Spatial Services

CRS / Datum requirements
for software development in NSW

Information Sheet May 2022

Introduction

This document aims to clarify requirements related to Coordinate Reference Systems (CRS) or datum, for the import, export, transformation or visualisation of spatial data.

Modern spatial software and Spatial Digital Twin (SDT) platforms must support the alignment of 1D, 2D, [2D+1D], 3D and 4D spatial data from multiple sources. Correct management of Coordinate Reference Systems is essential to ensure the seamless integration of spatial datasets. Most platforms are required to support the official Australian datums, GDA2020 and AHD, as well as additional CRS to cater for both modern and historic data.

Integration of datasets across multiple CRS is increasingly required by standards and software. Until recently, one could reasonably assume that most modern spatial datasets at a given location shared a single national or regional CRS. This assumption is demonstrated in the common use of 'null' transformations to bring local datasets into the global (albeit low accuracy) WGS 84 / Web Mercator CRS. In contrast, increased availability of high accuracy spatial data has required new regional CRS. Two examples are GDA2020 (which has replaced GDA94) and AVWS (which complements AHD). Modern spatial software is expected to correctly handle these multiple CRS and associated transformations.

Datum requirements – general

- Support import and export of data in common, well-defined CRS.
- Support appropriate CRS transformation(s) to align data for viewing or analysis.
- Support user choice of CRS and transformation(s). Clearly define any defaults employed.
- Metadata must clearly define all horizontal and vertical CRS. Data lineage and accuracy are highly desirable.
- Data transformation should be a reversible, non-destructive process. Initial data inputs should be reproducible. There should be no need (other than for efficiency or caching) to store multiple copies of data in different CRS.
- WGS 84 / Web Mercator must be treated as a low-accuracy (~2m) CRS, suitable for low-accuracy applications.
  WGS 84 / Web Mercator must be aligned with GDA2020 by default for all new development.
  WGS 84 alignment (to GDA2020, GDA94, [other] or 'unknown') should be captured in addition to CRS metadata.
- 3D data should explicitly define a vertical CRS. Height 'attributes' or 'z-values' without a CRS are ambiguous.
- Software may be required to support 4D data as in '3D data with time-stamps' (e.g. vehicle location over time). In contrast, support for time-dependent 4D CRS (e.g. ATRF2014) is not currently expected from most software.
- Ideally software should support any CRS or transformation defined in EPSG as exposed via PROJ (or similar).

Additional reference information:

- Common Australian EPSG Codes and Transformations Information Sheet – Dec 2021
- Spatial Services WGS 84 Information Sheet – April 2021
- 3D Data and Transformations Information Sheet – Dec 2021
- GMIWG advisory on WGS 84 and Web Mapping – June 2020
- ANZLIC Metadata WG advisory 'Preparing metadata for GDA2020 and the AGRS'

Datum requirements – specific

1. Import and export methods must support the following CRS. Exceptions must be clearly identified and justified:

   I. Horizontal CRS:
      a. GDA94 (2D), GDA2020 (2D) and their MGA projections. [Optional: additional map projections]
      b. WGS 84 (2D) and its Web Mercator projection, conforming to WGS 84-aligned-to-GDA2020. [Desirable: additional support for WGS 84-aligned-to-GDA94, [other] or 'unknown']
      c. AGD66 (2D), plus their AMG and ISG projections. [Optional: AGD84 for other jurisdictions]

   II. Vertical CRS:
      a. AHD (1D)
      b. AVWS (1D) – Note: new to EPSG from 2020, usage is currently limited but expected to increase.

   III. 3D CRS:
      a. GDA94 (3D including ellipsoidal height)
      b. GDA2020 (3D including ellipsoidal height)
      c. WGS 84 (3D including ellipsoidal height) – See notes on WGS 84 alignment, in section above.
      d. GDA94 + AHD (explicit compound CRS [2D+1D])
      e. GDA2020 + AHD (explicit compound CRS [2D+1D])
      f. GDA2020 + AVWS (explicit compound CRS [2D+1D])

2. Transformations for all import and export processes must support these CRS and transformations:
   For technical details refer to Common Australian EPSG Codes and Transformations Information Sheet.

   I. Horizontal CRS:
      a. GDA94 (2D) < NTv2-CPD grid > GDA2020 (2D) – default transformation in NSW
      b. GDA94 (2D) < NTv2-CON grid > GDA2020 (2D) – default in some Australian jurisdictions
      c. GDA94 (3D) < 7-parameter > GDA2020 (3D)
      d. WGS 84 / Web Mercator – see also WGS 84 Information Sheet, page 2
         i. GDA94 < NTv2-CPD equivalent > WGS 84-aligned-to-GDA2020 < NULL > GDA2020
         ii. GDA94 < NULL > WGS 84-aligned-to-GDA94 < NTv2-CPD equivalent > GDA2020
         iii. AGD66 < > GDA94 < > GDA2020 < NULL > WGS 84≈GDA2020 [and similar for AGD84]
         iv. [Optional: NTv2-CON equivalents of the above, for other Australian jurisdictions]

      e. Note: the NTv2 grids do not cover the entire extent of GDA2020. For data outside the NTv2 grid extent, the 7 parameter transformation (or a custom grid extended using 7P) is a suitable alternative.

   II. Vertical and/or 3D CRS:
      a. See 3D Data and Transformations Information Sheet for 1D, [2D+1D] and 3D methods.
      b. Use up-to-date geoid models where required, for example (correct at the time of publication):
         i. [GDA94 + Ellipsoidal Height] < AUSGeoid09 > [GDA94 + AHD]
         ii. [GDA2020 + Ellipsoidal Height] < AUSGeoid2020 > [GDA2020 + AHD]
         iii. [GDA2020 + Ellipsoidal Height] < AGQG_20201120 > [GDA2020 + AVWS]

   III. The user should have control of the transformation choice. Supply metadata to support that choice.

   IV. Transformation should be a reversible, non-destructive process.
   Example: Raster data should be transformed by changing location and CRS metadata, not by resampling.

3. Metadata, for CRS and transformation(s): See also ANZLIC's 'Preparing metadata for GDA2020 and the AGRS'
   I. must record horizontal and vertical CRS. Consider appropriate 1D, 2D, [2D+1D], 3D or 4D CRS.
   II. should record the lineage of CRS and transformation(s), e.g. using EPSG or WKID identifiers.
   III. should record the spatial accuracy of the dataset.

4. Software interfaces and spatial data platforms:
   I. must make metadata easily discoverable, and must promote capture and maintenance of metadata.
   II. must describe which CRS are supported or not supported (and any appropriate justification).
   III. must describe which transformation(s) are supported or not supported (and appropriate justification).
   IV. must describe WGS 84 alignment to GDA2020 (or GDA94), in terms of default and supported options.

5. Data display, visualisation and analysis may be performed in any CRS. This CRS must be explicitly declared. Measurement (e.g. distance) and coordinate interrogation tools must clearly indicate CRS and units. Note: many software expect or default to WGS 84. Be aware of known issues with WGS 84 accuracy and alignment.