

主编/张宗科 副主编/魏显虎 魏永明 沈 镭 T.G.Ngigi

CHIEF EDITOR Zhang Zongke

ASSOCIATE EDITORS Wei Xianhu Wei Yongming Shen Lei T.G.Ngigi



中国科学院遥感与数字地球研究所
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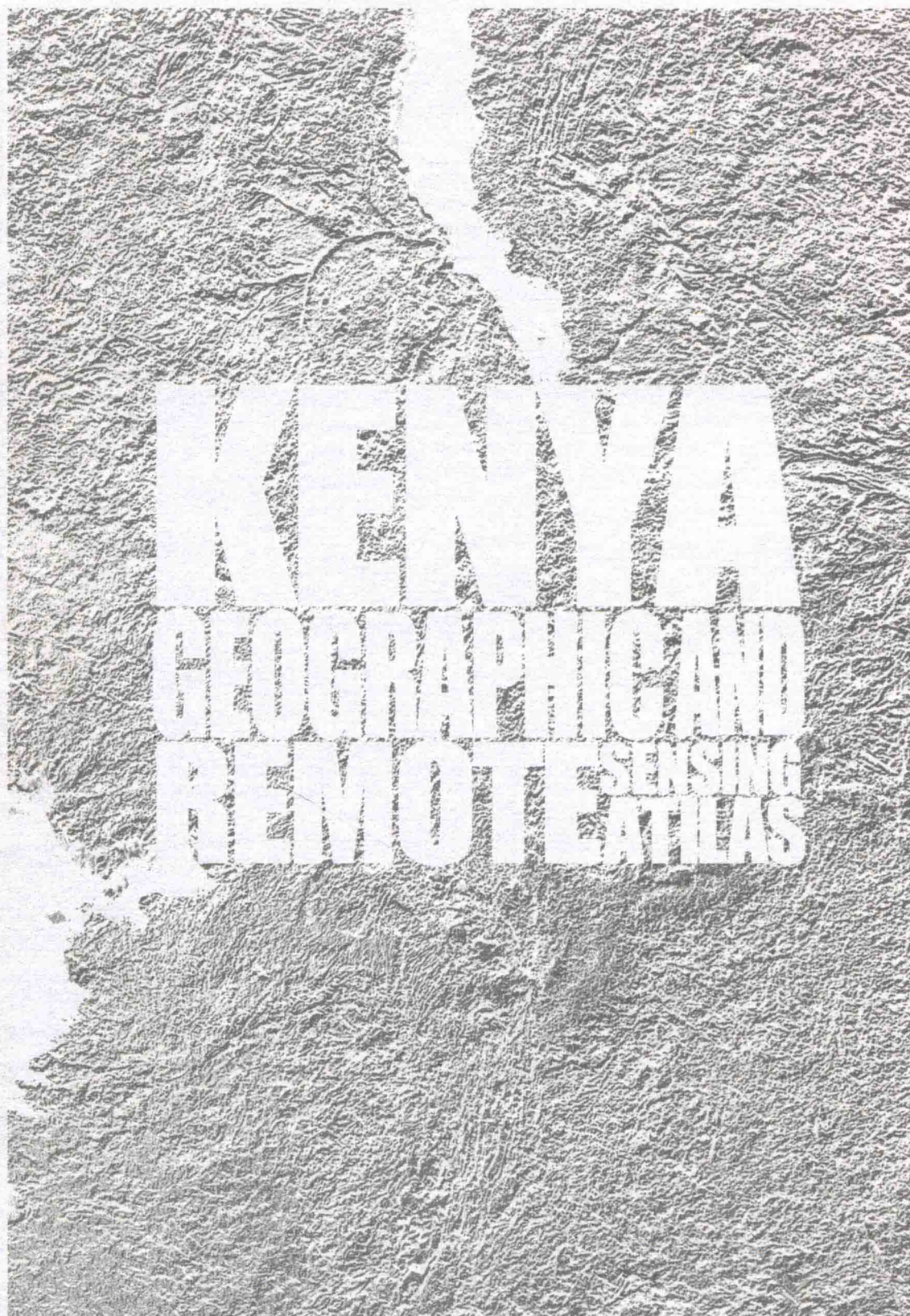
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乔莫·肯雅塔农业科技大学
Jomo Kenyatta University of Agriculture and Technology

肯尼亚国家地理遥感图集

Kenya Geographic and Remote Sensing Atlas



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肯尼亚 国家地理 遥感图集



KENYA
GEOGRAPHIC AND
REMOTE SENSING
ATLAS

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内容提要 / Preamble

《肯尼亚国家地理遥感图集》是“中国科学院中-非联合研究中心”系列图书之一。本图集是基于中肯资源环境科技合作的成果，宏观展现肯尼亚国家基本地理环境与奇特的地表景观，以便各界人士直观地认知“东非十字架”——肯尼亚。

"Kenya Geographic and Remote Sensing Atlas" (hereinafter referred to as "Atlas") is one of a series of publications by the "Sino-African Joint Research Center, CAS". Based on collaborative research in natural resources and environmental sciences between Kenya and China, the Atlas aims to show how remote sensing technology can exhibit Kenya's unique landscape.

主编单位 / 中国科学院遥感与数字地球研究所
Hosted by / Institute of Remote Sensing and Digital Earth, CAS

参加单位 / 中国科学院地理科学与资源研究所 肯尼亚乔莫·肯雅塔农业科技大学
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我们还将推进在肯尼亚建设“中-非联合研究中心”，围绕生物多样性保护、荒漠化防治、现代农业示范等非洲国家关心的问题，不断加强中非生态环保领域合作，积极发展清洁能源和可再生能源，在保护中发展，在发展中保护，让美丽中国和绿色非洲一路同行。

《开创中非合作更加美好的未来》——在非盟会议中心的演讲

中华人民共和国国务院总理 李克强

亚的斯亚贝巴

2014年5月5日

We will also promote the setting up of a "China–Africa joint research center" in Kenya which will focus on bio–diversity protection, desertification control, modern agriculture demonstration and other areas of interest to Africa. We will keep stepping up our cooperation on ecological and environmental protection and actively develop clean energy and renewable energy. The aim of these efforts is to pursue development and environmental protection in a holistic way and build a green Africa that enjoys sustainable development.

Bring about a better future for China–Africa cooperation

Speech by H.E. Li Keqiang

Premier of the State Council of the People's Republic of China

At the AU Conference Center

Addis Ababa, 5 May, 2014

序一

对中国人来说，非洲是一个神秘而又遥远的大陆。一提起非洲，人们总会想到那个地球的伤疤——东非大裂谷和奇特的地质构造、广袤的丛林和草原、美丽的湖泊和瀑布、成群的大象和角马、翱翔的苍鹰和怒吼的雄狮。而现代科学研究证明，这里还是地球人类的发祥地，我们的祖先就是从这里起源的。因而，研究非洲对我们来说不仅是亲切的，而且是我们的历史责任。

公元1405—1433年，中国航海家郑和七下西洋，其中多次到达非洲东岸，甚至到达了非洲南端的莫桑比克海峡，当时所谓的慢八萨就是今天肯尼亚最大的港口城市蒙巴萨。这开创了中国与非洲的肯尼亚、索马里、坦桑尼亚和莫桑比克等国家之间的友好往来历史，从此，中国的东方文明在非洲开始闪烁灿烂的光辉。

从郑和下西洋至今，时间过去了600多年！新中国成立以来，中非关系进入了一个崭新的历史时期，中非友谊成为这一时期的主旋律。2013年，习近平主席提出了共建“一带一路”的战略构想，中国政府本着“和平合作、开放包容、互学互鉴、互利共赢”的原则，沟通历史与未来，连接中国与世界，与沿线国家开展了一系列共赢性的务实合作，当前在建的内罗毕到蒙巴萨的铁路就是中非合作的很好例证。肯尼亚作为海上丝绸之路的要地之一，曾在中非友好交流的历史上起到重要作用。首都内罗毕是非洲最大的城市之一，也是一座国际化的大都市，多个国际组织的总部均设于此，这里气候温和、阳光充足，更被誉为“阳光下的花城”。肯尼亚政府在2030年远景规划中，将能源、基础设施和建筑业、农业、制造业、采矿业、旅游业、批发和零售业、金融服务业和信息产业等列为重点发展领域。“一带一路”战略构想和肯尼亚政府2030年远景规划的结合必将在合作共赢的道路上结出更加丰硕恢宏的成果。

中国科学院一直与肯尼亚等非洲国家有着十分紧密而友好的科技交流，与肯尼亚相关机构和大学签订了双边科技合作协议。为了帮助肯尼亚及其他非洲国家进一步提升其在生态环境保护、荒漠化治理、现代农业发展等学科领域的科研和产业化水平，中科院许多研究所的科研人员都积极参与到这一合作中来，发挥各自之所长，不远万里来到非洲，与当地的科研人员紧密合作，凝结出一个又一个的高水平成果。《肯尼亚国家地理遥感图集》（以下简称《图集》）就是中肯两国科学家在资源环境领域合作的产物。在两国的合作中，中肯两国科学家充分发挥了遥感卫星的优势，利用大量的遥感影像结合实地考察和相关的地理信息将肯尼亚的地形、地势、地貌、水文、气候、

城市等地理特征和奇特的地表景观展现在图集中。在这里，非洲城市的风貌、东非大裂谷的宏伟、河流的蜿蜒曲折、湖泊的星罗棋布、火山的万千仪态、景观的神奇别致以及植被资源的丰富多彩都在遥感影像中得到真实、客观的再现和一览无遗的表征。十分可喜的是在图集中我们看到我国的遥感系列卫星，如资源卫星系列、高分卫星系列在对非洲的研究中发挥了重要的作用。由中国科学院中-非联合研究中心组织，我国科学家主导编撰的这部图集，通过对非洲如此翔实精美的卫星影像的采撷和处理加之简赅的文字解译，使这一册图集成为研究肯尼亚进而研究非洲的一部不可多得的文献。它的出版必将为我国日益增长的对非洲研究的需求，对中非友谊和合作的增强，对增进“一带一路”战略的认知和落实提供重要参考，特别为进一步研究肯尼亚的自然地理条件、资源环境与生态系统、社会经济发展等重大问题提供重要科学基础。

在此，我祝贺《肯尼亚国家地理遥感图集》的出版，希望大家通过对《图集》的阅读能对肯尼亚的地理、地质、景观以及生态环境现状及其变化等有更为清晰的了解。更希望后续研究者和相关教学、研究人员能在此图集的基础上继续耕耘和雕琢，挖掘出更为丰富的信息和知识，更进一步发挥图集的作用，不负远赴非洲考察工作和图集编辑者的一番良苦用心。

余受命于编著者，能有机会先读为快。《图集》的编辑页页精彩、遥感影像幅幅珍贵、文字解译言简意赅，初读下来已是受益匪浅，故欣然命笔，以此为序。

中国科学院院士



2016年3月31日

Preface I

Africa is considered by the Chinese as the most mysterious and distant land on Earth. Every time Africa is mentioned, it reminds people of its unique geological formations like "the Earth's scars"-the Great Rift Valley, vast forests and grasslands, beautiful lakes and waterfalls, herds of elephants and wildebeest, soaring eagles and roaring lions. Modern scientific studies have proven that Africa is the oldest inhabited territory on Earth, with the human species originating from this continent. Thus, research in Africa is not only our interest but also our historical responsibility.

Zheng He, a great Chinese navigator, conducted seven expeditionary voyages from 1405~1433. He made several voyages to Mombasa located at the eastern coast of Africa and even to the Mozambique Channel of South Africa. Those voyages established for the first time the friendship between China and African countries including Kenya, Somalia, Tanzania and Mozambique. After Zheng He, Chinese ships continued to participate in Southeast Asian commerce and the Chinese and eastern civilization thrived in Africa.

The relationship between China and Africa has developed over the years to become a major focus of the People's Republic of China since its birth in 1949. In 2013, the Chairman of PRC, Xi Jinping, proposed a Strategic Concept known as the "One Belt and One Road" (also called the Silk Road Economic Belt and the Maritime Silk Route). Chinese government follows the great concept with the principle of "peace and cooperation, openness and tolerance, mutual learning, mutual benefit and win-win", using the relationship between history and future, between China and the world, and carrying out a series of pragmatic and win-win cooperation with countries along the Maritime Silk Road. Currently, the railway from Mombasa to Nairobi under construction is just a good example of China-Africa cooperation. Kenya, considered as one of the most important country for Maritime Silk Road, has played a key role in the history of China-Africa friendship. The capital city, Nairobi, the "Flower City under the sun", is one of the largest cities in Africa and is also international and cosmopolitan. Several headquarters of international organizations are located there due to its geographic and economic importance, and the mild climate. The Kenya Government has proposed "Vision 2030", which considers major future under taking for development such as energy, infrastructure and construction, agriculture, manufacturing, mining, tourism, whole sale and retail trade, financial services and the information industry. Therefore, the conjunction of "One Belt and One Road" concept of China and "Vision 2030" of Kenya will be a win-win cooperation and will yield more fruitful achievements.

The Chinese Academy of Sciences has been working closely and is friendly with Kenya and other African countries, and has signed bilateral cooperation agreements on science and technology with institutions and universities in Kenya. An increasing number of scientists from the Chinese Academy of Sciences have joined this cooperation to help Kenya and other African countries in research on environmental protection,

序二

2014年，李克强总理访问非洲，在非盟总部发表演讲表示，“推进在肯尼亚建设‘中-非联合研究中心’，围绕生物多样性保护、荒漠化防治、现代农业示范等非洲国家关心的问题，不断加强中非生态环保领域合作，积极发展清洁能源和可再生能源，在保护中发展，在发展中保护，让美丽中国和绿色非洲一路同行”。非洲国家领导人纷纷对这一倡议表示欢迎和赞赏。

“中-非联合研究中心”正是响应上述倡议，实施中非生态保护合作的重要举措。

“中-非联合研究中心”由中国商务部提供基建经费，中国财政部提供专项科研和教育经费，中国科学院武汉植物园和肯尼亚乔莫·肯雅塔农业科技大学负责筹建和建成后的日常运行。“中-非联合研究中心”总部位于肯尼亚内罗毕，采取开放、务实、共赢的合作政策，联合中国和东非国家的研究机构和大学，就东非地区乃至整个非洲大陆实现可持续发展所面临的共性问题，如生物多样性保护、荒漠化防治、粮食安全、传染病防控、环境保护等挑战，共同开展科学研究和人才培养合作。

遥感数据和技术既是肯尼亚等非洲国家重点发展的学科之一，也是中国与非洲国家在相关领域的科研合作高效实施的重要技术保障。为此，自“中-非联合研究中心”启动建设时起，应非方之请，来自中国科学院遥感与数字地球研究所、地理科学与资源研究所、肯尼亚乔莫·肯雅塔农业科技大学的科研人员便联合提出了加强东非地区遥感应用技术能力建设和项目合作的倡议。其中，编纂肯尼亚遥感影像图集是重点工作之一，由“中-非联合研究中心”提供资助，中国科学院遥感与数字地球研究所、地理科学与资源研究所、肯尼亚乔莫·肯雅塔农业科技大学科研人员共同实施。

整部图集约200页，以中文和英文对照出版，主要包括以下三部分内容：第一部分通过常规统计调查数据、遥感影像分析数据，以图文结合方式介绍肯尼亚国家地理的概要；第二部分以遥感影像数据为主，专题介绍肯尼亚主要城市、森林植被、河流湖泊、农业生产以及东非大裂谷等的现状和部分动态变化，为肯尼亚国土规划、环境保

护、生物多样性保护等方面深入研究提供基础信息服务；第三部分通过典型遥感影像直观展示肯尼亚独特的地表景观。

需要特别指出的是，图集的制作和出版合作很好地贯彻了“中-非联合研究中心”所积极提倡的科研合作和能力建设紧密结合的工作宗旨。在图集的制作和出版过程中，来自肯尼亚的科研人员和在华留学生积极参与并做出了重要的贡献。据悉，该图集还是肯尼亚首部覆盖全国的遥感影像图集，对肯尼亚遥感应用技术能力的建设意义重大。

自“中-非联合研究中心”筹建以来，双方科研人员积极互动、紧密合作，为“中-非联合研究中心”今后长期、稳定的运行奠定了扎实的合作基础。图集的出版是“中-非联合研究中心”面向非洲当地需求开展合作的重要成果之一。我们希望，肯尼亚遥感影像图集的出版将为双方其他领域的合作提供有益的支持，促成双方取得更多科研成果，从而为肯尼亚乃至非洲的可持续发展提供有力的科技支撑。

邱华威

2016年4月18日

Preface II

In 2014, Chinese Premier LI Keqiang visited Africa and delivered a speech at the African Union (AU). In his speech, Premier LI declared that China will cooperate with African countries in promoting the setting up of the "Sino-Africa Joint Research Center" (SAJOREC) in Kenya which will focus on bio-diversity protection, desertification control, modern agriculture demonstration and other areas of interest to Africa. China will keep stepping up the cooperation with African countries on ecological and environmental protection and actively develop clean energy and renewable energy. The aim of these efforts is to pursue development and environmental protection in a holistic way and build a green Africa that enjoys sustainable development. The decision and initiative from China were highly praised and warmly welcomed by leaders from Africa.

As an important initiative in promoting ecological and environmental protection and green development in Africa, SAJOREC received support from several Chinese ministries and research institutions. Ministry of Commerce provided financial support for construction of the center. Ministry of Finance provided researchers with funds for joint research activities and education. Wuhan Botanical Garden (WBG) of Chinese Academy of Sciences (CAS), and Jomo Kenyatta University of Agriculture and Technology (JKUAT) were entrusted by both governments to coordinate efforts from both sides on the setting up of the center and its operation after its inauguration. Headquartered at Nairobi, Kenya, the center has adopted an open, practical and mutually beneficial cooperative policy. The center will unite efforts from research institutions and universities from China and East African countries to deal with the common challenges to Africa's sustainable development. Research and education cooperation will mainly focus on biodiversity conservation, desertification prevention, food safety, infectious diseases control, and environment preservation.

Remote sensing technology plays a pivotal role for developing African nations, Kenya included. Following a firm request from African partners, researchers from Institute of Remote Sensing and Digital Earth (RADI) of CAS, Institute of Geographic Sciences and Natural Resources Research (IGSNRR) of CAS, and JKUAT proposed to strengthen joint efforts on science capacity building of east African countries in remote sensing applications. The compilation and publishing of Remote Sensing images of Kenya is among the first group of core cooperative projects initiated and sponsored by the SAJOREC. The project was jointly implemented by RADI, IGSNRR and JKUAT.

The Atlas is published in Chinese and English and it is in three parts. Based on existing statistics and processed remote sensing data, the first part provides the reader with a brief of the geography of Kenya. The second part is composed of the matic remote sensing images of Kenya's main cities, forests, rivers and lakes, agriculture, and the East African Great Riff Valley. The third part presents the reader with images of typical and unique landscapes of Kenya.

The compiling and publishing of the Atlas follows the capacity building principle that SAJOREC upholds. Researchers and graduate students from Kenya in RADl and IGSNRR worked actively with Chinese researchers towards publication of the Atlas. The Atlas, based on satellite remote sensing imagery, is set to be the first of its kind in Kenya. It is also an important achievement in Kenya's endeavor to promote its capacity building in remote sensing applications.

Researchers from both China and Africa have been working together actively and closely since the establishment of SAJOREC. This laid a concrete basis for the sound and long-term operation of the center in the years to come. The publishing of Remote Sensing Images of Kenya is one of the initial outcomes of Sino-Africa cooperation in meeting local development needs. We hope the publishing of the Atlas will lead to cooperation in other areas. With more outcomes in other research areas, SAJOREC will be able to fulfill its mission of supporting sustainable development in Kenya and even the whole continent.

Qiu Huasheng

18 April, 2016

前言

非洲作为世界上仅次于亚洲的第二大陆地，拥有众多的世界第一：最大的沙漠——撒哈拉沙漠、最长的河流——尼罗河、最大的海湾——几内亚湾、最长裂谷——东非大裂谷、最大盆地——刚果盆地及世界上最长的海峡——莫桑比克海峡；独特的地理位置造就其拥有超过40,000种以上的植物资源，其中不乏稀有或特有物种；因野生动物品种及数量繁多而闻名的非洲有野生动物王国之称；非洲也是人类发源的摇篮之一，是世界上民族成分最复杂的地区。

奇特的原生态景观、丰富的自然资源、多样化的文化特征，使非洲充满神奇色彩。同时，非洲也是当今世界经济发展落后的地区之一，其原因是多方面的，而科技发展缓慢无疑是重要因素之一。

中非虽然相距万里之遥，但是，中非的交往却源远流长。早在600年前，中国著名的航海家郑和就率船队到过非洲的肯尼亚等地区，从此开启了中非友好往来的历史。

中国政府一贯重视与非洲国家的友好交往。2013年3月25日，习近平主席在访问坦桑尼亚时指出：“实施好‘非洲跨国跨区域基础设施建设合作伙伴关系’，加强同非洲国家互利合作，帮助非洲国家把资源优势转化为发展优势；积极实施‘非洲人才计划’。”2014年5月5日，李克强总理在非盟总部演讲时提出：“围绕生物多样性保护、荒漠化防治、现代农业示范等非洲国家关心的问题，不断加强中非生态环保领域合作，积极发展清洁能源和可再生能源，在保护中发展，在发展中保护，让美丽中国和绿色非洲一路同行。”这是中国政府希望与非洲各国合作共赢的战略决策，也充分体现了中非科技工作者的心声。

为了促进中肯两国的科技交流，在中肯双方有关部门的积极支持下，中国科学院与肯尼亚乔莫·肯雅塔农业科技大学于2012年签订了合作协议，双方将在生态环境、动植物保护、遥感地理、农业科技等领域开展合作。

遥感技术以其在信息获取、信息分析等领域的独到优势，而被广泛应用于生态环境监测、生物多样性保护、农作物监测与估产、灾害监测与损失评估等领域。基于当前肯尼亚遥感技术研究与应用现状，遥感与地理科学方面的合作研究已经成为双方合作计划之一。

为了让双方的学者彼此加深了解，并能结合肯尼亚的国策和肯方的需求，中国科学院中-非联合研究中心编著了本图集。本图集分为三大部分：第一部分旨在通过常规调查数据、遥感影像分析数据，以图文结合方式介绍肯尼亚国家地理的概要；第二部分

以遥感影像数据为主，分专题介绍肯尼亚的主要城市、东非大裂谷、森林植被、河流湖泊以及农作物种植，并通过不同时期的影像数据对比分析反映其动态变化趋势，为资源利用、环境保护等深入研究提供信息服务；第三部分通过典型遥感影像直观展现肯尼亚独特的地表景观，拟为肯尼亚的旅游提供部分景观信息服务。

《肯尼亚国家地理遥感图集》遥感数据主要采用了中国资源环境卫星系列、高分遥感卫星系列、美国陆地资源卫星系列、MODIS等不同分辨率遥感影像及SRTM、ARSTER GDEM等数字高程模型数据；基础地理信息数据及常规统计观测数据部分由肯尼亚乔莫·肯雅塔农业科技大学、内罗毕大学提供，部分通过网络收集并加工处理，相关网站包括百度百科、维基百科、联合国粮农组织、联合国环境规划署、美国地质勘探局、美国国家航空航天局及肯尼亚国内相关网站。

若《肯尼亚国家地理遥感图集》能为肯尼亚政府部门制定农业发展、环境保护措施，实现2030年远景规划提供参考，为中-非联合研究中心各参与单位全面了解肯尼亚、制定符合肯方需求的合作研究课题提供基础资料，为中国政府派驻人员、赴肯尼亚工作及旅游人员提供帮助，我们将不胜荣幸。

在本图集编辑过程中，中国资深遥感专家童庆禧院士为本图集作序，并提出了宝贵的意见；中国科学院遥感与数字地球研究所、中国科学院地理科学与资源研究所及中国资源卫星应用中心在遥感卫星数据获取及图集编辑上给予了全力支持；肯尼亚乔莫·肯雅塔农业科技大学T. G. Ngigi博士、内罗毕大学Isaiah Ang' iro Nyandega博士等专家学者提供了大量相关背景资料和丰富的基础地理信息数据；中国科学院国际合作局房强、蒋一琪、陈海涛，中国科学院遥感与数字地球研究所张颢、李彤、郭松、陈明美，中国科学院武汉植物园中-非联合研究中心严雪、吴浩、燕丽娜、李媛媛等在资料收集、调查以及文字翻译等方面给予了大力支持。在此，一并表示衷心的感谢！

因我们经验不足，资料有限，在本图集编辑中肯定有很多不足和错讹之处。诚请各位专家和读者不吝赐教，给予批评指正。

编者

2016年3月10日

INTRODUCTION

Africa, world's second-largest continent, after Asia, holds world records for the largest desert—the Sahara, the longest river—the Nile, the largest Gulf—Gulf of Guinea, the longest rift—Great Rift Valley, the largest basin—the Congo Basin and the longest Strait—Mozambique Channel. Its distinctive geographical position contributed to evolutions of more than 40,000 varieties of plants, among which many are rare or aboriginal species. Africa is also popular for diverse species of wild animals, and thus called "paradise of wild animals". Africa is recognized as the anthropogenic cradle and has the most diverse ethnicity in the world.

While the unique and aboriginal landscapes, rich natural resources and cultural diversity have made Africa so amazing, Africa is one of the least developed regions in the world. Inadequate advancement in science and technology is undoubtedly among the most primary causes of underdevelopment.

China and Africa, although thousands of miles apart, have a long history of engagement. The well-known Zheng He's fleet visited Kenya and other African countries 600 years ago, pioneering the Sino-African friendship.

Chinese government attaches great importance to exchanges with African countries. In a keynote speech given during his visit to Tanzania on 25th March 2013, Chinese President, Xi Jinping opined that China will put into practice the partnership on transnational and trans-regional infrastructural development, enhance mutually beneficial cooperation and help African countries turn resource endowment into development strength. China will actively implement African talents program. Chinese Prime Minister Li Keqiang delivered a speech at Africa Union on 5th May 2014 that singled out biodiversity protection, desertification control, modern agriculture and other areas of interest to Africa that will be loci of the envisaged China-Africa cooperation. He further added that China will keep stepping up its cooperation with Africa on ecological and environmental protection and actively develop clean and renewable energy. The aim of these efforts is to pursue development and environmental protection in a holistic way and build a green Africa that enjoys sustainable development. This is a strategic decision made by Chinese government to pursue win-win cooperation with African countries, and embodies the aspiration of Chinese scientific community and its counterpart in Africa for scientific greatness.

The Chinese Academy of Sciences (CAS) and Jomo Kenyatta University of Agriculture and Technology (JKUAT) signed an agreement on scientific and technologic cooperation in 2012 to promote scientific and technologic communication and cooperation between China and Kenya. Based on this agreement, the cooperation will be developed in environment, animal and plant conservation, geography, remote sensing, and agricultural technology.

Remote sensing technology with its unique advantages in information acquisition and analysis is widely used for ecological environment monitoring, biodiversity conservation, crop growth monitoring and yield estimation, and disaster monitoring and damage assessment etc. Based on the current situation of the remote sensing research and application in Kenya, a pertinent collaborative research in remote sensing and geographic science has been included in the cooperation program.