TIME-SERIES DIGITAL AERIAL PHOTOGRAPHS FOR UNDERSTANDING THE AFRICAN'S LANDSCAPE EVOLUTION

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ABSTRACT

Aerial photographs, both historical and present, are an invaluable source of information for the monitoring and assessment of the nature and characteristics of the landscape and present a view of the Earth looking from the above. The view from above provides a context for our place, community, region and the world at large. They are crucial information for understanding and evaluation of series of changes on the land, its use and its cover, as well as the assessment of the impact of these changes on the environment and their effect on ecosystem, communities, climate processes, etc. This old archive of time-series aerial photos contributes to a wide range of scientists, planners and policy makers to evaluate past development and helps us to predict the results of planned measures with increased reliability. Although today there are many opportunities like satellite imagery and lately digital aerial photograph that can be produced to suite practically any application, both with respect to performance as well as budgetary restriction, the historical remote sensing information are crucial to assess the changes and understand/find/analyse the cause of the occurred changes.

Relatively new are the procedures that allow to convert the old aerial photograph - that until recently have been analogue, ie., recorded on film - to a digital format and this new technology is nearly 100 -times faster than the previously conventional scanning procedures. The GeoDyn is the company that has adapted this technology to convert the historical aerial photos from analogical to high resolution digital imagery. To enable this GeoDyn has developed tools and procedures that accelerate this process. The GeoDyn has long experiences in GIS and aerial photography with many applications in Africa. The focus of this paper is to give an overview of the importance that the improved historical aerial photographs converted in high resolution digital dataset has for the monitoring and analysing of the African's landscape evolution as well as the assessment of the impact of the land uses and land covers change over time in response to evolving economic, social, and biophysical conditions.
Keywords: *aerial photographs, remote sensing, GIS, land use-land cover change, environment, ecosystem, climate change, etc……*

INTRODUCTION

Competition over natural resources, such as land, water and oceans, is intensifying and in many places is leading to the exclusion of traditional users from resources and markets. Social and demographic changes in rural areas also affect the labour available for production. The increasing movement of people and goods, and changes in production practices, give rise to new threats from pests, diseases and invasive alien species. Climate change reduces the resilience of production systems and contributes to natural resource degradation. The agriculture sector is both a contributor to, and impacted by, climate change. Improved practices and reducing deforestation and forest degradation offer significant potential for climate change adaptation and mitigation (*source: FAO).*

Availability of reliable, timely and detailed geospatial information crucial for the assessment of environmental conditions and their changes over time is one of the fundamentals of sustainable development and management of land and water resources and protection of the environment. Land use policy-makers and rural development planners need time-series information in order to ensure food security for increasing population, supply of fresh water, creation of work opportunities in rural areas, and conservation of land and water resources. These tasks are particularly challenging in developing countries mainly in African continent, in the arid and semi-arid climatic zones because of the increasing impact of climate change damaging land and water ecosystems and reducing their production potential. Yet, the achievement of the Sustainable Development Goals (SDG)s, in particular the reduction of poverty and hunger, improvement of health conditions among population of developing countries and attainment of environmental sustainability depends on timely execution of these tasks.

The access to accurate, relevant and time-series geospatial information including past and recent aerial photographs and their generated information over time is critical for trend analysis of the main causes have impacted environment and climate change in the last decades. Moreover, to achieve sustainable natural resources planning and management and good policy decision, necessities to be based on consistent and accurate information.

FAO, as part of its mandate, is conducting monitoring and assessment of agricultural land, forest and fisheries resources, and assisting developing countries with their sustainable development and management. In order to fulfil these tasks, it has been involved in provision of geospatial data, information and services to its field projects and headquarters programmes since its establishment. The availability of a wide range of geospatial information including old and recent aerial photographs and satellite imageries, development of geographic information systems, and satellite-based global positioning systems over the last 30 years brought about a major paradigm shift in geospatial technologies. It greatly increased the scope of their applications and their impact, in particular on land use planning, natural resources management, mitigation of natural disasters, and environmental protection in developing countries.

By the other side many other companies are developing technologies and tools to produce high quality geospatial and non-geospatial information useful for sustainable management and utilization of natural resources for the benefit of present and future generations. GeoDyn is one of this company that use innovative technology for generation of digital high quality aerial photographs based on the historical analogical aerial photographs archive. This precious and improved historical is critical for the assessment of the impacts of changes in land cover/use across the last decades.

HISTORY

Socrates stated: "*Man must rise above the Earth—to the top of the atmosphere and beyond—for only thus will he fully understand the world in which he lives*". From photography's first days, photographers have been drawn to the "view from above" first using the elevated vantage point of windows, then balloons followed by kites and finally airplanes, rockets and satellites.
The first aerial photographs were created in 1858 by Gaspar Felix Tournachon who was also known as "Nadar" when he photographed the houses of the French village of Petit-Becetre. In early 1900 Auguste and Louis Lumiere developed a simple colour photography system that would establish the 35 mm film standard and only 3 years later Wilbur Wright produced aerial images from an airplane flying above Centocelli, Italy, using a motion picture camera.
The first recorded use of an' airplane in a combat environment took place on October 23d, 1911, when Italian Captain Carlo Piazza took off to explore Turkish gun emplacements. He installed a camera on his airplane, on the belly of his Bleriot aircraft with the lens pointing toward the ground. This first attempt was a limited beginning, but it established that aerial photography had great potential. Afterwards the development of the aerial photography technology was unrestrainable.
During WW II more sophisticated techniques in air photo interpretation were developed. In the 1950's there are many advances in sensor technology to include multi-spectral range and colour-infrared photography. In the 1960's, the United States begins collecting intelligence from Earth orbiting satellites, CORONA. Upon arriving on the Moon the Astronauts looked back to their origins and recorded the Earth view from above. …and since that, the satellite imageries and aerial photography became an invaluable source of information until nowadays…

CONVERSION METHODOLOGY

Many companies around the world produce aerial photographs. Many of them has large aerial photographs libraries and archive of precious information since the early time when the aerial photos were in analogical format like films or printed paper etc. Often the utilisation of this historical and analogical information is not so simple, because to convert this information in digital is a long, expensive and complex process.
The analogue-digital conversion is the prerequisite to comprehensive analysis of the past. In this respect the GeoDyn Company utilize innovative technology for the conversion of the historical aerial photos and provides dynamic spatial data to the world wide organisations and national institutions. The GeoDyn headquarter is based in Dubai and has additional operations facilities in Austria for equipment design and manufacture, and in Ethiopia for software development and data capture. It has more than 50 years of experience mainly in Africa.
To enable the aerial photograph conversion from analogical to digital the GeoDyn has designed equipment that speeds up the process about 100 -times faster than the previously conventional scanning procedures. The system is based on technology similar to that used in modern large format aerial camera systems. Multiple simultaneous pictures are captured by several high resolution cameras and the 20um imagery tiles are merged together in a unique image with an accuracy of 1/3 pixel. The process uses the full dynamic range of the cameras and includes extensive correction for lens distortions, light fall-off and colour adjustment.

The transformation technology developed from GeoDyn in partnership with ESRI utilizes the digital photo indices and scanned imagery to enable users working in a wide range of web or desktop applications. GeoDyn refines the accuracy of the imageries and utilize the dynamic mosaicking and on-the-fly processing capability of ArcGIS Server to provide accurately georeferenced information providing instantaneous access to the temporal imageries and ensuring that the full information content of the imagery is maintained and accessible.

APPLICATIONS OF TIME SERIES DIGITAL AERIAL PHOTOGRAPHS

Remote sensing, geographic information systems and other environmental observations assist in acquiring and processing reliable, timely and relevant data for addressing a variety of key issues related to environment and natural resources management, food production and food security, coastal area monitoring, desertification, biological diversity, energy and climate change impact. Other data sources, for example, socio-economic data, can also be combined with such geospatial and environmental data for more in-depth analyses.
The Food and Agriculture Organisation (FAO) has long experiences in developing data sets and in using space-technology-based data for: in situ monitoring, data collection, generation and analysis of reliable geospatial information to support agriculture and environment monitoring and development of sustainable agriculture policy in the country members. During the last 2 decades FAO Geospatial Unit has devoted considerable attention to the development of techniques integrated with geospatial information for: Land cover and agriculture mapping, and the assessment of their changes like: LCCS/LCML ISO standard and GLCN software suite; evaluation and planning of land resources through development of GAEZ, GLCShare, etc., at national and global level.
FAO, as many other international organizations and scientific institutions, needs timely and reliable information for the assessment of land use/ land cover and their changes overtime at all levels to support implementation of the UN Millennium Development Goals, UNCED Agenda 21, WSSD Plan of Implementation, Rio+20 Declaration, international environmental conventions on climate change, biodiversity, and desertification, and its programmes, projects and other activities.

In 2002 the Food and Agriculture Organization of the United Nations (FAO) and the United Nations Environment Program (UNEP) created the Global Land Cover Network with the objective to establish a global collaboration to develop a fully harmonized land cover/change assessment approach to make the required reliable and comparable land cover and land cover change data accessible to local, national and international initiatives. In particular, FAO support the stakeholder community in developing countries that have difficulty to produce and make accessible reliable, consistent and updated information.
To allow countries to make informed decisions and progressively ensure a harmonization of assessments, monitoring and reporting of the state and trends sustainable land management, FAO is making great efforts to enhance its core geospatial information systems. FAO main tasks are to improve the content of its geospatial data, develop decision support and management products and build capacity at country level on using these information systems.

To make informed decisions on climate change adaptation and mitigation strategies, the expansion of certain crop such as bio-energy ones and sustainable land management in general, core and time-series data on land and soil resources is needed. This information source will support countries to assess and analyse land resources, degradation and management. It is evident that to address the global challenges related to the impact of the land cover/use changes on the environment and climate change issues, much basic and consistent information is necessary including time-series geospatial information. The record/archive, time series and high resolution aerial photographs are an important source of information that allow the integration of multi-temporal sets of data to generate environmental change information, assisting users in environmental trend analysis and modelling and in the reaching of conclusions to address specific needs.

The key application of this precious source of information is the possibility of using time series and high resolution aerial photography for the land use and land cover change assessment overtime and generation of specific information in particular changes on agriculture, forests, rural and urban communities for the assessment of the impact of the environment and climate change process. Because humans control and improve the use of the land and, to a large extent, its cover, governments, individuals, businesses and non-profit organizations can make land decisions to adapt to and/or reduce the effects of climate change.

The assessment of the level annual/decadal rates of land changes in a long period of time can significantly support the analysing in the types, rates, and causes of change and the effect on the environment and climate.
Future changes of land use and land cover will interact with climate changes to affect human communities and ecosystems. At the same time, future climate changes will also affect how and where humans live and use land for various purposes. Land-use and land-cover-related options for mitigating climate change (reducing the speed and amount of climate change) include monitoring the deforestation process and where possible expanding forests to accelerate removal of carbon from the atmosphere, altering agricultural management practices to increase carbon storage in soil, modifying the way cities are built and organized to reduce energy, etc.

Through the multi-temporal and time-series aerial images we can assess and analyse how the land use/cover changes are affecting global atmospheric concentrations of greenhouse gases. The impact is expected to be most significant in areas with forest loss or land conversion, where the amount of carbon that can be transferred from the atmosphere to the land (or from the land to the atmosphere) is modified. Even in relatively un-forested areas, this effect can be significant. We are aware that if the natural vegetation is converted to agriculture it can cause the changes on air temperature and near-surface moisture. Other areas where uncultivated and conservation lands are being returned to cultivation, for example from restored grassland into agriculture temperature shifts could be experienced. Moreover, conversion of rain-fed cropland to irrigated agriculture further intensifies the impacts of agricultural conversion on temperature as well as can alter regional precipitation.
From many analyses nowadays show that the general historical trends of land-use and land-cover changes will continue, with some important regional differences. To understand the

criticality of these changes let's make an example: Africa is the region with higher deforestation rate in the world and as the result with high impact in the environment. Africa is suffering deforestation at twice the world rate, according to the United Nations Environment Programme (UNEP). According to the FAO, Africa lost the highest percentage of tropical forests of any continent during the 1980s, 1990s, and early 2000s. An extreme example is Nigeria which has lost 81% of its old-growth forests in just 15 years (1990–2005) (FAO). As result, this massive deforestation threatens food security in many African countries and not only. By the other side, land-use and land-cover changes are very much related on rates of population and economic growth.

That's why we need to know how our land is changing and which is the rate of this change in order to project it in the future and create a model of our land for future generations. If we measure the land use and land cover changes over time we could be able to analyse the effect of this changes on climate and environment and try to find sustainable solutions on land management.