National Geospatial Policy: present status and a way forward towards unambiguous and consistent geodetic positioning in India

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Geodetic positioning in India began with the Great Trigonometric Survey. The Survey of India (SoI) has since undertaken significant initiatives, such as the National Mapping Policy 2005, National Ground Control Points Library, and establishing Continuously Operating Reference Stations (CORS). The National Geospatial Policy 2022 emphasizes the importance of precise coordinates and advocates for the liberalization of geodetic data collection and dissemination. It also aims to develop a new geodetic reference frame. Unambiguous positioning requires also specifying the reference frame, ellipsoid, epoch and datum. This article provides an overview of the current status of the geodetic positioning in India and a way forward towards consistent geodetic positioning in India through CORS-based Indian Geodetic Datum.

Keywords: Continuously operating reference station, geodetic position, horizontal datum, National Geospatial Policy.

GEODETIC positioning or geometric positioning is fundamental to the whole geospatial science and technology domain. This concept has also been well-versed in the Indian geospatial guidelines, which define geospatial data as 'Positional data with or without attribute data tagged, whether in the form of images, videos, vector, voxel and/or raster datasets or any other type of geospatial dataset in digitized or non-digitized form or web-services' with the positional data being defined as (in the Indian geospatial guidelines) 'Latitude, longitude and elevation/depth of a point or its x, y and z coordinates in the territory of the Republic of India.'[1] It may be noted that elevation in this article does not correspond to the physical heights (height above geoid or mean sea level) but only about the geometric height, also known as ellipsoidal height. Readers interested in physical heights may refer to Goyal *et al.*[2], which discusses vertical datum and physical heights in India.

These guidelines were followed by the release of the National Geospatial Policy 2022 (NGP2022), which liberalized the collection, archival and dissemination of geospatial data[3]. To avoid duplication and maintain consistency in geospatial data collection, one of the main aims of the NGP2022, a milestone has been set to be achieved by 2025: redefinition of the national geodetic framework (clause 2.2.4). This clause is important for consistent positional data, a fundamental requirement for nationwide consistent geospatial data.

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Further, the policy is proactive in government-industry-academia-research collaboration for data collection and its consistency to strengthen the geospatial sector for national development. It is clear from the following excerpts from the policy: 'The need for continuous updating of existing data sets, requirement of manpower and technology, and avoiding duplication in data acquisition/processing make it imperative for the Government to collaborate with private and other agencies for improving Geospatial information delivery. Towards this objective, this policy shall replace the National Map Policy (NMP), 2005.' The main objective of the NMP was to provide two sets of topographical maps, i.e. defence series maps (DSMs) and open series maps (OSMs) in the geocentric coordinate system and globally best-fitting ellipsoid in contrast to the pre-NMP era, where a non-geocentric coordinate system on a locally best fitting ellipsoid (Everest ellipsoid) was used[4,5]. Following NMP2005, the OSM maps were to be in 'UTM Projection on WGS-84 datum'. To transform the old topographical maps on scales 1 : 25,000 and 1 : 50,000, transformation parameters (for ten zones covering the whole of India) were calculated from the 'Everest coordinate system to the International Terrestrial Reference Frame (ITRF) coordinate system'. This was also followed by establishing a national ground control point (GCP) library on which coordinates were calculated in ITRF2008 on WGS84 ellipsoid. The details and discussion on the GCP library are provided in the next section.

Numerous questions could arise from the previous paragraph on maintaining the consistency of the coordinates. A few of them have been provided in the next section, which discusses the current status of geometric positioning in India. Several questions are not addressed in this article because it focuses on providing more discussion on the way forward from current status toward consistent positioning as envisioned in the NGP2022.

The first three paragraphs contain numerous related phrases (and miss a few), which are essential to understanding the 'positional data' or the 'coordinates'. Following are the elements to understand and practice consistent horizontal or geodetic positioning: 'coordinate system', 'reference system', 'reference frame', 'datum', 'epoch', 'geocentric ellipsoid', 'network adjustment', 'coordinate transformation' and 'solid earth permanent tide system'.

Although these are described in various articles, we will briefly overview them before discussing specifics on Indian geodetic positioning[6,7]. In the following paragraph, an attempt has been made to provide a layman's visualization of a few of the above terms with a daily world example, sometimes used synonymously.

Consider one wishes to build a house on a land parcel. The land parcel is the second parcel, square in shape, on the north side of the society road when moving east to west from the main highway. The land has four pillars at the four corners, which depict a square shape and are connected by a brick boundary. From the first boundary pillar, we start laying down the house plan provided in metric units. First of all, we establish all the columns of the house with respect to the boundary pillars. Then these columns are now connected with walls. After this, further walls are constructed with measurements from these columns and the connected walls to complete the house structure. In this example, we are defining the location of the parcel, which will never change, as the reference system. This definition, 'realized' by well-connected boundary pillars, is the reference frame. The first pillar and corresponding two sides intersecting at that pillar form the origin and axis of the coordinate system respectively, from which measurements will be done in metric units, hence, cartesian coordinates. The established columns form the backbone of the house structure, the local datum.

Now, translating this to the global scenario for geometric three-dimensional geocentric coordinates, reference system (e.g. ITRS, WGS84) is a definition that says for geometric positioning, the origin is the geocentre, Z-axis is towards the axis of rotation (more precisely, IERS Reference Pole), X-axis is towards the international reference meridian (not the original Greenwich meridian), and Y-axis is in equatorial plane 90° anticlockwise of the X-axis, and the unit of measurement is metre. Another component of the definition, i.e. no net rotation, is not covered in the article, but is available in earlier studies by Altamimi *et al.*[8,9]. These are realized by various, one or combinations of space geodetic techniques stations, such as global navigation satellite system (GNSS), very long baseline interferometry (VLBI), satellite laser ranging (SLR) and doppler orbitography and radio-positioning integrated by satellite (DORIS). This realization is called a reference frame (e.g. ITRF, WGS84). Since Earth is not a hard-solid entity, due to numerous geophysical, geodynamical and other reasons, this realization of the definition has to be repeated, which brings the term 'epoch' that provides timestamping to 'realizations' or reference frame (ITRF2005, ITRF2020, WGS84, WGS84 (G1150), etc.). This X, Y, Z system is also known as a geocentric cartesian coordinate system, or Earth centred Earth fixed (ECEF) coordinates. We know Earth is ellipsoidal in shape but not a geometrically smooth ellipsoid. The shape of the Earth is undulating, and one of its approximations is a geopotential surface known as geoid[2]. However, for ease of computations, we fit a geometric ellipsoid to the Earth's geoidal shape, also known as a globally best-fitting ellipsoid. The coordinates obtained concerning this globally best-fitting ellipsoid, with its centre coinciding with the Earth's centre of mass, are known as geodetic coordinates (latitude, longitude and ellipsoidal height). Well-known conversion formulas exist for obtaining ECEF coordinates from geodetic coordinates and vice-versa[7]. That means if we are ready to work only in cartesian coordinates for all our positional/location-based applications, which obviously would be very challenging and complicated to visualize, we do not need an ellipsoid (except for some other geodesy reasons!). To define national datum (e.g. NAD83, GDA2020), we compute coordinates of well-established points in a country and make a network adjustment accordingly, details of which are discussed in the section on the way forward towards establishing Indian Geodetic Datum.

Current status

Horizontal position in India used to be referenced to the Great Trigonometric Survey (GTS) stations with the Everest ellipsoid. There have been three adjustments known with the GTS stations, i.e. the adjustment of 1880, 1916 (important for Burma), and the readjustment of 1937. The details of all these three adjustments have been provided in ref. 10. However, this article does not discuss positioning before NMP2005; instead, see Survey of India (SoI) reports[11,12]. This is because, after NMP2005, transformation parameters were calculated to convert the topographic map from the Everest datum to the geocentric datum. These parameters were not computed for the whole country, but different parameters were calculated for ten (10) zones covering India[13]. Nothing can be discussed on the methodology adopted for computing these parameters, as there has not been any document on the same available in the public domain. However, some questions arise, such as NMP2005 and its implementation guide, which only mention converting to the WGS84 datum (generally, the WGS84 reference frame with the WGS84 ellipsoid). Other documents mention that after NMP2005, coordinates will be in ITRF2008 on the WGS84 ellipsoid, without mentioning an epoch, number of stations in different zones, parameter computation strategy, etc.

Further, if there exist different transformation parameters for ten (10) different zones and after NMP2005, maps were to be produced in UTM projection, some documentation would have been helpful for various stakeholders depicting how the overlapping regions in UTM at boundaries of ten (10) zones were handled. The bigger question is how to define their coordinates today using a topographic map and with what quality (variance–covariance and reliability). How much do they deviate from present-day coordinates?

Anyways, we will not discuss this further as NMP2005 was followed by the project 'Creation of National Ground Control Points (GCP) Library for India', which formed the basis of the existing National Spatial Reference Frame (NSRF)[14]. GCP library was a three-phase planned exercise to provide coordinates in ITRF2008 epoch 2005 on the WGS84 ellipsoid. The last update on GCP library is available from 2014 at https://www.surveyofindia.gov.in/pages/national-gcp-library. According to this, as of 30 June 2014, 292 phase-I and 2252 phase-II GCPs have been processed and adjusted. The first phase of the project included GCPs, established at a spacing of 250–300 km across the country. These were high-precision GCPs on which GNSS observations were made for 72 h. Phase II was a densified network, and the GCPs were established by taking GNSS observations for 8 h. Phase III, however, could not be materialized. The present Indian horizontal or geodetic datum, or NSRF, is said to be based on this GCP network. However, due to the non-availability of any information in the public domain, it is impossible to understand how the NSRF was established and what accuracy can be expected from the same, along with its present status. Information on the following questions is required to understand the positioning in NSRF.

Why does the number of phase-I GCPs, which are the fundamental network for existing NSRF and was completed in 2009 (according to SoI's annual report 2008–09)[15] differ in different SoI's documents, and what is the real number of phase-I GCPs? If phase-I GCPs were processed by 2008–2009, how were they processed in ITRF2008, which was released in 2011, or were the whole phase-I and subsequent phase-II GCPs reprocessed in ITRF2008 after 2011? If Bernese software was used to process the phase-I GCPs in ITRF, how would the geodetic coordinates be provided on WGS84 ellipsoid because, by default, ellipsoidal parameters for ITRF in Bernese are of GRS80 ellipsoid? If geodetic coordinates are provided in WGS84 ellipsoid, was Molodensky transformation used, or was the geodetic datum file in Bernese modified? Is the epoch 2005 in NSRF referred to as the epoch of ITRF2008, or were all the GCP observations reduced from epoch of observation to epoch 2005 during processing[16]? What was the method followed in adjustment? Also, were phase-I and phase-II adjustments done separately in a hierarchical way, or were all the data adjusted at once? Most importantly, were any constraints applied during the adjustment, or was it a free net adjustment? Have the Phase-I or Phase-II GCPs been ever reobserved? Phase-I and Phase-II GCPs were processed for 72 h and 8 h respectively. Hence, what is the targetted accuracy of the NSRF? Further, due to several geophysical and geodynamical activities and infrastructural development, what is the current status of the GCPs (physical existence and position integrity) and the reliability of their positioning?

Although GCPs are used in various national schemes and projects, including Survey of Villages Abadi and Mapping with Improvised Technology in Village Areas (SWAMITVA) and Digital India Land Records Modernization Programme (DILRMP), SoI has recently undertaken a massive exercise to establish ~1100 GNSS Continuously Operating Reference Station (CORS) stations all over India during past 3–4 years. All the required information on the various services and data available from this CORS network, along with video tutorials, is available in detail at the SoI CORS website (https://www.cors.surveyofindia.gov.in/). CORS is extremely helpful in various GNSS applications and in re-establishing the Indian Geodetic Datum for unambiguous positioning. The latter is discussed in the next section, which discusses how to develop a new geodetic datum for India. Because government schemes like SWAMITVA are being parallelly implemented along with the establishment of CORS, it might have been thought wise to provide the reference coordinates of CORS in ITRF2008 epoch 2005 to agree with the NSRF-GCPs. However, it may be noted that the coordinates provided on the CORS site are independent of the GCP network and are processed separately in ITRF2008 epoch 2005. Hence, it is incorrect to say that CORS provides the coordinates in NSRF. Further, some discrepancies in positioning also arise due to different network adjustment approaches. As a result, various projects might now use NSRF and CORS as consistent systems, which will only accumulate discrepancies, making it difficult to achieve consistent positioning. Thus, this tends to defeat the primary goal of the NGP2022, i.e. maintaining consistency and avoiding duplication in geodetic data collection.

Therefore, pursuing the milestone mentioned in the NGP2022 is urgent, i.e. redefining the national geodetic framework using modern positioning technologies. It can be achieved by establishing a new geodetic datum for India to provide consistent and unambiguous positioning using CORS infrastructure. A few of the components for achieving this would be deciding upon which ITRF (ITRF2008, ITRF2014 or ITRF2020), epoch (2005 or some epoch in 2023 or 2024), ellipsoid (WGS84 or GRS80), and adjustment procedure to be used. Choosing an ellipsoid is important for the new horizontal datum because, to date, horizontal positioning is based on the WGS84 ellipsoid in India. In contrast, vertical positioning and gravity anomalies use the GRS80 ellipsoid.

Next, we discuss how to establish a new geodetic datum, which the SoI may consider.

A way forward

SoI has established ~1100 CORS sites all over India. It is impossible to define a datum using all these sites, primarily due to the logistical reasons of maintaining them for decades. We suggest using the ITRF2020 and any latest epoch as a reference to developing the geodetic datum. Further, the GRS80 ellipsoid may be chosen because (i) almost all the countries that use ITRF as a frame use GRS80 ellipsoid, (ii) even the USA (that has always worked with WGS84 ellipsoid) has mentioned using GRS80 in their North American Terrestrial Reference Frame (NATRF) and (iii) our vertical coordinate and gravity anomalies use GRS80.

Recalling that a national datum is a set of well-established and stable stations that could be used as a reference for geodetic positioning, one of the most important tasks in re-establishing the geodetic datum would be to choose ~50 CORS sites from ~1100 sites. These would form the backbone network (also known as a set of fundamental or fiducial stations) of the Indian Geodetic Datum. It could be achieved using the following multistep filtering:

(i) Use metadata of stations and photographs to ensure required long-term surrounding clearance to avoid signal interference and degradation. Further, any indication of future infrastructure development near the site and anthropogenic activities may also be considered in consultation with the associated department/office.

(ii) Use seismic and geological maps to avoid stations in seismically active zones, fault lines and expansive soils.

(iii) Quality check of data based on parameters like data availability, signal to noise ratio (SNR), cycle slips based on ionospheric delay, multipath, etc.

(iv) Stability check using the repeatability and trend analysis based on time series analysis of coordinates. Frequent spikes and relative motion beyond a threshold in the time series will indicate instability.

Once the fiducial stations are selected, free network adjustment can be performed to check the geometry of the Indian Geodetic Datum Network (IGDN). Stations whose residuals are larger than a threshold value can be omitted from the network, and the network may be re-evaluated. It is preferred that stations should not be more than 250–300 km apart from each other. Hence, the chosen stations should also be selected based on uniform geographical distribution in the country, which can be achieved using GIS tools. An illustrative distribution of IGDN stations is shown in Figure 1. It may be noted that to have an overlapping coverage within a 250 km radius, only 39 IGDN stations are required. Hence, the competent authority may choose an appropriate number and distribution to establish the IGDN. Once the IGDN stations are finalized, the next step is to constrain the positions of these stations using IGS stations. The IGS stations should be selected based on information such as station log files, position time series, residuals, RMS

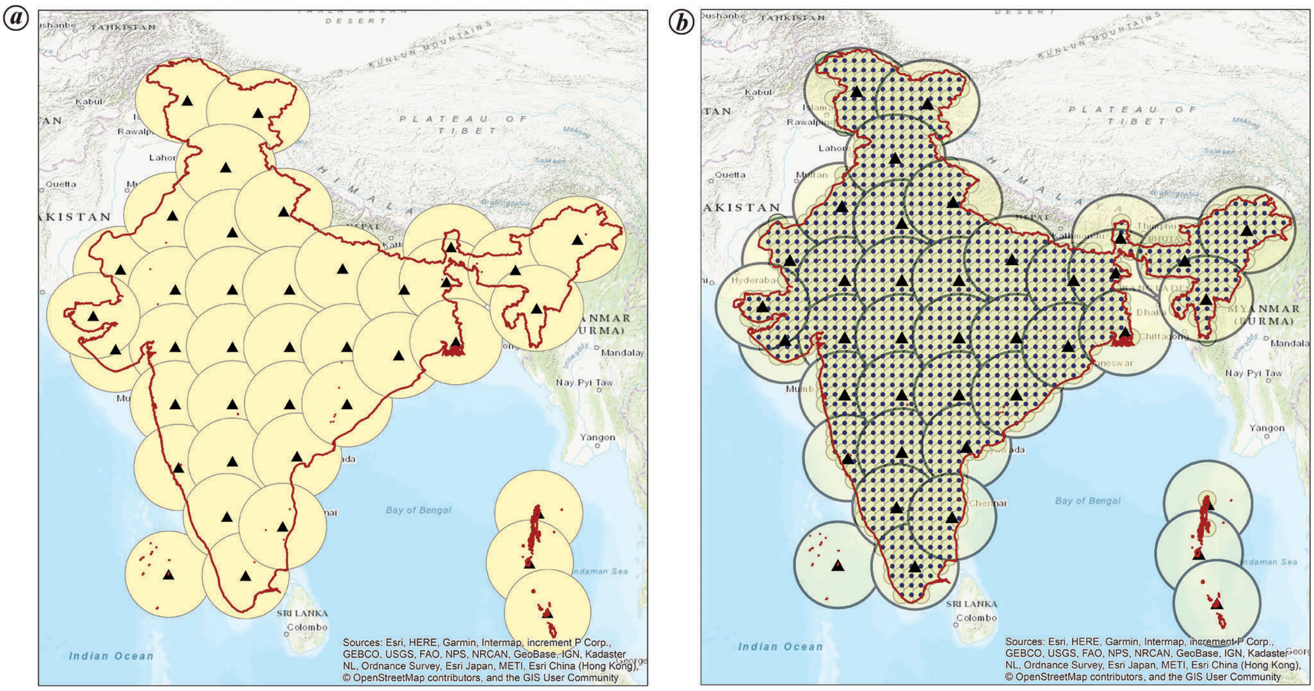

Figure 1. (***a***) Thirty nine Indian Geodetic Datum Network stations (black triangle) with a 250 km radius around each station. (***b***) 1159 Indian Geodetic National Network stations (blue circles) with a 50 km radius around each station.

multipath, and cycle slips available on the IGS site (https://network.igs.org/). A good spatial distribution of IGS stations around the fiducial CORS is also recommended. The processing may be done in ITRF2020 at the chosen epoch, preferably in 2024. Various free and commercial software are available to process the RINEX data. These software include Bernese, GAMIT/GLOBK, GipsyX, Leica Infinity, Trimble Business Center, PANDA, etc. These software have benefits and limitations based on employed geophysical models and techniques for processing the baseline, precise point positioning, etc.

Once the datum points are fixed, the next step is to set up a network (Indian Geodetic National Network (IGNN)) with stations at around 40–50 km distance apart, which will be utilized for providing a consistent geometric position with reference to the Indian Geodetic Datum. IGNN can comprise a combination of well-distributed CORS and GCPs. Regular monitoring of these stations in campaign mode can provide information on inter- and intra-plate movement. Figure 1 *b* shows that around 1200 stations will be required to have an overlapping coverage with a 50 km radius from each IGNN station. The coordinates of these stations will also be obtained using the same processing as for the IGDN stations. Further, IGNN should be then adjusted by constraining the IGDN stations using stochastically constrained adjustment. There could be other ways of providing the coordinates with reference to the Indian Geodetic Datum, like:

(i) Process IGNN with respect to IGS stations and adjust IGDN first using free-net adjustment and then IGNN by constraining IGDN.
(ii) Process IGNN using adjusted IGDN as reference stations and adjust IGNN by constraining IGDN.
(iii) Process IGNN with respect to IGDN stations and adjust IGDN and IGNN combinedly using free-net or constrained adjustment.

Countries could adopt any of the above or entirely different strategies to realize their national horizontal datum. To define static datum, one must also consider constraining the station velocities to a given epoch and removing the inter-plate motion but accounting for the intra-plate motion. Discussing all these is out of the scope of this General Article, and the same will be discussed in a technical paper on this topic.

Once we have the IGNN providing coordinates in the Indian Geodetic Datum, there are three ways of obtaining geodetic coordinates in the national datum at a further densified or local level (15–20 km). We recommend the second and third strategies to avoid additional complexities in attaining consistent coordinates:

(i) Establish more CORS and/or GCPs (with observations of at least 24 h after the structural settlement of the station). This network can then be adjusted by constraining to fundamental and national network stations.
(ii) Establish GCPs and fix their position with respect to the nearby adjusted national network stations, hence not requiring a further nationwide adjustment. It can be realized by reobserving the established GCPs.
(iii) Use Virtual Reference Network, a service that SoI is already providing through established CORS.

Another vital aspect of datum establishment is monitoring, maintaining, and checking for required updates. It is achieved by generating weekly, monthly, and yearly solutions of the datum points and monthly readjustment. It will have two-fold checks: (i) reliability and repeatability of datum points, and (ii) impact on coordinates provided in developed datum along with their reliability and repeatability. If any of the datum points or the coordinates of IGNN exceed the chosen respective thresholds, necessary measures for updating the station may be taken. It may be noted that a shift of five (5) cm/year is expected in the coordinates of IGDN and IGNN due to plate movement. Therefore, the checks may be applied with the IGDN, and IGNN coordinates are reduced to the epoch of datum realization. Once the datum points deviate significantly from any new realization of ITRF (because ITRF uses global plate motions while national datum will be regional plate fixed) or if some advancement of technologies to ensure mm or sub-mm accurate datum is introduced in the future, a new realization of national datum may be required. However, transformation parameters must always exist between datums, frames and epochs.

The datum or fiducial or fundamental stations can be used to calculate the transformation parameters from one frame or datum to another. It is further recommended that once we have sufficient data (at least three years) at datum stations, SoI may think of including Indian land motion models, i.e. regional plate model and vertical land motion model (VLMM). It may be noted that VLMM is also required for precise positioning because a change in 'x' cm in ellipsoidal height corresponds to an equivalent 'x' cm change in cartesian coordinates but with maximum deviation being caused in 'Y' coordinate of the cartesian coordinates. It can be easily observed by using the available coordinates conversion formulas for ECEF to geodetic coordinate systems. However, one could argue that horizontal positioning is generally done at the ellipsoidal surface (the ellipsoidal height is zero). Hence, some error propagation study is also required to study its impact on datum realization. Nevertheless, land motion models would be a way to establish semi-dynamic or dynamic geodetic datum, which would be necessary in the coming years for various applications, including autonomous positioning and navigation. The formulations of transformation between frames, datums and epochs are well documented in the literature. However, computation of the transformation parameters can only be strategized once information on transformation methods, processing, and adjustment of and among previous networks (GTS, NMP, GCP and CORS) are available.

Conclusion

With the (i) release of National Geospatial Policy 2022, (ii) one of the NGP2022 mandates being establishing the geodetic reference frame and (iii) ongoing surveying and mapping schemes like SWAMITVA and DILRMP, the article discussed the current status of horizontal positioning in India with emphasis on various aspects and parameters required to have an unambiguous positioning, which is in line with the main aim of the NGP2022, i.e. to avoid duplication and maintain consistency in geodetic data collection, archival and dissemination. It has been discussed that the information presently available in the public domain is restricted to practice consistency in geodetic data collection and processing. Considering that the present government schemes are based on coordinates with reference to NSRF defined based on ITRF2008 epoch 2005, which may not provide the present-day accuracy and consistency requirements of large-scale mapping, a way forward to establish a CORS-based Indian horizontal datum has been provided for consideration by the SoI. However, due to the inaccessibility (in the public domain) of various information on transformation, processing, and adjustment of/among previous networks, we have not provided the strategy for transformation from GCP- or presently practiced CORS-based coordinates to the suggested new horizontal datum. Nonetheless, it is envisaged that various stakeholders may ask for the parameters mentioned in the article as metadata while obtaining the fundamental data, which will be the basis for their respective applications and maintain consistency in densified data collection.

Conflict of interest: The authors have no known conflicts of interest.

1. DST, Guidelines for acquiring and producing geospatial data and geospatial data services including maps, Department of Science and Technology, Government of India (GoI), 2021, p. 5; https://dst.gov.in/sites/default/files/Final%20Approved%20Guidelines%20on-%20Geospatial%20Data.pdf (accessed on 12 September 2022).
2. Goyal, R. and Dikshit, O., National geospatial policy: perspectives on height systems, vertical datums, and gravimetric geoid modelling in India. *Curr. Sci*., 2024, **126**(3), 309–319.
3. DST, Draft National Geospatial Policy, Department of Science and Technology, GoI, 2021, p. 24; https://dst.gov.in/sites/default/files/Draft%20NGP%2C%202021.pdf (accessed on 12 September 2022).
4. SoI, National Mapping Policy-2005, Survey of India, GoI, 2005, p. 4; https://surveyofindia.gov.in/documents/national-map-policy.pdf (accessed on 30 January 2024).
5. SoI, Guidelines for implementing national map policy, Survey of India, GoI, 2005, p. 9; https://www.surveyofindia.gov.in/documents/guidelines-for-implementing-national-map-policy.pdf (accessed on 30 January 2024).
6. Illiffe, J. and Lott, R., *Datums and Map Projections: For Remote Sensing, GIS and Surveying*, Whittles Publishing, USA, 2008, p. 192.
7. Torge, W. and Müller, J., *Geodesy*, De Gruyter, Berlin, 2012, p. 444.
8. Altamimi, Z., Rebischung, P., Métivier, L. and Collilieux, X., ITYRF2014: a new release of the international terrestrial reference frame modeling nonlinear station motions, *J. Geophys. Res.*, 2016, **121**(8), 6109–6131.
9. Altamimi, Z., Rebischung, P., Collilieux, X., Métivier, L. and Chanard, K., ITRF2020: an augmented reference frame refining the modeling of nonlinear station motions, *J. Geod.*, 2023, **97**, 47; https://doi.org/10.1007/s00190-023-01738-w.
10. Bomford, G., *The Readjustment of the Indian Triangulation*, Survey of India Professional Paper 28, Dehradun, 1939, p. 136.
11. Phillimore, R. H., *Historical Records of the Survey of India Volume II*, Survey of India, Dehradun, 1950, p. 478.
12. Phillimore, R. H., *Historical Records of the Survey of India Volume V*, Survey of India, Dehradun, 1968, p. 566.
13. Balasubramanian, N. and Sawhney, R. K., Redefinition of Indian geodetic datums-horizontal and vertical. *Coordinates*, 2007, **3**(4); https://mycoordinates.org/pdf/Apr07.pdf (accessed on 30 January 2024).
14. SoI, National GCP library, Survey of India, GoI, 2014, p. 2; https://surveyofindia.gov.in/documents/gcp-library 1.pdf (accessed on 2 May 2024).
15. SoI, Annual Report 2008–2009, Survey of India, GoI, 2009, p. 34; https://www.surveyofindia.gov.in/documents/annual-reports/annual-report-2008-09.pdf (accessed on 2 May 2024).
16. Goyal, R., Dikshit, O. and Tiwari, A., National geospatial policy: status of Indian geodetic data. *Curr. Sci.*, 2023, **125**(1), 18–25.

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