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Original article

Recovery of the aerial photographs of Ethiopia in the 1930s

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ABSTRACT

The aerial photographs (APs) acquired by the Istituto Geografico Militare (IGM) in the period of the Italian occupation of Ethiopia (1935–1941) have recently been discovered, scanned and organised. Until recently, the oldest APs of the country that were available had been taken in the period 1958–1964. The APs over Ethiopia in 1935–1941 consist of 8281 assemblages on approximately 50 cm × 20 cm hardboard tiles, each holding a label, one nadir-pointing photograph flanked by two low-oblique photographs and one high-oblique photograph. The four APs were exposed simultaneously and were taken across the flight line. The high-oblique photograph is presented alternatively at left and at right. There is approximately 60% overlap between subsequent sets of APs. One of Santoni's glass plate multi-cameras was used, with focal length of 178 mm and with a flight height of 4000–4500 m a.s.l., which resulted in an approximate scale of 1:11,500 for the central photograph and 1:16,000 to 1:18,000 for the low-oblique APs. The surveyors oriented themselves with maps of Ethiopia at 1:400,000 scale, compiled in 1934. The flights present a dense AP coverage of Northern Ethiopia, where they were acquired in the context of upcoming battles with the Ethiopian army. Several flights preceded the later advance of the Italian army southwards to the capital Addis Ababa. Further flights took place in central Ethiopia for civilian purposes. As of 1936, the APs were used to prepare topographic maps at 1:100,000 and 1:50,000 scales. To re-process the imagery using novel techniques, procedures using digital image-based modelling have been developed. The 1935-1941 APs together with those of 1958–1964, 1994 and recent high-resolution satellite imagery are currently being used in spatio-temporal analysis, including change studies of land cover, land management and geomorphology in Ethiopia over a time span of 80 years.

1. Research aims

Nadir-pointing and oblique aerial photographs acquired in the period of the Italian occupation of Ethiopia (1935–1941) have recently been discovered, scanned and organised. Here, we investigate the conditions of the acquisition of the original aerial photography, instrumentation used and subsequent cartographic production. State-of-the-art technology for the production of ortho-mosaics is evaluated.

2. Introduction

The use of airborne photogrammetry took off with the military activities of the First World War, where it was particularly used with the aim of intelligence [1,2]. It also became a tool for mapping in industrialised countries in the interwar period. With a few exceptions, before the Second World War, the British and French colonial administrations and military cartographic services did not use aerial photography for mapping purposes in Africa [3,4]. The Dakar area was mapped in 1927 using aerial photographs (APs) [5], as was the inland "delta" of the Niger R. [2] and parts of Senegal in 1929 [6]. Large area coverage of the copperbelt in Northern Rhodesia (now Zambia) was undertaken in the 1920s and 1930s

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Fig. 1. An example of a set of four photographs comprising – from left to right – high-oblique; low-oblique; near-vertical; and low-oblique exposures in a fan configuration covering an area east of Quiha in Northern Ethiopia. Date: 1935-12-16; Photo number Mai Dolo 11-2-37; centre of the vertical photo at 13.46574°N, 39.59906°E. ©EMA. Width of the conformably oriented fan configuration is 36 cm on hardboard tile and 6.24 km on the terrain. Permanent farmland boundaries are clearly visible, as well as bush land that occupies structurally determined scarps. Bright dots correspond to threshing floors. The photographs cover part of the eastern edge of the Ethiopian plateau at approximately 2350 m a.s.l. Besides a dolerite sill (at left) and structural geomorphological elements (at right), the major WSW-NNE trail used by camel caravans on their way to the Arho salt plains in the Rift Valley (Afar Triangle) [43] assisted in relocating the historical AP.

(personal souvenirs GP). In 1929–1930, the boundary zone between British and Italian Somalia was mapped using aerial photographs taken from two British and two Italian airplanes [7]. During the 1930s, large-scale aerial photographs were taken in the then Tanganyika, particularly the coastal areas around the city of Dar Es Selam and the island of Zanzibar [8]. In March 1935, 11,000 km^2 of the western Eritrean lowlands were mapped using aerial photography for which ground signals were established [7]. In South Africa, a decision was made in 1936 to map the country at 1:50,000 and to use aerial photographs for that purpose. The actual aerial photography took only place after the Second World War, for which the expertise gained in the war period was very useful [9]. In 1940–1941, the South African Air Force's surveyors supplied aerial photographs that were used to prepare strip maps of important routes in Kenya [9] and Ethiopia [10].

Recently, a large archive of pre-1940 aerial photography has come to light. This collection comprises the coverage of Northern and Central Ethiopia that was acquired during the Italian invasion of the country in 1935–36 and during the period of occupation. This activity ceased after the defeat of the Italian army in East Africa in 1941. The rediscovery of this archive opens new perspectives for change studies as it seems to be the largest set of pre-1940 APs in Africa. For Ethiopia, the oldest APs of the country that are known so far were taken in the period 1958–1964.

3. Presentation of the archive

Though the existence of these aerial photographs was well known, both through literature [11] and evidence of its use as basic data to prepare maps in that period (http://www.igmi.org/ancient/) and for geological studies [12], the original photographs themselves could not be accessed for a long time. For instance, at the archives of the Italian Istituto Geografico Militare (IGM) in Firenze, only 45 glass plate negatives have been conserved. They cover the town of Addis Ababa and unidentified rural areas and were taken during the years 1935–1936 (pers. comm. Col. Furio Donati). The nearly complete archive of these aerial photographs was re-discovered in 2006 in the basement of the Ethiopian Mapping Agency (EMA) building in Addis Ababa. The APs were stored in ammunition boxes that had belonged to the Italian army, and were left behind when the army withdrew from the city of Addis Ababa in 1941. In total, the archive comprises approximately 34,000 individual photographs, made up of 8281 discrete assemblages, each comprising four adjacent photographs. An individual group or set of four photographs comprises a vertical (nadir-pointing) photograph, flanked by two low-oblique photographs and a single high-oblique photograph, which is present alternatively at left and right (Fig. 1). Photographs bear no fiducials and merely a two- or three-digit identification number. All four photographs had been exposed simultaneously in a fan configuration in the cross-track direction (perpendicular to the flight line) to ensure the widest possible angular coverage of the terrain. The vertical and oblique photographs of each successive set of four photographs overlap on the previous set by approximately 60% in the along-track direction, to ensure stereo-coverage of the terrain. The format size of each individual photograph in the archive is 10×15 cm, though many oblique photographs were slightly cropped on their borders to minimise the seam with the nadir-pointing photographs. Each set of four photographs in the archive had been mounted as an unrectified print laydown, glued on to a 50×20 cm hardboard tile, and identified by a label (Figs. 1 and 2). As a result of an agreement between Ghent University (Belgium), the Ethiopian Mapping Agency (EMA) and Mekelle University (Ethiopia), all the photographs in the archive have been transformed into digital form at the EMA offices in Addis Ababa using a Plustek A3 scanner (Optic Pro A320) with a resolution of 600 spi. Moreover, the scanned photographs have been carefully organised into a searchable inventory.

4. Acquisition of the original aerial photography

Northern Ethiopia had only been mapped at a very small scale prior to the Italian invasion through ground surveys conducted along the main routes in the border area by Cap. A. Latini, an Italian officer in civilian clothes, and his team who posed as merchants over a 15 months period. Under that cover, they utilised basic instruments (notebook, compass, altimeter, camera, but no tripod) and came with three-dimensional information of all landscapes they had crossed [7]. In 1934, the IGM (nowadays IGMI) produced a set of maps of northern Ethiopia (http://www.igmi.org/ancient/) that was based on a compilation of earlier maps as well as information from Latini's trajectories. Areas that were hidden to Latini by mountains or escarpments appeared as blank areas on those maps.