic species, the park supports a number of interesting animals. Twenty-one mammals have been recorded, of which three are endemic. In addition to the Walia ibex, Gelada baboon, and Simien fox, mammals include hamadryas baboon, colobus

monkey, serval, leopard, caracal, wild cat, spotted hyena, jackal, bushbuck, duiker and klipspringer. There are seven endemic birds found in the park.

In general, the Ethiopian highlands are very densely populated agricultural areas. At the turn of the century, an estimated 10,000 people lived inside the park. The cultivation of land associated with the human communities has had a strong negative effect on native wildlife populations. Overgrazing is a key threat to the integrity of the park. A road currently goes through the park, and for a time the Walia ibex moved out of the park due to the human presence. Populations of other mammals (bushbuck, Simien fox, and bushpig) have also declined. For these reasons, the park was inscribed on the List of World Heritage Sites In Danger in 1996.

Although the park remains on the List of World Heritage Sites In Danger, management interventions are planned to change park boundaries to exclude villages along the border, and extend the park boundaries elsewhere

to include ibex populations and wolf habitat. An alternative livelihood strategy for local residents is in development in an attempt to reduce the human population density within the park. Mapping and monitoring of agricultural encroachment in the park has been identified as a high priority. Imagery such as that shown in the inset on this page enables the quantification of land use and land cover change inside and outside the park.

The satellite image on the facing page is a moderate resolution (30 m) Landsat image in natural color which shows the park in its mountainous landscape context. The northeastern region of the park is bisected by a river, the southwestern portion has a higher topographic diversity. The high resolution inset image on this page shows an area of encroaching human settlement inside the park boundaries. The satellite imagery can assist park authorities to improve park demarcation to more closely follow ecological features.

SIMIEN NATIONAL PARK, ETHIOPIA

LANDSAT - JANUARY 27, 2000



The image on this page is a Landsat 7 ETM+ moderate resolution (30 m) natural color image of the Ethiopian highlands. The topographic and vegetative diversity of this region is evident in the imagery, with river-cut valleys, forests on mountain flanks in dark green, montane grasslands in lighter green, and agriculturally developed parcels as extensive light and tan speckling.

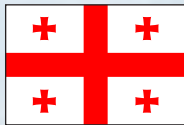


0 2.5 5 Kilometers





HISTORICAL MONUMENTS OF MTSKHETA



Georgia

Year of Inscription as World Heritage Site: 1994
Year of Inscription on Sites In Danger List: 2009
City of Mtskheta
N41 50 38 E44 42 59

The Historical Monuments of Mtskheta are a group of structures and ruins that represent examples of medieval religious architecture from an ancient kingdom in what is today the sovereign state of Georgia. The ensemble of antiquities includes surviving architectural monuments and excavated archaeological sites. Over the span of time from about 2000 BC to the present, a high level of culture and architectural sophistication was achieved, and the site is a testament to that human development. It was inscribed as a World Heritage site in 1994 as an example of an architectural style important to both the history of the country and the history of Christianity throughout its geographic distribution. Moreover, the mosaics and metalwork uncovered in archaeological expeditions are an important resource for understanding the origin and evolution of the Georgian language.

The area is in a fertile location near rivers and ancient trade routes, and has been occupied since the Bronze Age (2000-3000 BC). The ancient kingdom of Iberia rose to prominence in the 4th century BC, with Mtskheta as its capital.

The city was destroyed and rebuilt several times throughout its long history, and was always politically important in the region. Although rebuilt several times, many of the structures from the earlier periods remained. Christianity arrived in the region in the 4th century AD, brought by the famous Georgian saint, St. Nino. A new set of structures, including cathedrals, smaller churches, monasteries, and shrines, were created.

Today, the ensemble of antiquities are protected by law, and the town has been declared a City Museum. Though restored and reconstructed several times over the course of 4000 years, the site has retained a large measure of authenticity. Collectively, the buildings and remains are very important in understanding the Georgian culture.

In 2009, however, the site was placed on the List of World Heritage Sites In Danger. The state of conservation was reported to have been deteriorating at the turn of the century. Inappropriate reconstruction interventions involving use of non-authentic materials had occurred which jeopardized the authenticity

of the site. New structures had been erected in some of the complexes of ancient buildings. The legal boundaries defined for the site were not found to be accurate or sufficient for the protection of Heritage values. The satellite imagery could assist conservation authorities in defining the site boundaries. Funding for management was considered inadequate, and a management plan and presence were also insufficient to the conservation task. Acid rain has also damaged the stonework.

The satellite image on the facing page is a high resolution image of the city of Mtskheta, located at the confluence of two rivers. The major threats to the site, loss of authenticity, inadequate management resources, etc. are not discernible in the imagery at this scale. The image is useful, however, in showing the juxtaposition of the locations of the monuments within the surrounding urban development. Moreover, the high resolution image can be zoomed in to show single structures in great detail, and could detect the erection of new, inappropriate structures within the monument site.



Photo Taken By Claire à Taiwan, <http://www.flickr.com/photos/clairea taiwan/>

These photographs depict two of the structural antiquities at the ancient Georgian capital of Mtskheta. The site contains significant examples of Georgian Christian architecture in the form of monasteries, cathedrals, fortresses, palaces, tombs, churches, and ancient gardens.

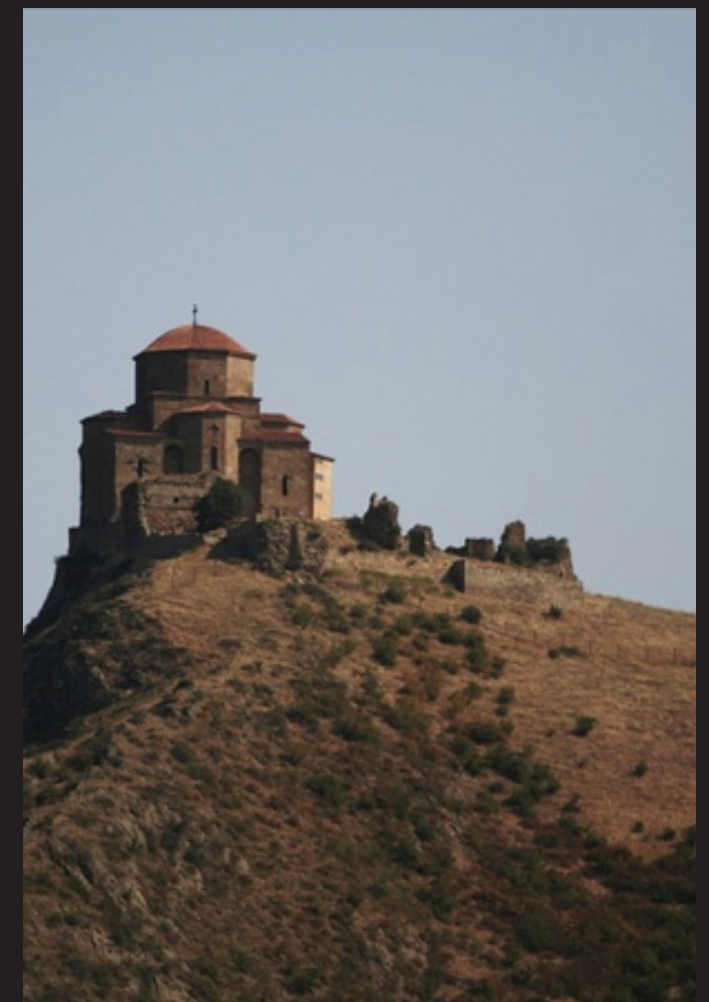


Photo Taken By Dariva, <http://www.flickr.com/photos/27611747@Noo>

HISTORICAL MONUMENTS OF MTSKHETA, GEORGIA

WORLDVIEW 1 - AUGUST 26, 2008

 BEBRIS TSIKHE FORTRESS

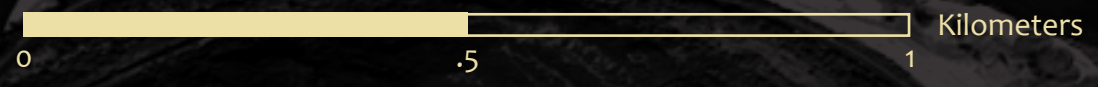
 SAMTAVRO MONASTERY

 SVETITSKHOVELI CATHEDRAL

JVARI MONASTERY 



The satellite image on this page is a high spatial resolution (61 cm), panchromatic (black and white) QuickBird image. The layout of the city, located at the confluence of two rivers, is evident in the image. The locations of four of the Mtskheta churches are shown.



Worldview 1 © 2008 DigitalGlobe
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MANAS WILDLIFE SANCTUARY



These photographs provide an interesting juxtaposition between two of the charismatic animals included in the fauna of Manas Wildlife Sanctuary. The Asian elephants in the picture above are encountered in the reserve, and have even been domesticated. On the other extreme, the tiger is rarely encountered, but leaves its tracks (below) as a reminder of its presence and place in the ecosystem.



India

Year of Inscription as World Heritage Site: 1985
Year of Inscription on Sites In Danger List: 1992
Year Removed from Sites In Danger List: 2011
State of Assam
N26 43 30 E91 01 50

Manas Wildlife Sanctuary is a protected area in the north of the Indian state of Assam along the border with Bhutan. The sanctuary is in a low altitude flat plain just south of the foothills of the Himalaya Mountains. The plain slopes to the south, and is dissected by numerous rivers, including the Manas River, which drain the Himalayas, carrying a substantial amount of silt and rock debris. Much of the sanctuary is an alluvial plain formed from these depositional materials. The park contains tropical semi-evergreen forests, tropical deciduous forests (moist and dry), wetlands, and alluvial grasslands.

These varied habitats support an astonishing diversity of plants and animals, including some very rare and endangered species. Recorded species in the sanctuary include 55 mammals, 36 reptiles, 3 amphibians, over 300 birds. The most notable fauna include Asian elephant, tiger, the greater one-horned rhino, clouded leopard, sloth bear, buffalo, pigmy hog, hispid hare, golden langur, Bengal florican, and gharial.

The sanctuary contains viable habitat for the pigmy hog and the hispid hare, two rare and endangered regional endemics, as well as over more than a dozen other threatened species. Part of the reserve was decreed as a protected forest as early as 1907. The Manas Wildlife Sanctuary was created in 1973 as the core of the larger Manas Tiger Reserve. In 1985, primarily to protect viable habitat of the pigmy hog and the hispid hare, the Manas Wildlife Sanctuary was inscribed as a World Heritage site.

The sanctuary is a wilderness zone, with no resource extraction permitted. Boundaries are clearly marked. Monitoring efforts are in place, and prior to 1989, management efforts were effective at conserving the park's rich natural heritage.

In the period from 1989 to 1992, Bodo militants occupied the park while attempting to create an autonomous state. During this time there were armed attacks against park personnel, and the staff abandoned their posts. Much of the park's infrastructure

was destroyed. Poaching and illegal timber extraction ensued, and habitat for rare and endangered species was threatened. The park was inscribed on the List of World Heritage Sites In Danger in 1992. Today the major problem facing the park is the alienation of local villagers, who have always depended on the park's resources, but are increasingly prevented from accessing them. Poaching of wildlife and timber continues.

The satellite image on the facing page is a moderate resolution image that shows the boundary of the reserve and its location in the foothills of the Himalaya. The landscape south of the park is highly developed, and the cultivated parcels extend to the park boundary. The northern boundary of the park, also the international border with Bhutan, is not similarly developed, owing to the existence of the Royal Manas National Park of Bhutan. The foothills of the Himalayas are discernible in the northern part of the park. The park is also very well dissected by numerous shifting river channels, which drain the park from north to south.

MANAS WILDLIFE SANCTUARY, INDIA

LANDSAT MOSAIC - DECEMBER 05, 2006



This image is a mosaic of natural color, moderate resolution (30 m) Landsat images which show the sanctuary in its landscape context. Mountainous regions are seen in the north, where many rivers rise and flow to the south. The largest river, in the western region of the park, is the Manas River. This river is comprised of many shifting river channels. The development frontier to the south of the park advances directly to the reserve boundary along most of the southern periphery.



0 10 20 Kilometers





BAM AND ITS CULTURAL LANDSCAPE



© Sacred Sites/Martin Gray

These images depict sections of the Bam citadel, with its beautiful mud-brick architecture, prior to the earthquake of 2003.



© Sacred Sites/Martin Gray



Iran (Islamic Republic of)

Year of Inscription as World Heritage Site: 2004

Year of Inscription on Sites In Danger List: 2004

Kerman Province

N29 07 00 E58 22 07

Bam and its Cultural Landscape is located on the southern edge of the Iranian plateau, in a desert oasis. Several ancient trade routes came through this area, including the great Silk Road. First established around 500 BC, Bam reached its peak as an ancient civilization from about AD 700 to 1100. It was an important center of production for elegant garments, and was known for its impressive military fortress, bustling bazaars, and palm trees. The ancient citadel and settlement of Bam, Arg-e Bam, was built using mud layers and mud bricks, in a traditional style of architecture representative of the ancient culture. Due to its location, Bam supported a culture enriched by many interacting influences.

Bam was also remarkable for the system of underground mud chambers, pipes and tunnels (called qanats) which transformed the inhospitable desert into a flourishing oasis. The qanats allow limited agricultural production, and have been sustainable over the centuries. They continue to function today, and are used for the production of dates, for which Bam is famous.

Bam is considered to be the largest mud brick complex of its kind in the world, retaining its original architecture and layout. Unfortunately, in December of 2003, a powerful earthquake devastated the Bam historical site and surrounding town, killing approximately 30,000 inhabitants. Most standing structures were essentially destroyed, the citadel reduced to a field of rubble.

In spite of the devastation, the site was inscribed as a World Heritage site in 2004 for its historical and cultural value. Due to the widespread destruction of structures, the site was immediately inscribed on the List of World Heritage Sites In Danger. The site still holds incredible architectural value as well, in the structures that remain. Moreover, the earthquake opened access to new archaeological sites containing new discoveries, many of which remained intact. Following active participation in humanitarian relief efforts, UNESCO has been involved with national, local, and foreign organizations to plan for and implement restoration of Bam.

The satellite image on the facing page is a Landsat image of the region taken in 1999, prior to the earthquake. The location of the ancient citadel and historic settlement is indicated by a symbol in the north-central part of the image. The modern town of Bam surrounds the citadel on the eastern, western, and southern sides. The major threat to this site is vulnerability to earthquakes. The location of the epicenter of the 2003 earthquake is indicated by a symbol in the south-central part of the image. Emerging satellite technologies using radar enable the determination of the exact location of earthquake epicenters.

BAM AND ITS CULTURAL LANDSCAPE, IRAN (ISLAMIC REPUBLIC OF)



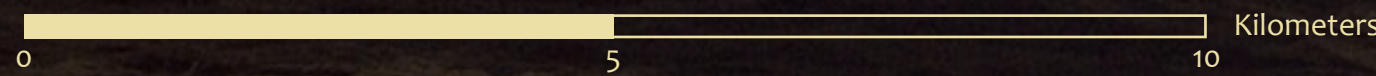
LANDSAT - OCTOBER 01, 1999



This image is a moderate spatial resolution (30 m) Landsat image of the ancient and modern towns of Bam. The image is rendered in natural color. Bam is located in a desert environment on a high plateau. The dark greens in the image depict vegetation, largely date palm plantations. An ancient but still functioning system of underground mud irrigation pipes supplies water for the vegetation. Purple, gray, yellow, and white represent the desert. The epicenter of the 2003 earthquake is located in the south central part of the image.



EPICENTER OF 2003 EARTHQUAKE



BAM AND ITS CULTURAL LANDSCAPE, IRAN (ISLAMIC REPUBLIC OF)

QUICKBIRD - SEPTEMBER 30, 2003



BAM AND ITS CULTURAL LANDSCAPE, IRAN (ISLAMIC REPUBLIC OF)

QUICKBIRD - JANUARY 03, 2004



The images on these two pages are high resolution images of the historical site of Bam, three months before (left) and one week after (right) the earthquake. The images are natural color QuickBird multi-spectral images at a 4 meter spatial resolution. The devastation is clearly seen in the image on this page, primarily as a loss of definition of geometric shapes, and disappearance of whole structures and roads. The devastation is evident both within the site, and in the surrounding town, especially to the northwest, which has been turned into rubble. Approximately 30,000 human lives were lost in this catastrophe.



0 200 400 Meters

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ASHUR (QAL'AT SHERQAT)



Iraq

Year of Inscription as World Heritage Site: 2003
Year of Inscription on Sites In Danger List: 2003
Salah ad Din Governorate
N35 27 32 E43 15 34

Ashur was the first capital of the Assyrian Empire, founded in the 3rd millennium BC. It is located on the western bank of the Tigris River in northern Iraq about 390 km north of Baghdad. Ashur rose to prominence during the period from 1400 to 1100 BC, and exerted tremendous political, religious, and artistic influence throughout Assyria. The ancient city was named for the Assyrian god Ashur, and was a place of worship and a seat of power for kingdoms. It is one of very few sites in the region representing continuous occupation, multi-period development.

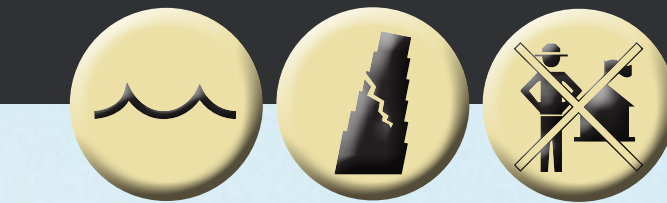
Ashur today is a set of archaeological excavations through different stratigraphic layers dating back to its earliest settlements. It contains a major temple of worship to Ashur and a significant ziggurat, a terraced, pyramid-like holy structure found elsewhere in the region as well. Two partial, lesser ziggurats are also present, as well as the remains of a palace, royal tombs, other temples, and living quarters.

For its importance as the center of Assyrian civilization, and its rich collection of excavations

from multiple time periods in its long history, Ashur was inscribed as a Cultural Site in 2003. Many excavations and restorations have taken place over generations, and there is rubble from these excavations throughout the property. A conservation management focus has been advocated at Ashur from the start of these excavations, and the site has contained a museum in past years.

The major threat to the site is hydrological. Situated on the banks of the Tigris River, both occasional flooding and sustained high water tables are experienced. The structural integrity of the site, and in particular the walls and antiquities near to the river bank, is impacted by the instability of the substrate during flooding. Parts of the site have been steadily eroding away.

The vulnerability to flood events, and concerns over the high water impacts of a reservoir created by a dam being constructed 30 km downstream resulted in the direct inscription of the site on the List of World Heritage Sites In Danger in 2003. There were fears that the



reservoir created by the dam would flood parts of the archaeological area. Campaigns to circumvent flooding impacts by the construction of coffer dams and gabion-reinforced stream banks and structures were launched.

The satellite image on the facing page is a high resolution (2.5 m) image showing the location of the site on the Tigris River. The river is to the west of the site, and water in the channel appears as blue or aqua color. The image also shows where flooding and high water table might impact the site, particularly in the southeast section of the excavation. The orange hatchmarks are an actual observation of the extent of inundation from a flood event in 1993, as interpreted from a Landsat image (not shown). The yellow hatchmarks are an estimate of potential surface flooding resulting from the construction of the dam downriver from the site. Satellite imagery can be useful in hydrological modeling to predict inundations.



© UNESCO/Véronique Dauge


These two photographs show excavated areas of Ashur and views of the Tigris River floodplain. The site is vulnerable to the breaching of certain walls by the rising river in times of extreme storm events, or from construction of a downstream reservoir.




© UNESCO/Giovanni Boccardi

ASHUR (QAL'AT SHERQAT), IRAQ

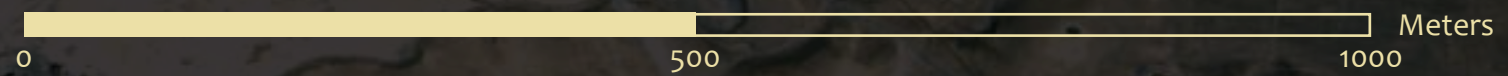
QUICKBIRD - AUGUST 02, 2005

 MODELED POTENTIAL INUNDATION EXTENT

 OBSERVED (1993) INUNDATION EXTENT
(FROM LANDSAT IMAGE INTREPRETATION)



The image on this page is a high resolution (2.5 m) QuickBird multispectral image rendered in natural color. It shows the location of the Ashur site along the banks of the Tigris River. The water in the Tigris River is an aqua to dark blue color. The yellow shading denotes potential (modeled) flooded/ high water table areas associated with the rising waters from the reservoir construction downstream. The orange shading depicts the extent of flooding from a past high water event, as interpreted from a 1993 Landsat image (not shown).



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SAMARRA ARCHAEOLOGICAL CITY



Iraq

Year of Inscription as World Heritage Site: 2007
Year of Inscription on Sites In Danger List: 2007
Salah ad Din Governorate
N34 20 28 E43 49 25

Samarra is an ancient city that represents the seat of power and influence of the Islamic empire of Abbasid. This empire stretched from northern Africa to central Asia during the period from 836 – 892. The site is located on both sides of the Tigris River, and is a collection of historical landscapes and antiquities along a 40 km stretch of the river about 130 km north of Baghdad. Many of the sites remain unexcavated.

The original plan, architecture, and artistic constructions are largely retained, and Samarra is the only ancient Islamic capital that has survived as such. It contains two large mosques, several minarets, and the largest palaces in the Islamic world. An artistic style of working with stucco was developed there and spread throughout the Islamic world at the time. It was inscribed as a Cultural Site in 2007 in recognition of its cultural, historical, and artistic importance. It represents a significant stage in architectural development in the Abbasid period for its mosques and associated settlements, as well as its decorations and ceramic industries. It is the finest preserved

example of the pride and workmanship of the empire of the Abbasid Caliphate, a world power at the time.

Military occupation of the area since 2003 and the associated armed conflict is a major threat to the integrity of the site. For this reason the site was inscribed directly into the List of World Heritage Sites In Danger in 2007. The hostilities in the area have resulted in an inability of the management authorities to control the sites. Some areas have been damaged from vehicular traffic, explosions, looting and agricultural intrusion.

Tourism has not been a threat since the start of the armed conflict, but graffiti and defacement of mosaics are observed. Dust from rain and wind represents a significant natural threat, and excavated areas are subject to rapid burial. Dumping of garbage and debris has created an environmental problem at some of the antiquities. The major problem facing Samarra is the inability of authorities to maintain a conservation management presence due to the political unrest in the region.

The satellite image on the facing page is a moderate resolution image showing the location of the site along the Tigris River. This is a color infrared rendering, which results in vegetation appearing as red. The Samarra World Heritage site is a collection of antiquities spread out over a large region. Each of the antiquities, the locations of which are depicted with the World Heritage symbol, is a unique historical and holy site.



These photographs show some of the architectural and artistic treasures at Samarra. The image above is the spiral minaret of the Abu Dulaf Mosque, and the photograph below shows some of the ornate artwork included in the interior walls of a house.



SAMARRA ARCHAEOLOGICAL CITY, IRAQ

LANDSAT - JULY 06, 1976



This is a moderate resolution (30 m) Landsat image rendered in color infrared using a particular combination of bands. In a color infrared image, vegetation appears as red, with lush and healthy vegetation noticeable as a deep red color. The image shows an arid desert surrounding the Tigris River, which is seen as a north-south ribbon of blue and black in the center of the image. There is considerable vegetation in the river channel. Each World Heritage symbol represents the location of one of the many antiquities.





The image on this page is a high resolution (2.5 m), pan-sharpened, multispectral QuickBird image of the Great Mosque and the Malwiya spiral minaret, one of the most famous of the Samarra antiquities, and a revered Islam shrine. The mosque was the largest in the Islamic world at the time. The mosque is an open courtyard surrounded by 10 m high walls. A parking lot for visitors, with several vehicles, is evident to the immediate west of the mosque.

SAMARRA ARCHAEOLOGICAL CITY, IRAQ

QUICKBIRD - JULY 05, 2008



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SAMARRA ARCHAEOLOGICAL CITY, IRAQ

QUICKBIRD - JANUARY 06, 2005



SAMARRA ARCHAEOLOGICAL CITY, IRAQ

QUICKBIRD - JULY 05, 2008



The images on this page are high resolution (61cm) QuickBird panchromatic images of the modern city of Samarra. In the middle of each image is the al-Askiriya Mosque, a famous and revered antiquity containing the tombs of two holy imams. In 2006, the famous golden dome of the mosque was obliterated in a terrorist explosion. These before (left) and after (right) images reveal the impact of the explosion. The dome, clearly discernible in the left image, is missing from the right image. Although this site is outside of the core zone of the World Heritage site, it is an illustrative example of the effect of civil unrest impacting the greater Samarra archaeological site and similar cultural treasures elsewhere in the country.



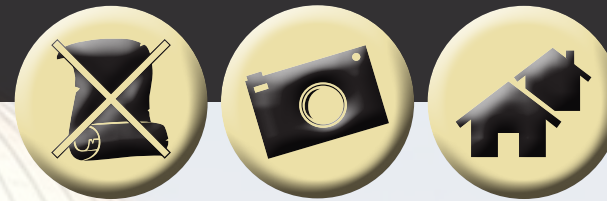
0 150 300 Meters



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OLD CITY OF JERUSALEM AND ITS WALLS



© UNESCO/Francesco Bandarin

These photographs represent some of the most important holy sites in Christianity, Judaism and Islam. The photograph above is of the Church of the Resurrection, also called the Church of the Holy Sepulchre, and the picture below shows the Western Wall, an important prayer and pilgrimage site in the Jewish religion. The Dome of the Rock, one of the most important mosques in all of Islam, rises up above the Western Wall.



© UNESCO/Peter von Puttnamer

The Old City of Jerusalem and its Walls (Site Proposed By Jordan)

Year of Inscription as World Heritage Site: 1981
Year of Inscription on Sites In Danger List: 1982
Jerusalem District
N31 47 00 E35 13 00

The walled city of Jerusalem is one of the most important holy places on Earth. It is a very significant and revered site for the three monotheistic religions of humankind: Judaism, Christianity, and Islam. Jerusalem contains important shrines and places of worship for each of these faiths. The Western Wall, an ancient foundational wall of the second Jewish Temple, is an important place of prayer and pilgrimage and is visited continuously by worshippers. The Dome of the Rock is a revered shrine. With the al-Aqsa Mosque, the Dome of the Rock is the third sacred place of Islam after Mecca and Medina in Saudi Arabia. The Church of the Holy Sepulchre is a venerated pilgrimage site as the location of the crucifixion and burial of Jesus. Each of these major monuments has had considerable influence on the development and continuity of these great monotheistic religions, and their associated art and architecture.

The nomination of the Old City of Jerusalem, submitted in 1980, recognized the importance of protecting the totality of Jerusalem given its importance to the three religions. The Old

City was inscribed as a Cultural Site in 1981 for its exceptional cultural, historical, religious, architectural, and artistic values.

In 1982, a year after its inscription as a World Heritage site, the Old City of Jerusalem was inscribed on the List of World Heritage In Danger and remains there today. The primary threat to the integrity of the site is loss of historical authenticity and loss of cultural significance. Tourism is rampant, and structural changes associated with the development of this industry have been damaging. The area was also characterized as suffering from rapid urbanization.

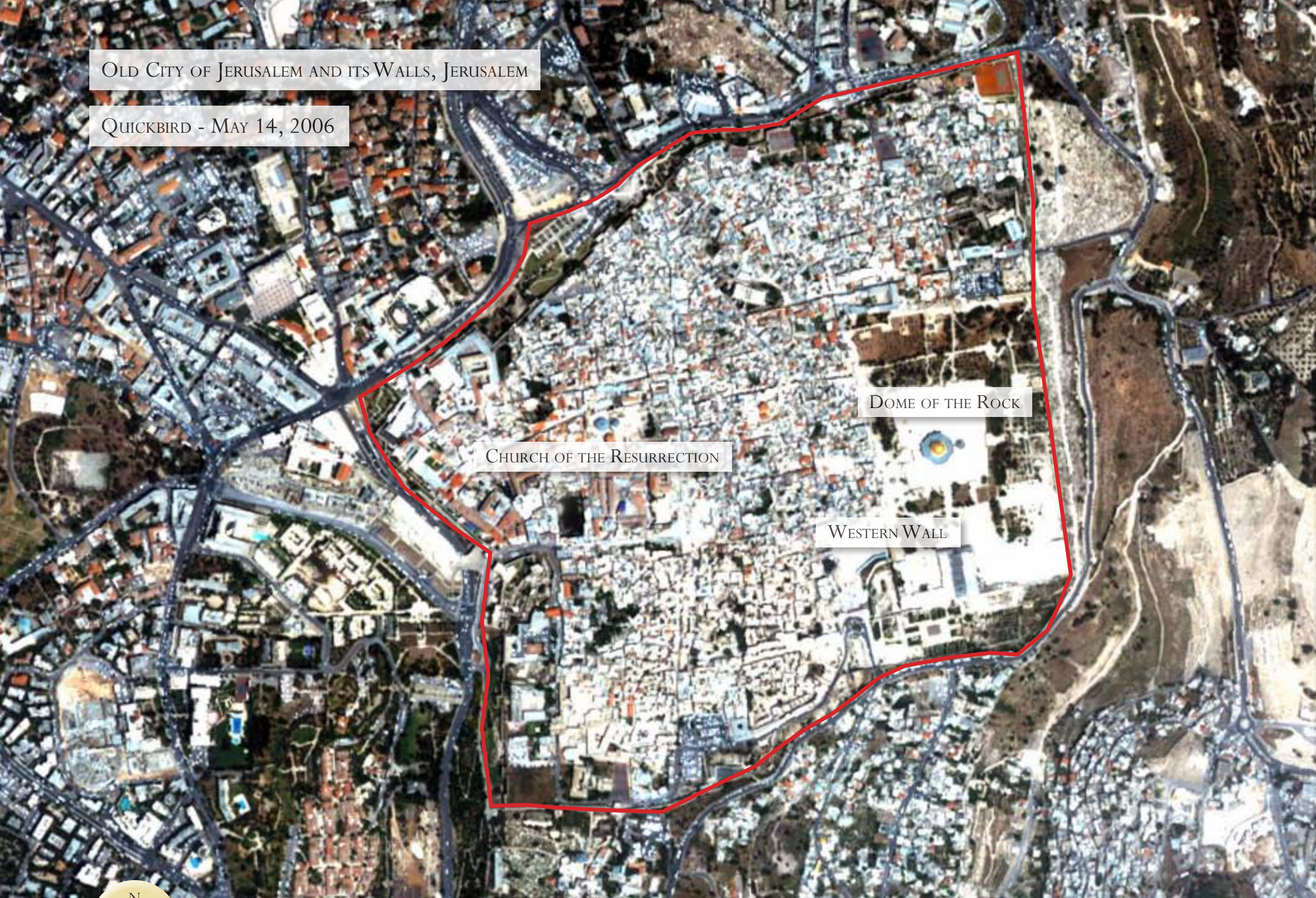
The satellite image on the facing page is a high resolution image of the old walled city of Jerusalem. The urbanization surrounding the walled city is evident. Some of the most venerated structures of Judaism, Islam, and Christianity are visible in this satellite image. The Dome of the Rock is in the eastern section of the old city and the cupola and base of the shrine is visible as a gold circle in a blue octagon. The Dome is surrounded by an open

courtyard where green vegetation is evident. Another famous site, the al-Aqsa Mosque, is located in the southern portion of the courtyard, appearing as a dark grey T-shape. The Western Wall is just west of a large grove of trees below the Dome of the Rock and the al-Aqsa Mosque. The Church of the Holy Sepulchre is located west of the Dome of the Rock, with its cupola discernible as a blue circle.

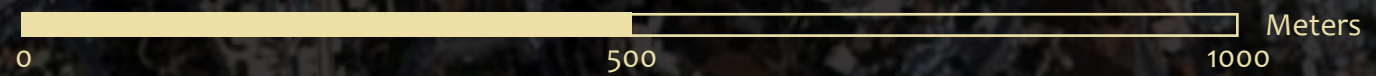
© UNESCO/Francesco Bandarin

OLD CITY OF JERUSALEM AND ITS WALLS, JERUSALEM

QUICKBIRD - MAY 14, 2006



The image on this page is a high resolution (2.5 m), multispectral QuickBird image showing the old city of Jerusalem, and its surrounding urbanized setting. The resolution is sufficient to discern several major monuments in Jerusalem, including the Dome of the Rock, the Western Wall, and the Church of the Resurrection.



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AIR AND TÉNÉRÉ NATURAL RESERVES



Niger

Year of Inscription as World Heritage Site: 1991
Year of Inscription on Sites In Danger List: 1992
Department of Agadez
N18 00 00 E09 00 00

This reserve, the largest protected area in Africa, sits in the Sahara Desert region of north central Niger. Much of the reserve is barren desert, but the volcanic Air Mountains in the western part of the reserve represent northern pockets of the Sahel ecoclimatic zone. The reserve was first gazetted in 1988 as an approximately 7.5 million hectare reserve with an inner core wildlife sanctuary of approximately 1.2 million hectares. The mountain massifs rise to heights of 2000 m, are very geologically diverse, and contain a variety of wet and dry habitats.

The diversity in habitat types gives rise to a similar high richness of species. Species numbers recorded from assessments in the reserve have included 40 mammals, 165 birds, 18 reptiles and one amphibian. The reserve is home to several threatened Saharan desert antelopes, including the Dorcas gazelle, the Dama gazelle, the aoudad and the addax, the largest wild animal in the Sahara. Other threatened species recorded in the reserve include the cheetah and the ostrich. The reserve was inscribed as a Natural Site in

1991 for its geological and biological diversity and beauty, and as an important area for endangered species.

The site has been inhabited by humans for over 30,000 years. It has high archaeological value, and is recognized as an area demonstrating the harmonious interaction of man and the environment; these outstanding values are also recognized in the World Heritage designation. Today, the reserve is home to both resident and nomadic pastoralist Tuareg people.

The civil unrest and military conflict in the region resulted in the reserve being inscribed on the Endangered Heritage list in 1992. These hostilities included hostage-taking of several park staff. Poaching of animals, particularly ostrich, and illegal international trade of live animals has contributed to declining populations of species. Subsequent peace agreements between government and rebel groups improved the situation considerably, but threats to the natural heritage continue, owing to the fragile state of conservation of many threatened and declining species.

The image on the facing page is a striking Landsat image mosaic of the desert region around the site. Multiple satellite images between 1986 and 1990 were acquired and mosaicked together to cover the very large area. The core (inner polygon) reserve is a strict nature conservation reserve set up to protect the critically endangered addax, one of the screw-horned antelopes. The outer polygon delimits the larger extent of the World Heritage site, from which managed resource extraction is permitted. The variety of pink, yellow, and orange hues reflect different mineral composition across desert landscapes with no or sparse vegetation. Light and olive green colors depict vegetation.



© Krzysztof Pakulski

These two photographs depict the typical landscapes encountered in this site. Deserts are expansive, and wind-blown sand dune formations called ergs are a common feature. Mountain massifs also rise out of the desert, and support vegetation and oases which are attractive to wildlife.



Photo Taken By Willemstom, <http://www.flickr.com/photos/11028736@N03/>

AIR AND TÉNÉRÉ NATURAL RESERVES, NIGER

LANDSAT MOSAIC - JANUARY 1986 TO AUGUST 1990



The image on this page is a mosaic of several Landsat images obtained between 1986 and 1990, and rendered in false color. The band combination used is 7, 4, 2, a combination typically used in desert-like settings. Bright green and olive green colors represent vegetation and various shades of pink, orange and brown reflect geochemical variation in sand and mineral deposits over areas with sparse vegetation. The eastern half of the image shows sand formations known as ergs, or sand-seas. Striations in texture and color represent the distinct types of dunes.



0 100 200 Kilometers





FORT AND SHALAMAR GARDENS IN LAHORE



Pakistan

Year of Inscription as World Heritage Site: 1981
Year of Inscription on Sites In Danger List: 2000
Lahore, Punjab
N31 35 25 E74 18 35

The Fort and Shalamar Gardens are located in the city of Lahore in northeastern Pakistan. The Fort was built during the time of the rise of the Mughal civilization in approximately AD 1000. It was destroyed and rebuilt several times, with a definitive reorganization and rebuilding in the 1500s. The Gardens were created in the 1600s. The Fort and the Shalamar Gardens are two properties separated by about seven kilometers. These monuments are a testimony to the creative and artistic accomplishments of the Mughal civilization.

The Fort and the Shalamar Gardens contain some of the most beautiful palaces and structures in the world. The Fort was built of fired red brick and red sandstone blocks. It contains beautiful and sophisticated mosaics of tile and glass, and marble structures are numerous. Some of the antiquities include gilt and semi-precious stones in their constructions. The Gardens consist of three terraces with planting beds, water basins, crenulated enclosing walls and elegant pavilions. It boasts a sophisticated hydrological system with canals, 31 tanks, 414 fountains and 4 cascades.

Although the cultural heritage represented in these two monuments were values considerably diminished during the decline of the Mughal civilization, the Sikh wars and the British occupation, they have persisted. The Fort and the Shalamar Gardens were inscribed as a Cultural Site in 1981 for their representation of the history and artistic expression of the Mughal civilization.

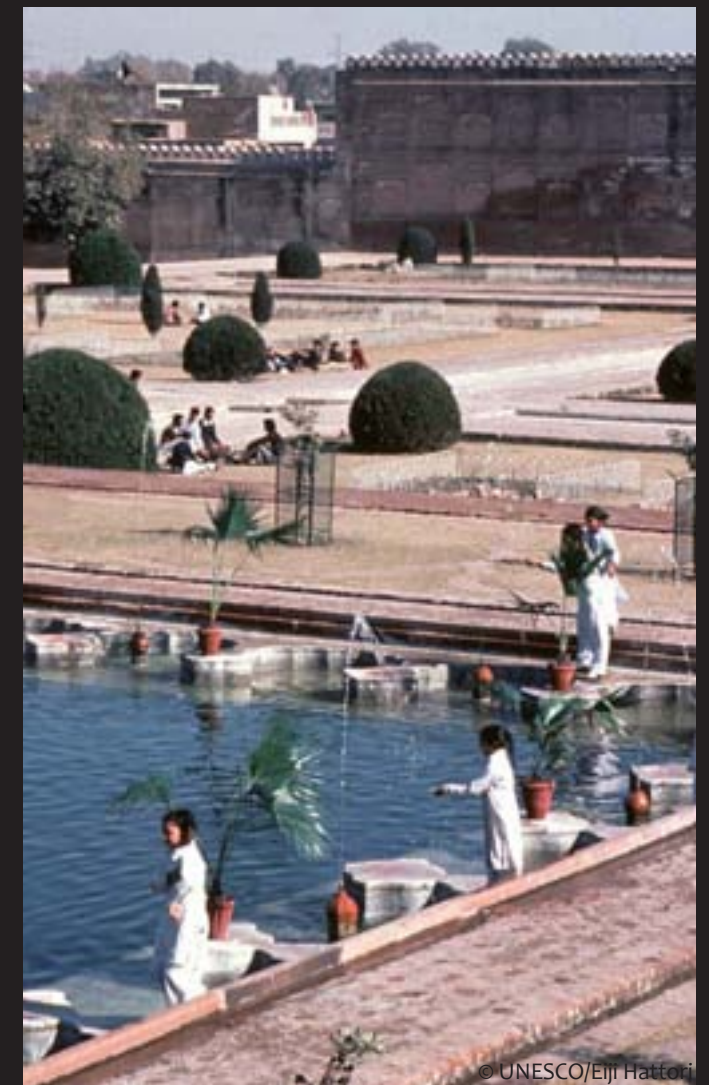
In 2000, the site was placed on the List of World Heritage Sites In Danger due to unacceptable destruction of elements of the properties, particularly the Gardens. A four lane road bordering the Gardens was expanded into a six lane highway, resulting in the destruction of the ancient hydraulic works. Two of the three tanks were destroyed, and the third partially demolished. Rapid urbanization has encroached on the site with negative effects, and the boundaries are considered inadequate, in need of a buffer zone.

The high resolution satellite images on the facing page are a change pair of images

showing the growth of urbanization around the site during a nearly 40 year period from 1967 to 2006. In each image, the Fort is the red polygon on the left, and the Shalamar Gardens is the red polygon on the right. In the mid 1960s image, the Gardens are situated in an essentially agricultural landscape, with urbanization and human settlements beginning to encroach from the south and east. By 2006, the Gardens are completely embedded in an urban landscape, and regionally, agriculture has completely disappeared. Satellite imagery can be very useful in documenting changes in urbanization around sites, and in some cases over very long time periods. In this case the archive contains data over a 45 year period.



These photographs show some of the architectural splendor encountered at this World Heritage site. The image above is a part of the Fort, and the photograph below shows some of the walkways, water basins and structures in the Shalamar Gardens.



FORT AND SHALAMAR GARDENS IN LAHORE, PAKISTAN

CORONA - OCTOBER 04, 1965



QUICKBIRD - DECEMBER 18, 2006



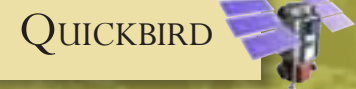
The images on this page are high resolution images showing the environment around the Fort and Shalamar Gardens. The top image is a panchromatic Corona image from 1967 (1.0 m spatial resolution), the bottom image is a 2.5 m multispectral Quickbird image pan-sharpened with the 61 cm panchromatic band. The Fort is located by a red polygon in the left part of the images and the Shalamar Gardens are located by the red polygon on the right side of the images. The two images constitute a change pair, and show the extent of urbanization that occurred over a 39 year period.



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The image on this page is a high resolution (2.5 m) QuickBird multispectral image of the Fort at Lahore. Structures, several courtyards, and large trees are discernible in the image. Although the Fort is surrounded on all sides by urban development, undeveloped buffer space appears to exist around most of the perimeter (red polygon).



FORT AND SHALAMAR GARDENS IN LAHORE, PAKISTAN

QUICKBIRD - DECEMBER 18, 2006



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0 200 400 Meters



FORT AND SHALAMAR GARDENS IN LAHORE, PAKISTAN

QUICKBIRD - DECEMBER 18, 2006



The image on this page is a high resolution (2.5 m) QuickBird multispectral image of the Shalamar Gardens. The Gardens are completely surrounded by urbanization, and the road at the southern end was expanded at the turn of the century, causing the destruction of important antiquities which were part of the ancient hydraulic system.



0 200 400 Meters



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CHAN CHAN ARCHAEOLOGICAL ZONE



Peru

Year of Inscription as World Heritage Site: 1986
Year of Inscription on Sites In Danger List: 1986
Trujillo Province, La Libertad Region
So8 05 60 W79 04 60

Chan Chan, located in northwestern Peru, is the seat of the ancient Chimú Kingdom. The site where the archaeological city is today was first occupied in about AD 400. The original Mochica inhabitants were replaced by the Chimú around AD 1200, and the huge settlement of Chan Chan flourished as the Chimú capital until the late 1400s, when the Chimú were conquered by the Incas. Chan Chan, the largest city in pre-Columbian America, was essentially abandoned.

The city planners used advanced social and political thinking to layout the city into nine autonomous citadels. A dry area, Chan Chan was made hospitable by sophisticated irrigation systems, including an 80 kilometer canal from a distant perennial river. The division of the city into separate autonomous urban units, with differentiated use of inhabited space including dwellings, places of worship, storehouses, kitchens, reservoirs, orchards and gardens represents a masterpiece of early urban planning. For this architectural and planning sophistication, and as a testimony to the Chimú culture, the site was inscribed on the World Heritage List in 1986.

Interest in excavation of the site was evident as early as the mid 1700s, with an archaeological plan produced by a Spaniard in the late 1700s. Unfortunately, the site has been plundered for centuries. Looting, first by Spanish conquistadors, continues today. Many prized artifacts have been removed, including ceremonial knives, necklaces, breastplates, diadems, bracelets and masks. Plundering is one of the main reasons why the site was inscribed on the List of World Heritage Sites In Danger in the same year it was inscribed as a World Heritage site. An effective management plan and presence is necessary to control this threat to the site.

Another threat to the integrity of the site, and a second reason for its placement on the List of World Heritage Sites In Danger, is structural instability. The primary building material used in Chan Chan is adobe, a clay material that has not proved sufficiently resistant to the elements over the centuries. The structures are eroding from both wind and rain, even though the latter is rare.

The image on the facing page is a high resolution image of the site, showing its landscape context and its location with respect to the Pacific Ocean coastline. Although extensive urban development has occurred to the east and north of Chan Chan, the site appears to be very well buffered by adjacent agricultural fields. It does not appear that encroaching urbanization is an immediate threat to the site, but two major roads run east-west through the park in its middle and coastline sections. The primary threats to the site, looting and structural erosion, are not discernible in satellite imagery.



© UNESCO/Vautier-Decool

The top image is illustrative of some of the artistic decoration found in the site. The bottom image shows the adobe construction material in a state of erosion. Wind and occasional rain are literally melting away the archaeological city of Chan Chan.



© UNESCO/Jim Williams

CHAN CHAN ARCHAEOLOGICAL ZONE, PERU

QUICKBIRD - SEPTEMBER 26, 2006



The image on this page is a high resolution (2.5 m), pan-sharpened multispectral QuickBird image showing the Chan Chan site in its landscape context. Two roads run through the site, in the middle and coastal sections, but in general the site is surrounded by a buffer of agricultural parcels and the ocean. Urbanization is evident to the east and north of the site.



0 1 2 Kilometers

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RICE TERRACES OF THE PHILIPPINE CORDILLERAS



These photographs show some of the Rice Terrace properties. The photograph above shows a typical village and terraces landscape. Deforestation, a major threat to the site, is apparent up slope from the village. The photograph below shows terraces cut into very steep slopes, where the rice strips are only a few meters wide.



Philippines

Year of Inscription as World Heritage Site: 1995
Year of Inscription on Sites In Danger List: 2001
Ifugao Province, Cordillera Region, Luzon Island
N16 56 02 E121 08 12

The 2000 year old Rice Terraces are located in the Central Cordillera Mountains on Luzon Island. The terraces have been shaped by hand for centuries and are laid out on the contours of the steep slopes. These terraces are at higher altitudes than other Philippine rice terraces and are carved into steeper slopes. They have been handed down from generation to generation.

The terraces represent an unparalleled example of harmony between man and nature, and today are a living cultural landscape. Great physical and sociocultural challenges were overcome to construct these agricultural systems. The cultural traditions and agricultural practices have remained essentially unchanged for 2000 years, and therefore represent the persistent influence and continuity of ancient traditions. A cooperative approach to the maintenance of these systems, and their grounding in knowledge of local biodiversity and lunar cycles results in a sustainable, community-based production system with few historical rivals. For these reasons, the Rice Terraces were inscribed as a Cultural Site in 1995.

The rice terraces have existed for centuries as intact clusters of terraced slopes, villages, surrounding ringed buffers of private forests, and sacred groves. The importance of conserving the properties has been an essential part of the knowledge handed from generation to generation, and has resulted in the persistence of the terraces over such a long time span. Since the late 1900s, however, the Rice Terraces have become particularly vulnerable to social and economic changes.

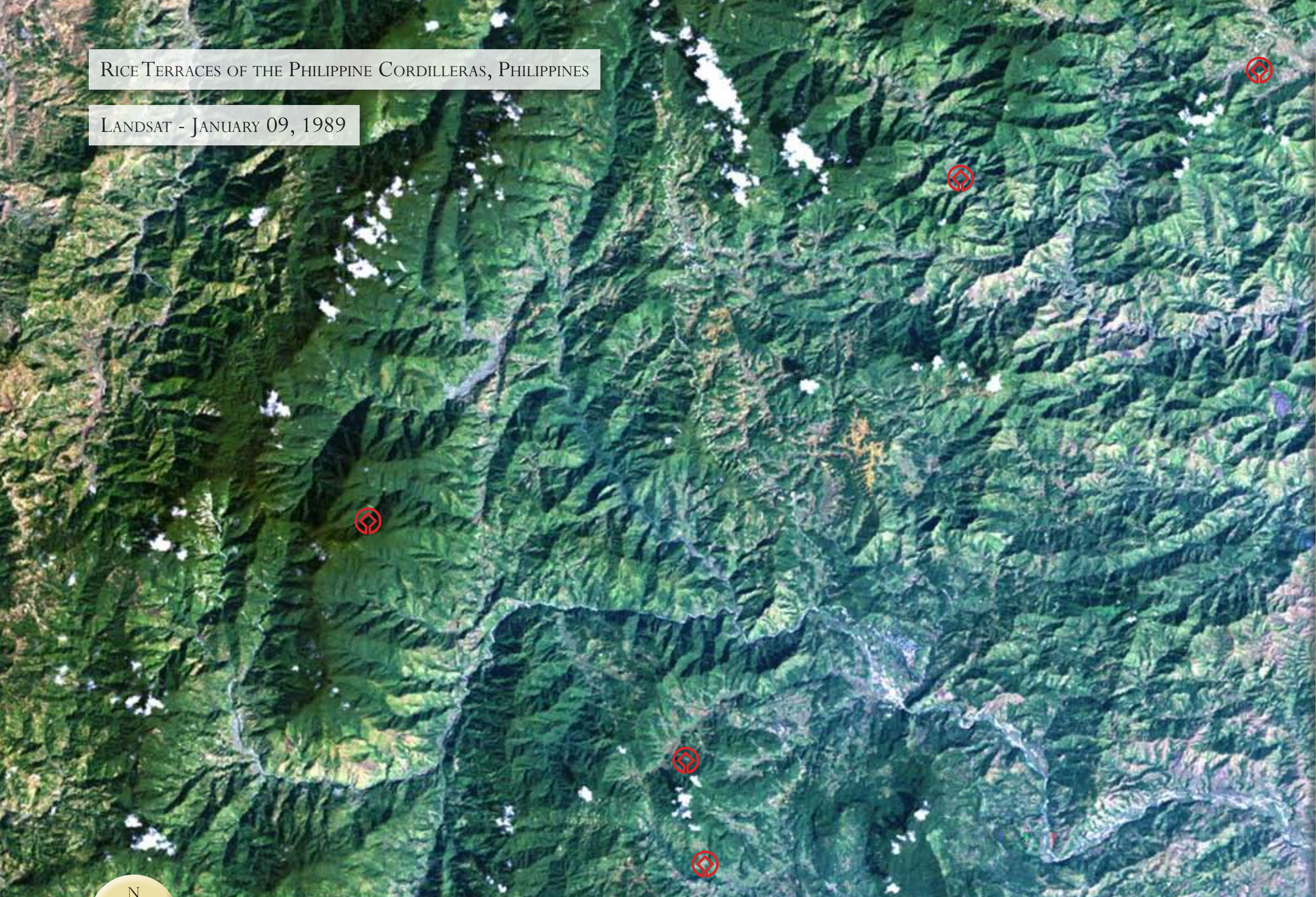
A successful campaign to bring Christianity to the region has resulted in an end to the ancient pagan belief systems for many of the younger generations. The traditional pagan belief in the need for a harmonious balance between man and nature is now held mainly by the elders, many of whom are unable to keep the terraces maintained. Residents are increasingly seeking alternative income sources, and are abandoning the terraces. Considerable deforestation in the region is also removing a key structural element of the terrace systems. For these reasons, the Rice Terraces site was placed on the List of World Heritage Sites In Danger in 2001.

The moderate spatial resolution satellite image on the facing page shows the location of the five rice terrace clusters which collectively comprise the World Heritage site. The region is very mountainous, with peaks rising to heights over 2000 m. Rivers dissect the mountain ranges. Neither of the primary threats facing the properties, abandonment and deforestation, are discernible in imagery at this resolution. However, higher resolution imagery, such as that illustrated on pages 70 and 71, can be extremely useful at depicting changes on the landscape due to human manipulations.

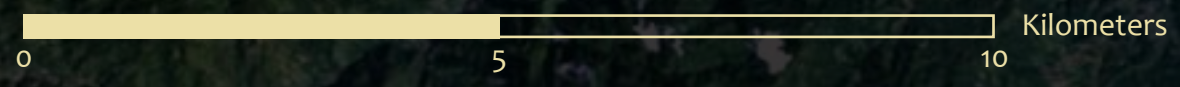


RICE TERRACES OF THE PHILIPPINE CORDILLERAS, PHILIPPINES

LANDSAT - JANUARY 09, 1989



The satellite image on this page is a moderate spatial resolution (30 m) Landsat image rendered in natural color. The five inscribed Rice Terrace clusters are located using red World Heritage symbols. The region is mountainous and essentially forested, and is dissected by rivers.



RICE TERRACES OF THE PHILIPPINE CORDILLERAS, PHILIPPINES

QUICKBIRD - NOVEMBER 02, 2003



RICE TERRACES OF THE PHILIPPINE CORDILLERAS, PHILIPPINES

QUICKBIRD - NOVEMBER 02, 2003



The satellite images on these two pages are from a QuickBird image acquired November 2, 2003. The image on the facing page is a 2.5 m multispectral image which shows forests as dark green, vegetative regrowth as light green, and cultivated rice as brown. The image on this page is a 61 cm panchromatic image of the same area. Individual terraces are easily discernible in the panchromatic image as darker grey bands that contour around the hillslopes. As indicated on the images, abandoned terraces appear in the panchromatic image as contoured linear features without the dark grey strips. On the color image, the abandoned terraces appear as vegetative regrowth.





NIKOLO-KOBA NATIONAL PARK



Senegal

Year of Inscription as World Heritage Site: 1981
Year of Inscription on Sites In Danger List: 2007
Eastern Senegal and Upper Casamance Regions
N13 04 00 W12 43 00

Niokolo-Koba National Park is located in southern Senegal along the upper reaches of the Gambia River and its two main tributaries, the Niokolo-Koba and the Koulountou. The region is essentially flat and is an example of the greater Guinea savanna ecosystem. There are several types of vegetation in the park, including moist gallery forests along watercourses, marshes, wet and dry savanna grasslands and dry woodland systems. This diversity of habitats supports one of the highest animal diversities encountered in West Africa.

Recorded observations of animal richness in the park include 80 mammal species, 330 bird species, 36 reptiles, 20 amphibians and 60 species of freshwater fish. The endangered Derby eland, a subspecies of the Giant eland, only occurs in the park. It is the largest of all African antelopes. The park also contains endangered chimpanzees, leopards, and elephants, as well as abundant lions, hunting dogs, buffalo, roan, Guinea baboon, colobus monkeys and all three African crocodiles. In 1981 Niokolo-Koba National Park was inscribed as a Natural Site for its outstanding

biodiversity and as a suitable habitat for maintaining endangered species.

For years, Niokolo-Koba has been a well-managed and well-researched park with an effective management presence. At the time it was inscribed, poaching, particularly for elephants and leopards, was recognized as a significant emerging threat. Small scale agriculture in the park was observed, and the construction of dams and roads were seen as potential future threats to the integrity of the area. The government was urged by the World Heritage Committee to develop a management plan addressing the adverse effects of water resource development in the park.

In-park road upgrade projects in the 1990 and 2000 eras opened access to the site, with the effect of increased poaching and illegal grazing. A UNESCO mission to the site in 2007 concluded that rampant poaching had decimated the populations of many large mammals, and although the condition of much of the habitat was still acceptable, the park had become an “empty forest”. A proposed

dam was threatening to exacerbate the effects of human activity on the park, and in 2007 the site was inscribed on the List of World Heritage Sites In Danger.

The satellite image on the facing page is a moderate resolution image of the park. The Gambia River is visible as the southeastern boundary of the park. The river then turns north and flows through the park in a northwesterly direction, and becomes the northern boundary of the park in its western section. The denser forests and woodlands appear as a darker green, and the savanna grasslands appear as lighter green and brown. Bright tan areas are human settlements or clearings, and these are evident in the northern part of the park in its midsection and along the western edge. The major threat to the park, excessive poaching which the management authorities have been unable to control, is not visible in the image. However, land transformations by humans are evident.



These two photographs are examples of some of the rich faunal diversity encountered in the park. While some of this biodiversity is abundant, like the green monkey above, many species are in decline. The leopard, below, has been extensively poached, and is endangered in the park.



NIKOLO-KOBA NATIONAL PARK, SENEGAL

LANDSAT MOSAIC - NOVEMBER 29, 1990 & DECEMBER 24, 1990



The satellite image on this page is a mosaic of two adjacent Landsat 5 images from 1990, rendered in natural color. Mosaicking of two or more images is necessary when the extent of the area of interest is large, and requires a reconciliation of images with different spectral properties in an attempt to make them as visually similar as possible. Perfect mosaics are difficult to achieve, and straight line seams, such as the one in the southern middle part of this image, are often evident.

In this image, forests are darker green and purple, savannas are light brown and light purple, and bright tan parcels are cleared areas. There are several prominent river systems, including the Gambia River, which forms the southeastern boundary of the park.



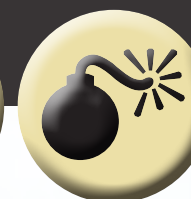
0 25 50 Kilometers





© UNESCO/Graciela Gonzalez Brigas

MEDIEVAL MONUMENTS IN KOSOVO



© UNESCO/Horst Gödicke

These images show several of the structures from the four properties. Although the buildings themselves are in a relatively good condition, the frescoes they contain are in need of conservation attention. Political instability in the region has precluded an effective management presence and monitoring program.



Serbia

Year of Inscription as World Heritage Site: 2004

Year of Inscription on Sites In Danger List: 2006

Autonomous Province of Kosovo

N42 39 40 E20 15 56

There are four separate properties that make up the Medieval Monuments in Kosovo World Heritage site. Each property contains rich works of art that reflect the religious culture of the Byzantine-Romanesque era. This distinct art form developed in the Balkan region from the 13th to the 17th centuries.

The first of the four properties is the Decani Monastery, built for King Stefan Decanski, and where he is laid to rest. Built in the mid 14th century, this church represents the last important phase of Byzantine-Romanesque architecture in the region. Most of the interior is covered with encyclopedic paintings that depict the history of Christianity until that present day, including paintings of over a thousand saints. For its importance in representing an influential art tradition of the era, this site was inscribed as a Cultural Site in 2004.

Three more properties were added to the inscription in 2006, extending the representation of the cultural heritage and art tradition. The Patriarchate of Pec Monastery includes four domed churches that contain

another series of important wall paintings. These paintings were of a style (Palaiologian Renaissance) that has come to be recognized as the most influential art form of the era. More beautiful and monumental frescoes are found in the other two properties, the Gracanica Monastery and the Church of the Virgin Ljevisa. The murals in these four structures cover almost the entire surface of the structures, including the narthex, the dome, the altar, the walls, the arches and the vaults.

At the time of the inscription of the three additional sites, a recommendation was also registered that the sites be placed on the List of World Heritage Sites In Danger. Many of the frescoes were suffering from the passage of time, and a lack of attention to their restoration. A strong management presence and restoration plan was precluded by the armed conflict in the region in 1998 and 1999. The site was placed on the List of World Heritage Sites In Danger in 2006 for unclear legal protection status, lack of a management plan, decay of frescoes, inadequate buffer zones, unsatisfactory state of conservation

and difficulty monitoring the properties due to political instability.

The satellite image on the facing page is a high resolution image of the original property, the Decani Monastery. This site is north of a grove of chestnut trees. This property is located in a relatively rural setting. Although the image is high resolution, the primary threat to the site, lack of management due to political instability, is not a visible feature. The high resolution imagery could be useful, however, in supporting the definition of buffer zones.



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© UNESCO/Horst Gödicke

MEDIEVAL MONUMENTS IN KOSOVO, SERBIA

IKONOS - JUNE 30, 2006



The image on this page is a high spatial resolution (60 cm) panchromatic QuickBird image, showing the landscape context of the Decani Monastery property. The Monastery is in a rural setting, bounded on the south by a grove of cedars, on the north by a river, and on the east by cultivated fields.



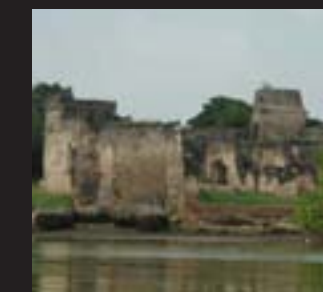
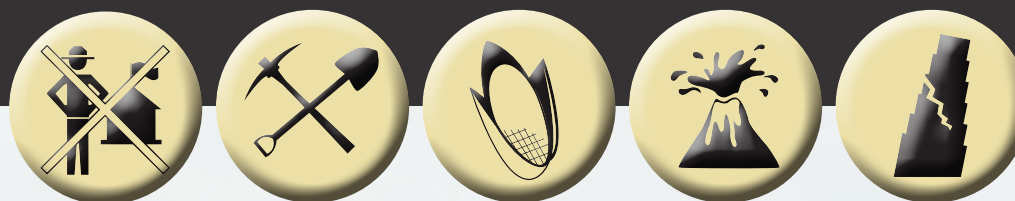
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RUINS OF KILWA KISIWANI AND RUINS OF SONGO MNARA



These pictures present multiple views of the ruins at the site. Many arches and walls are still standing. The site is in need of maintenance and restoration to fight encroaching vegetation and erosion by wave action.



United Republic of Tanzania

Year of Inscription as World Heritage Site: 1981
Year of Inscription on Sites In Danger List: 2004
Lindi Region, Kilwa District
So8 57 28 E39 31 22

Kilwa Kisiwani and Songo Mnara were two ancient African ports on two islands in an archipelago off the southern coast of Tanzania. These ports were visited by most of the early merchants plying the waters of the Indian Ocean, including Cabral and Vasco de Gama. Kilwa Kisiwani was regarded as one of the most beautiful cities in the world at the time, and was occupied from the 9th to the 19th century. The civilization peaked in the 15th and 16th century during the great era of Indian Ocean commerce.

Today both sites are complexes of ruins managed by the Government of Tanzania. The Kilwa Kisiwani site consists of a mosque made from coral tiles embedded in puddled mud, a similarly constructed palace, several smaller mosques, a prison and an urban settlement with houses, public squares and burial grounds. The lesser ruins at Songo Mnara contain five mosques and several houses made of clay and wood. Objects uncovered in the excavations of the two sites include earthenware, and several objects characteristic of bartering systems at the time: cowrie shells, glass beads, Islamic faience and Chinese porcelain.

The two complexes of ruins were inscribed as a Cultural Site in 1981 for their great archaeological importance in understanding the emergence of the Swahili culture, the Islamization of the east coast of Africa, and the maritime commerce of past and modern times. At the time of their inscription, a recommendation was also made to place the site on the List of World Heritage Sites In Danger owing to the rapid deterioration of the ruins. The site was eventually added to the List of World Heritage Sites In Danger in 2004.

The sites have lacked adequate financial resources and trained personnel to implement an effective conservation-based management program. Agricultural intrusions into the sites from nearby villages threaten the buried archaeological resources. Clearings from farming activities are particularly evident in Kilwa Kisiwani. Elsewhere, vegetation is overtaking areas of the ruins. Erosion by wave action has impacted the structural stability of the ruins. In this millennium, both land-use conflicts and beach erosion have increased. The deterioration from wave action is now being linked by management authorities to climate change.

The image on the facing page is a high resolution image of a portion of the Tanzanian archipelago that contains the two sites. Kilwa Kisiwani is the northern site, and Songo Mnara is on another island to the south. The archipelago is a shallow water region, and the islands are surrounded by coral reefs and seagrass beds. The fringing reefs are visible in the imagery on the eastern side of the islands. Dark green vegetation is mangrove, occurring on the western side of the Kilwa Island and the eastern side of the mainland. Development is discernible in the area around the Kilwa site as clearings in the vegetation. Satellite imagery has great potential utility in understanding threats to World Heritage sites caused by climate change.



RUINS OF KILWA KISIWANI AND RUINS OF SONGO MNARA, UNITED REPUBLIC OF TANZANIA

QUICKBIRD - FEBRUARY 17, 2006



The satellite image on this page is a high resolution (2.5 m) QuickBird multispectral image rendered in natural color. The image shows the two islands that contain the Kilwa Kisiwani site (north) and the Songo Mnara site (south). The shallow waters to the east of the islands contain seagrass beds and coral reefs. The dark green vegetation on the western side of the Kilwa Island and the mainland across the channel is mangrove.



0 2.5 5 Kilometers



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RUINS OF KILWA KISIWANI AND RUINS OF SONGO MNARA, UNITED REPUBLIC OF TANZANIA

QUICKBIRD - FEBRUARY 17, 2006



This is a high resolution (2.5 m), pan-sharpened, natural color QuickBird satellite image of the Songo Mnara site. The excavated ruins are visible in the western central part of the image as rectangular foundation walls. The excavations are in a cleared area between mangrove and coastal forests. One structure is visible, but in general human settlement is not present. Star-shaped tree crowns are planted palm trees.

QUICKBIRD



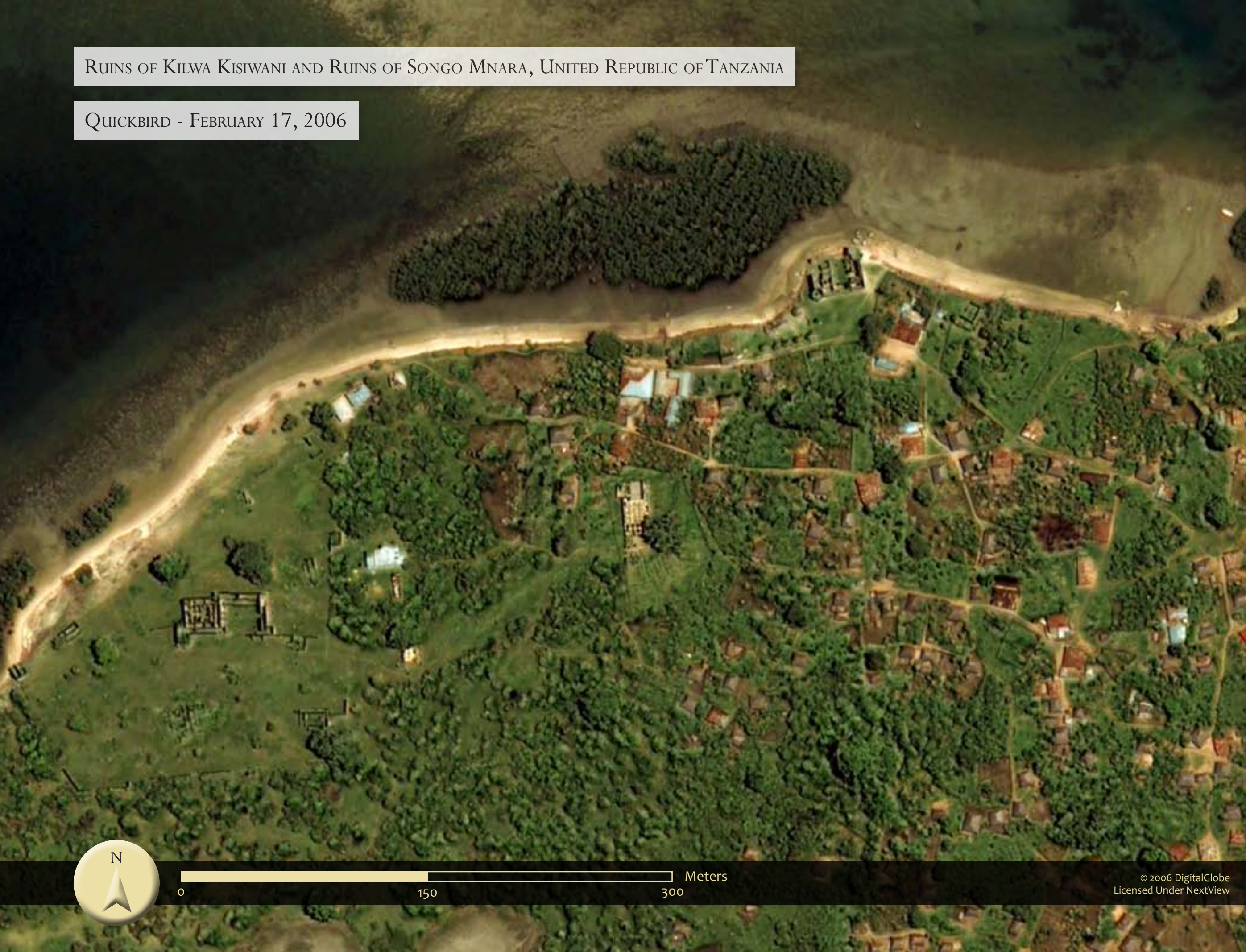
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0 150 300 Meters



RUINS OF KILWA KISIWANI AND RUINS OF SONGO MNARA, UNITED REPUBLIC OF TANZANIA

QUICKBIRD - FEBRUARY 17, 2006



This is a high resolution (2.5 m), pan-sharpened, natural color QuickBird satellite image of the Kilwa Kisiwani site. Most of the structures visible in the image are ruins. The walled fort is located in the northernmost section of the coastline. Wave erosion, recently linked to climate change, is impacting the fort and undermining its structural integrity on the coastal edge.



0 150 300 Meters



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CORO AND ITS PORT



Venezuela (Bolivarian Republic of)

Year of Inscription as World Heritage Site: 1993

Year of Inscription on Sites In Danger List: 2005

State of Falcon

N11 24 00 W69 41 00

On the northwestern coast of Venezuela lies the city of Coro. Coro is a unique settlement in the region because it evolved as a fusion of different cultural expressions and retains these historical influences today. Coro was primarily an earthen settlement, distinct from the stone-built villages of the time. Its earthen constructions have persisted through many changes in Coro's historical development, while other earthen settlements in the region have not fared as well. The city thrived for nearly three centuries, and was the geographical basis for both the exploration and Christianization of the region.

The site of Coro was occupied by Caquetio Indians when it was first visited by Spanish explorers in 1527. A city was erected there, built in the tradition of Mudejar architecture such as existed in Andalusia and the Canary Islands at the time. Over time the Spanish technical influence was added to the style, and the proximity to the Dutch West Indies resulted in considerable Dutch architectural influence as well.

The site was vulnerable to pirate raids, and a series of attacks in the late 1500s and mid 1600s devastated the city. It regained prosperity, however, as a center of agricultural production (sugar, coffee, and cocoa) and trade. It suffered again during the War of Independence in 1812, but returned again to prosperity during the subsequent oil boom.

The site has a core zone with over a dozen ecclesiastical structures. These monuments include the cross of San Clemente, representing the foundation of the city, a convent, several churches, a hospital and other secular buildings. Surrounding the core zone is both a historical and artistic zone and a zone of controlled architecture, each containing many significant earthen structures. The cultural and architectural importance of Coro led to its inscription as a Cultural Site in 1993.

In 2005, largely due to the lack of a management plan and presence, Coro was placed on the List of World Heritage Sites In Danger. The earthen structures are fragile and in need of conservation attention. Many suffered from

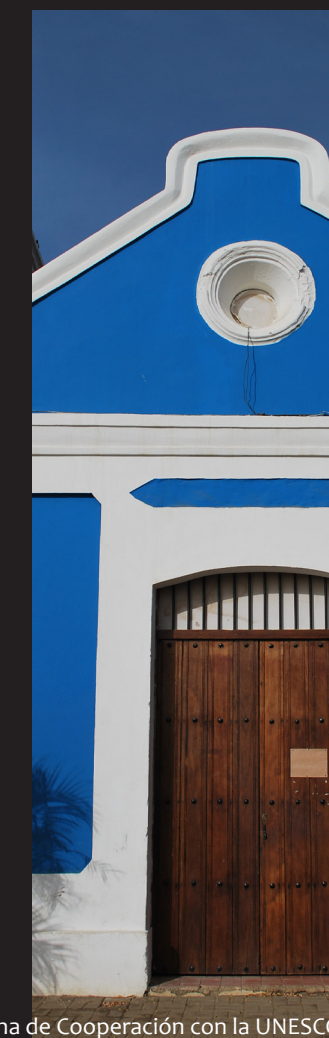
significant deterioration during heavy rains in 2004 and 2005. Vehicular traffic in the city is aggravating the deterioration, and the restoration efforts that are being undertaken may be compromising the authenticity of the site through the use of non-traditional materials.

The satellite image on the facing page is a high resolution color image of the protected zones and neighboring settlements of Coro. While individual structures are discernible, their level of deterioration is not distinguishable from the satellite image.



© Comisión Nacional Venezolana de Cooperación con la UNESCO

These pictures show some of the structures which represent the cultural heritage of Coro and its Port. Brightly colored paint and Dutch-influenced stylings are characteristic of the many ecclesiastical buildings in the old town. Passageways are largely composed of cobblestone.



© Comisión Nacional Venezolana de Cooperación con la UNESCO

CORO AND ITS PORT, VENEZUELA (BOLIVARIAN REPUBLIC OF)

QUICKBIRD - NOVEMBER 07, 2006



The image on this page is a high resolution (2.5 m) multispectral QuickBird satellite image of the old city of Coro and its surrounding environs. The core zone is in the center of the site, and is characterized by a number of larger structures with red tile roofs. An airport is situated just north of the site.



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HISTORIC TOWN OF ZABID



Yemen

Year of Inscription as World Heritage Site: 1993
Year of Inscription on Sites In Danger List: 2000
Province d'al-Hudayda
N14 11 53 E43 19 48

Zabid is an ancient city in the fertile southwestern Yemeni coastal plain near the Red Sea that persists today. Zabid was the capital of Yemen from the 13th to the 15th centuries. Established around AD 800, the city has been the site of an Islamic university that has been tremendously influential over the centuries, attracting scholars from throughout the Arab world.

Zabid is an example of domestic and military architecture that was quite influential in the region at the time, but has not persisted elsewhere. The domestic architecture style was that of a baked brick courtyard house. The house unit was a single rectangular room off of a narrow street or alley, which opened into a walled courtyard, with kitchens, wells, latrines and washing areas in the corners. This style of architecture, the Tihama style, became popular over much of the southern Arabian Peninsula.

The layout of Zabid included palaces, mosques, fortifications, a marketplace and 66 schools, of which 22 are still present today. Zabid became a very important center of Islamic teaching.

For its outstanding example of an influential domestic and military urban architecture, and its importance as a persistent center of education for Islam, Zabid was inscribed as a Cultural Site in 1993. In 2000, however, Zabid was placed on the List of World Heritage Sites In Danger primarily due to a lack of authenticity.

Urbanization in the area has increased dramatically over the past 40 years. New structures have been built inside the city and around its circular periphery. These new structures are generally constructed from cement, and lack the artistry of the original brick structures. Some are built inside the properties of historic structures. Sheet metal doors have replaced highly ornamental wooden doors. Second and third stories are being added to original buildings, affecting their foundations and impacting the visual environment of the old city. Electrical and sewage infrastructure has been installed in many areas without regard to the visual or architectural impact. Management authorities have been unable to prevent these and other increasingly damaging impacts from expanding human activity in historic Zabid.

The satellite images on the facing page show the encroaching urbanization around and into the old city of Zabid. The images are a high resolution change pair showing the urban development that occurred between 1967 and 2004, a 37 year period. While the circular perimeter of the old town is still identifiable in 2004, much change is evident. There are new structures inside and outside of the circular settlement, and many new roads through and around the city. Agricultural development of the surrounding region has greatly expanded. This visible increase in human activity is indicative of the threat to the old city. Most of the new structures are cement buildings, impacting the authenticity of the site through the use of non-traditional, modern construction materials.



These images show examples of the beautiful artwork found on the walls of the entries of many of the historical residences and buildings in Zabid. Loss of authenticity is the major threat to this site, as the new constructions in the historical city are made of cement rather than the traditional building materials, and lack the intricate facades.



HISTORIC TOWN OF ZABID, YEMEN

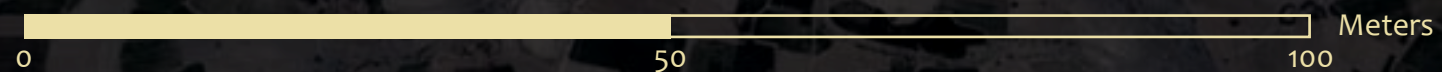
CORONA - DECEMBER 17, 1967



QUICKBIRD - MAY 07, 2004



The satellite images on this page are a change pair showing the urbanization of the town of Zabid over a 37 year period. The top image is a high resolution (1.0 m) Corona panchromatic image obtained in 1967. The bottom image is a high resolution (2.5 m), natural color multispectral QuickBird image taken in 2004. New roads, new structures, and expanded agricultural development of the surrounding environment are evident in the comparison.



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CONTRIBUTING ORGANIZATIONS

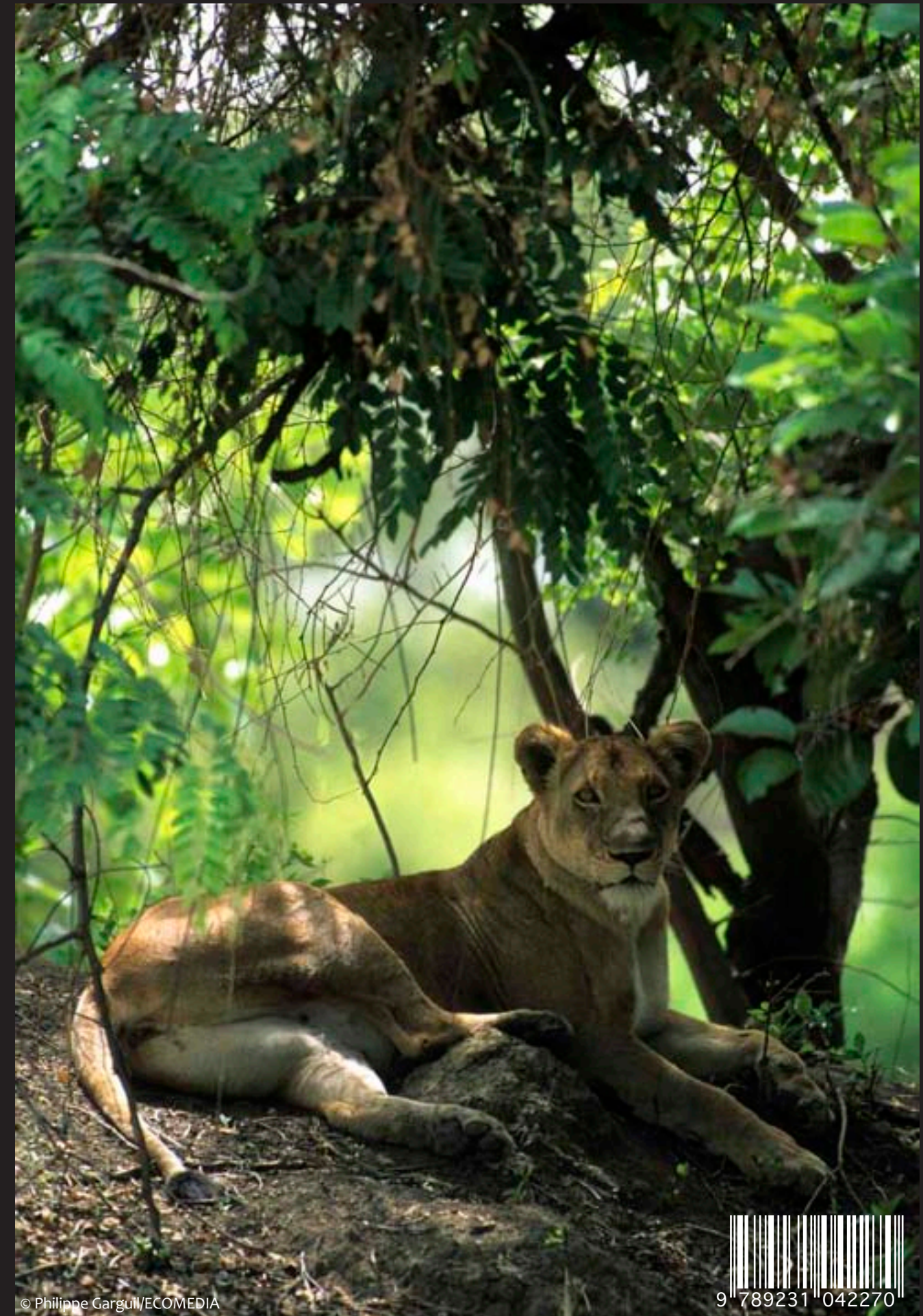
ABOUT UNESCO

The United Nations Educational, Scientific and Cultural Organization (UNESCO) is a specialized agency of the United Nations established in 1945. UNESCO's mission is to contribute to the building of peace, the eradication of poverty, sustainable development and intercultural dialogue through education, the sciences, culture, communication and information. The overarching objectives within this mission are to 1) attain quality education for all, 2) mobilize science knowledge and policy for sustainable development, 3) address emerging social and ethical challenges, 4) foster cultural diversity, intercultural dialogue, and a culture of peace, and 5) build inclusive knowledge societies through information and communication.

ABOUT USGS

The U.S. Geological Survey (USGS) was created in 1879 as a science agency charged with providing information and understanding to help resolve complex natural resource problems across the nation and around the world. The mission of the USGS is to provide relevant, impartial scientific information to 1) describe and understand the Earth, 2) minimize loss of life and property from natural disasters, 3) manage water, biological, energy, and mineral resources, and 4) enhance and protect our quality of life.

The United Nations Education, Scientific and Cultural Organization (UNESCO) and the United States Geological Survey (USGS) are proud to present From Space To Place – An Image Atlas of World Heritage Sites on the ‘In Danger’ List. This book is a visual and narrative tour of 31 World Heritage sites around the world whose natural and cultural treasures are endangered from a variety of natural and human-caused threats. The book focuses attention on the plight of these sites in the hope that an improved understanding of the threats they face will lead to an improved management and conservation of these globally important areas. The book also shows the utility of satellite imagery and associated image analysis technologies for detecting threats, and for understanding the greater landscape context in which the sites are situated. We hope that this book will encourage site authorities and other World Heritage advocates to include the use of satellite imagery and space technologies in their stewardship efforts.



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