HIGH RESOLUTION DEM DERIVED FROM THERMAL INFRARED IMAGES : EXAMPLE OF ABER BENOIT (France)

Damien GAUDIN 1, Christophe DELACOURT 1, Pascal ALLEMAND 2, Marion JAUD 1, Jérôme AMMANN 1, Chantal TISSEAU 1

1- Laboratoire Domaines Océaniques - UMR 6538,
Université de Bretagne Occidentale - IUEM, Place Nicolas Copernic, 29280 Plouzané, FRANCE
2- Laboratoire de Sciences de la Terre - UMR 5570,
Université Claude Bernard Lyon 1 - Bat Géode – R6, 2 rue Raphaël Dubois, 69622 Villeurbanne cedex, FRANCE

The need of very high resolution and high precision Digital Elevation Models (DEM) of the intertidal and estuarial zone increases for both ecological, geological and land development purposes. At present day, most of those DEMs are built by photogrammetric methods or from Differential GPS (DGPS) technique. The resolution of these products is generally around 1 meter with a precision of 10cm which is not sufficient for applications such as hydro modeling. We describe here a new method to derive high resolution and high precision DEM. This method is based on the detection of the shoreline evolution during a rising tide on a series of thermal infra red images. The method has been applied on a beach of the Aber Benoit, near Lanillis (French Brittany), notably known and studied for its large oysters cultures and fishponds (Prat-Ar-Coum fishponds) [1]. The DEM computed by this method has been compared to a DEM built from DGPS data.

A thermal infra red camera with a 288x384 pixel sensor has been installed at low tide on a 15m high mound above the beach of Prat ar Coum. Because the sensor is not vertical, the distance ranges from 50m to 150m of the shoreline. Images have been acquired at a frequency of 1 Hz during the rising of the tide. The resolution of the images ranges from 4cm to 12cm according to their distance from the camera. As water has different temperature and emissivity than the mud of the beach, the shoreline is clearly visible on the images [3], and no atmospheric correction is needed. Steady waves are clearly visible with infra-red [2] so to limit emission contrast on the water, images are averaged on the period of these waves which is around

10s. During the acquisition, the tide level is registered by a DGPS installed on a boat located just in front of the studied beach. The position of Ground Control Points (GCP) visible on the thermal images have also been measured in order to orthorectify the images. The shoreline is then automatically detected on the averaged images by measuring the temperature gradient. The position of the camera is estimated from the GCP using the equation of photogrammetry. The position of the shoreline is then projected on a map. The DEM is then computed from the various position of the shoreline associated to the measure of the sea level given by the DGPS on board.

A comparison between the DEM computed from the images and the DEM interpolated from DGPS data shows that the resolution of the thermal DEM is obviously higher than the DGPS DEM. The thermal DEM captures details smaller than 20cm not visible on the DGPS data, and we show that, up to a few millimetres, the only limitation is the sensor resolution. The precision of the thermal DEM is of 2cm. The lack of precision is mainly due to errors in the detection of the shoreline and, to a lesser expand to the process of orthorectification. Vertical photographs, for example taken by unpiloted aircraft could widely limit these problems. However, the method described here is a promising tool to extract high resolution DEM of beaches.

References :

[1] J. Chavez-Villalba, J. Barret, C. Mingant, et al., "Influence of timing of broodstock collection on conditioning, oocyte production, and larval rearing of the oyster, Crassostrea gigas (Thunberg), at six production sites in France", *Journal of Shellfish Research*, vol. 22, no. 2, pp 465-474, Sep. 2003

[2] J.P. Dugan, H.H. Suzukawa, C.P. Forsyth, and M.S. Farber, "Ocean wave dispersion surface measured with airborne IR imaging system", *IEEE Transactions on Geoscience and Remote Sensing*, vol. 34, no. 5, pp1282-1284, Sep. 1996

[3] J-H. Ryu, C-H. Kim, Y-K. Lee , J-S.Won, S-S. Chun, S. Lee, "Detecting the intertidal morphologic change using satellite data", *Estuarine, Coastal and Shelf Science*, vol. 78, pp. 623-632, 2008