

# Mapping the Maldives

Photogrammetry was already in existence more than a century ago, although, judging by current standards, only in its infancy. This technology, gradually refined over time and now ripened into maturity, means that today reliable, accurate and detailed geo-data can be acquired of large areas by taking measurements from imagery recorded by film or digital camera onboard an aircraft. A few significant dates. The International Society for Photogrammetry (ISP), predecessor of ISPRS, was founded by E. Dolezal in Austria in 1910. In 1921 came introduction of the Autocartograph, the first universal analogue plotter. In 1932 Schermerhorn, famous founder of the International Institute for Geo Information Science and Earth Observation (ITC) in the Netherlands, began systematic tests on aero-triangulation techniques. These he applied in 1936 to mapping Irian Jaya, then under Dutch East Indies colonial rule and today part of the developing world. The purpose was oil exploration.

## Maldives

How is aerial photogrammetry applied today for mapping extensive areas? In answer we can look at a recent project aimed at digital mapping of the Republic of Maldives. Whilst a very popular tourist destination, the Maldives is geographically tricky territory, scattered and spread as it is across an area of 100,000km<sup>2</sup> between 1° S to 8° N latitude, 72° E to 74° E longitude. Ninety-nine percent of the country is water and the landmass consists of 26 atolls and 1,192 islands, only 33 of them exceeding 1km<sup>2</sup> in area. During his state visit to India in August 2000 the President of Maldives, His Excellency Mr Maumoon Abdul Gayoom also discussed mapping of his country. The project was realised through a collaborative effort between the Government of India and the Republic of Maldives, and carried out by the National Remote Sensing Agency of the Department of Space, Govt. of India, Hyderabad. Details of the project can be found in a white paper published on our website. Fronting such a project stands the requirement for a nation-wide geodetic reference frame for obtaining consistent coverage with homogeneous accuracy. At the tail end comes product specification, and for the Maldives this was the creation of 1:25,000 digital line maps of the entire country from 1:40,000 aerial photos, and 1:1,000 maps from 1:6,000 aerial photos of sixteen islands. The 1:25,000-scale maps needed to demarcate all land and water boundaries, atolls, built-up areas, roads and vegetation.

## Analogue Camera

Thirteen GPS reference stations and 41 ground control points signalised with 5m x 5m targets established the reference frame in WGS84 datum for the entire Maldives. In this era of even cellular phones being equipped with digital cameras, aerial photogrammetry is still beneficially carried out using film cameras in many regions. Nevertheless, compared to film the digital aerial camera offers better radiometric performance, eliminating the need for costly film processing and scanning and enabling semi-automatic creation of photogrammetric products such as orthophotos/mosaics and, eventually, digital elevation models (DEM). This allows, for example, rapid response in the aftermath of a disaster. But prompt availability of end products is not a decisive factor in mapping large areas, and the Zeiss RMK 15/23 camera used in this project provides metric-quality photographs with wide swath, so reducing overall flying time. To manage the project appropriately the country was divided into seven geographical blocks.

## Flight to Map

During February, 2004 – the ideal cloud-free season in the region – a total of 4,456 photos were taken using a metric film camera integrated with INS and Kinematic GPS onboard a Beech Super King Air B-200 guided during flight by a Computer Controlled Navigation System. The aircraft was transported by ferry from Hyderabad to Male International Airport, the base of the operations. An optimal flight plan was devised in terms of flying time and avoiding wastage of aerial film. Account was also taken of the limited window of cloud-free days, and the plan was prepared using IRS 1C/1D satellite images, existing atlases, old maps and so on. To prevent heat degradation, rolls of film were kept in an air-conditioned safe. After aerial survey, 2,377 B&W stereo 1:40,000 photos were scanned using a precision Zeiss SCAI photogrammetric scanner pixel size 21µm, corresponding to Ground Sample Distance (GSD) of around 85cm. The 1:6,000 photos were scanned with 20µm pixels. Digital photogrammetric techniques were used for automatic aero-triangulation and block adjustment using Socetset software and Orima block-adjustment software. Next, 1:25,000-scale line maps were created by first producing digital orthoimages using a DEM and then capturing vectors from the orthophotos using PC-based, low-cost systems. The 1:1,000 scale maps were created using Digital Photogrammetric Workstations, resulting in 3D-maps and contours.

Thus the first nation-wide aerial photography and establishment of reference datum in WGS84 was executed for the entire Maldives. But why use aerial photographs at nearly 1m GSD when today there are very high-resolution satellites permanently observing the earth and producing images at 1m GSD (Ikonos) and even 60cm (QuickBird)? The use of Ikonos data would have required non-selective purchase of eight hundred scenes over the entire 100,000km<sup>2</sup> area, whilst aerial photos enabled selective data acquisition covering only those areas of significant landmass and provided stereo images for generating DEMs. More than a thousand small, scattered islands covering just 1% of an area of 100,000km<sup>2</sup> made aerial photography preferable to satellite imagery.