

Soft Computing and Conventional Interpolation Methods in Geoid Modelling: A Case Study in Istanbul

*Muge Albayrak¹, M. Tevfik Ozludemir¹, Orhan Akyilmaz¹, Kerem Halicioglu²

1. Istanbul Technical University, 2. Bogazici University

Geoid is the fundamental geodetic infrastructure for rational use of Global Navigation Satellite System (GNSS) technology. For this reason, definition a "cm geoid" is an actual subject in all countries. Development of geoid modelling is based on geodetic, gravimetric and astrogeodetic techniques, which are maintained using the geopotential models produced by the combination of gravity measurements, astrogeodetic vertical deflections, GNSS/Levelling data, satellite gravity data, satellite altimetry data and the combination of these data. GNSS/Levelling geoid determination has great importance with regard to the transformation of GNSS-derived ellipsoidal height (h), into the orthometric height (H), which is used in engineering projects and determined by levelling. Instead of levelling, which is an expensive and time-consuming method, orthometric heights can be calculated by using a well-defined geoid models. These geoid models enable us to compute the geoid height (N), which is the difference between ellipsoidal and orthometric height values ($N=h-H$). Then orthometric heights can be computed using these geoid heights and known ellipsoidal heights. Therefore, this will reduce the measurement work in the basic land surveying to a great extent and make economic contribution. In geoid modelling several methods can be employed. Such a geoid model has been developed for the metropolitan area of Istanbul city. In this context, Istanbul GPS Triangulation Network (IGN) and the Istanbul Levelling Network (ILN) provided reliable data, ellipsoidal and orthometric heights, respectively. This study focuses on the development of Istanbul geoid model with soft computing techniques and its comparison with conventional interpolation algorithms used for modelling. For this purpose, geoid heights in Istanbul metropolitan area have been computed by soft computing methods, namely Adaptive Network based Fuzzy Inference System (ANFIS) and Artificial Neural Networks (ANN) and modeled by twelve different interpolation methods. For computations and modelling in the study area, homogeneously distributed 1005 model and 178 test points were selected. These are the common points in IGN and ILN whose latitude, longitude, ellipsoidal heights and orthometric heights are known to construct ANFIS and ANN models in Istanbul. To construct these models in model and test points, latitude and longitude are taken as inputs and geoid heights are taken as outputs. The results obtained from ANFIS and ANN methods are quite satisfactory. The model derived orthometric heights were compared with the known orthometric heights for model and test points. The standard deviation has been obtained in ANFIS as $\pm 4.3\text{cm}$ and $\pm 4.0\text{cm}$ for model and test areas, respectively. On the other hand, the standard deviation in ANN model are $\pm 4\text{ cm}$ and 3.1 cm , for model and test areas, respectively. In addition, conventional interpolation methods as modified Shepard's method, radial basis function, Kriging, Nearest neighbor, minimum curvature, inverse distance to a power and local polynomial yield better results than ANFIS and ANN in model and test areas. The others interpolation methods such as polynomial regression, moving average, triangulation with linear interpolation, natural neighbor and data metrics yield worse results than ANFIS and ANN in each area.

Keywords: geoid modelling, soft computing, interpolation methods

