Investigation of the Integrity of the Australian Height Datum (AHD) with a View to its Unification in a Global Vertical Datum

Degree:	PhD
Key-words:	geodesy, vertical datum definition, systematic errors, geodetic levelling, orthometric corrections, Australian Height Datum, sea surface topography, topographic density, heights, geoid
Entry:	Bachelors, preferably 1st class Honours, Postgraduate Diploma or Masters degree in geoscience, physics, mathematics, or any related discipline
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Project Funding:	Australian Research Council
Student Funding:	Department of Spatial Sciences Scholarship
Resources:	Australian gravity and terrain data, geoid computation software, Australian Height Datum data, sea surface topography models, GPS measurements across Australian and at tide gauges
Collaboration:	Geoscience Australia, International Association of Geodesy
Starting Date:	Unrestricted

Project Description:

The Australian Height Datum (AHD; Roelse *et al*., 1971) is known to contain systematic errors (eg. Featherstone, 1998 and the references cited therein). These are due to a combination of factors, including but not limited to the omission of orthometric corrections based on observed gravity data, the fixing of 30 tide gauges to zero around the coast of Australia, and systematic errors in the levelling observations. Over the years, various studies have cast dispersions on the accuracy and integrity of the AHD (eg. Morgan, 1992; Kearsley, 1988). However, what is currently lacking is a coordinated and systematic study of the error sources affecting the AHD, coupled with recommendations of what effects to model in any future redefinition of the AHD. As well as quantifying and correcting the systematic errors in the AHD, it is also important to place it in a global vertical framework.

The proposed project will involve research into one or more of the following:

- A complete readjustment of the AHD that includes all additional levelling data collected since the original 1971 adjustment and tide gauge measurements of mean sea level that have been collected over a longer time period. This will compare and contrast a free network adjustment, where only one tide gauge is fixed, and a constrained adjustment, where other tide gauges are constrained, rather than fixed, to the geoid. Importantly, these adjustments will trial different sea surface topography models to account for

the difference between mean sea level observed at tide gauges and the geoid. This will determine to what extent the original adjustment strategies have introduced distortions into the AHD. A recent set of GPS data has been collected at the majority of the tide gauges used to define the AHD, and these data will place some additional constraints on the adjustments.

- Another important aspect in the redefinition of the AHD is the computation and application of orthometric corrections to levelling data. The 1971 definition of the AHD used normal orthometric corrections, where normal gravity, rather than observed gravity, was used in the orthometric correction formula. This aspect of the project will apply orthometric corrections by predicting gravity and thus geopotential numbers at benchmarks and along levelling runs from observed gravity data using least-squares collocation. The computation of the orthometric corrections will also investigate the use of topographic density models and gravimetric terrain corrections to improve upon the Helmert method. Alternatively, a purely normal height system can be defined.

- Vertical datums were historically defined using optical levelling and trigonometric height data. However, modern techniques, notably the Global Positioning System (GPS), are being increasingly used for height determination. Therefore, a redefinition of the AHD that includes heights derived from GPS and geoid data, as well as hydrodynamic data between tide gauges (if available), is necessary. Importantly, this redefinition and readjustment requires the proper weighting among observation types and proper account for correlated errors among these quantities. This will lead to a modern vertical datum that is compatible with modern height measurement techniques.

- There is a growing trend towards the unification of vertical datums into a consistent global vertical framework (eg Colombo, 1980; Rapp, 1995). Therefore, it is important for the AHD to be properly integrated in such a global vertical datum. Such unification is reliant upon the proper determination of the geopotential, either through a gravimetric geoid (Kumar and Burke, 1997) or geopotential numbers computed at tide gauges (Bursa et al., 1999). Therefore, this aspect of the project will compare and contrast these techniques, and potentially devise new ones specific to the AHD.

Recommended Reading:

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