From DrukRef03 to DrukRef23: Grid-Based Geodetic Datum Transformation of Cadastral Parcels in Bhutan

Chokila Na (Bhutan), Gonçalo Henriques (Portugal), Jamphel Gyeltshen and Dorji Pema (Bhutan)

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SUMMARY

Bhutan's first modern geodetic reference frame, DrukRef03, was realised two decades ago from a sparse network of campaign-style GNSS observations. Since then, continuing Indian–Eurasian plate convergence has introduced measurable deformation across the country, while the control infrastructure has been densified through permanent GNSS stations. Together these developments created the need for a new reference frame—DrukRef23—materialised through a national CORS network and accompanied by a transformation model suitable for cadastral use.

To support this transition, we developed a grid-based NTv2 transformation linking DrukRef03 and DrukRef23. Paired GNSS control points were used to model horizontal shifts, and an iterative filtering strategy was applied to remove outliers and stabilise the solution. The final transformation grid was generated at 10″ resolution, merging information from finer and coarser native grids to ensure continuous national coverage.

Validation shows that the model achieves sub-decimetre accuracy in horizontal coordinates, while preserving cadastral parcel areas within Bhutan's legal tolerances. The approach provides a robust and legally defensible mechanism for migrating national spatial data to DrukRef23, aligning Bhutan with international practice in tectonically active regions, and offering a flexible framework for future refinement as additional control becomes available.