# GEO-IT IN RECONSTRUCTION OF BAPTISM AREA

# Archaeology and GIS in Jordan

Geo-information technology, in particular photogrammetry, digital elevation models, ground-penetrating radar, GIS and 3D modelling, was used to document the recently discovered Baptism area in Jordan for purposes of both science and tourism. Requirements for 3D models included high-level geometric accuracy, detailed reconstruction and efficiency in model size and photo-realism. Geomatics technology helps generate accurate digital records of historical and archaeological objects while reducing overall costs.

The Baptism area is an important site of early Christianity, rich in spiritual associations from the old and new Testaments. It is the settlement of Bethany, in Jordan, where John the Baptist lived and performed baptisms during the time of Christ. For nearly two thousand years local church tradition and pilgrims have all identified the small hill at the centre of Bethany as the place from which Elijah ascended to heaven. The site has been known for centuries as Elijahâ€™s hill, or Tell Mar Elias or, in Arabic, Jabal Mar Elias. Today the entire region between Bethany and the Jordan River is called El-Maghtas (Figure 1).

## Past Environment

Photogrammetry offers a rapid and accurate method of acquiring 3D information on heritage sites. Combining photogrammetric measurements with 3D-CAD models enables the reconstruction of the past environment. We used photogrammetry for the production of Digital Terrain Model (DTM), orthophotos and 3D-modelling of existing archaeo-logical structures. For DTM generation, conjugate points in stereo-images were automatically extracted using adaptive matching techniques that take into account the relief of the terrain, so that more points are collected in hilly terrain than in flat. Validation between the generated DTM and collected GPS checkpoints ensured the quality of the DTM. Figure 2 shows the DTM along Wadi Al-Kharar, where elevations vary from 399 to 342 metres below mean sea level.

## Realism

Using the DTM, orthophotos are created from the aerial images (Figure 2). Basically, an orthophoto is a photo transformed from perspective projection to orthog-onal projection by the performance of corrections for tilt and relief displacement. The characteristics of automatic matching require the resulting DTM be edited; if editing is not performed correctly flat or sloped areas may appear in the orthophoto as breaks and cuts. Editing was done by removing errors after visual inspection and manual editing of the DTM. The last stage is 3D modelling, which deals with the actual representation of features, shapes and texture. The purpose of 3D modelling is to represent reality as realistically as possible by, among other things, use of texture. The 3D coordinates resulting from photo-grammetric ad-justment procedures are used to create 3D-models of structural elements (Figures 3) and of a church that has been recently constructed on the River Jordan (Figure 4). Textures added to the surfaces of 3D-models give a â€˜real worldâ€™ appearance to displayed models. This is very important for the presentation of ruined heritage sites, since architects and renovation experts require realistic views for further inspiration. The 3D-model can also be digitally rotated so that the viewer can study the scene from many different perspectives. During the generation of models requirements must be considered such as high geometric accuracy, availability of all detail and efficiency in model size and photo-realism.

## Radargram

The assets of a ruined heritage site are often partially or entirely buried beneath the ground. Geophysical methods such as Ground-Penetrating Radar (GPR) were used to explore the underlying structure of the area. For reliable and precise analysis of such meas-urements a DTM is also needed. GPR emits into the ground ElectroMagnetic (EM) waves of frequency band 10-1,000MHz and in this way the subsurface is imaged and structures detected. GPR has become a popular tool in fields as diverse as geology, archaeo-logy, environmental science, engineering and construction, glaci-ology and forensic science. We used GPR to map buried walls, graves, buried ruins, cavities or chambers, crypts, marble plates and other buried antiquities, with the purpose of directing onward excavations. Figure 5 shows a radargram taken along a 23m profile using the 40MHz frequency band; the anomaly between 15.5 and 17.5m indicates the presence of a buried wall.

## Collati

The information from different sources has to be brought together for complete documentation of the Baptism area. In a GIS system all the data can be combined, including boundary maps, point location of archeological sites, transportation layer, hydrological maps, digi-tal elevation model, orthoimages, satellite images, land classification image, aquifer profiles and geology of the area. All these layers are stored in databases and contain descriptive attributes. The system is designed to allow easy and flexible updating of the database.

## Future Work

Geophysical methods will also enable the generation of hydro-geological maps for the shallow aquifer in the Baptist area, determination of depths and extension of active faults, and estimation of the hydrodynamics characteristics of the groundwater aquifers. All the geophysical results will be mapped on the orthophoto.

## Further Reading

â€¢ Abueladas, A., 2005, Ground-penetrating Radar Investigations of Active Faults and Antiquities along the Dead Sea Transform in Aqaba and Taba Sabkha, Jordan University of Missouri-Kansas City, masterâ€™s thesis, pp 37, 61.

â€¢ El-Hakim, S., A. Beraldin and M. Picard, 2002, Detailed 3D Reconstruction of Monuments using Multiple Techniques. In: ISPRS/CIPA International Workshop on Scanning for Cultural Heritage Recording, Corfu, Greece, pp 58-64.

â€¢ Habib, A., Mwafag G R. Al-Ruzouq, and E. M. Kim 2004. 3D Modelling of Historical Sites using Low-cost Digital Cameras. XXth Congress of ISPRS, July 12-23 2004.