GDA - What it Means to You

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GDA

GDA
Geocentric Datum of Australia

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Background

Australia is changing to a new coordinate system - the Geocentric Datum of Australia (GDA). In July 1988 the Intergovernmental Committee on Surveying and Mapping (ICSM) passed a resolution recommending the adoption of an appropriate geocentric datum on 1 January 2000.

All State and Commonwealth surveying and mapping agencies will progressively introduce the new datum. Other public and private organisations in NSW that deal with spatial data in any form will need to assess the impact of the new datum and implement their own changes over time.

Detailed information and the GDA Technical Manual are available from ICSM, the national coordinating body for the implementation of GDA.

See also AUSLIG for more information.

Implications for NSW

All users of spatial data must have a basic understanding of datums and coordinate systems during this transition period.

The current datum in NSW is the Australian Geodetic Datum 1966 (AGD66). Coordinates are expressed in terms of latitude/longitude, the Australian Map Grid (AMG) or the Integrated Survey Grid (ISG). Both AMG and ISG are transverse mercator projections, where AMG uses 6º degree zones and ISG uses 2º zones.

The projection system for GDA is the Map Grid of Australia (MGA). MGA is a Universal Transverse Mercator (UTM) projection using 6º zones. This ensures consistency between the states and will result in less zone boundaries than the current ISG system.

The move to GDA will cause the following approximate coordinate changes in NSW:

- If you are using geographicals, then the numerical value of the latitude will decrease by ~5.6" and longitude increase by ~4.2"
- If you are using AMG, then both eastings and northings will increase by approximately 105m and 190m respectively
- If you are using ISG, then the numbers will be completely different due to different zone widths and different false coordinates for the origin used by the MGA. See also Implications for Surveyors in NSW

For those with an interest in height above sea level, i.e. the Australian Height Datum (AHD), adoption of GDA has no effect whatsoever. This is because GDA is a datum for horizontal coordinate systems only.

Progress to Date

- GDA adopted by ICSM - November 1994.
  The new datum was proclaimed and coordinates of GDA origin sites (Australian Fiducial Network) were listed in the Commonwealth Gazette - 6 September 1995.
  Coordinates of Australian National Network (ANN) sites Gazetted in NSW - 20 October 1995.
- National readjustment complete - 23 March 1997.
  This is the GDA94 coordinate set which consists of over 7000 survey marks across Australia.
  GDA94 adjusted coordinates are available for ~3200 sites in NSW.
- Various methods of transforming coordinates between the datums are being developed and tested.
  The outcome will be three types of transformation.
  - Block shift / Molodensky - for use in navigation, map reading and low accuracy GIS data
  - 7 Parameter - for use in GIS and some surveying applications
  - MRE - for use with survey control data
- NSW GDA implementation strategy developed - September 1997.
  The Surveyor General approved a series of strategies for implementation of the new datum in NSW by 1 January 2000
- Datum conversion notes for maps introduced - May 1998.
  Warning labels containing information on converting to and from GDA are being placed on all existing paper maps distributed in NSW.
- User Education - ongoing
  Educational material has been developed and ICSM brochures with basic information on GDA are being distributed.
  A number of seminars are being held in various locations around the state. See below for upcoming GDA events.

SCIMS 2000

- A new database is under development which will contain coordinates for the state survey control network in both GDA94 and AGD66.

  More information about "SCIMS 2000" will be available soon.

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A Geocentric Datum for Australia

Survey Issues for New South Wales

Historical

Governor Darling recognised the importance of a proper system of survey for the colony over 170 years ago and directed a trigonometrical (trig) survey to commence. This survey formed the basis of Sir Thomas Mitchell's map of the colony in 1831 where he adopted the longitude at Parramatta Observatory and latitude determinations at Lake George, Warrawolong and other trig sites as a datum.

With the technical bits and pieces of spheroids hidden behind volumes of tables, a large portion of the surveying community in New South Wales remains unaware of the different coordinate systems and datums that were used since Mitchell's time. Those involved with map-making and geodesy have recollections of the Transverse Mercator (TM) grid system (in yards) using Clarke's 1858 spheroid and that's about all.

Recent history saw the "new" Australian Geodetic Datum (AGD66) adopted for mapping purposes by the National Mapping Council in 1965 using Johnston Geodetic Station in the Northern Territory as the origin, and the Australian Map Grid (AMG) as a projection.

In the early 1970's New South Wales adopted a system of "Survey Integration", where the Integrated Survey Grid (ISG) was introduced to minimise projection corrections for cadastral surveys. It was determined that corrections for a 2° zone were less than 1:8000 and could therefore be ignored. AGD66 remained as the datum.

In 1984 the opportunity arose to change datums again, however New South Wales along with Victoria, ACT and Tasmania declined and the rest of Australia moved on to the Australian Geodetic Datum 1984 (AGD84). This decision was taken with the knowledge that yet another change, to a geocentric datum, may not be too far away.

November 1994 saw the adoption of GPS derived coordinates for the Australian Fiducial Network (AFN), allowing Australia to position itself within a truly global mathematical framework and minimising the distortions introduced by deflection of the vertical, refraction and other phenomena in our physical world. These coordinates define the Geocentric Datum of Australia (GDA) using the reference ellipsoid GRS80 (Geocentric Reference System 1980).

Constrained by the new datum, a national adjustment of geodetic observations was then undertaken and completed in June 1997. New South Wales contribution was some 40000 terrestrial and GPS observations which produced a coordinate set known as GDA94 for over 3000 sites in this State.

Current Situation

The Surveyor-General's Department is the GDA coordinating agency for New South Wales and is forming a number of working parties to address implementation issues for survey, mining, GIS and other applications. The Department provides technical advice and promotional activities are ongoing.

Adjusted GDA94 coordinates of the 3000 sites are available from the Department on request and a new survey control database is under construction which allows for a choice of datums. The database will be operational later this year and users will have access via the internet or normal counter services.

Transformations

The transformation between AGD66 and GDA94 can be undertaken in two ways:

- Using a standard seven parameter transformation. This method is common to many software applications and parameters will be published by the Department.

- Using a program used by the Department which employs multiple regression equations to compensate for the distortions in the existing AGD66 survey network. This program is only necessary for special applications.

Implementation Strategy

GDA94 coordinates for the majority of our 160000 state survey control marks will be generated "overnight" using the multiple regression transformation process. These transformed values will be replaced on a region by region basis over the next few years by re-adjustment of the original observations.

Existing AGD66 projection coordinates, AMG & ISG, for all survey marks will be maintained by the survey control database in parallel with their GDA94 values, however the coordinates will not be updated indefinitely. Phasing out AGD66 depends on changes to legislation and progress of the re-adjustment program.

Projections

The projection for GDA is the Map Grid of Australia 1994 (MGA94). This is a standard 6° Universal Transverse Mercator (UTM) projection and will be used by all states and territories across Australia.

All GDA projection coordinates issued by the Department will be MGA94. There will not be an ISG 2° zone equivalent. This does not preclude the use of other projection systems for specific projects, however a system of survey integration must be maintained to ensure compatibility across all geographic systems at the local, national and global level.

There are a number of benefits in using MGA94:

- There will be less zone boundaries across NSW.
- Many issues to do with crossing state borders will be resolved.

  There will be large changes to the numerical values of coordinates, avoiding confusion when using survey plans prepared on ISG.

  MGA94 is a standard UTM projection used by all software applications.

Projection corrections for MGA94 are significantly larger than those of ISG and although most computations are handled by software applications, combined sea level and projection correction tables will be available.

Legislation

References to datums or coordinate systems are found in the following legislation:

Surveyors (Practice) Regulation 1996

Survey Coordination Regulation 1993

Mining Act 1992

Mining (General) Regulation 1992

Petroleum (onshore) Act 1991

Passenger Transport (taxicab services) Regulation 1995

It is intended to amend all legislation to allow for a transition period with formal adoption of GDA by 1st January 2000.

Summary

For those in the surveying industry who understand coordinate systems, the impact of changing to a geocentric datum is minimal when compared to the advantages of creating one homogenous national datum. GDA will provide direct compatibility with the Global Positioning System (GPS), minimise the need for transformations and allow our spatial data systems to move to a common "user friendly" environment across Australia.

For further information on the implications of changing from ISG to MGA see Implications for Surveyors

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7 Parameter Similarity Transformation

The 7 parameter similarity transformation is a mathematical process which relates two datums by three origin translations, a rotation about each axis and a change of scale. This is a conformal transformation which preserves the *shape* of data.

The following values are known as the Regional NSW/VIC parameters and supercede the "LIC93" transformation values for NSW.

The absolute accuracy of transformed data will be in the order of 1 metre, however users should be aware that the relative accuracy between points over a small area will be maintained.

AGD66 ➡ GDA94

Parameter	Value	RMS
X axis Translation (metres)	**-119.353**	**±0.08**
Y axis Translation (metres)	**-48.301**	**±0.08**
Z axis Translation (metres)	**139.484**	**±0.08**
X axis Rotation (seconds)	**-0.415**	**±0.03**
Y axis Rotation (seconds)	**-0.260**	**±0.03**
Z axis Rotation (seconds)	**-0.437**	**±0.03**
Scale (parts per million)	**-0.613**	**±0.11**

Note: Two different conventions for rotation definitions are in use in the survey industry. The position vector rotation (Bursa-Wolfe model) commonly used in Europe and the coordinate frame rotation commonly used in Australia and the USA. The only difference being the sign of the rotation parameters.

To transform between AGD66 and GDA94 using these parameters, click here

Whilst all effort is made to ensure the accuracy and currency of this information, the Surveyor-General's Department does not accept responsibility for any actions arising from the use of this data

See the GDA Technical Manual for other regional AGD66/GDA94 similarity parameters or for the national AGD84/GDA94 parameters.

Overview of Other Transformation Methods

- **Block Shift / Molodensky**

  The Block Shift is a simple method of applying an average shift determined using one or more points with coordinates in both datums.

  Average block shifts have been determined for all 1:250,000 map sheets across Australia, these values can be downloaded from the GDA Technical Manual. The accuracy of these shifts is limited to about 10 metres.

  Molodensky's formula uses an average origin shift and the difference in parameters of the two ellipsoids.

  Formulae can be veiwed and a spreadsheet for these calculations downloaded from the GDA Technical Manual. Accuracy is limited to about 5 metres.

- **Multiple Regression Equation**

  A survey accurate method for transformation of geographical and grid coordinates between AGD66 and GDA94. This surface fitting transformation method has been developed as a two stage process.

  The first is by multiple regression equations which model the distortions in the AGD66 coordinate set across the state. The second stage is the application of a further correction based on the multiple regression residuals, which removes localised residual distortions not accurately modeled by the multiple regression technique.

  Its main purpose is transformation of survey accurate data that cannot be adjusted on the new geocentric coordinates.

  This transformation program is available on floppy disk with a listing of all GDA stations in the state.

  For use in NSW only and will eventually be replaced by the National grid interpolation technique.

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Transform Your Coordinates

Here you can transform coordinates between AGD66 and GDA94 using the Regional NSW/Vic seven parameters.

Enter either geographic or grid coordinates, select the coordinate type and click on Transform.

A separate screen will display the results in all coordinate types.

Although the absolute accuracy of the regional parameters is about one metre, the results are shown to the millimetre for those who require it for testing purposes.

Geographic Coordinates

○ AGD66
○ GDA94

Latitude: [ ] [ ] [ ]

Longitude: [ ] [ ] [ ]

Ellipsoidal Height * : [ ] m

Grid Coordinates

○ AMG66
◉ ISG
○ MGA94

Easting: 352623.374

Northing: 1299489.854

Zone: ISG 55/3

Ellipsoidal Height * : 749.369 m

Transform Clear

Note: * If ellipsoid height is not available use AHD or any approximate height, the difference will have only a small effect on the transformed horizontal position.

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Coordinate Transformation Report

ISG Input

March 04 1999

Transformation Parameters AGD66 to GDA94

dx = -119.353	dy = -48.301	dz = 139.484	scale = -0.613ppm
rx = -0.415"	ry = -0.260"	rz = -0.437"	

AGD66

Latitude:	-33 25 52.46492
Longitude:	149 33 57.22443
Ellipsoidal Height:	749.369 m

AMG66

Easting:	738554.884
Northing:	6297947.141
Zone:	55
Ellipsoidal Height:	749.369 m

ISG

Easting:	352623.374
Northing:	1299489.854
Zone:	553
Ellipsoidal Height:	749.369 m

GDA94

Latitude:	-33 25 46.83160
Longitude:	149 34 01.46518
Ellipsoidal Height:	756.860 m

MGA94

Easting:	738667.852
Northing:	6298130.834
Zone:	55
Ellipsoidal Height:	756.860 m

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