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A Different view to Modeling of Systematic Errors in Precise Leveling Networks, Case study: First order leveling network of Iran

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There are several sources of systematic errors which affect the precise leveling observations and cause limitations to obtain high quality measurements. Some of these sources are refraction effects, rod scale error, vertical movement of instrument, temperature effect on rods and level, non-vertically of rods, bench mark movements. So far, many efforts have been carried out by different people to eliminate or reduce significantly the effects of systematic errors in leveling observations. These investigations mainly focus, especially in Iran, on physical modeling of atmospheric refraction and leveling rod expansion during the measurements. Based on the developed models of systematic errors, National Cartographic Center of Iran (NCC) uses the relative thermometer sensors along the precise leveling rods simultaneous with height difference observations to better model atmospheric refraction as the most important source of the systematic errors. In fact the relative thermometer sensors could be a great help to determine the vertical temperature gradient along the leveling rods. Obviously these auxiliary data imply more expenses to the NCC.

In spite of all these tries, the precise leveling observations are not yet free of systematic errors due to atmospheric refraction, rod scale error and other unknown resources of errors. In this research, we try to run a new and simple method based on mathematical modeling of systematic errors resultant. The basic of this method is the expectation of errors must be zero, as a fundamental condition before adjusting the observations. In absence of any systematic error in precise leveling observations, we can see the forward-backward discrepancies along a leveling line vary around zero as it is expected. But in reality we do not have such a case and see an important accumulated height differences when we go far from the initial leveling bench mark in leveling lines. In fact we confront a trend analysis problem and should try to estimate a mathematical model to the trend by using approximation theory. Supposing the best fitted mathematical model is representative of the systematic errors resultant for each leveling line, we remove it from the corresponding height difference observations as a mathematical correction to the measurements. After obtaining the corrected observations, based on the mathematical model, we calculate a new series of height differences as corrected observations and put them in adjustment process. Finally we do a comparison between the results from this investigation (mathematical method) and the results from the current method (physical method).