03 How coordinates on different datums can be used together

Users of location information often work with multiple datums or reference frameworks, such as when coordinates from historic national datums are used together with positions observed from GNSS.

All coordinates should be on the same datum before they are used together. Changing a coordinate on one datum (the source) to the corresponding coordinate on another datum (the target) involves a process called coordinate transformation. This is also called a datum transformation, although this terminology can be misleading because the 'coordinate', rather than the datum, is being transformed.

Spatial software, apps and online mapping systems use a range of coordinate transformation models to transform coordinates between datums. The models can be based on mathematical equations or grid-shift interpolations.

How are the transformations defined?

Coordinate transformation is a mathematical process that models the relationship between coordinates on two datums. Ideally, this relationship model is defined empirically using common points with 'known' coordinates on the source and target datum. Once defined, the relationship can be applied to transform all other coordinate locations in a dataset.

Sometimes, there won't be a direct transformation between a source and target datum defined using common points. Applying a chain of transformations using 'known' relationships between one or more other datums is an alternative approach. There are even instances where a transformation between similar datums is deemed appropriate to apply to other datum relationships, if high coordinate accuracy is not essential (such as in small-scale mapping).

GDA94
23° 40′ 12.45″ S 133° 53′ 07.85″ E
GDA2020
23° 40′ 12.40″ S 133° 53′ 07.88″ E
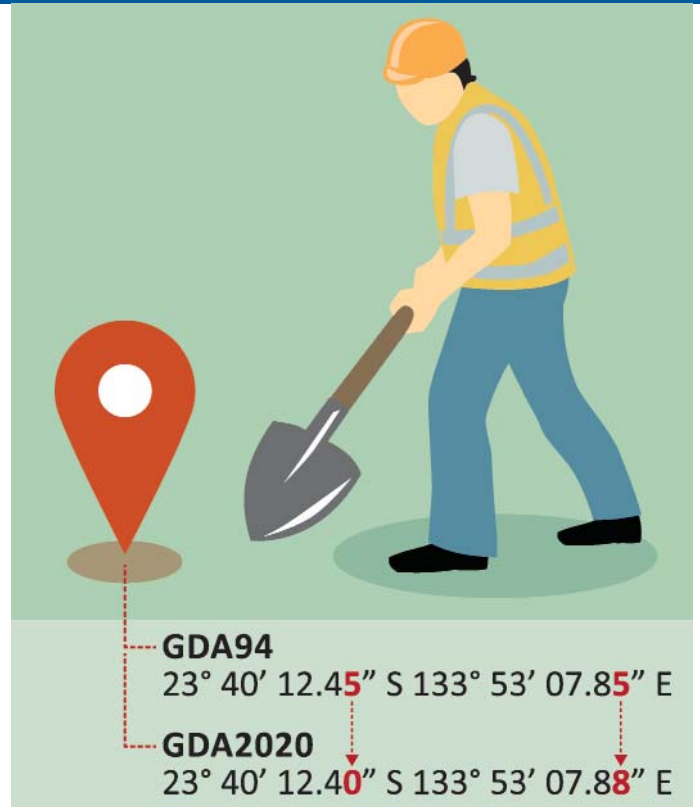
A physical location on the Earth represented by latitude and longitude coordinates on GDA94 and GDA2020. Latitude and longitude are at best ambiguous unless they are described with the related datum.

What do I need to know?

To be reliable, location information must be identified by the datum as well as the coordinates. When the relevant datum information is available, coordinates may be transformed into corresponding coordinates on another datum. Different coordinate transformations may have varying levels of accuracy and be suited to particular circumstances. ICSM publishes official information about transformations to use in Australia.

GDA 2020

Modernising Australia's Datum www.icsm.gov.au

ICSM
INTERGOVERNMENTAL COMMITTEE ON
SURVEYING & MAPPING

03 How coordinates on different datums can be used together

Different transformation = different answer

Different coordinate transformation models can and do produce a different coordinate on the target datum. Transformation approaches can vary in accuracy from one centimetre to tens of metres, and importantly, some transformations are meant only for certain regions, purposes or data types. For example, less-accurate transformations suit only small-scale mapping data.

If users apply different transformation methods to the same coordinates on a source datum, it can easily lead to the unexpected misalignment of spatial data on the target datum. This can have serious consequences where the accuracy of the spatial data is being relied upon.

For example, if a low-accuracy transformation is used to change the coordinates of an accurately located underground asset that is critical to engineering design, costly delays may ensue while the design is altered, or infrastructure may be damaged during construction.

### A conversion is not a transformation

Coordinate conversions switch between coordinate reference systems on the same datum or reference frame, such as from a geographic coordinate (GDA2020 latitude and longitude) to a projected coordinate (MGA2020 Easting, Northing and Zone).

Coordinate conversions produce only one result, unlike transformations, for which there are many options and therefore many potential results.

What does 're-projection' mean?

Software and apps that handle spatial information often refer to both coordinate transformation and coordinate conversion as simply 're-projection' or 'projection'. Added to this ambiguity, the process being applied may include a sequence of transformations or conversions (such as MGA94 > GDA94 > GDA2020 > MGA2020).

Users who are unfamiliar with the difference between a transformation and a conversion may be unaware that, in doing a 're-project' or 'projection', spatial data potentially can be misaligned on the target datum if different transformations are applied to different datasets.
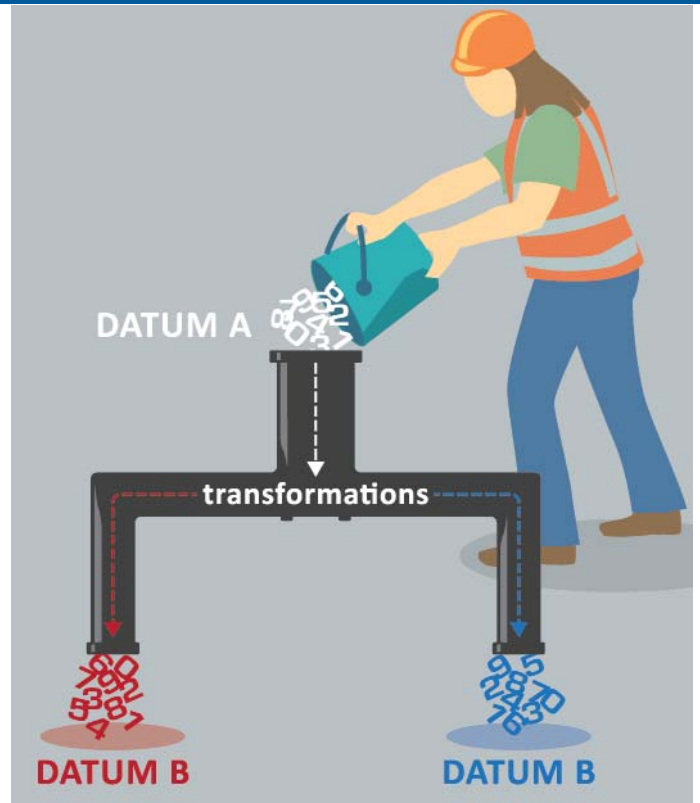
Different coordinate transformations can yield different results. Care should be taken when choosing a transformation method

Know your data know your datum

Correctly dealing with coordinates on different datums is very important. The metadata for the transformed dataset must always contain details of the transformation method to ensure other users of the data are able to determine the transformation accuracy and data lineage.

Information about datum transformation

In Australia, Geoscience Australia and state and territory jurisdictions determine the 'known' coordinates of points on international reference frames and national datums, and the transformation models. ICSM provides official information about transformations and conversions for Australia. See: http://www.icsm.gov.au/gda/tools.html

Further information

Information about the datum modernisation – including a simple explanatory animation, frequently asked questions, fact sheets and progress updates – is available on the ICSM website: www.icsm.gov.au

GDA 2020

Modernising Australia's Datum www.icsm.gov.au

ICSM
INTERGOVERNMENTAL COMMITTEE ON
SURVEYING & MAPPING

3

4 December 2017