

Towards A New Vertical Datum For India

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Key words: Reference frames; Reference systems

SUMMARY

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Abstract

A National vertical datum has been providing the reference frame for a variety of practical applications, for example, navigation, building of roads and other infrastructure and variety of developmental activities in the country. Many scientific studies require a precise knowledge of not only horizontal position but also the vertical position of point on the earth's surface as well as in the space. The situation regarding vertical positioning is not as advanced as that of modern space based horizontal positioning. This is likely due to the fact that there is no conventional global vertical datum in reference to which a local vertical datum can be realized in a country. In India the 3D geodetic datum has already been established in relation to ITRF 2008. Clearly a similar approach is needed for the new vertical datum realizations. The present Indian vertical datum refers to Mean Sea Level which was determined more than a century ago. Over the period of time it has been realized that the local mean sea level is usually departed from the geoid, which should be the local datum surface for height, due to the effect of sea surface topography. For the sake of establishment of local vertical datum, one has to investigate the geometrical relationship between local vertical datum and the geoid. In order to achieve this objective, it is necessary to compare the geo-potential of the geoid with that of the local Mean Sea Level defining the local height

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FIG Congress 2018

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Istanbul, Turkey, May 6–11, 2018

system.

The current Indian vertical datum was defined during the period 1905-1909 on the basis of sea level observations at nine tidal observatories, four each on east and west coast and one in Karachi, with the assumption that Mean Sea Level measured at each of these nine observatories represents the same water level. However, later on this concept was found to be incorrect while performing the fresh adjustment of level network of India during 1977-1983 and a difference of about 35 cm was reported between Mumbai(west coast) and Chennai(East coast) tide gauge stations with west coast being lower than the east coast. This problem could not be resolved at that point of time and the idea of redefining Indian vertical datum was dropped

A concept for the definition of a global vertical datum has been evolved in recent times. This concept suggests that a (conventional) Mean Sea Level (and geoid) be uniquely specified by adopting a geo-potential value W_0 which best represents the Mean Sea Level in global sense. In fact a conventional value of $W_0 = 62636856.0 \text{ m}^2\text{s}^{-2}$ has already been adopted by the IERS (International Earth Rotation Service) conventions 2010 and used by the International Astronomical Union (IAU) to derive a constant required for relativistic time transformations and atomic time realization at Mean Sea Level. Once a conventional W_0 is adopted for global vertical datum the individual vertical datum at regional, national or continent level can be related to the adopted W_0 by means of a global gravity field model, precise ITRF positions and leveled heights, which must allow a proper transformation into the corresponding geo-potential number.

In order to implement the above approach of realization of modern vertical datum for Indian subcontinent a project was initiated in 2006-07 by Geodetic & Research Branch of Survey of India. Under the project named as “Redefinition of Indian Vertical Datum” a number of field activities for example, High Precision height measurements and gravity observations on levelling bench marks(BMs) were done over a period of more than three years. During the progress of fieldwork all possible efforts were made to connect the old bench marks falling on levelling lines planned for the project. It has been found that most of the old bench marks were destroyed due to the developmental activities in the area and very few bench marks were located for the purpose of High Precision Levelling and gravity observations.

In the present scenario, it has been planned to define the Indian Vertical Datum in terms of geo-potential value W_0 (LVD) at eight numbers of tide gauge observatories located four each on east and west coast. GNSS observations at all the eight tide gauge bench marks have been done. The height differences to be computed from the ellipsoidal (h), orthometric (H) and geoid (N) heights will be adjusted in order to estimate the geo-potential value. In principle the residual part of the height differences correspond to the offset between the geo-potential value used in the selected Global geoid model and the local geo-potential value W_0 (LVD). Apart from this approach the computation of W_0 (LVD) will also be carried out using the methodology based on Molodensky theory. The ultimate aim of new vertical datum is to provide –

Award on New Vertical Datum System India (2017)
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A system to enable users to obtain height above mean sea level or a level (equipotential) surface close to it.

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The ability for users to be able to compute the local instantaneous sea level in terms of the national height datum.