Machine Translated by Google
RCMOS – Multidisciplinary Scientific Journal The Knowledge.
ISSN: 2675-9128. São Paulo-SP.

Year VII, v.1 2026 | Submission: 05/23/2026 | Accepted: 05/26/2026 | Publication: 05/29/2026

The importance of the SIRGAS2000 geodetic system for the standardization of topographic surveys in Brazil.

The importance of the SIRGAS2000 geodetic system for standardizing topographic surveys in Brazil

The importance of the sirgas2000 geodetic system for the standardization of topographic surveys in Brazil

Luciana Andrade Villar[1] Pedro

Thiago Venzon[2] [1]

Undergraduate student at UNIFEBE. Course linked to the Topography II discipline. [2]

Supervising professor of the Topography II discipline at UNIFEBE.

ABSTRACT: The standardization of topographic surveys is an essential requirement for contemporary Civil Engineering, especially in the design, execution, and control of foundations, earthworks, land registration, and georeferencing. This article analyzes the importance of the Geocentric Reference System for the Americas, in its 2000 version, called SIRGAS2000, for the standardization of coordinates used in topographic surveys in Brazil. The general objective is to understand how the adoption of an official geodetic reference system contributes to data integration, the reduction of incompatibilities between cartographic bases, and the improvement of the reliability of positional information. The methodology adopted was an exploratory and descriptive bibliographic review, with a qualitative approach, based on technical documents from IBGE and INCRA, technical standards, and national articles in the areas of geodesy, cartography, and geomatics. The results indicate that SIRGAS2000 strengthens the traceability of surveys, favors the use of GNSS and IBGE-PPP, guides the transformation of old data, and increases the technical security of projects that depend on homogeneous coordinates. It is concluded that mastery of this system is indispensable for training and professional practice in Civil Engineering, as it connects topography, geodesy, and decision-making in infrastructure projects.

Keywords: SIRGAS2000; topography; georeferencing; GNSS; Civil Engineering.

ABSTRACT: The standardization of topographic surveys is essential in contemporary Civil Engineering, particularly for design, execution, and control activities related to foundations, earthworks, territorial cadastre, and georeferencing. This paper analyzes the importance of the Geocentric Reference System for the Americas, in its 2000 realization, known as SIRGAS2000, for the standardization of coordinates used in topographic surveys in Brazil. The general objective is to understand how the adoption of an official geodetic reference contributes to data integration, the reduction of incompatibilities between cartographic databases, and the improvement of the reliability of positional information. The methodology was based on an exploratory, descriptive bibliographic review using a qualitative approach, supported by technical documents from IBGE and INCRA, technical standards, and national papers in geodesy, cartography, and geomatics. The results indicate that SIRGAS2000 strengthens survey traceability, supports the use of GNSS and IBGE-PPP, guides the transformation of legacy data, and increases the technical safety of projects that depend on homogeneous coordinates—
keywords: SIRGAS2000; topography; georeferencing; GNSS; Civil Engineering.

w

This article is published in open access under the Creative Commons Attribution license, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Machine Translated by Google
RCMOS - Multidisciplinary Scientific Journal The Knowledge.
ISSN: 2675-9128. São Paulo-SP.

Year VII, v.1 2026 | Submission: 05/23/2026 | Accepted: 05/26/2026 | Publication: 05/29/2026

INTRODUCTION

Civil engineering relies on reliable spatial information to transform the landscape.
In design, construction and infrastructure. In foundations, earthworks, drainage, land leveling,
Paving, retaining walls and building placement, minor positional inconsistencies.
These can lead to location errors, project incompatibilities, and rework in the field.
doubts regarding the actual correspondence between the plan, the land, and the execution. For this reason, the
Topography is no longer understood merely as an initial measurement step and has become...
to establish a permanent technical basis for the planning, execution, monitoring and
Quality control of the works.
In this context, the geodetic reference system plays a central role.
The coordinate must be linked to a known, stable, and officially adopted reference;
Otherwise, different teams may produce correct information in themselves, but
incompatible when combined into a single database. SIRGAS2000 was established by IBGE.
as the new geodetic reference system for the Brazilian Geodetic System and the System
National Cartographic Institute, due to the need to make the country compatible with methods
modern satellite positioning systems with global geocentric reference frames (IBGE, 2005).
The adoption of SIRGAS2000 gained greater relevance as GNSS technologies...
They began to be used in routine professional activities. Dual-frequency receivers,
stations of the Brazilian Network for Continuous Monitoring of GNSS Systems, post-services
Online processing and geographic information systems have increased speed and accuracy.
of the surveys. However, such tools require that the data be associated with a
single datum, as the coordinate mix in SAD 69, Córrego Alegre, WGS 84, without
proper treatment, and SIRGAS2000 can produce displacements capable of compromising
projects and registrations.
The rationale for this study stems from the need to understand the relationship between topography,
Geodesy and data standardization. In earthworks, for example, the quantification of volumes.
It depends on consistent digital terrain models; in foundations, the location of axes and points.
Surveying requires planimetric and altimetric control; in drainage and containment, the position of the
The elements directly affect performance and safety. Therefore, SIRGAS2000 is...
treated in this article not only as a regulatory requirement, but also as a
Technical condition for the integration of surveys and the reliability of information.
Space.

w

This article is published in open access under the Creative Commons Attribution license, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Machine Translated by Google

Year VII, v.1 2026 | Submission: 05/23/2026 | Accepted: 05/26/2026 | Publication: 05/29/2026

The overall objective of this article is to analyze the importance of the SIRGAS2000 geodetic system for Standardization of topographic surveys in Brazil. The specific objectives are:
To present the evolution of geodetic reference systems in the country; to describe the main... characteristics of SIRGAS2000; relating the system to GNSS, IBGE-PPP technologies and to Reference networks; discuss the impacts on Civil Engineering, with emphasis on foundations and construction. of land; and identify practical precautions to avoid inconsistencies in the use of coordinates.
The guiding research question can be formulated as follows: how does the SIRGAS2000 contributes to the standardization and reliability of topographic surveys.
How are these methods applied to Civil Engineering in Brazil? To answer this question, a review was conducted. A bibliographical study of an exploratory and descriptive nature, with a qualitative analysis of publications. official documents, technical standards, and recent national studies. Choosing this approach allows To bring together technical fundamentals and discuss their practical application in a professional context.
The academic relevance of the topic lies in bringing the training of civil engineers closer to... Current requirements for georeferencing and land management. The discipline of Foundations and Works. Terrain engineers work with decisions that depend on actual terrain, elevations, boundaries, slopes, and axes. and 2 volumes. In this way, understanding the coordinate reference used in plans and Surveys help prevent decisions based on spatially inconsistent information.
Professional relevance, in turn, lies in the need to produce technical documents. Accepted by public bodies, registries, contractors, and multidisciplinary teams.
The article is organized into five sections. The introduction defines the topic and presents the... Objectives. The theoretical framework discusses concepts of geodetic systems, evolution of Brazilian reference systems, characteristics of SIRGAS2000, GNSS, IBGE-PPP, standards and applications in Civil Engineering. The methodological section describes the type of research, the sources and The analysis procedure. The analysis of the results synthesizes the contributions of SIRGAS2000. for the standardization of surveys. Finally, the concluding remarks reiterate the objectives. and present conclusions about the importance of the topic.

THEORETICAL FOUNDATION

Geodetic reference systems and topographic coordinates

A geodetic reference system is the mathematical and physical framework that allows one to assign coordinates to points located on the Earth's surface. It involves defining a origin, of axes, of orientation, of a reference ellipsoid and of a form of materialization

w

This article is published in open access under the Creative Commons Attribution license, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Machine Translated by Google
RCMOS - Multidisciplinary Scientific Journal The Knowledge.
ISSN: 2675-9128. São Paulo-SP.

Year VII, v.1 2026 | Submission: 05/23/2026 | Accepted: 05/26/2026 | Publication: 05/29/2026

through geodetic stations. In surveying practice, this system serves as the basis.
common feature that allows for comparing and integrating surveys conducted at different times and using different equipment.
and different scales.

Traditional surveying can be performed using local references, especially when the
The work is confined to a small construction site and does not require integration with official bases.
However, when the survey needs to interact with public cartography, cadastral records,
licensing, registrations, infrastructure networks, road projects or information systems
Geographically, local references become insufficient. In these cases, the adoption of an official system is necessary.
It prevents each professional from creating their own origin without a clear connection to the national territory.
The use of geodetic and projected coordinates also requires care. Geodetic coordinates
They express latitude, longitude, and ellipsoidal altitude, while plane coordinates, such as those of
The UTM system represents positions in meters on a map projection. The passage
Which of these forms is which depends on the datum and projection used. Thus, stating only that one
The point being in UTM is not enough; it is necessary to declare the geodetic system, the zone, the area, the
unit, the reference period, when applicable, and the procedures for obtaining the
coordinates.

In a construction setting, the absence of this information can lead to misinterpretations.
A project might provide seemingly correct coordinates, but referenced to a different datum.
old; another survey may be in SIRGAS2000; a satellite image may be in
WGS 84; and a municipal database may have been converted without control. When this data is
When superimposed, displacements arise that can be mistaken for measurement error. Borges
et al. (2017) highlight that the adoption of SIRGAS2000 as the official system favored the
It standardized the information and reduced the confusion arising from the use of different...
benchmarks.

Geodetic standardization, therefore, is not a mere formality. It influences compatibility.
including topographic surveys, earthwork projects, descriptive report, and registration.
of networks, expropriations, land regularization, and control of the project's implementation. Regarding
More digital data is being integrated into BIM, GIS, or construction management systems.
The greater the need, the greater the need for everyone to start from the same point of reference. Without this compatibility, the
The precision of the equipment does not guarantee the quality of the final product.
Another relevant aspect is the distinction between precision and accuracy. A survey can be
very precise internally, that is, exhibiting good repeatability between points, and yet
to be out of sync with the official system. Absolute positional accuracy depends on

This article is published in open access under the Creative Commons Attribution license, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Machine Translated by Google
RCMOS – Multidisciplinary Scientific Journal The Knowledge.
ISSN: 2675-9128. São Paulo-SP.

Year VII, v.1 2026 | Submission: 05/23/2026 | Accepted: 05/26/2026 | Publication: 05/29/2026

Linkage to the geodetic reference system. The Technical Manual for Georeferencing Properties.
Rurais treats absolute positional accuracy as related to its connection to the Geodetic System.
Brazilian, with propagation of covariances from its vertices (INCRA, 2022). This
This concept is also useful for civil engineering, as the work needs to be correct both in its...
internal geometry as well as its position within the territory.
The integration between topography and geodesy is also evident in altimetry. Although the topic
The central point of this article is that SIRGAS2000 serves as the geocentric reference, the surveys
Applications to earthworks require attention to elevations. The ellipsoidal altitude obtained by GNSS does not
This corresponds directly to the orthometric height used in engineering projects. Therefore,
Geoid models and level references are needed to transform GNSS measurements into
Useful altimetric information for drainage, cuts, embankments, and foundations. Standardization
Planimetric analysis must be accompanied by altimetric coherence for the survey to be effective.
Technically complete.

Evolution of geodetic reference systems in Brazil and adoption of SIRGAS2000

The history of Brazilian geodetic reference systems follows the evolution of technology.
measurement. For decades, cartographic databases and surveys have been referred to as systems such as the
Córrego Alegre and SAD 69. These systems met the demands of their time, but were
conceived within non-geocentric frameworks and bound by the limitations of the instruments.
available. With the expansion of satellite positioning, it has become necessary to adopt a
A reference frame compatible with the precision and scope of GNSS techniques.
SIRGAS2000 represents this paradigm shift. The Resolution of the President of IBGE
Decree No. 1/2005, in its 2000 edition, established the Geocentric Reference System for...
Americas as a new geodetic reference system for the Brazilian Geodetic System and
for the National Cartographic System. The resolution itself points out that the adoption of a system
Geocentricity became mandatory due to the precision of positioning methods.
satellite and the need for compatibility with global systems (IBGE, 2005).
The transition did not happen instantaneously. The 2005 resolution allowed for coexistence.
temporary arrangement between SIRGAS2000, SAD 69 and Córrego Alegre, so that users could adapt.
bases, methods and procedures. In 2015, IBGE Presidential Resolution No. 1/2015
defined the end of the transition period and determined that, starting on February 25, 2015, the
Users in Brazil should exclusively adopt SIRGAS2000 in their activities.
ending the concurrent use of the old reference systems in the SGB and SCN (IBGE, 2015).

w

This article is published in open access under the Creative Commons Attribution license, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Machine Translated by Google
RCMOS - Multidisciplinary Scientific Journal The Knowledge.
ISSN: 2675-9128. São Paulo-SP.

Year VII, v.1 2026 | Submission: 05/23/2026 | Accepted: 05/26/2026 | Publication: 05/29/2026

This milestone had direct consequences for topography. From then on, surveys aimed at official databases, georeferencing, land registration, and cartographic production have become... require compatibility with the official system. For the civil engineer, this means that the Data received from public bodies or produced by contracted teams must be verified with respect to the adopted reference. Simple reliance on the digital file or drawing. This is not sufficient; the datum information must be included in plans, reports, and documentation. Borges et al. (2017) analyze the conversion of geographic data to SIRGAS2000 and They note that this change represented an important step towards the homogenization of information. However, the authors also indicate that transforming old databases requires 4. Careful analytical monitoring. This observation is essential for works that utilize historical surveys, old maps or land regularization documents, because the Improper conversion can transfer errors to existing projects.

The adoption of SIRGAS2000 also accompanied the consolidation of the geodetic infrastructure. national. The Brazilian Network for Continuous Monitoring of GNSS Systems provides Permanent observations that support precision positioning. The existence of stations. Active and processing services enable field surveys to be connected to the SGB with greater ease. Thus, standardization does not depend solely on standard, but also a technical network that materializes the reference framework in the territory.

At the regional level, SIRGAS2000 is part of the Geocentric Reference System for... The Americas, whose definition is compatible with the International System of Reference for Earth. IBGE reports that the reference period is 2000. It was chosen because it corresponds to the campaign. SIRGAS from May 2000, when GPS stations were observed throughout the Americas and in The Caribbean to materialize the new system (IBGE, 2026). This demonstrates that SIRGAS2000 does not It's not just a name used in plants, but a geodetic reference associated with observations. time and infrastructure.

The reference epoch is a point often overlooked in basic applications, but it is relevant in precision geodesy. The territory is not static: tectonic movements alter it. coordinates over time. According to the IBGE, the movement of the South American plate contributes to the displacement of Brazilian territory towards the northwest, in just over of one centimeter per year, which justifies associating precise coordinates with a period of (Reference: IBGE, 2026). For many topographic surveys of construction projects, this effect can be... small in relation to the project's tolerances, but in geodetic networks and studies of Monitoring makes it crucial.

This article is published in open access under the Creative Commons Attribution license, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Machine Translated by Google
RCMOS – Multidisciplinary Scientific Journal The Knowledge.
ISSN: 2675-9128. São Paulo-SP.

Year VII, v.1 2026 | Submission: 05/23/2026 | Accepted: 05/26/2026 | Publication: 05/29/2026

The evolution of benchmarks shows that standardization is an ongoing process. The adoption of SIRGAS2000 solved an important part of the problem, but it does not eliminate the need for... declare methods, transform data correctly, control quality, and monitor the... Service updates. Civil engineering training should include this understanding, because... A constructed work depends on spatial decisions that begin long before the physical execution in the land.

Technical characteristics of SIRGAS2000

SIRGAS2000 is a geocentric system, meaning it originates from the Earth's center of mass. This characteristic distinguishes it from older local or regional references and makes it compatible. with GNSS technologies, which operate in global systems. IBGE Resolution No. 1/2005 characterizes SIRGAS2000 as linked to the International Terrestrial Reference System and to the GRS80 ellipsoid, with a semi-major axis of 6,378,137 meters and flattening of 1/298,257222101 (IBGE, 2005).

In practical terms, the geocentric concept allows us to relate the coordinates obtained by The satellite is linked to a coherent reference. The GNSS receiver determines positions from signals. sent by satellites in orbit and therefore operates naturally in a global context.

Three-dimensional compatibility with SIRGAS2000 reduces the need for adaptations. local areas and promotes integration with international, national, and regional bases. That is fundamental for topographic surveys that need to be repeated, audited or integrated throughout the life cycle of a project.

Another important characteristic is the materialization through reference stations. One An abstract reference system needs to be made concrete through point coordinates. physical or permanent stations. In Brazil, the RBMC plays a fundamental role in to provide continuous GNSS data. From this data, the professional can perform relative processing or using post-processing services that link observations to official system. In this way, standardization does not depend on isolated estimates, but on a Geodetic support network. Nascimento, Dal Poz and Freitas (2021) analyzed the parameters of transformation between the ITRF/IGS and SIRGAS2000 materializations in IBGE-PPP and verified that, after the parameter update in 2020, the SIRGAS2000 series presented more consistent results. The authors highlight that IBGE-PPP provides coordinates compatible with SIRGAS2000 and that the adaptation of the transformations reduces the impacts resulting from changes in reference frames over time. This study demonstrates that the

This article is published in open access under the Creative Commons Attribution license, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Machine Translated by Google
RCMOS – Multidisciplinary Scientific Journal The Knowledge.
ISSN: 2675-9128. São Paulo-SP.

Year VII, v.1 2026 | Submission: 05/23/2026 | Accepted: 05/26/2026 | Publication: 05/29/2026

Standardization also requires technical updates to processing services.

The relationship between SIRGAS2000 and WGS 84 is another point of attention. In many software programs and In equipment, WGS 84 is the standard reference. Although in certain applications, the differences Even though they may be small, absolute equivalence should not be assumed for technical purposes without verification. the time period, the implementation, and the transformation adopted. In engineering projects, the statement An explicit description of the system is indispensable, since technical responsibility rests with the documentation. produced and regarding the consistency of the data used.

SIRGAS2000 is also related to the UTM projection, which is widely used in topographic maps. and in engineering projects, because it presents coordinates in meters. The use of UTM SIRGAS2000 simplifies distance calculations and cartographic representation, but requires Please provide the correct time zone. Brazil spans several UTM time zones, and the incorrect adoption of one... The time zone can cause significant shifts. In areas near the boundaries of time zones, the The professional should evaluate the best representation strategy and make the parameters explicit. of the project.

In earthworks, the choice of coordinate system influences the calculation of areas and volumes. and locations. Differences between geodetic coordinates, projected coordinates, and local systems. These factors should be considered before terrain modeling. Topographic surveying can be... executed on a local construction site to facilitate implementation, but, when there is Given the need for integration with official databases, this local system must be linked to SIRGAS2000 through appropriate control points and parameters.

The value of SIRGAS2000 lies precisely in offering a common language. When everyone The surveys report the same reference points and follow traceable procedures, making it... It is possible to overlay topographic survey, cadastral data, image, and earthwork project. drainage network, foundation plan and property boundaries with the lowest risk of incompatibility. Geodetic standardization, therefore, supports interoperability between Technical documents and computer systems. It is important to note that SIRGAS2000 does not replace the quality of the survey. One piece of data It may be formally referenced to SIRGAS2000 and still be considered bad if measured. with an inadequate method, without control, without calibration, or without a technical report. The system Official certification is a necessary but not sufficient condition. The final quality depends on equipment, positioning method, tracking time, satellite geometry, Processing, adjustment, field control, and independent verification.

This article is published in open access under the Creative Commons Attribution license, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Machine Translated by Google
RCMOS - Multidisciplinary Scientific Journal The Knowledge.
ISSN: 2675-9128. São Paulo-SP.

Year VII, v.1 2026 | Submission: 05/23/2026 | Accepted: 05/26/2026 | Publication: 05/29/2026

SIRGAS2000, GNSS, IBGE-PPP and topographic surveys

The popularization of GNSS has profoundly changed the routine of topographic surveys.
Previously, connection to a geodetic network more frequently depended on occupation of
landmarks, coordinate transport, and support polygons. Today, GNSS receivers
They allow you to quickly obtain the coordinates of the control points, provided the method is
compatible with the purpose of the survey. The positioning can be static, fast-
static, real-time kinematic, post-processed, or point-by-point, each with
advantages, limitations and specific requirements.
IBGE-PPP is one of the most relevant services in this scenario. According to the gov.br portal, the
The service allows users with GPS or GLONASS receivers to send files.
GNSS observation and obtain coordinates referenced to SIRGAS2000 by means of
precise processing (BRAZIL, 2026). For professionals and students, this tool reduces
It eliminates barriers to accessing precision positioning, as it eliminates the need to set up a station.
It has its own reference point and facilitates linking to the official system.
Nascimento, Dal Poz and Freitas (2021) observe that the IBGE-PPP is an adaptation of a
precise point positioning service for use in Brazil and provides results in both
ITRF/IGS as well as SIRGAS2000. The authors show that the compatibility between
The reference framework involves the Helmert transformation and the parameters provided by IBGE.
Thus, the user receives a seemingly simple result, but one that is based on a chain of events.
A complex geodesic system that needs to be understood for responsible use.
The adoption of SIRGAS2000 in GNSS surveys also facilitates integration with the
RBMC. Permanent stations provide reference data for relative processing.
allowing for greater precision in determining control points. In surveying work.
When applied to construction projects, these points serve as a basis for surveys using total stations, drones,
laser scanner or combined methods. The result is a hybrid flow in which GNSS provides
Geodetic surveying and terrestrial techniques provide detailed information about the terrain and built elements.
This integration is particularly useful in locations with GNSS restrictions. In urban areas
dense, under trees, next to slopes, in deep cuts, in flowerbeds with metal structures
or in the vicinity of tall buildings, satellite signals may be obstructed and
multipath. In these cases, the total station remains essential. França, Klein and Veiga (2024)
They point out that, in locations where GNSS is not suitable, such as urban canyons, networks of
Reference data can be densified through angle and distance measurements with a station.
total. SIRGAS2000 remains important because it provides the reference to which these networks

This article is published in open access under the Creative Commons Attribution license, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Machine Translated by Google

Year VII, v.1 2026 | Submission: 05/23/2026 | Accepted: 05/26/2026 | Publication: 05/29/2026

They must be linked.

Combining GNSS and traditional surveying requires planning. The professional must define
Stable support points, perform redundant observations, check for residuals, adjust networks.
and document the method. INCRA (2022) presents different positioning methods.
applicable to the georeferencing of rural properties, including classical surveying methods.
such as polygonation, triangulation, trilateration, triangulateration, and radiation. Although the manual
If intended for rural georeferencing, its control and traceability logic is useful for
engineering surveys.

In the case of earthworks, the combined use of GNSS and a total station can be crucial.
GNSS allows for the establishment of a control grid and the productive surveying of open areas;
A total station can provide detailed information on points where GNSS provides low quality; drones can...
generate surface models; and the design software uses this information to calculate
Cuts and fills. If each stage is in a distinct reference frame, the final model will be...
Inconsistent. If all are referenced to SIRGAS2000, the integration becomes more secure.
Another benefit of SIRGAS2000 is the possibility of repetition and monitoring. Works
Containment structures, dams, slopes, and sensitive structures may require successive campaigns to
Compare displacements. When coordinates are obtained from an official reference frame and the
Methods are documented, and there is a greater ability to compare different periods. Even though
High-precision monitoring demands specific attention to timing and models.
and to processing; initial standardization reduces unnecessary uncertainties.

Technology, however, does not eliminate the need for technical judgment. The result of a
The online service should be analyzed in light of the tracking time and the quality of the RINEX file.
of the constellations used, any obstructions, the height of the antenna and the report of
The coordinate in SIRGAS2000 should not be automatically accepted only.
Because it was issued by a system. The engineer must interpret the quality indicators.
and verify that they meet the project tolerances.

Thus, SIRGAS2000 acts as a link between high geodetic precision and the needs
The practices of construction surveying. It allows different methods to interact with each other, provided that
The professional must know how to declare, transform, process, and control the coordinates. Standardization
This does not diminish the importance of field surveys; on the contrary, it demands that the survey
be better documented and technically sound.

w

This article is published in open access under the Creative Commons Attribution license, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Machine Translated by Google
RCMOS – Multidisciplinary Scientific Journal The Knowledge.
ISSN: 2675-9128. São Paulo-SP.

Year VII, v.1 2026 | Submission: 05/23/2026 | Accepted: 05/26/2026 | Publication: 05/29/2026

Technical standards, land registration and georeferencing

The standardization of topographic surveys in Brazil does not depend solely on SIRGAS2000, but also technical standards and institutional procedures. NBR 13133 establishes requirements for carrying out topographic surveys, while NBR 14166 deals with the Municipal Cadastral Reference Network. These rules guide the way in which to... To plan, execute, control, and present surveys, contributing to the achievement of results. They are comparable and technically defensible.

The 2022 revision of NBR 14166 reinforced the importance of municipal referral networks. cadastral in a more up-to-date logic. França, Klein and Veiga (2024) observe that the standard It adopted international concepts of land registration and established a hierarchy between vertices, which facilitated the deployment and densification of networks. This discussion is relevant. because many municipalities still lack dense local networks, which leads professionals to They offer individual and repeated support, with increased costs and potential heterogeneity.

The existence of dense referral networks benefits society. When the municipality has of well-distributed, materialized and documented points, public and private surveys These projects can be carried out at a lower cost and with greater consistency. This is of interest to works of infrastructure, land regularization, inspection, urban planning, drainage, Mobility and risk management. SIRGAS2000 provides the national benchmark, while the network The local context reinforces this reference on a scale of everyday use.

In the georeferencing of rural properties, INCRA plays a central role. The Manual Technical Course on Georeferencing of Rural Properties, in its second edition, has been updated. procedures for incorporating new technologies and methods, establishing the required conditions. for the execution of services and the certification of rural properties (INCRA, 2022). The manual demonstrates how the standardization of coordinates, methods, and technical documents is indispensable for legal certainty and territorial integration.

Michels, Silva and Souza (2021) analyzed the georeferencing of rural properties, Comparing topography, RTK, and the TM system, highlighting the organization and location. Accurate property measurements in the Brazilian Geodetic System are among the objectives associated with Georeferencing. This perspective highlights that the discussion about SIRGAS2000 It goes beyond the topography of the work and reaches territorial planning, property registration and... public administration.

w

This article is published in open access under the Creative Commons Attribution license, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Machine Translated by Google

Year VII, v.1 2026 | Submission: 05/23/2026 | Accepted: 05/26/2026 | Publication: 05/29/2026

Compatibility between standards, systems, and procedures also reduces conflicts between parts.
techniques. In many processes, the plant, the descriptive report, the registration, the project and the
Field surveys must be consistent with each other. When boundaries, confrontations and
Coordinates are produced without a standardized reference frame, which increases the chances of...
Overlapping, area divergence, and dispute. The use of SIRGAS2000 contributes to...
the documents are linked to the official system.

In urban areas, the discussion gains momentum with the growing demand for land registration.
multi-purpose, land regularization and integration of real estate data. The works of
Urban infrastructure requires knowing the location of plots of land, existing networks, curbs,
of the buildings, the galleries, the poles, the retaining walls and the interferences. The absence of a
A common reference point hinders the integration of data from concessionaires, the city hall, and...
designers and construction companies. SIRGAS2000, associated with municipal cadastral networks, offers
a more consistent basis for this interoperability.

From a technical responsibility standpoint, standardization avoids ambiguities. A report
The topographic survey must specify the equipment, method, date, geodetic system, projection, and...
time zone, control points, processing procedure, estimated accuracy and the
limitations. These elements allow the survey to be audited. Without them, even a
A visually appealing design may lack technical validity. (ABNT and manuals)
Institutions reinforce this documentary culture.

Linking to SIRGAS2000 is also important for projects that are financed, audited, or
received by public bodies. Engineering contracts often require the delivery of
Georeferenced maps, digital files, and memorials. The adoption of the official system facilitates the...
The receipt and incorporation of this data into public collections. Furthermore, it reduces rework.
when the project needs to be compatible with environmental, road, land or other regulations.
registration details.

Therefore, SIRGAS2000 must be understood within the context of a set of regulations and
institutional. It provides the framework; the standards define procedures; the manuals provide guidance.
specific applications; and professionals materialize all of this in surveys, plans and
reports. Effective standardization occurs when these elements are handled in a way that...
integrated.

w

This article is published in open access under the Creative Commons Attribution license, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Machine Translated by Google
RCMOS - Multidisciplinary Scientific Journal The Knowledge.
ISSN: 2675-9128. São Paulo-SP.

Year VII, v.1 2026 | Submission: 05/23/2026 | Accepted: 05/26/2026 | Publication: 05/29/2026

Applications in foundations and earthworks.

Although SIRGAS2000 is often associated with cartography and georeferencing,
Its relevance to foundations and earthworks is direct. These areas depend on knowledge.
I need the land, the position of existing elements, and the design elevations. The earthworks
It requires the calculation of cut and fill volumes; the foundations require the location of axes, blocks,
piles, footings and sounding points; retaining walls require the identification of slopes and boundaries.
and neighboring structures. All of these products are based on a topographic survey.
In earthmoving projects, inconsistencies between surveys can alter the balance of...
masses. If a point cloud, a GNSS survey, and a cadastral map are not
Within the same reference frame, the digital terrain model may exhibit horizontal displacements.
that distort sections, areas, and volumes. Even when the horizontal difference seems small,
It can be relevant in slopes, boundaries, channels, or platform edges. (SIRGAS2000)
It contributes to the integration of different layers of information into a single system.
In foundations, the correct location depends on the relationship between the structural design and the survey.
Planimetric and altimetric surveys and field implementation. In urban works, the axes may be close together.
the boundaries, neighboring buildings, underground networks, and legal restrictions. An error of
Positioning may result in interference with existing foundations, encroachment on setbacks, or...
The need for emergency adjustments. The official geodetic reference does not replace the...
It's a local conference, but it provides a basis for relating the work to the property and its surroundings.
Geotechnical investigations can also benefit from standardization. Drilling points,
Field tests and samples should be positioned so that they can be correlated with the
project and terrain. When the points are registered in the SIRGAS2000 system, it becomes more
It's easy to integrate surveys, geological maps, environmental data, previous surveys, and...
digital models. This contributes to a broader understanding of the subsoil and its conditions.
implantation.
In linear works, such as highways, railways, water mains, drainage networks and canals, the
The importance is even greater. The undertaking covers large areas and may involve
different teams and sections. Standardizing the coordinates prevents each section from being treated separately.
as an isolated system without consistent linkage. Control points in the system
SIRGAS2000 allows for projects, expropriations, cross-sections, culverts, and other works.
Art and interventions should be integrated in a continuous way.

w

This article is published in open access under the Creative Commons Attribution license, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Machine Translated by Google

Year VII, v.1 2026 | Submission: 05/23/2026 | Accepted: 05/26/2026 | Publication: 05/29/2026

In slope containment and stabilization works, monitoring displacements requires...
a reliable reference. When monitoring the evolution of a slope or structure,
It is necessary to distinguish the actual movement from the difference in method or frame of reference. The appropriate
Linking control points and repeating procedures increases reliability.
from the analyses. In risky situations, the quality of spatial information can influence
decisions regarding intervention, evacuation, or reinforcement.

The relationship with drones and photogrammetry also deserves highlighting. Surveys
Aerial photogrammetry can produce orthomosaics, digital surface models, and contour lines.
level. For these products to be useful in engineering projects, they need to be
Georeferenced with well-distributed control points linked to the official system.
SIRGAS2000 facilitates the integration of these products into public plants, projects, and databases.
Without geodetic control, the image may be visually appealing, but technically...
insufficient.

The adoption of SIRGAS2000 can also assist in the management of construction projects. Digital systems of
monitoring, machines with GNSS control, design platforms and applications of
Field data depends on consistent coordinates. In mechanized earthmoving, for example,
Design models can guide equipment; for this to work, the model must be referenced.
Consistent with field control. Standardization reduces communication failures between the
office and the construction site.

In teaching Foundations and Earthworks, the topic encourages an integrated perspective. The student
realizes that the stability of a slope, the choice of a foundation, or the volume of fill do not
It depends not only on geotechnical formulas, but also on the spatial quality of the survey.
The position of the land, the elevations, and the constructed elements are integral to the technical safety of the site.
project. Thus, SIRGAS2000 emerges as a basic reference for interpreting plans and
reports of greater criticality.

In summary, SIRGAS2000 contributes to foundations and earthworks by enabling...
Compatibility between land, project, registration, and execution data. It is not visible.
It is present in the construction as concrete, steel, or compacted soil, but it is also present in the information that guides the work.
the decision. When this information is standardized, the work tends to be safer, more traceable and
efficient.

w

This article is published in open access under the Creative Commons Attribution license, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Machine Translated by Google

Year VII, v.1 2026 | Submission: 05/23/2026 | Accepted: 05/26/2026 | Publication: 05/29/2026

METHODOLOGICAL PROCEDURES

The research developed in this article is basic in nature, as it seeks to broaden understanding.
Theoretical discussion on the importance of SIRGAS2000 for the standardization of surveys.
Topographical studies in Brazil. Regarding the approach, it is characterized as qualitative, since the
The analysis is not based on statistical measurements, but on the interpretation of documents.
Technical standards, norms, and scientific studies related to geodesy, surveying, and engineering.
Regarding the objectives, the research is exploratory and descriptive. It is exploratory because it approaches...
of the topic of the academic reality of Civil Engineering, especially the discipline of Foundations and
Earthworks, identifying concepts and relationships that often appear in a fragmented way in technical documents. It
is descriptive because it presents characteristics of
SIRGAS2000, its official adoption, its relationship with GNSS, IBGE-PPP, technical standards and
applications in topographic surveys.
Regarding the technical procedures, a literature review and a document review were adopted.
Official publications from the Brazilian Institute of Geography and Statistics were consulted, such as
Resolutions and technical pages regarding SIRGAS and the Geodetic Reference System Change Project.
In addition to INCRA documents and articles published in national journals in the areas of
Cartography, geomatics, and geodesy were also considered. Brazilian technical standards were also taken into account.
related to topographic surveys and cadastral reference networks.
The selection of sources considered three main criteria: institutional credibility, relationship
Directly related to the topic and current or technically relevant. Documents from the IBGE (Brazilian Institute of Geography and Statistics) were prioritized.
because it is the body responsible for the Brazilian Geodetic System; INCRA documents, because
dealing with the standardization of georeferencing; and national scientific articles published in
journals in the field, such as the Brazilian Journal of Cartography, the Brazilian Journal of Geomatics and
The journal Geografias. ABNT standards were also used due to their importance in
professional practice.
The information was gathered through an analytical reading of the sources. Initially, they were...
The following central concepts were identified: geodetic system, datum, SIRGAS2000, GNSS.
IBGE-PPP, coordinate transformation, reference network and topographic survey. In
Next, the information was organized into thematic areas: evolution of benchmarks in
Brazil, characteristics of SIRGAS2000, positioning technologies, standards and applications in
civil engineering. This organization allowed for the construction of the theoretical foundation and the execution of the
analysis of the results.

w

This article is published in open access under the Creative Commons Attribution license, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Machine Translated by Google
RCMOS - Multidisciplinary Scientific Journal The Knowledge.
ISSN: 2675-9128. São Paulo-SP.

Year VII, v.1 2026 | Submission: 05/23/2026 | Accepted: 05/26/2026 | Publication: 05/29/2026

The analysis was conducted in a qualitative and interpretive manner. The aim was to relate the contents...
Technical data from sources to practical situations of topographic surveying in engineering works.
For example, the mandatory implementation of SIRGAS2000 was linked to the need for compatibility.
plants, cadastral records and projects; the studies on IBGE-PPP were related to obtaining
support points; and discussions about referral networks were linked to the reality of
Urban surveys and infrastructure projects.

There was no field data collection, application of questionnaires, or conducting of a study.
specific case. This delimitation is consistent with the objective of producing a review.
A bibliographical review focused on understanding the topic. Even so, the research sought to maintain a link.
with professional practice through examples applied to foundations, earthworks,
Earthmoving, land surveying, and georeferencing.

As a methodological limitation, it is acknowledged that the analysis depends on the sources selected and
This does not replace a field trial. Future research could compare the coordinates obtained.
Using different positioning methods, evaluate transformations between reference frames in a
real area or analyze the quality of topographic surveys delivered in public works.
Even with this limitation, the review allows us to understand the importance of SIRGAS2000.
as a technical basis for standardizing surveys in the country. The method adopted is
aligned with the proposed theme, since the discussion about the geodetic system requires understanding.
normative, historical, and technical. The analysis of official documents ensures that the description of
The adoption of SIRGAS2000 should be faithful to the Brazilian institutional framework, while the articles
Scientists contribute with recent assessments on GNSS processing, the
Transformation of reference frames and densification of reference networks.

ANALYSIS OF RESULTS

Contributions of SIRGAS2000 to topographic standardization

The review carried out indicates that the main contribution of SIRGAS2000 is to establish a
A common reference for the production and integration of spatial data in Brazil. Before adoption
Unique to this system, the coexistence of distinct reference points favored the formation of bases.
heterogeneous cartographic patterns. After the end of the transition period in 2015, the
SIRGAS2000 became the benchmark to be adopted by Brazilian users in activities.
linked to the Brazilian Geodetic System and the National Cartographic System (IBGE, 2015).
This standardization reduces ambiguities in topographic surveys. When a

This article is published in open access under the Creative Commons Attribution license, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Machine Translated by Google
RCMOS - Multidisciplinary Scientific Journal The Knowledge.
ISSN: 2675-9128. São Paulo-SP.

Year VII, v.1 2026 | Submission: 05/23/2026 | Accepted: 05/26/2026 | Publication: 05/29/2026

The plant provides the coordinates in SIRGAS2000, the UTM zone, the method of obtaining the coordinates, and the...
With precision, the user is able to integrate the data with other official databases. This does not eliminate
It removes field errors, but allows tracing the origin of the coordinates. Standardization is therefore...
a form of documentary and technical qualification.

Borges et al. (2017) reinforce that the adoption of SIRGAS2000 contributed to homogenization.
of geographic information in Brazil, but they warn that the conversion of old data must be
done carefully. This result shows that SIRGAS2000 does not automatically resolve the
The existing cartographic liability. On the contrary, it makes the need to assess the more evident.
origin of each basis and apply appropriate transformations.

In civil engineering practice, standardization facilitates the compatibility between surveys.
of different phases. A preliminary survey can guide feasibility studies; another,
More detailed information can support the detailed design; new surveys can update the project.
during execution; and final products can be included in the as-built catalog. If all phases
If they adopt the same reference point, the comparison between them is more reliable. If each phase uses a different approach, the comparison between them is more reliable.
With a different reference, the risk of incompatibility increases.

The analysis also shows that SIRGAS2000 favors the integration between topography and the
Digital systems. Projects in CAD, GIS, BIM, drones, GNSS-controlled machines and...
Territorial databases depend on consistent coordinates. Geodetic standardization.
This creates the foundation for interoperability. In a scenario of digitalization in the construction industry,
This aspect tends to become increasingly relevant.

Another result is the expansion of technical responsibility for spatial information.
A professional should not only provide coordinates; they must explain the system, the method, and the...
Quality. Standardization by SIRGAS2000 requires that plans, reports, and documentation be...
more complete. This contributes to transparency and the possibility of auditing.
important elements in public works, georeferencing, and regularization.

Standardization also helps reduce rework. Incompatible databases may require...
new field campaigns, emergency transformations, or manual adjustments to the design.
These procedures are time-consuming and can introduce new errors. When the
The survey is produced correctly in SIRGAS2000 from the beginning, the chances of
Rework is reduced and communication between designers, surveyors, and contractors improves.

Therefore, SIRGAS2000 contributes to standardization not only because it is mandatory, but also because it is mandatory.
also for offering a technical framework capable of uniting different data into a single language.
Common spatial organization. Its importance is evident both at the national level, in organizing the System

w

This article is published in open access under the Creative Commons Attribution license, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Machine Translated by Google

Year VII, v.1 2026 | Submission: 05/23/2026 | Accepted: 05/26/2026 | Publication: 05/29/2026

Brazilian Geodetic, both at the local level, when guiding the execution of construction surveys and registration.

Data integration, accuracy, and reliability.

The reliability of a topographic survey depends not only on the accuracy of the equipment, but also the consistency of the process. The analysis of the sources shows that High-precision coordinates can become useless if they are not correctly linked. to the official reference. SIRGAS2000 provides the basis for transforming measurements into information. Comparable spatial data, especially when using GNSS, IBGE-PPP, and reference networks. Nascimento, Dal Poz and Freitas (2021) demonstrate that the compatibility between ITRF/IGS and SIRGAS2000 in IBGE-PPP involves transformation parameters, and updating these... Standardization of parameters improves the consistency of the series. This result indicates that standardization... Geodesy is dynamic: services, models, and parameters need to be updated. To keep up with the evolution of global benchmarks. The end user must understand that... Processed coordinates are the result of a technical methodology and not just a reading. direct from the receiver.

Data integration also depends on quality control. A survey can Combining GNSS points, total station data, and photogrammetry is necessary, but consistency between these sources is crucial. to be verified through checkpoints, redundancy, and residue analysis. França, Klein Veiga (2024) and others show that network densification methods can achieve high precision. when planned and adjusted properly. This finding reinforces that standardization The SIRGAS2000 system must work together with well-established local networks. In urban environments, reliability also depends on the ability to cope with limitations. observation. GNSS can be hampered by obstacles and multipath; the station Total visibility requires intervisibility; photogrammetry depends on control points; and laser scanning It needs proper registration. SIRGAS2000 does not eliminate these limitations, but it provides... a reference for integrating results obtained by complementary methods.

In earthworks, spatial reliability influences quantities and costs. A model Displaced terrain can alter volume calculations, cut and fill limits, or... Areas of intervention. In contracts, differences in volume can lead to financial disputes. Thus, adopting a single, documented reference point helps to provide transparency to... measurement process. Geodetic quality becomes part of the technical and economic management of work.

w

This article is published in open access under the Creative Commons Attribution license, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Machine Translated by Google
RCMOS – Multidisciplinary Scientific Journal The Knowledge.
ISSN: 2675-9128. São Paulo-SP.

Year VII, v.1 2026 | Submission: 05/23/2026 | Accepted: 05/26/2026 | Publication: 05/29/2026

In foundations, positional reliability contributes to the compatibility between soundings. Structural design and implementation. The position of a borehole can be crucial for... interpreting soil layers and defining solutions. When these points are raised without Without a clear reference, it becomes difficult to correlate geotechnical data with design elements. SIRGAS2000 allows information to be integrated with maps, cadastral plans and digital models in a more consistent way.

The analysis also shows that standardization improves temporal traceability. Projects They undergo updates, works undergo intermediate measurements, and structures may be monitored. If the campaigns use the same framework and compatible procedures, the Comparison between eras is more reliable. This aspect is essential in works that require... Control of settlements, displacements, slopes and deformations.

It can be concluded, therefore, that SIRGAS2000 increases the reliability of surveys by To provide a common foundation, but the final quality depends on proper procedures. The system must be accompanied by planning, documentation, field control, and analysis. Critique of the results.

Transforming old data and preventing inconsistencies.

One of the main challenges identified in the review is the coexistence of old data in legacy benchmarks. Many municipalities, companies, and professionals still have plants and bases produced in SAD 69, in Córrego Alegre or in local systems. Exclusive adoption SIRGAS2000 requires that this data be evaluated before being combined with new data. surveys. Transforming coordinates without knowing the origin and scale of the data can generate errors that are difficult to detect.

IBGE Resolution No. 1/2015 mandates that the databases referring to Córrego Alegre and SAD 69 be transformed according to specific procedures, including the use of grids and guidelines. from IBGE (IBGE, 2015). This shows that the transformation should not be treated as a Simply changing the datum name in the software. The process depends on the correct parameters. and knowledge of the scope of the original database.

Borges et al. (2017) point out that the transformation of existing data into systems Legacies is a task that requires analytical care. This care is especially important. in Civil Engineering, as projects can reuse old surveys for cost savings or Due to availability. When an old database is inserted into a new project without verification,

This article is published in open access under the Creative Commons Attribution license, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Machine Translated by Google
RCMOS – Multidisciplinary Scientific Journal The Knowledge.
ISSN: 2675-9128. São Paulo-SP.

Year VII, v.1 2026 | Submission: 05/23/2026 | Accepted: 05/26/2026 | Publication: 05/29/2026

The error may remain hidden until the construction phase, at which point correction is usually more difficult.
face.

Preventing inconsistencies begins at the contracting stage. The terms of reference for
The survey should require the indication of the geodetic system, the projection, the zone, and the method.
of the support points, the accuracy, and the files delivered. You should also request a report.
Technical report, supporting sketch, and report when necessary. The absence of these elements creates opportunities.
for differing interpretations.

Another preventative measure is checking for common points. When receiving an old database
and a new survey, the identifiable points in both can be compared. If there is
Whether for systematic displacement, rotation, or scaling, the reference frame and method must be investigated beforehand.
Adjusting graphically is not recommended. Manual adjustments may mask the problem and compromise the result.
Traceability. The technical solution must be documented.

In earthworks, this prevention is essential when there is an expansion of projects.
Resumption of old projects or use of preliminary surveys. A landfill designed on
A displaced base can interfere with property boundaries, riparian zones, existing networks, or elevations.
drainage. Verification of the reference point should be part of the initial consistency analysis of
project.

In urban areas, inconsistencies between databases can lead to conflicts with the municipal registry.
and with the registration. The discussion on cadastral reference networks shows that the densification of
Points and the adoption of technical standards contribute to reducing this problem. França, Klein and
Veiga (2024) observes that the lack of municipal cadastral reference networks leads many
professionals offering support individually and repeatedly, which doubles costs and can generate
heterogeneity. SIRGAS2000, associated with local networks, helps to organize this reality.

Preventing inconsistencies ultimately requires technical training. Many errors are not caused by...
due to a lack of equipment, but also due to a lack of knowledge of datum, projection, time zone and
transformation. Therefore, the topic should be addressed in the training of engineers and technicians. A
The ability to interpret a plant's coordinate system is just as important as knowing
Use the drawing software.

Synthesis applied to Civil Engineering

The analysis allows us to summarize that SIRGAS2000 fulfills four main functions in
Civil Engineering: reference function, integration function, control function and function
documentary. The reference function consists of linking the coordinates to the official system of

w

This article is published in open access under the Creative Commons Attribution license, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Machine Translated by Google
RCMOS – Multidisciplinary Scientific Journal The Knowledge.
ISSN: 2675-9128. São Paulo-SP.

Year VII, v.1 2026 | Submission: 05/23/2026 | Accepted: 05/26/2026 | Publication: 05/29/2026

country. The integration function allows you to gather data from different sources. The control function.
It facilitates comparison between surveys and monitoring over time. The function
Documentation makes plans and reports more traceable.

These functions are interdependent. There is no reliable integration without a common reference; not
There is no efficient control without documentation; and there is no traceability if the method of obtaining the
If coordinates are not provided, then SIRGAS2000 should be viewed as part of a...
Quality chain. This chain begins with the planning of the survey, and continues through the measurement.
and through processing, it arrives at the presentation of results and continues with the use of
Data in design and construction.

Table 1 presents a summary of the main contributions identified in the research.
relating the use of SIRGAS2000 to practical impacts in topographic surveys and
in engineering works.

Table 1 - Summary of the contributions of SIRGAS2000 to topographic surveys

Contribution	**Technical application**	**Impact on construction projects**
Official reference	Linking the coordinates to Brazilian Geodetic System	Reducing ambiguities between plan, land, and cadastral data.
Data integration	Compatibility between GNSS, total station, drones, GIS and public databases.	Reduced risk of displacement between design layers.
Traceability	Declaration of datum, time zone, method, control points and precision.	Ease of auditing, technical and conference.
Controlled transformation	Conversion of legacy databases to the official system.	Preventing errors in projects that use old blueprints.
Support for earthworks	Digital terrain models and volume calculations in reference common	Larger reliability in measurements, cuts and fills
Support for foundations	Location of shafts, drilling points and structural elements.	Compatibility between geotechnical investigation and design.

Source: Prepared by the author (2026), based on IBGE (2005, 2015), Nascimento, Dal Poz and Freitas (2021), INCRA (2022) and França, Klein and Veiga (2024).

The chart shows that SIRGAS2000 does not operate in isolation. Its contribution is present
when the survey is planned to be integrated into engineering processes. In a
In earthmoving work, for example, the official reference allows for the initial survey, the
The cut and fill project, the monthly measurements, and the final survey should be compared with
greater safety. In foundations, it allows relating soundings, structural axes and boundaries to a
common ground.

It is also observed that standardization promotes communication between professionals.

w

This article is published in open access under the Creative Commons Attribution license, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Machine Translated by Google
RCMOS – Multidisciplinary Scientific Journal The Knowledge.
ISSN: 2675-9128. São Paulo-SP.

Year VII, v.1 2026 | Submission: 05/23/2026 | Accepted: 05/26/2026 | Publication: 05/29/2026

Surveyors, civil engineers, designers, geotechnical engineers, public managers and registrars.
They can interpret the information with less ambiguity when the system is declared. This
Communication is essential in multidisciplinary projects and reduces the need for adjustments.
Informal steps, performed solely to ensure the files visually match.
The applied synthesis therefore demonstrates that SIRGAS2000 should be incorporated into the culture.
Civil Engineering technique. It is not enough for the surveyor to know the system; the engineer who
The company that hires, receives, and uses the survey also needs to understand its importance.
The quality of the project depends on the ability to assess whether the spatial information received is
suitable for the intended purpose.
Finally, the analysis indicates that geodetic standardization impacts safety. Earthworks and
Foundations involve technical, economic, and human risks. Decisions based on location.
Incorrect installations can affect stability, drainage, interference, and legal limits.
SIRGAS2000 helps to reduce these risks by establishing a common reference, but
Its effectiveness depends on the conscious adoption of good professional practices.
Finally, it is recommended that the civil engineer not treat the geodetic reference system as an issue.
Exclusive to surveyors. Those who use surveying to design foundations, calculate volumes.
To guide machines, one needs to understand the limitations of the data. A critical reading of the system is essential.
Knowing coordinates is part of professional competence, as the quality of the work depends on it.
quality of the spatial information that precedes it. In this sense, SIRGAS2000 is a
a standardization tool, but also an element of technical responsibility.
shared.
The seventh practice is to preserve raw and intermediate data. RINEX archives, observations.
Total station data, adjustment reports, transformation spreadsheets, and file versions should be included.
to be filed along with the technical process. This organization facilitates audits, corrections and
Future updates. In long projects, where teams may change, the preservation of
Data prevents loss of knowledge and improves the continuity of topographic control.
The sixth practice involves reconciling planimetry and altimetry. SIRGAS2000 defines
The geocentric planimetric reference, but engineering projects depend on elevations with
physical meaning. Therefore, reports should state whether the heights are ellipsoidal,
Orthometric or normal, which geoidal model was used and what level references were used.
adopted. In drainage and earthworks, confusing ellipsoidal altitude with elevation of
This project could lead to serious errors in flow and volume.
The fifth practice is to verify the received documentation before starting the project. CAD files or

This article is published in open access under the Creative Commons Attribution license, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Machine Translated by Google
RCMOS - Multidisciplinary Scientific Journal The Knowledge.
ISSN: 2675-9128. São Paulo-SP.

Year VII, v.1 2026 | Submission: 05/23/2026 | Accepted: 05/26/2026 | Publication: 05/29/2026

GIS can contain coordinates without metadata, artificial displacements, or information.
inherited from old surveys. Before using them in foundations, earthworks or
When considering drainage, it is advisable to identify the origin, datum, time zone, and method.
For safety reasons, one should request clarifications, compare known points, or conduct a new assessment.
Support survey. The savings obtained by reusing an uncertain database may result in cost.
greater in execution.

The fourth practice is to treat local construction systems with transparency. In certain
For construction sites, it may be convenient to create local axes to facilitate location and reduce costs.
numerical or adapt the project to field practice. This is acceptable when there is a
A clear transformation occurs between the local system and SIRGAS2000. The problem arises when the
The local system is used without any linkage, which prevents subsequent integration with the registry, as-
built or based on public resources. The coexistence between the local system and the official system must be
controlled by known parameters and points.

The third practice is to use independent control points whenever the purpose requires it.
Greater safety. In surveys for earthwork projects, the simple collection of points...
It does not guarantee that the model is correctly positioned. Checkpoints allow
assess for displacement, time zone error, coordinate reversal, altitude failure.
antenna or inconsistency between the equipment. Checking is especially important.
when drone, total station, and GNSS data are integrated.

The second practice consists of maintaining a complete technical report. The report should
Introduce the equipment, the serial number (when applicable), and the positioning method.
the tracking time, the support points, the processing, the software used, the
Accuracy indicators and potential limitations. In GNSS-supported surveys,
It is recommended to attach processing reports, relevant files, and a sketch of
location of the points. This documentation increases traceability and allows another
The professional should understand how the coordinates were obtained.

Based on the results analyzed, it is possible to indicate good practices for the presentation of
Topographic surveys in the SIRGAS2000 system. The first step is to declare
The geodetic system and cartographic projection are explicitly included in all delivered products.
Plans, memorials, reports, digital files, and drawings must be submitted to the system.
SIRGAS2000 projection, UTM zone, hemisphere, unit of measurement, method of obtaining
the coordinates and the date of the survey. This statement prevents future users from relying
based on assumptions or information external to the document.

This article is published in open access under the Creative Commons Attribution license, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Machine Translated by Google
RCMOS - Multidisciplinary Scientific Journal The Knowledge.
ISSN: 2675-9128. São Paulo-SP.

Year VII, v.1 2026 | Submission: 05/23/2026 | Accepted: 05/26/2026 | Publication: 05/29/2026

Best practices for submitting surveys in SIRGAS2000

Standardization should also encompass the digital files delivered to the client. In addition to...
Whether it's a PDF or a printed version of the drawing, it's advisable to submit editable and geospatial formats with
Preserved metadata, preventing loss of information about the coordinate system. This
This practice encourages the continued use of surveying in later stages of the project, in
Maintaining the infrastructure and building a reliable technical database.
Another recommendation is to avoid mixing files without spatial verification. In many cases...
Offices and bases of different origins are incorporated into the same design by means of
Procedures such as copying and pasting, moving, or rotating manually. These actions can be
Useful for preliminary visualization, but they do not replace documented geodetic transformation.
In finished products, any adjustments must have a technical justification and a record of the procedure.
adopted.

It is also recommended that the drawings contain a specific technical legend for the
coordinates. This legend may provide: SIRGAS2000 datum, UTM projection, time zone,
Central meridian when necessary, geoid model used, scale, equidistance of the curves.
level, date of the survey, and responsible technician. This information is simple, but
They avoid confusion when the document circulates among designers, inspectors, implementers, and regulatory bodies.
public.

These best practices demonstrate that standardization through SIRGAS2000 is an ongoing process.
It begins with the choice of method, moves on to execution in the field, and continues through
The processing is only complete with the clear presentation of the results. Thus, the system
Official geodetic surveying becomes part of the project's quality management.
In smaller works, the same logic can be applied on a reduced scale. Two or more points
Well-defined support mechanisms, described in reports and protected against removal, are already increasing.
significantly improves the security of the rental. The difference between a survey only
operational and technically traceable data lies precisely in the ability to
reconstruct the path by which the coordinates were obtained.
When the survey is associated with large-scale projects, the implementation of a network
Self-support should also be considered. This network can be materialized through
Stable, protected landmarks distributed to serve different work fronts. A
Linking these milestones allows future measurements to be resumed with less accuracy.
uncertainty, even in the face of changes on the construction site or team changes.

This article is published in open access under the Creative Commons Attribution license, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Machine Translated by Google

Year VII, v.1 2026 | Submission: 05/23/2026 | Accepted: 05/26/2026 | Publication: 05/29/2026

FINAL CONSIDERATIONS

This article analyzed the importance of the SIRGAS2000 geodetic system for the Standardization of topographic surveys in Brazil, with attention to applications in Civil Engineering, and especially in the discipline of Foundations and Earthworks. The research showed that SIRGAS2000 should not be understood merely as a formal requirement in plans and reports, but as the technical basis that allows relating field measurements to a official, homogeneous reference compatible with modern positioning technologies.

The overall objective was achieved by demonstrating that SIRGAS2000 contributes to standardization. by offering a common reference for GNSS surveys, classical topography, Photogrammetry, land registration, and engineering projects. The specific objectives also The following were considered: the evolution of Brazilian benchmarks was presented, and the following were described. Technical characteristics of the system were discussed, its relationship with GNSS and IBGE-PPP was analyzed, and... Standards and applications were reviewed, and the necessary precautions to avoid inconsistencies were identified.

The review revealed that IBGE Resolution No. 1/2005 established SIRGAS2000 as the new system. reference system for the SGB and the SCN, while IBGE Resolution No. 1/2015 ended the The transition period consolidated its exclusive adoption. This milestone is fundamental for to understand why current surveys should be referenced to the official system.

It was also found that old data existed in SAD 69, in Córrego Alegre or in Local systems require careful transformation, as simply changing parameters in Software can generate errors.

The studies analyzed indicate that services like IBGE-PPP broaden access to coordinates. in the SIRGAS2000 system, but they require technical interpretation. The accuracy of a result It depends on the method, the transformation parameters, the observation time, and the quality. of the data and the control carried out. Thus, standardization by the official system needs to be accompanied by good data collection, processing and documentation practices.

In the context of foundations and earthworks, it can be concluded that SIRGAS2000 contributes to the safety and efficiency by enabling the integration of topographic surveys, soundings, Projects, boundaries, digital terrain models, and construction measurements. In earthmoving, this helps. In the reliable calculation of volumes; in foundations, it assists in location and correlation with data. geotechnical; in retaining walls and monitoring, it facilitates temporal comparisons. The quality The spatial representation of information is part of the quality of the work.

w

This article is published in open access under the Creative Commons Attribution license, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Machine Translated by Google

Year VII, v.1 2026 | Submission: 05/23/2026 | Accepted: 05/26/2026 | Publication: 05/29/2026

A key strength of the research is the connection between official documents, standards, and...
national scientific articles. As a limitation, it is acknowledged that no study was conducted on
field. For future work, it is suggested to carry out a practical comparison between coordinates.
data obtained by post-processed GNSS, RTK, and total station in a construction area, evaluating the
differences in SIRGAS2000 and the impacts on earthwork volumes or location of
foundations.

In conclusion, knowledge of SIRGAS2000 should be part of the training.
and the work of the civil engineer. The work begins on the site, but this is interpreted through
of coordinates, dimensions, and references. When this basis is standardized, the projects become
More integrated data leads to more traceable surveys and more reliable decisions. SIRGAS2000,
Therefore, it is a strategic element for the modernization and reliability of surveys.

Topographic surveys in Brazil.

REFERENCES

Brazilian Association of Technical Standards. NBR 13133: Execution of topographic surveys. Rio de Janeiro: ABNT, 2021.

Brazilian Association of Technical Standards. NBR 14166: Municipal Cadastral Reference Network - Procedure. Rio de Janeiro: ABNT, 2022.

BORGES, André Ferreira; TIMBÓ, Marcos Antonio; NERO, Marcelo Antonio; TEMBA, Plínio da Costa. Geodetic reference systems adopted in Brazil and the conversion of geographic data to the official SIRGAS2000 system: transformations and error evaluation. Geografias Journal, Belo Horizonte, v. 12, n. 1, p. 45–63, 2017. DOI: 10.35699/2237-549X..13414. Available at: https://periodicos.ufmg.br/index.php/geografias/article/view/13414. Accessed on: May 27, 2017. 2026.

BRAZIL. Federal Government. Obtain coordinates referenced to SIRGAS2000. Brasília, DF: Federal Government (2026). Available at: https://www.gov.br/pt-br/servicos/obter-coordenadas-referenciadas-ao-sirgas2000. Accessed on: May 27, 2026.

FRANÇA, Rovane Marcos de; KLEIN, Ivandro; VEIGA, Luis Augusto Koenig. Low-cost densification of RRCM without centering errors. Revista Brasileira de Cartografia, Uberlândia, v. 76, p. 1-19, 2024. DOI: 10.14393/rbcv76n0a-69641. Available at: https://seer.ufu.br/index.php/revistabrasileiracartografia/article/view/69641. Accessed on: May 27, 2026.

Brazilian Institute of Geography and Statistics. Presidential Resolution No. 1, of February 25, 2005. Establishes the Geocentric Reference System for the Americas, in its 2000 realization, as the new geodetic reference system for the Brazilian Geodetic System (SGB) and the National Geodetic System (SCN). Rio de Janeiro: IBGE, 2005. Available at: https://geoftp.ibge.gov.br/metodos_e_outros_documentos_de_referencia/normas/rpr_01_25fe v2005.pdf. Accessed on: May 27, 2026.

Brazilian Institute of Geography and Statistics. Presidential Resolution.

w

This article is published in open access under the Creative Commons Attribution license, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Machine Translated by Google

Year VII, v.1 2026 | Submission: 05/23/2026 | Accepted: 05/26/2026 | Publication: 05/29/2026

No. 1, of February 24, 2015. Defines the end date of the transition period established in RPR 01/2005 and provides other measures relating to the transformation between the geodetic reference systems adopted in Brazil. Rio de Janeiro: IBGE, 2015. Available at: https://geoftp.ibge.gov.br/metodos_e_outros_documentos_de_referencia/normas/rpr_01_2015_sirgas2000.pdf. Accessed on: May 27, 2026.

Brazilian Institute of Geography and Statistics. SIRGAS. Rio de Janeiro: IBGE, 2026. Available at: https://www.ibge.gov.br/geociencias/informacoes-sobre-posicionamento-geodesico/sirgas.html. Accessed on: May 27, 2026.

Brazilian Institute of Geography and Statistics. Geodetic Reference System Change Project - PMRG. Rio de Janeiro: IBGE, 2026. Available at: https://www.ibge.gov.br/geociencias/informacoes-sobre-posicionamento-geodesico/sirgas/16691-projeto-mudanca-do-referencial-geodesico-pmrg.html. Accessed on: May 27, 2026. 19

Brazilian Institute of Geography and Statistics. Specifications and standards for geodetic surveys associated with the Brazilian Geodetic System. Rio de Janeiro: Available at IBGE, https://geoftp.ibge.gov.br/metodos_e_outros_documentos_de_referencia/normas/normas_levantamentos_geodesicos.pdf. Accessed on: May 27, 2026. 2017. in:

NATIONAL INSTITUTE FOR COLONIZATION AND AGRARIAN REFORM. Technical manual for georeferencing rural properties. 2nd ed. Brasília, DF: INCRA, 2022. Available at: https://sigef.incra.gov.br/static/documentos/manual_geo_imoveis.pdf. Accessed on: May 27 2026.

MICHELS, Nicolas Berwanger; SILVA, Reginaldo Macedônio da; SOUZA, Sérgio Florêncio de.

Georeferencing of rural properties: analysis of the area between topography, RTK and the TM system. Brazilian Journal of Geomatics, (2021). Curitiba Available at in: https://periodicos.utfpr.edu.br/rbgeo/article/view/12734. Accessed on: May 27, 2026. of

NASCIMENTO, Lécio Alves; DAL POZ, William Rodrigo; FREITAS, Krisley Xavier Soares de. Evaluation of the new transformation parameters between ITRF (IGS) and SIRGAS2000 in IBGE-PPP with time series analysis. Revista Brasileira de Cartografia, Uberlândia, v. 73, n. 2, p. 435-452, 2021. DOI: 10.14393/rbcv73n2-57735. Available at: https://seer.ufu.br/index.php/revistabrasileiracartografia/article/view/57735. Accessed on: May 27, 2026. 20

w

This article is published in open access under the Creative Commons Attribution license, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.