CONCEPTOS BÁSICOS DE SISTEMAS DE COORDENADAS EN LA RELOCALIZACIÓN DE UTILIDADES EN PROYECTOS DE CARRETERAS

por

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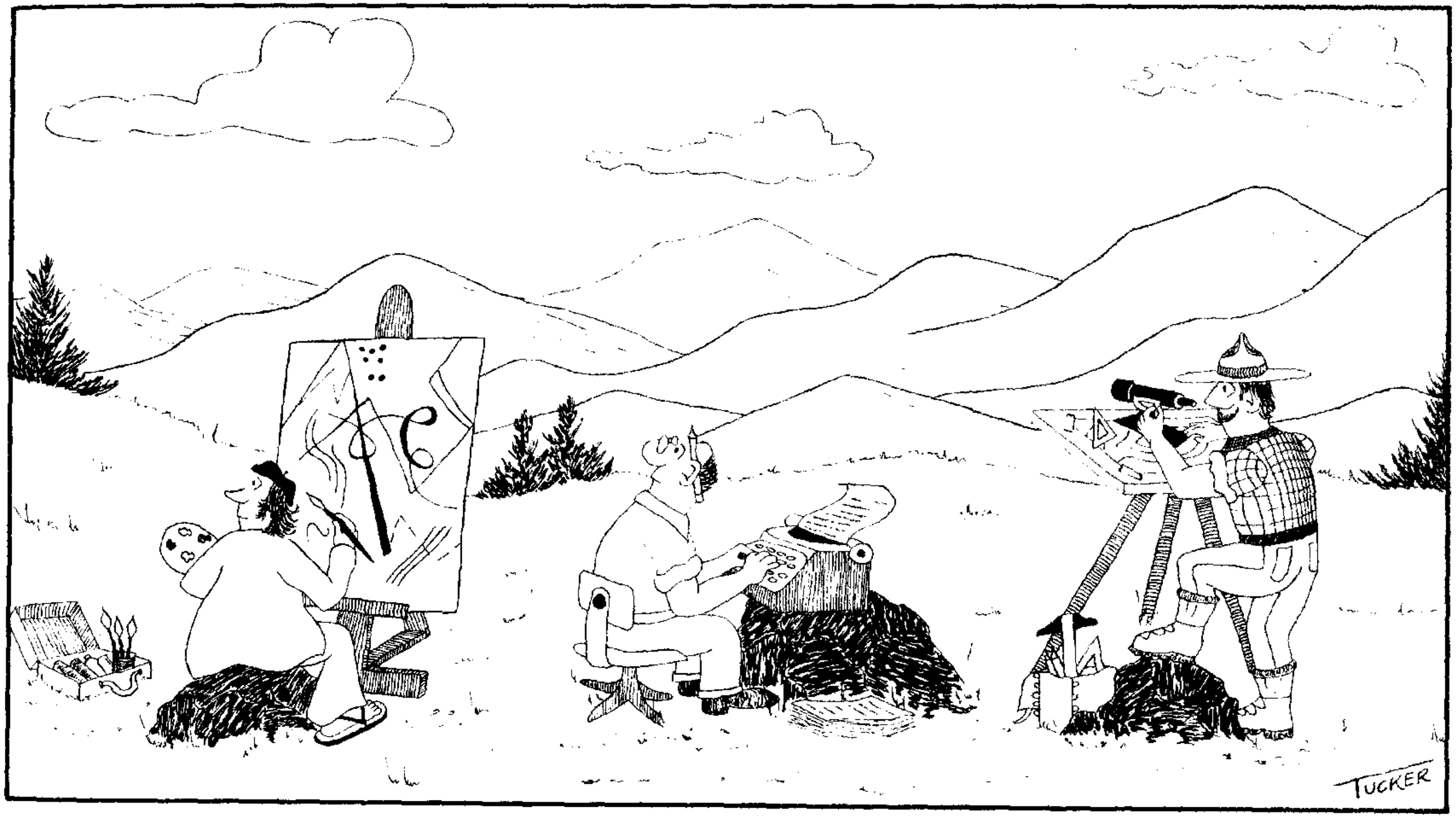
Temas - AM

- Introducción
- Requerimientos por Ley y Reglamento
- Conceptos Básicos de:
  - Gedésia y sus superficies
  - Marcos de Referencia y la Ley 264 del 2002
  - Agrimensura y como se obtienen las Coordenadas Planas X,Y
    - Referencia "NOTAS SOBRE AGRIMENSURA"
  - Proyecciones cartográficas y sus Sistemas de Coordenadas: Referencia "SISTEMA LAMBERT" en www.revistatp.com

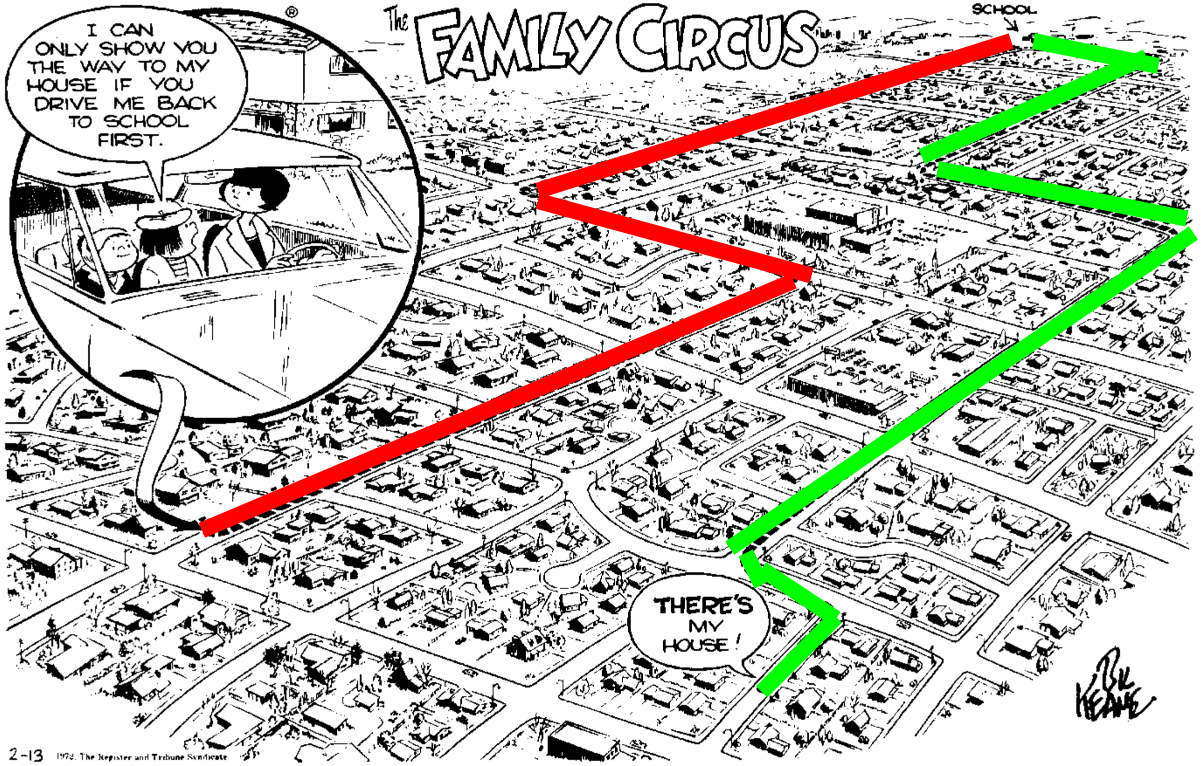
Temas - PM

- National Geodetic Survey (NGS): sus Datasheets y sistemas de coordenadas
  - Referencia: www.ngs.noaa.gov/
- Infraestructura, Utilidades y sus Atributos
- Caso de carretera PR-106 Km 1.6 Mayaguez
- Carretera PR-3108 conecta la PR-2 y PR-108

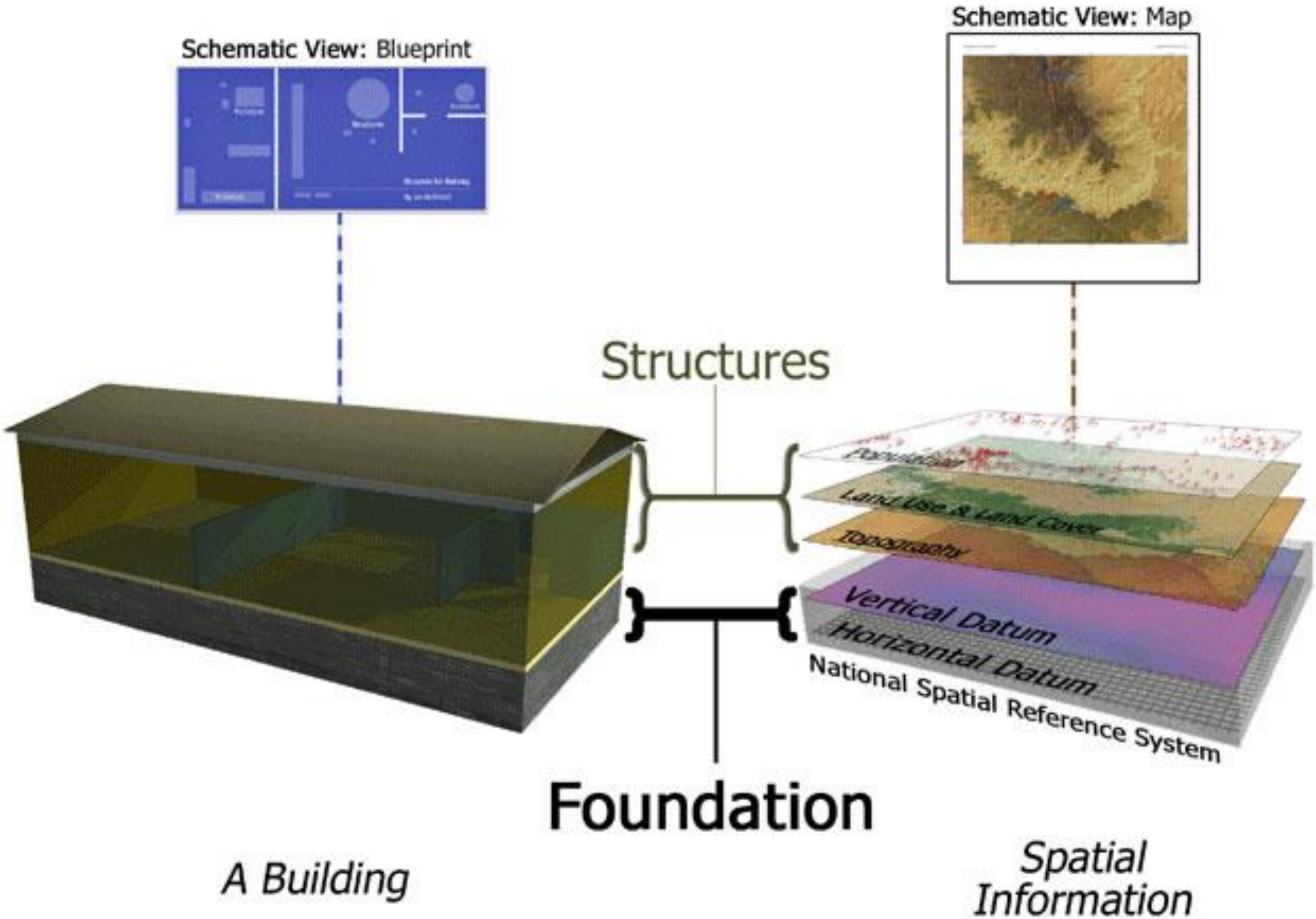
Realidad vs. transformación



Realidad vs. transformación



Estructura VS. Datos Geo-Espaciales



Que nos requieren

- **Ley 264 del 16 de noviembre del 2002**

  - Para adoptar el Sistema de Coordenadas Planas Estatales utilizando el método de la Proyección Conforme Cónica Lambert y el North American Datum of 1983, o su versión más reciente

Ley Núm. 264 del año 2002

(P. del S. 990), 2002, ley 264

Ley para adoptar el Sistema de Coordenadas Planas Estatales de Puerto Rico
Ley Núm. 264 aprobada en 16 de noviembre de 2002

Para adoptar el Sistema de Coordenadas Planas Estatales utilizando el método de la Proyección Conforme Cónica Lambert y el *North American Datum of 1983*, o su versión más reciente, como el sistema de mapa oficial de las agencias, instrumentalidades y municipios del Estado Libre Asociado de Puerto Rico, a los fines de uniformar el uso de proyecciones cartográficas por los organismos gubernamentales, disponer lo relativo a la certificación de ubicaciones o posiciones geográficas, y para otros fines.

EXPOSICION DE MOTIVOS

La Junta de Planificación del Estado Libre Asociado de Puerto Rico es el organismo gubernamental responsable de guiar el desarrollo integral de Puerto Rico de modo coordinado, adecuado y económico, para atender necesidades actuales y futuras. La Junta también sirve como centro de información para el Gobierno y para la ciudadanía en general.

Una de las herramientas de mayor importancia, para la evaluación y estudio de casos que se someten ante la Junta de Planificación, es el Archivo Gráfico. En este Archivo se recopila información gráfica en mapas, relacionada con las consultas que se someten ante la Junta, así como la información relacionada con mapas de zonificación, zonas inundables y planes de usos de terrenos y expansión urbana. Este recurso de la Junta ofrece un marco de referencia abarcador y preciso, el desarrollo físico y estructural de Puerto Rico.

Las agencias gubernamentales, los municipios y las empresas privadas utilizan este banco de datos continuamente para planificar sus proyectos Más eficientemente. Por ello, la Junta de Planificación mecanizó sus sistemas de información a fin de poder cumplir con la continua demanda de información del sector público y privado y para atender la cantidad de casos radicados. Para mantener actualizada esta información, se ha requerido, que toda consulta radicada ante la Junta presente la ubicación exacta del centro del proyecto propuesto, utilizando para ello la proyección de coordenadas geográficas conocida como Coordenadas Lambert.

El Servicio Geodésico Nacional ha diseñado para los estados y territorios de los Estados Unidos de América, una red de sistemas de coordenadas conocido como Sistemas de Coordenadas Planas Estatales. El propósito de dichos sistemas es lograr la mejor representación cartográfica de las características geográficas de cada uno de los estados o territorios.

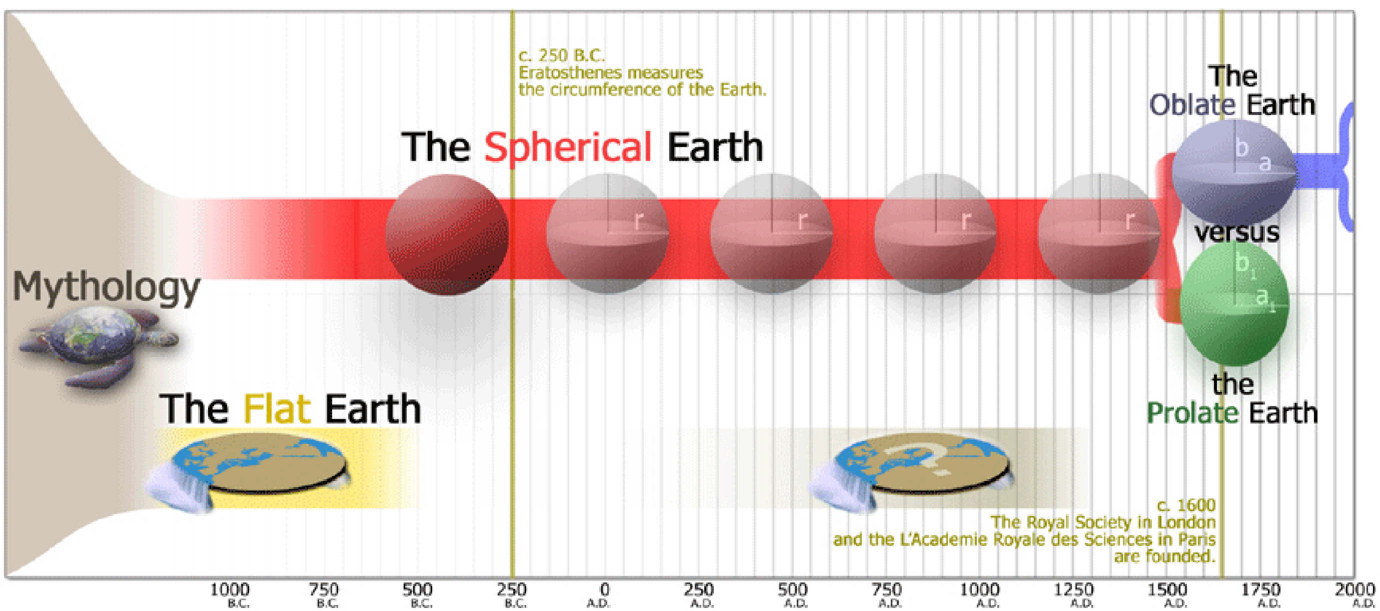
Las proyecciones que utilizan dichos Sistemas toman en consideración diferentes criterios. Así por ejemplo, se utiliza la extensión del área cuando se trata de un hemisferio, un

Que nos requieren

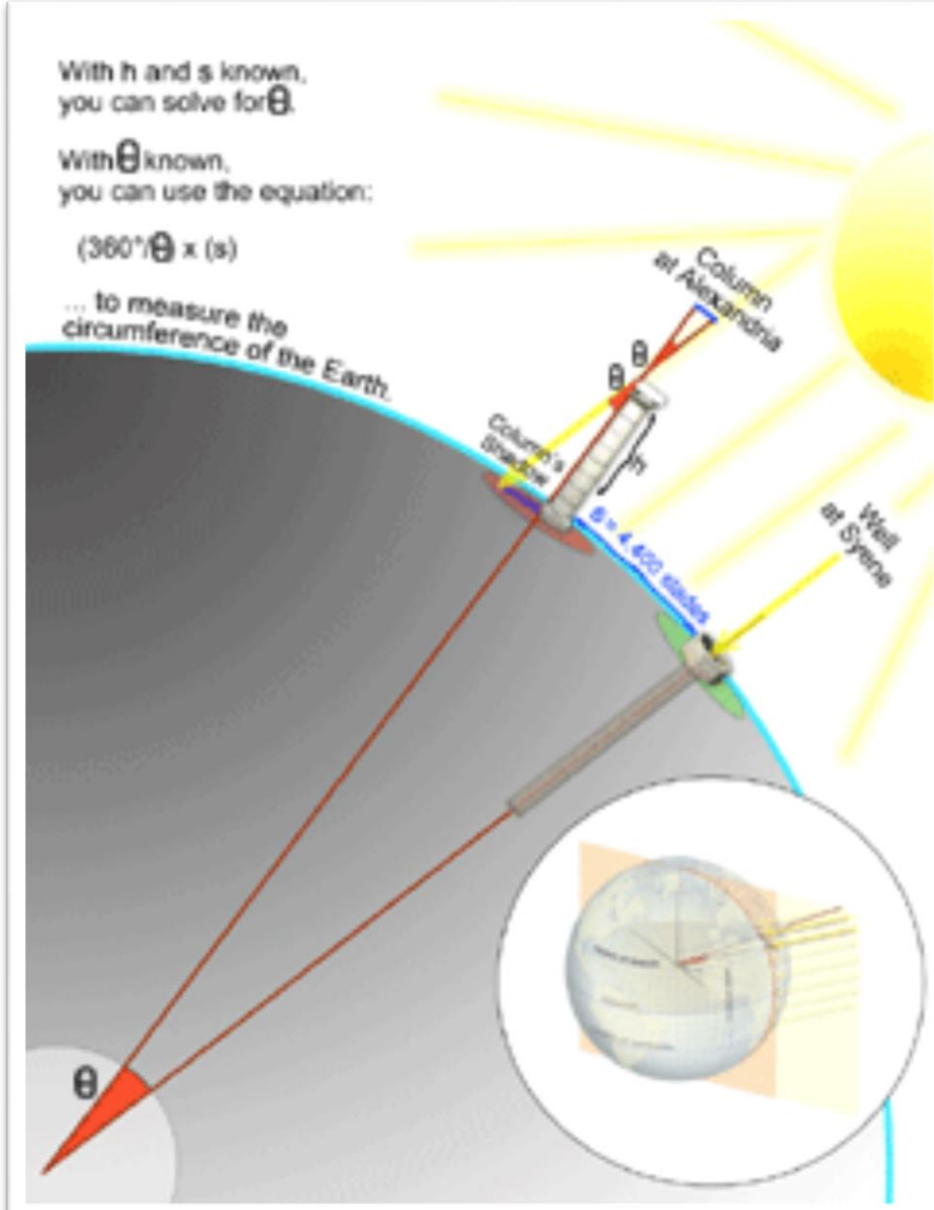
- **Reglamento Conjunto para Obras de Construcción y Usos de Terrenos vigende desde el 29 de noviembre del 2010 en su** Sección 5.2.3 – Sistema de Coordenadas Planas Estatales

Geodesia

- Se define como la rama de la matemática aplicada que tiene que ver con el estudio de la forma y tamaño de la Tierra al igual que su campo gravitacional. Es una de las Geo-Ciencias o Ciencias Terrestres, junto con: Geografia, Geologia, Geofisica y Geomorfologia

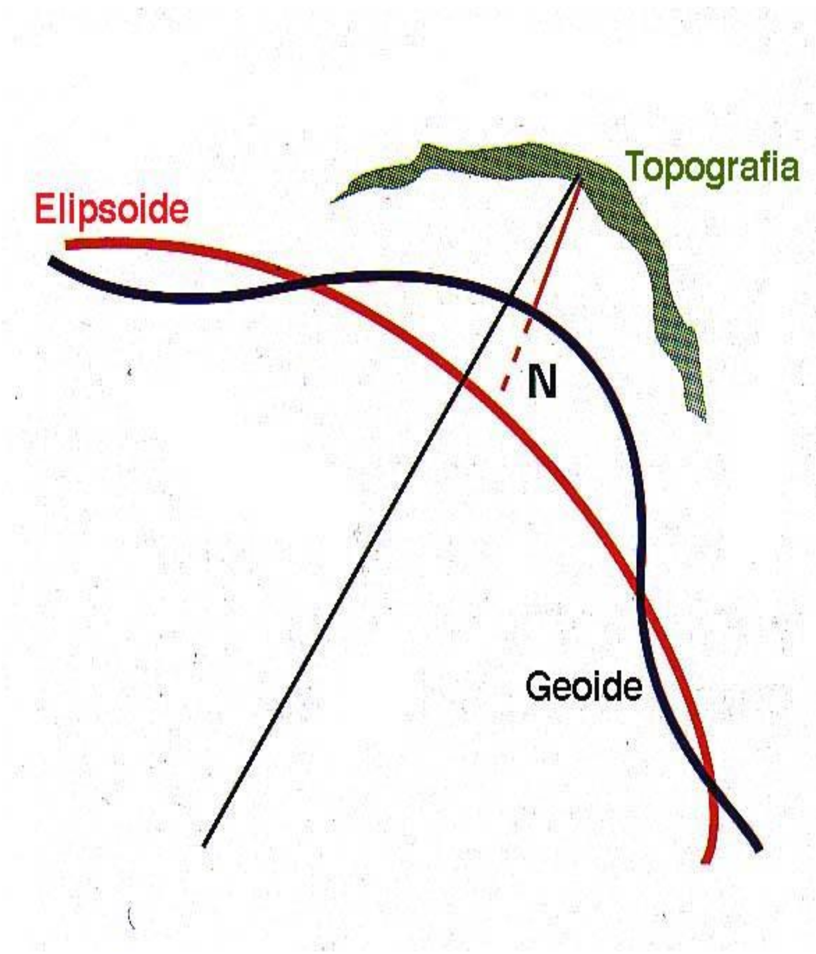


Eratostenes: Padre de la Geodesia



Tres Superficies
Una Realidad

- **Topografía** - superficie de nuestro planeta donde nosotros hacemos las observaciones
- **Elipsoide** - superficie matemática que usamos para describir la tierra
- **Geoide**- superficie física que denota el potencial de gravedad de nuestro planeta



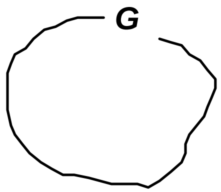
Geoide

- nosotros habitamos un planeta cuya forma es única y puede ser descrita por el término geoide. Esta palabra procede del griego “geoeides” que quiere decir “perteneciente a la tierra” (GE de tierra y EIDOS de forma).
- El geoide es la forma que tiene la superficie de la tierra allí donde el nivel del mar es uniforme y siempre es perpendicular a la dirección de la gravedad.

EL GEOIDE

¿Que es ?

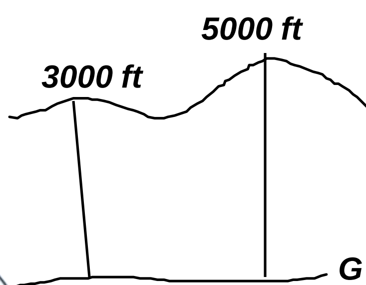
TEORICAMENTE:

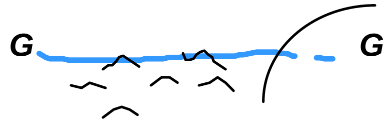


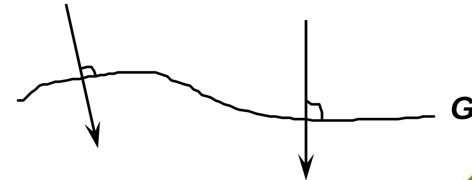
UNA SUPERFICIE A NIVEL EN ESPECIFICO DEL CAMPO GRAVITACIONAL

EN LA PRACTICA:

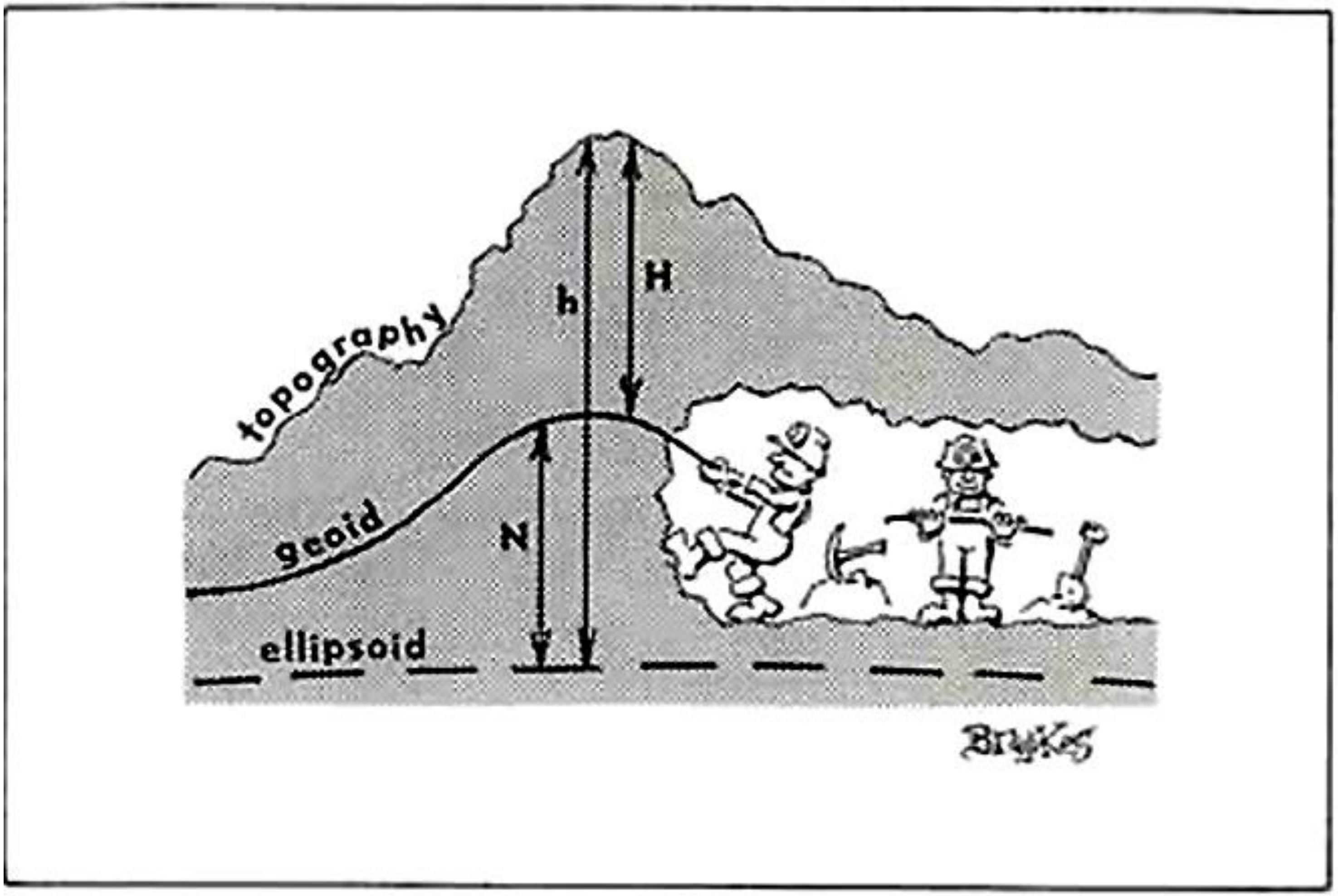
- ***REFERENCIA CERO PARA ELEVACIONES Y PROFUNDIDAD***
- ***"MEAN SEA LEVEL" CONTINUO EN LOS CONTINENTES***
- ***LA SURPERFICIE PERPENDICULAR A LA DIRECCION DE LA GRAVEDAD***

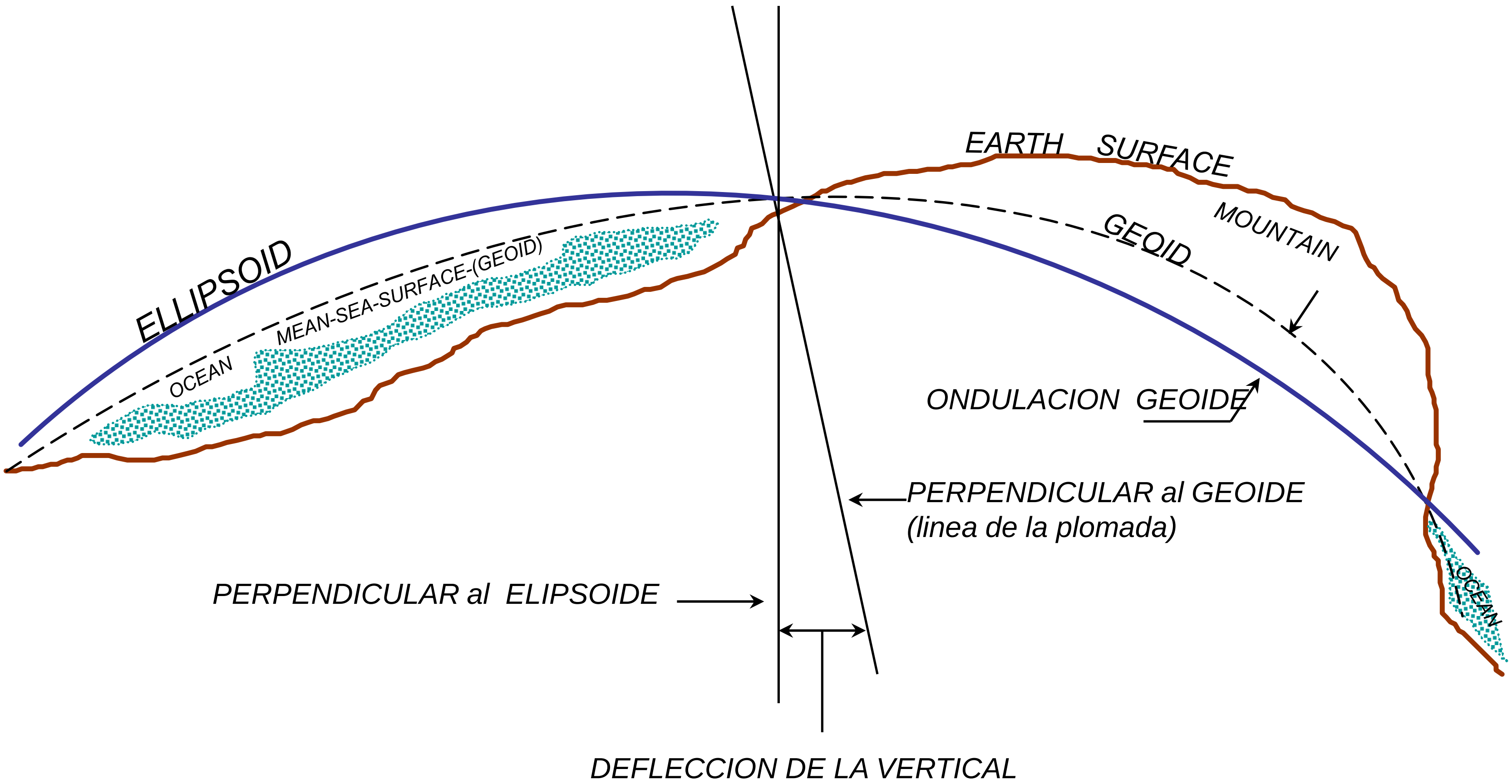






En busca del Geoide…

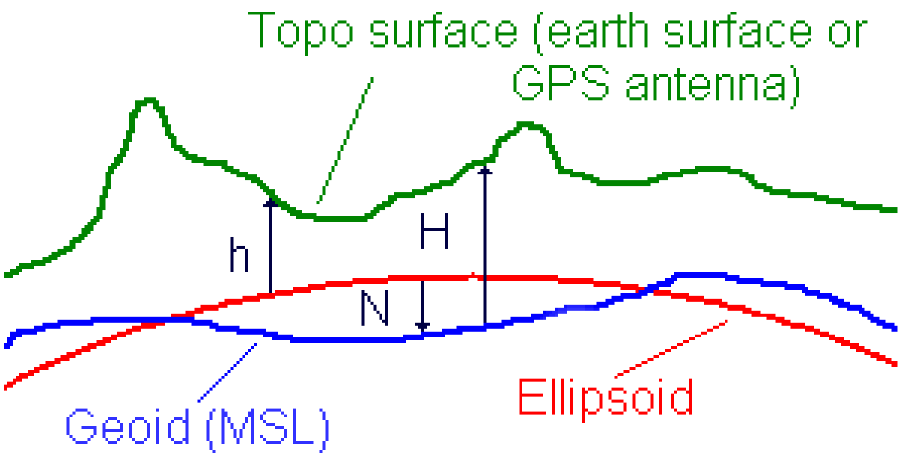




RELACION GEOIDE-ELIPSOIDE

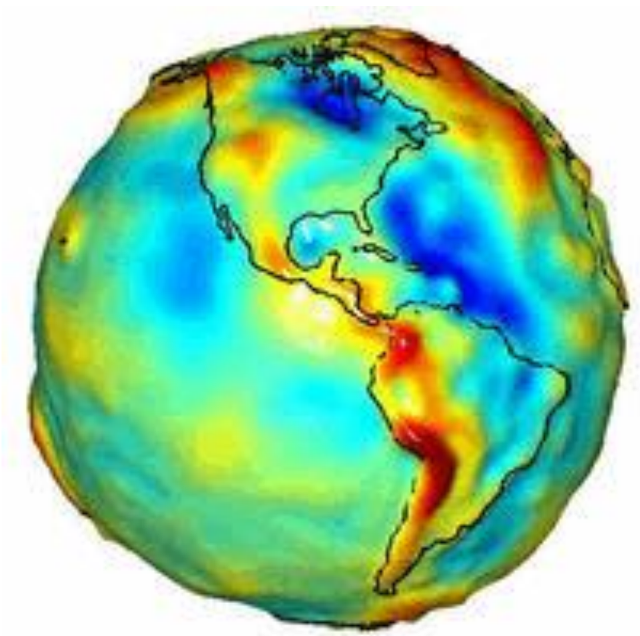
Relación de alturas (height) y las Tres superficies

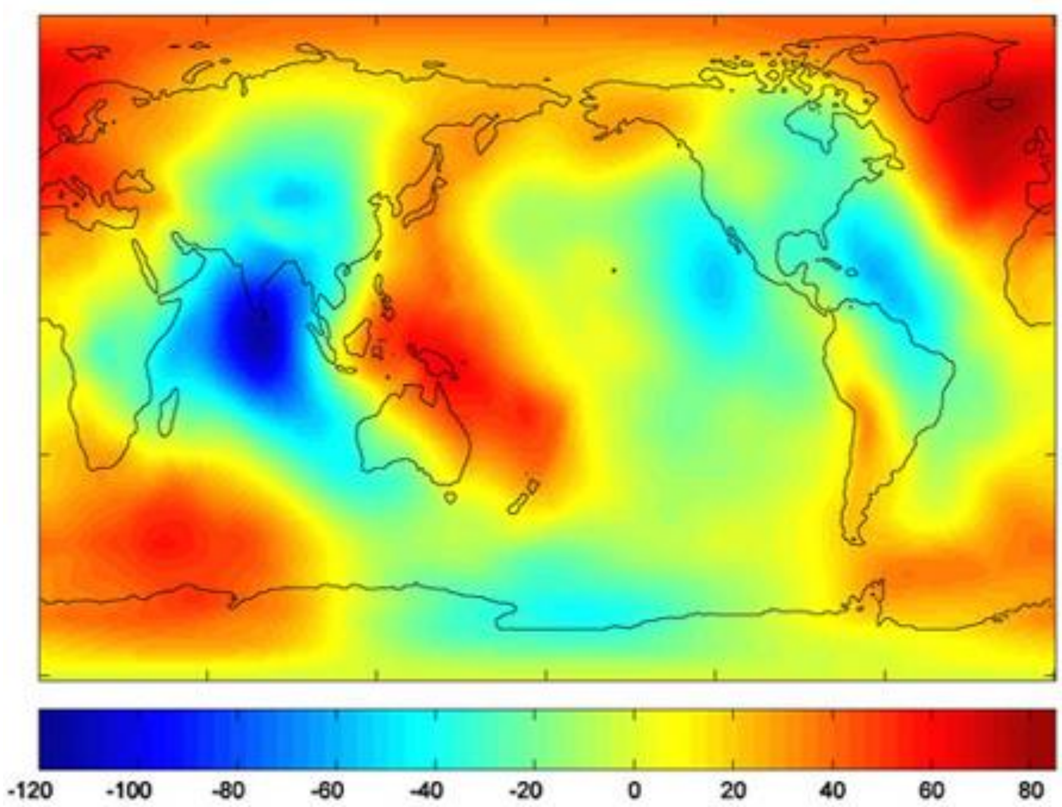
$$h=H+N$$



h=ellipsoid height
H=orthometric height
N=geoid height

Gravity Recovery And Climate Experiment (GRACE)





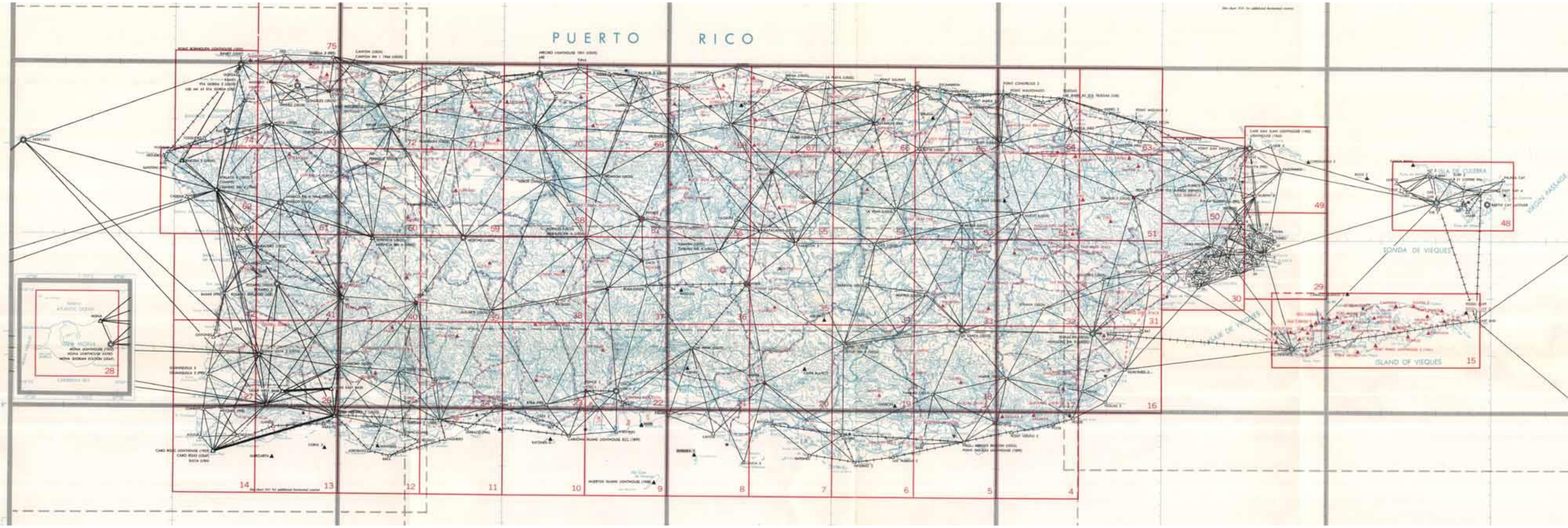
DATUMS

- Un DATUM es un conjunto de parámetros que definen un sistema de coordenadas y un conjunto de puntos de control cuya relación geométrica es conocida ya sea por medidas o cálculos.

  Dewhurst, 1990

- Todos los DATUMS se fundamentan en un elipsoide, el cual aproxima la forma de la **Tierra.**

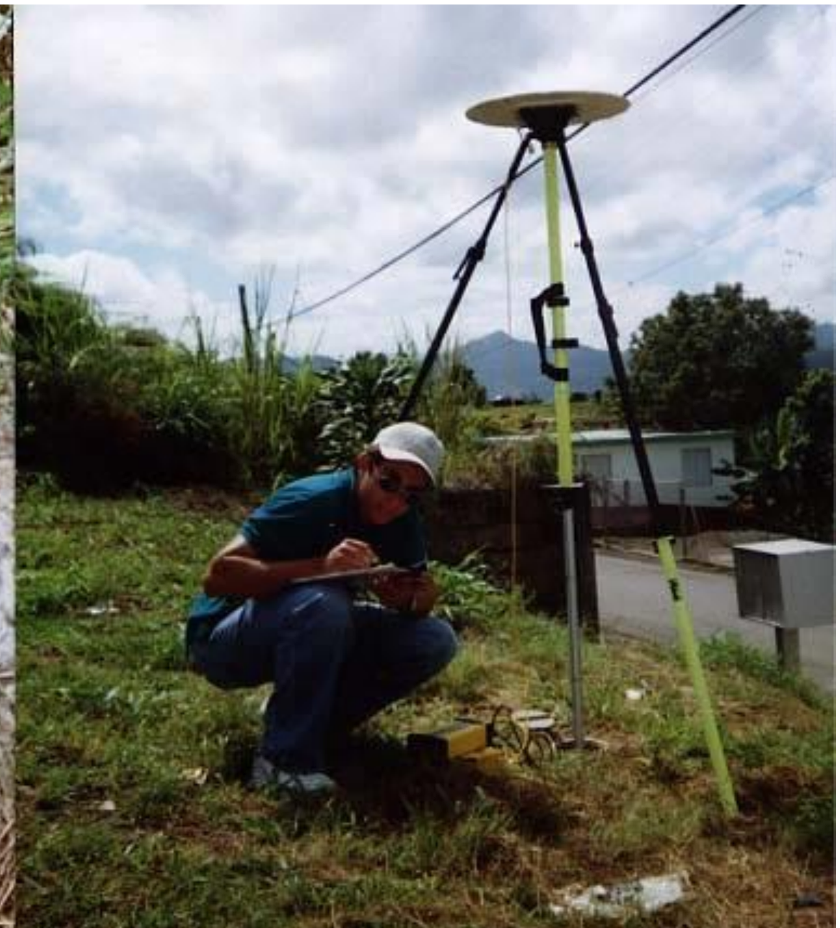
Red de Triangulación



Red del CRIM del 1995

(**C**entro de **R**ecaudación de **I**ngresos **M**unicipales)

Las Marias 2
Control Geodésico establecido en 1995 por el CRIM

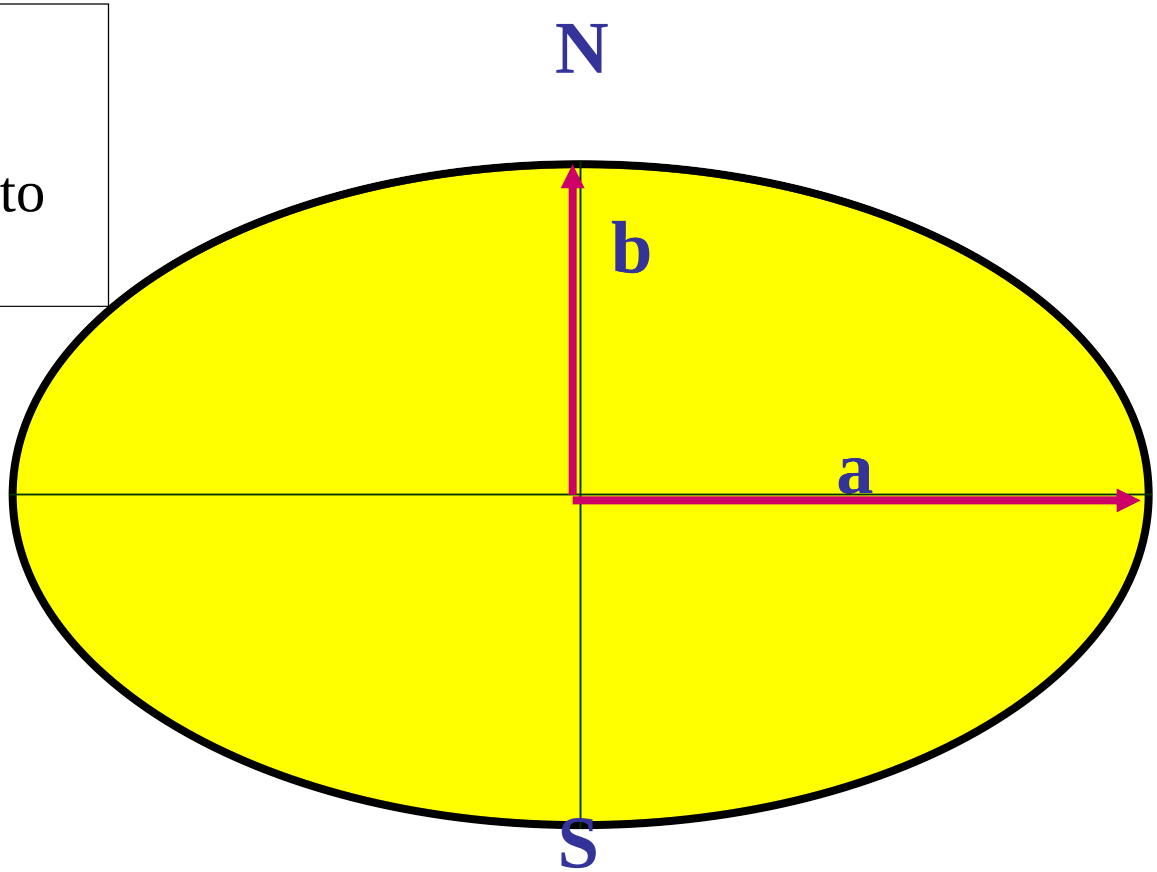


EL ELIPSOIDE
MODELO MATEMATICO DE APROXIMACION DE LA TIERRA

a = Semi Eje Mayor

b = Semi Eje Menor

$f = \frac{a-b}{a}$ = Achatamiento



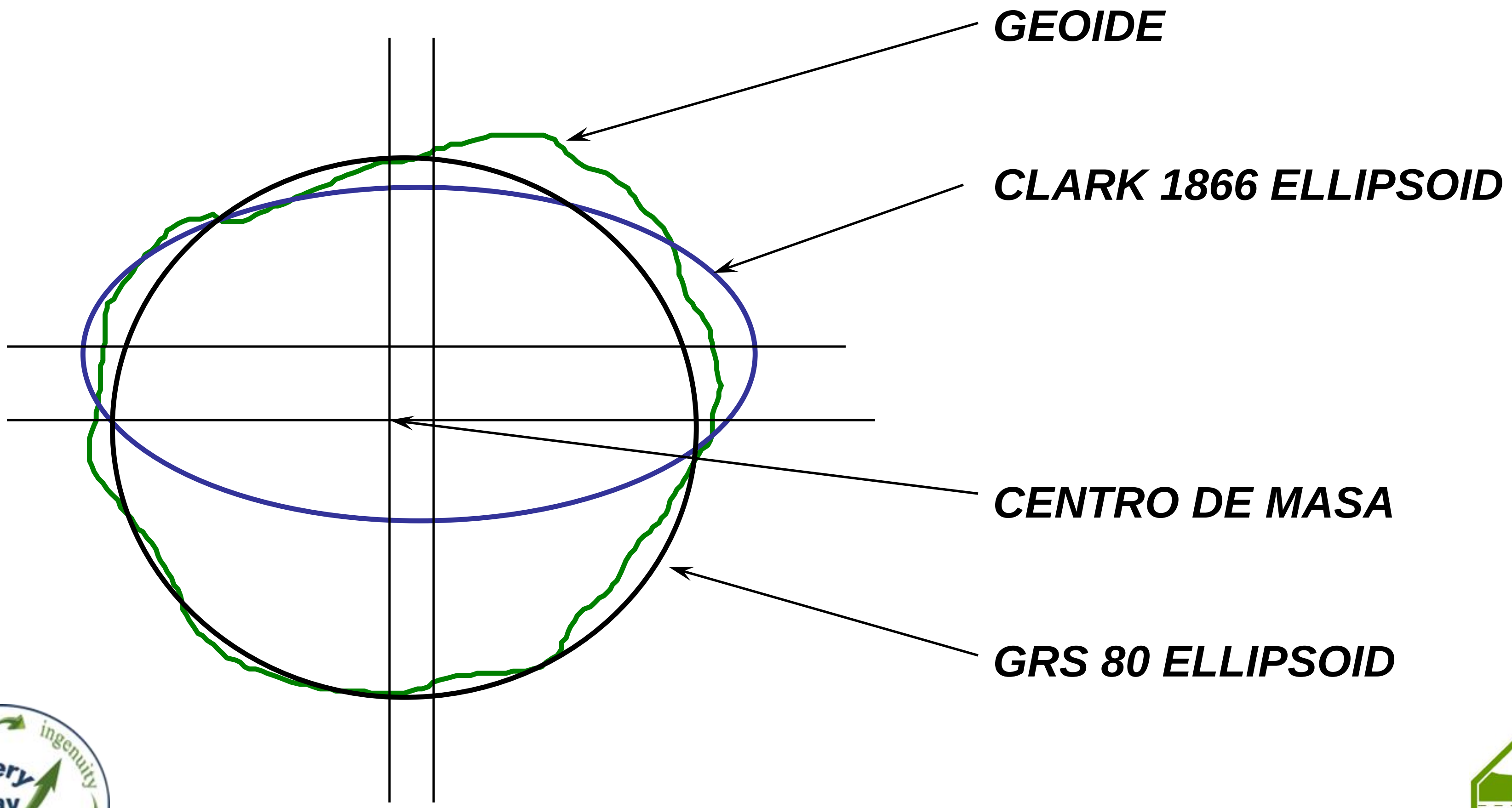
Datum Horizontales y sus Elipsoides

• PR Datum	Clarke 1866
• NAD27	Clarke 1866
• NAD83	GRS80
• WGS84	WGS84

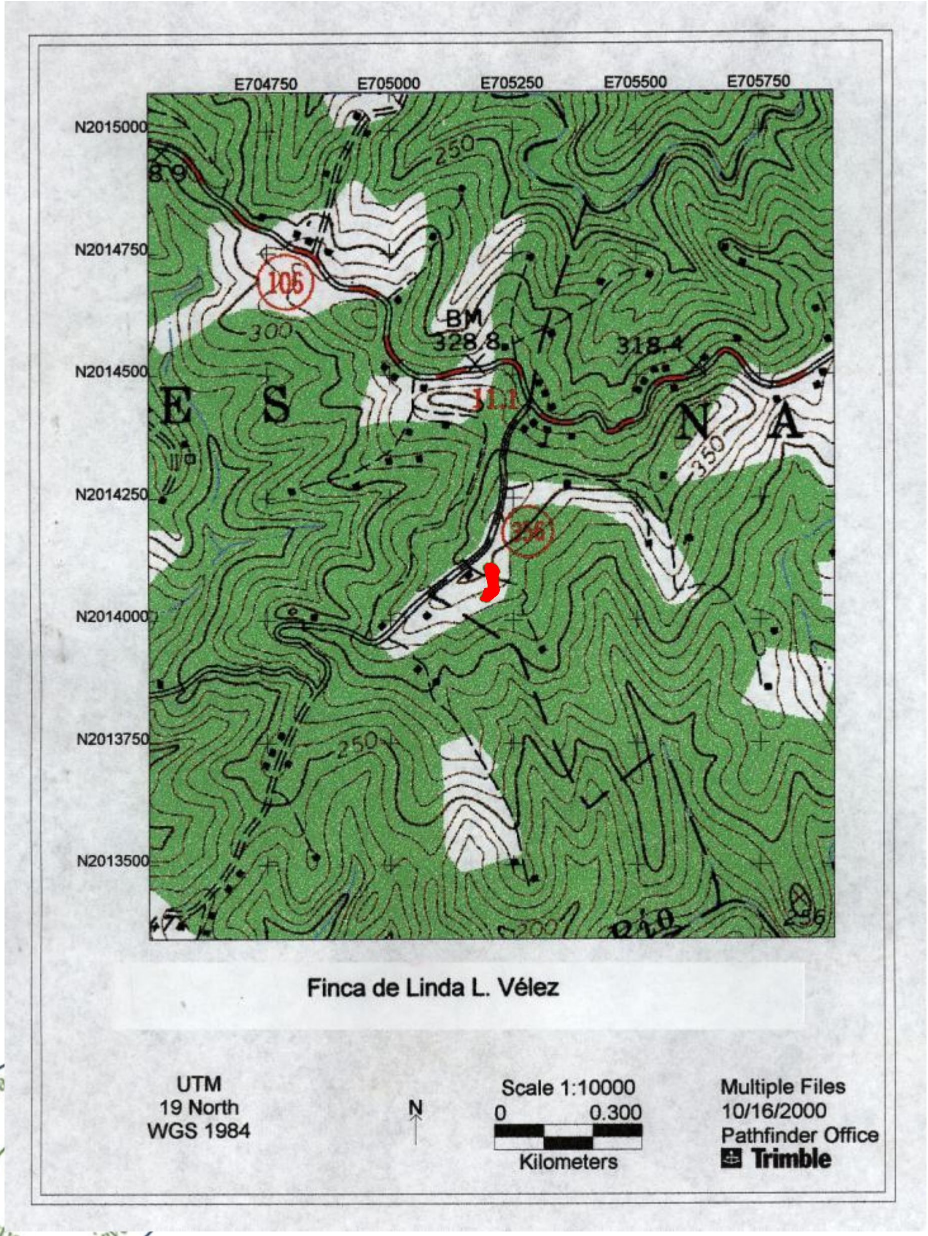
North American Datums

NAD 27 & NAD 83

EL GEOIDE Y DOS ELIPSOIDES



Mezcla de Datums



Mapa en PR Datum
y Datos en WGS84

Modern Terrestrial Reference Systems (Part 1)

Dr. Richard A. Snay and Dr. Tomás Soler

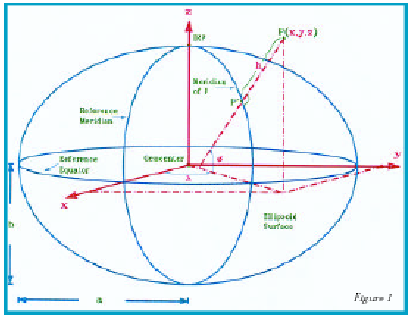


Figure 1

Surveyors, GIS/LIS professionals, engineers, cartographers, and others who work in North America face the challenge of dealing with at least three different 3D terrestrial reference systems. For many legal activities, these people express positional coordinates in the reference system known as the North American Datum of 1983 (NAD 83). Alternatively, they often favor using the World Geodetic System of 1984 (WGS 84) for various practical positioning activities involving the Global Positioning System (GPS), or they find the International Terrestrial Reference System (ITRS) more suitable for achieving superior positional accuracy. While these three reference systems differ from one another only slightly in concept, they differ significantly in how they have been realized, where the realization of a particular reference system is called a "reference frame". A particular reference frame is usually established by designating positions and velocities for several identifiable points. To date there have been several realizations of each of these three reference systems, as institutions have systematically revised positions and velocities from time to time to keep pace with how evolving technology has improved positioning accuracy. Here, we review the evolution of these reference frames, and we discuss transforming positions between different reference frames. Finally, we address some practical considerations for accurate positioning and discuss plans for a new NAD 83 realization.

Defining a Reference System

The modern approach to defining a 3D terrestrial reference system may be divided into four steps. The first step links the axes of a 3D cartesian coordinate system to a configuration of physically measurable locations on or within the earth. As a result, the location and orientation of the three coordinate axes are defined. The second step relates the concept of distance to physically measurable quantities whereby a unit of length is introduced. The third step introduces an auxiliary geometric surface that approximates the size and shape of the earth. Finally, the fourth step addresses the question of how Earth's gravity field contributes to the notion of position, and especially that of height. We shall be concerned here with only the first three steps, thus focusing on the geometric aspects involved in defining a reference system.

For the first step, most scientists involved in defining modern reference systems agree that the origin of the 3D cartesian system should be located at Earth's center of mass (geocenter); also that the cartesian system's z-axis should pass through the conventional definition of the North Pole, or more precisely, the International Reference Pole (IRP) as defined by the International Earth Rotation Service (IERS), an international organization established in 1988 and headquartered in Paris, France. The x-axis should go through the point of zero longitude located on the plane of the conventional equator, which is also defined by the IERS. The meridian going through this point is located very close to the meridian of Greenwich although the two are not coincident. The y-axis forms a right-handed coordinate frame with the x- and z-axes. Indeed, each of the three reference systems—NAD 83, WGS 84, and ITRS—has been accordingly defined in concept. They differ, however, as we shall soon discuss, in their realizations; that is, in how the location and orientation of their respective cartesian axes have been physically materialized as well as their respective concepts of distance. Unfortunately, what initially appears to be a simple geometric procedure is complicated by Earth's dynamic behavior. For example, Earth's center of mass is moving relative to Earth's surface. Also, there are variations of Earth's rotation rate as well as motions of Earth's rotation axis both with respect to space (precession and nutation) and to Earth's surface (polar motion). Moreover, points on the earth's crust are moving relative to one another as a result of plate tectonics, earthquakes, volcanic/magmatic activity, postglacial rebound, people's extraction of underground fluids, solid Earth tides, ocean loading, and several other geophysical phenomena. Modern terrestrial reference systems, hence, need to account for these motions. One option is to relate the cartesian axes to the locations of selected points measured at a particu-

Modern Terrestrial Reference Systems
PART 2: The Evolution of NAD 83

Dr. Richard A. Snay and Dr. Tomás Soler

The first realization of NAD 83 was introduced in 1986 by a group of institutions representing the various North American countries to upgrade the previous reference system; that is, the North American Datum of 1927 or NAD 27. In particular, the National Geodetic Survey (NGS) represented the United States, and this federal institution officially refers to the first NAD 83 realization as NAD 83 (1986). For this realization, the group of institutions relied heavily on Doppler satellite observations collected at a few hundred sites to estimate the location of the Earth's center of mass and the orientation of the 3D cartesian axes. They also relied on these same Doppler observations to provide scale for NAD 83 (1986). More precisely, the group of institutions relied on 3D Doppler-derived positions that had been transformed by:

- a translation of 4.5 m along the z-axis
- a clockwise rotation of 0.814 arc seconds about the z-axis
- a scale change of -0.6 ppm

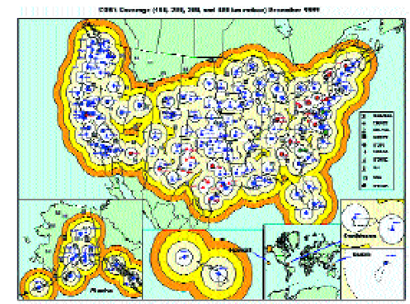
The Doppler-derived positions were so transformed to make them more consistent with the very long baseline interferometry (VLBI), satellite laser ranging (SLR), and terrestrial azimuth measurements that were available in the early 1980s. While NAD 83 (1986) is 3D in ...pe, NGS adopted only horizontal co...inates (latitude and longitude) for ...r 99% of the approximately 250,000 ... control points that were involved in ...ining this reference frame. Unfortu...ly, this first realization of NAD 83 oc...red a few years before GPS technolo...made the vertical dimension econom...ly accessible.

...S Changed Everything

Around the same time that NGS adopt... NAD 83 (1986), the agency had begun ...g GPS technology, instead of triangu...on and/or trilateration, for horizontal ...itioning. The fact that GPS technology ... provided accurate ellipsoidal heights ... somewhat overlooked in the 1980s ...ause surveyors, hydrologists, and oth...users of vertical positions required or...metric heights relative to mean sea ...l, as obtained with tide gauges and spirit leveling, and not geometric heights relative to an abstract mathematical surface (the ellipsoid), as obtained with GPS. The attitude towards using GPS to measure heights gradually evolved, however, as NGS and other institutions developed improved geoidal models for determining the spatial separation between mean sea level and the ellipsoid. These improvements enabled people to convert ellipsoidal heights into orthometric heights with greater and greater accuracy. Moreover, practitioners can measure heights much more economically with GPS than with spirit leveling.

As GPS matured, so did other space-age geodetic technologies; in particular, SLR and VLBI. Within a few years after 1986, both GPS and SLR measurements had allowed geodesists to locate Earth's center of mass with a precision of a few centimeters. In doing so, these technologies revealed that the center of mass that was adopted for NAD 83 (1986) is displaced by about 2 m from the true geocenter. Similarly, GPS, SLR, and VLBI revealed that the orientation of the NAD 83 (1986) cartesian axes is misaligned by over 0.03 arc seconds relative to their true orientation, and that the NAD 83 (1986) scale differs by about 0.0871 ppm from the true definition of a meter. These discrepancies caused significant concern as the use of highly accurate GPS measurements proliferated. In particular, starting with Tennessee in 1989, each state–in collaboration with NGS and various other institutions–used GPS technology to establish regional reference frames that were to be consistent with NAD 83. The corresponding networks of GPS control points were originally called High Precision Geodetic Networks (HPGN). Currently, they are referred to as High Accuracy Reference Networks (HARN). This latter name reflects the fact that relative accuracies among HARN control points are better than 1 ppm, whereas relative accuracies among pre-existing control points were nominally only 10 ppm.

For defining these regional reference frames, NGS retained the location of the geocenter and the orientation of the 3D cartesian axes which had been derived in 1986 from the transformed Doppler observations. This agency, however, opted to introduce a new scale that would be consistent with the scale of the then cur-



Modern Terrestrial Reference Systems
PART 3: WGS 84 and ITRS

Dr. Richard A. Snay and Dr. Tomás Soler

The Department of Defense (DoD) developed the WGS 84 reference system to support global activities involving mapping, charting, positioning, and navigation. More specifically, DoD introduced WGS 84 to express satellite orbits; that is, satellite positions as a function of time. Accordingly, WGS 84 is widely used for "absolute" positioning activities whereby people assume that satellite orbits are sufficiently accurate to serve as the sole source of control for positioning points of interest. In particular, absolute positioning does not rely on using positional coordinates for pre-existing terrestrial points for control, except indirectly in that orbits are derived from adopted positions for a small set of tracking stations (Fig. 3). The general user, however, never needs to know the positions of these tracking stations.

DoD provides both "predicted" and "postfit" orbits in the WGS 84 reference system. As implied by the name, predicted orbits are calculated ahead of time by applying physical principles to extrapolate currently observed satellite positions. On the other hand, postfit orbits are calculated from previously observed satellite positions. Postfit orbits are more precise than predicted orbits both because they do not involve predicting the future and because they are usually derived using a larger number of tracking stations. GPS predicted orbits and satellite clock parameters are generated by the Air Force at the GPS Operational Control Segment, located at Schriever AFB, Colorado. The Air Force then uploads these predicted quantities to the GPS satellites so that this information may be included in the radio signal transmitted by these satellites. These predicted orbits support all real-time positioning and navigation activities involving GPS. Postfit GPS orbits and satellite clock parameters are generated by the National Imagery and Mapping Agency (NIMA), who currently makes this information available on its Geodesy and Geophysics World Wide Web pages. A number of other organizations also generate postfit GPS orbits which they usually express in a particular realization of the International Terrestrial Reference System (ITRS).

The original WGS 84 realization essentially agrees with NAD 83 (1986). Subsequent WGS 84 realizations, however, approximate certain ITRS realizations. Because GPS satellites broadcast the predicted WGS 84 orbits, people who use this broadcast information for positioning points automatically obtain coordinates that are consistent with WGS 84. Hence, the popularity of using GPS for real-time positioning has promoted greater use of WGS 84. Despite its popularity, people generally do not use WGS 84 for high-precision positioning activities, because such activities require the use of highly accurate positions on pre-existing terrestrial points for control. For example, various differential GPS techniques use known positions for one or more pre-existing terrestrial points to remove certain systematic errors in computing highly precise positions for new points. Consequently, before WGS 84 can support high-precision positioning activities, a rather extensive network of accurately positioned WGS 84 terrestrial control points would have to be established.

DoD established the original WGS 84 reference frame in 1987 using Doppler observations from the Navy Navigation Satellite System (NNSS) or TRANSIT. The WGS 84 frames have evolved significantly since the mid-1980s. In 1994, DoD introduced a realization of WGS 84 that is based completely on GPS observations, instead of Doppler observations. This new realization is officially known as WGS 84 (G730) where the letter G stands for "GPS" and "730" denotes the GPS week number (starting at 0h UTC, 2 January 1994) when NIMA started expressing their derived GPS orbits in this frame. The latest WGS 84 realization, called WGS 84 (G873), is also based completely on GPS observations. Again, the letter G reflects this fact, and "873" refers to the GPS week number starting at 0h UTC, 29 September 1996. Although NIMA started computing GPS orbits in this frame on this date, the GPS Operational Control Segment did not adopt WGS 84 (G873) until 29 January 1997.

The origin, orientation, and scale of WGS 84 (G873) are determined relative to adopted positional coordinates for 15 GPS tracking stations: five of them are maintained by the Air Force and ten by NIMA (see Fig. 3). NIMA chose their sites to complement the somewhat equatorial distribution of the Air Force sites and to optimize multiple station visibility from each GPS satellite. People may anticipate further improvements of WGS 84 in the future, as new GPS tracking sites may be added or existing antennas may be relocated or replaced. NIMA is dedicated to take appropriate measures to guarantee the highest possible degree of quality and to perpetuate the accuracy of WGS 84. As mentioned earlier, however, most regions lack a network of accessible reference points that might serve as control points from which highly accurate WGS 84 coordinates may be propagated using an appropriate static differential GPS technique involving carrier phase observables. Another minor drawback affecting accurate GPS work is the unavailability to the general GPS user of the crustal velocities at the WGS 84 tracking stations. More information about WGS 84 may be obtained via the Internet by accessing: http://164.214.2.59/GandG/tr8350_2.html

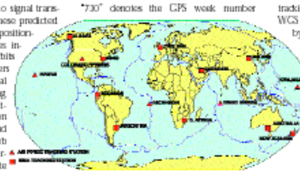


Figure 3. Combined DoD tracking network that defines WGS 84.

The Evolution of ITRS

In the late 1980s, the International Earth Rotation Service (IERS) introduced ITRS to support those scientific activities that require highly accurate positional coordinates; for example, monitoring crustal motion and the motion of Earth's rotational axis. The initial ITRS realization was called the International Ter-

NSRS Coordinate Systems

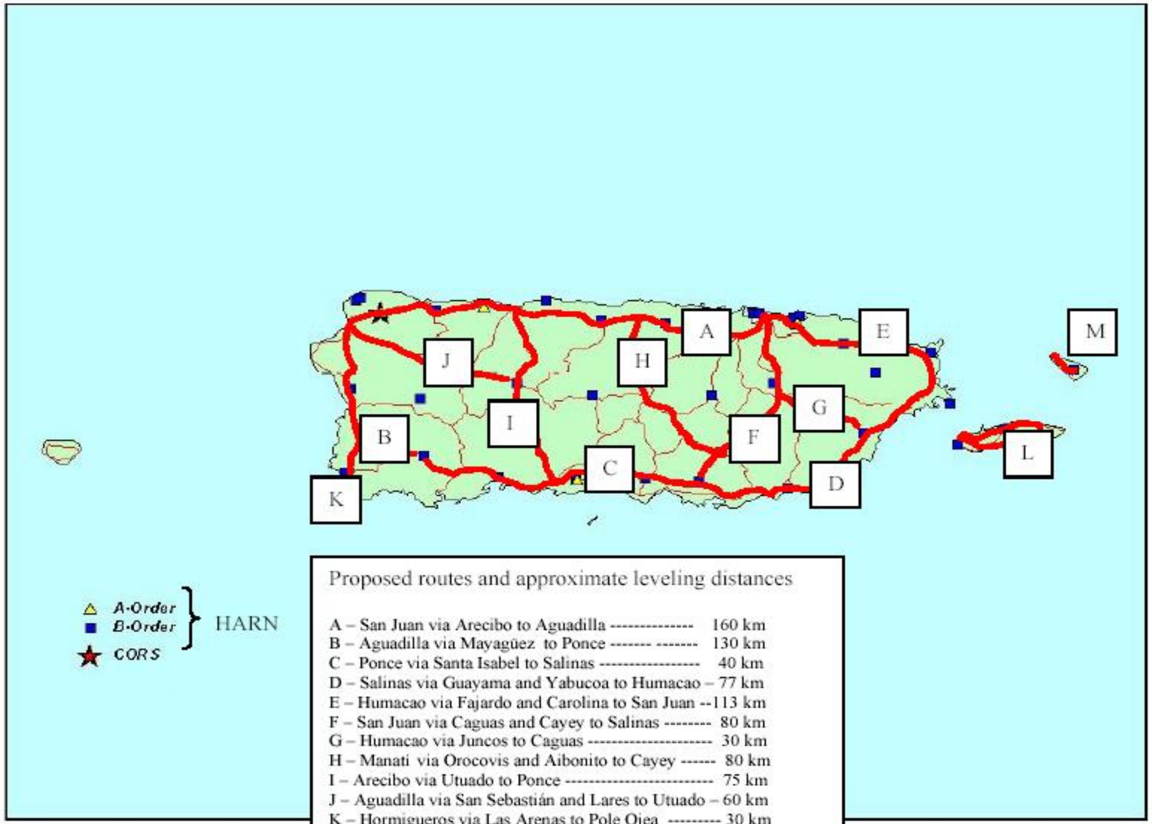
Latitud & Longitud
Coordenadas Planas Estatales
Coordenadas UTM
“Earth-Centered
Earth-Fixed”

NAD 83
NAD 27
NGVD 29
NAVD 88
PRVD 02
ITRF00

Datum Verticales

- Los Datums Verticales son locales
  - Puerto Rico Vertical Datum 2002 (PRVD02)
  - Se usa en PR en el epoch del 1982-2001 de datos del mareógrafo de La Puntilla
  - El cero esta en las Oficinas de la Guardia Costanera en La Puntilla en el Viejo San Juan
  - Se corrió una nivelación en Mayo del 2002 desde La Puntilla hasta Aguadilla bajo el auspicio del National Geodetic Survey (NGS)
  - Este proyecto del PRVD02 lo están realizando dos firmas de agrimensores de Puerto Rico, siguiendo los “standards” del NGS pues es una nivelación de primer orden.

Rutas propuestas en el proyecto de control vertical de Puerto Rico-PRVD02 para un total de 925 kilómetros incluyendo Vieques y Culebra



Proposed routes and approximate leveling distances

A – San Juan via Arecibo to Aguadilla --------------	160 km
B – Aguadilla via Mayagüez to Ponce ------- -------	130 km
C – Ponce via Santa Isabel to Salinas -----------------	40 km
D – Salinas via Guayama and Yabucoa to Humacao –	77 km
E – Humacao via Fajardo and Carolina to San Juan --	113 km
F – San Juan via Caguas and Cayey to Salinas --------	80 km
G – Humacao via Juncos to Caguas --------------------	30 km
H – Manati via Orocovis and Aibonito to Cayey ------	80 km
I – Arecibo via Utuado to Ponce ------------------------	75 km
J – Aguadilla via San Sebastián and Lares to Utuado –	60 km
K – Hormigueros via Las Arenas to Pole Ojea ---------	30 km
L – Isla de Vieques ---------------------------------------	40 km
M – Isla de Culebra --	10 km
TOTAL	925 km

PRVD02 –Importancia

- Como parte de este proyecto se realizaron observaciones gravimétricas en Mayagüez y Aguadilla, y se efectuó un vuelo en enero del 2009 con un gravímetro en el avión como parte del proyecto denominado GRAV-D (Gravity for the Re-definition of the American Vertical Datum).
- Se integrara esta tecnología para tener un solo datum uniendo el Horizontal y el Vertical, obteniendo asi alturas ortometricas derivadas.

Daniel Winester, Geodesta del NGS monumentando estación en CI-019-RUM

MAYAGUEZ A A 2008

MAYAGUEZ A A 2008

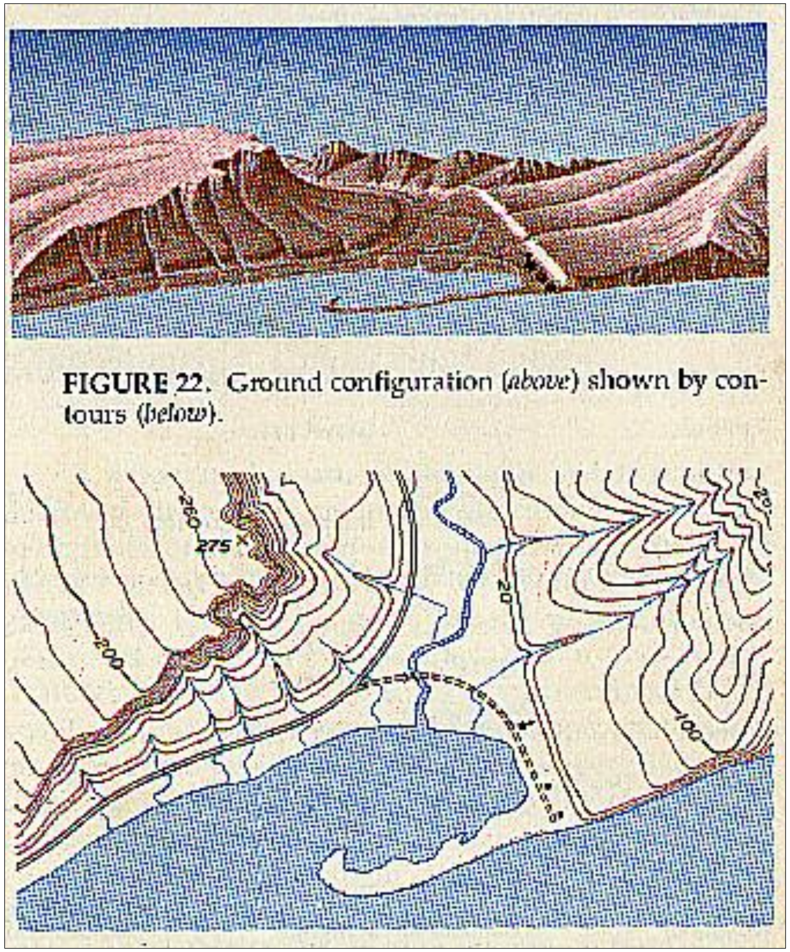
Observaciones Gravimetricas por 48 horas

PRVD02 –Importancia

- El gobierno del Estado Libre Asociado de Puerto Rico aporto $3,000,000 por conducto de tres de sus agencias ellas son la Oficina de Presupuesto y Gerencia; el Departamento de Transportación y Obras Públicas y la Autoridad de Energía Eléctrica.

- El Colegio de Ingenieros y Agrimensores de Puerto Rico ha tenido un rol muy importante en este proyecto, pues se esta muy conciente de la importancia del mismo y lo que significa para el desarrollo de la infraestructura del país, junto con los cambios que ocasionara en el desempeño de la profesión de la agrimensura en lo referente a obtener elevaciones.

Controles Verticales del USGS



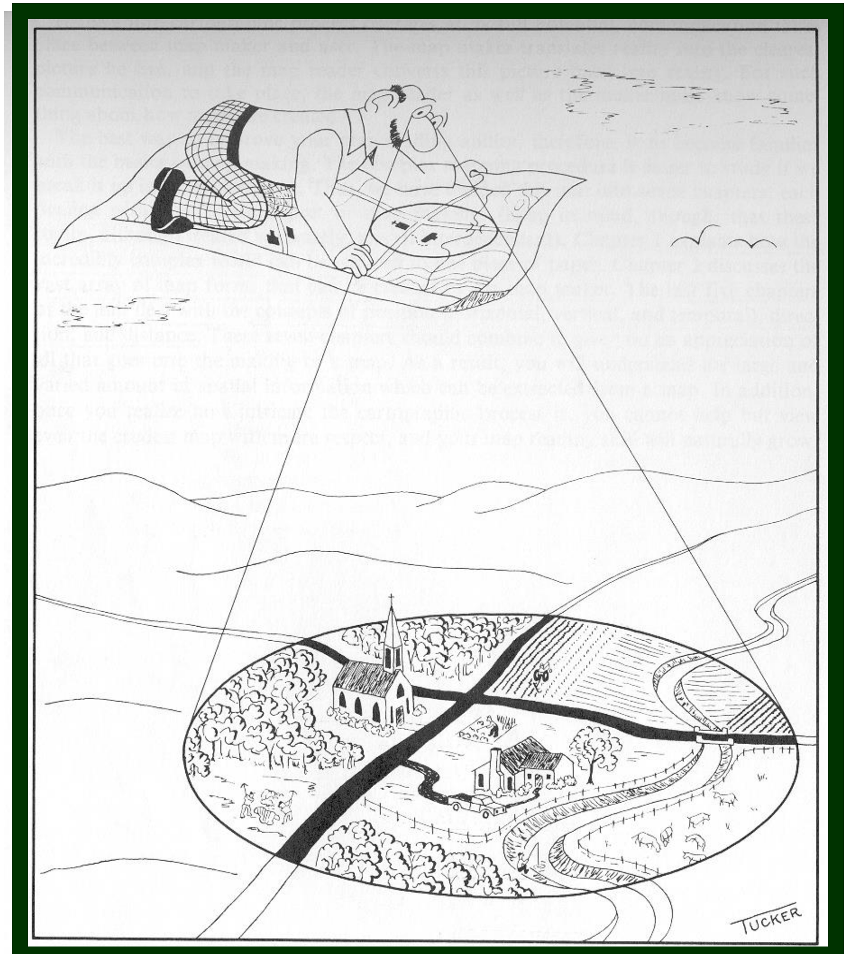
Vélez 2002


ATION OR TO REPORT DAMAGE WRITE
VERTICAL CONTROL MARK
VÉLEZ
2002
THE DIRECTOR
NATIONAL GEODETIC SURVEY
WASHINGTON, D.C.


Monumentación en roca firme de
Control Vertical Orden A - VELEZ 2002

AGRIMENSURA: localización = coordenadas

- Se define como el arte, ciencia y tecnologia de determinar la posicion de un punto en, sobre o bajo la superficie de la tierra, o establecer la posicion de dichos puntos. Envuelve todo lo que tenga que ver con nuestro ambiente pues TODO tiene una definicion en el espacio que habitamos, y de eso es de lo que se trata el NEGOCIO de la AGRIMENSURA, de la localizacion. La superficie se considera plana, asi que se geometria plana. Al **agrimensor** se le conoce como **geometra**.

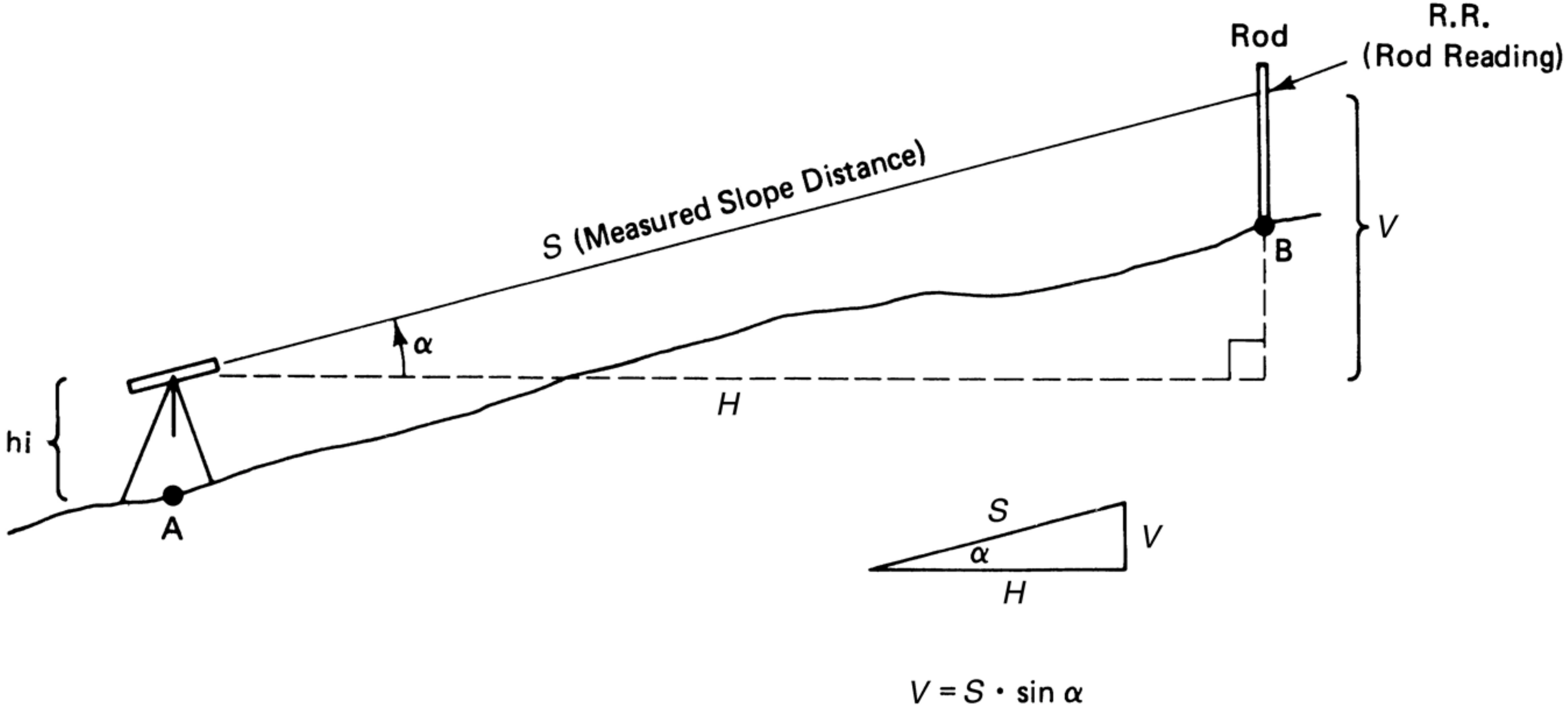


Medidas Básicas en Agrimensura

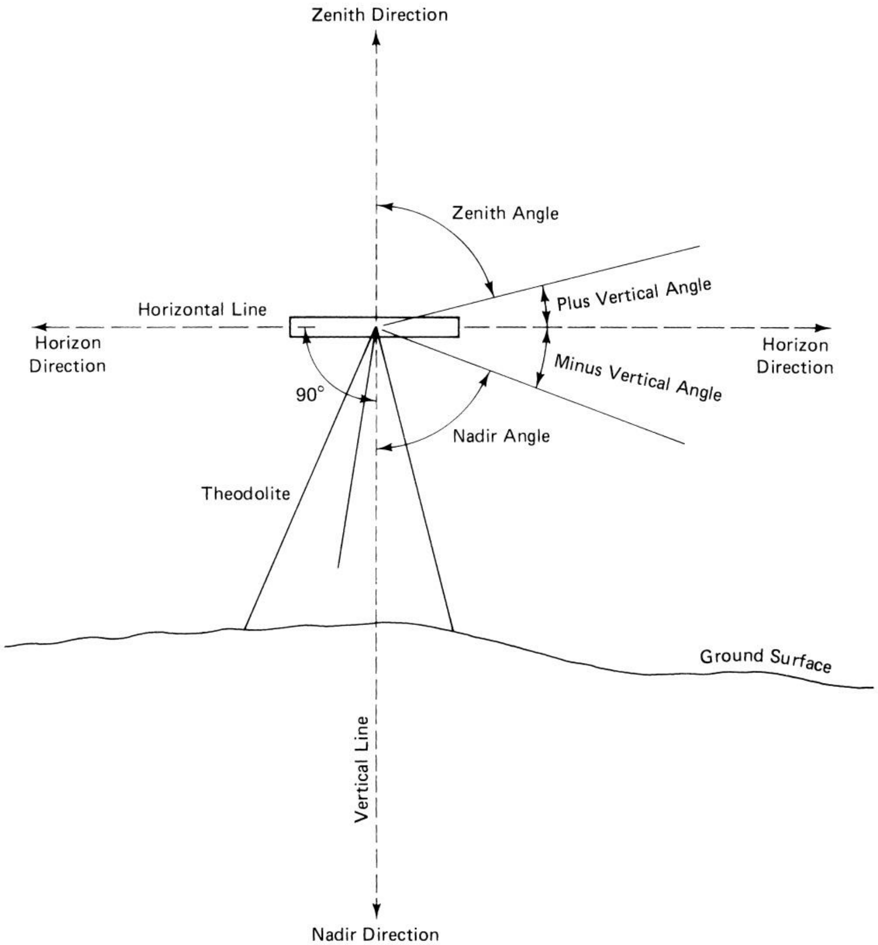
- Distancias Horizontales
- Distancias Verticales
- Distancias en Pendiente
- Angulos Horizontales
- Angulos Verticales

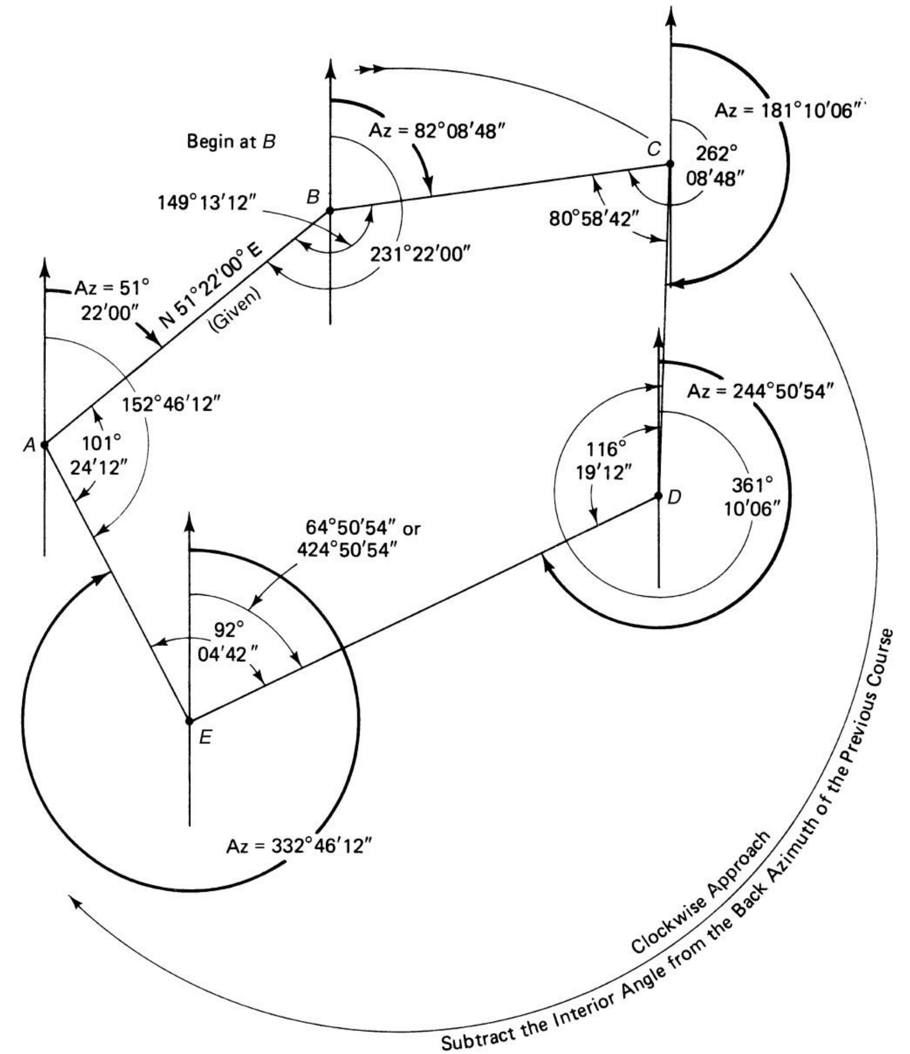
Total Station, Prisma y Baston con Bipode

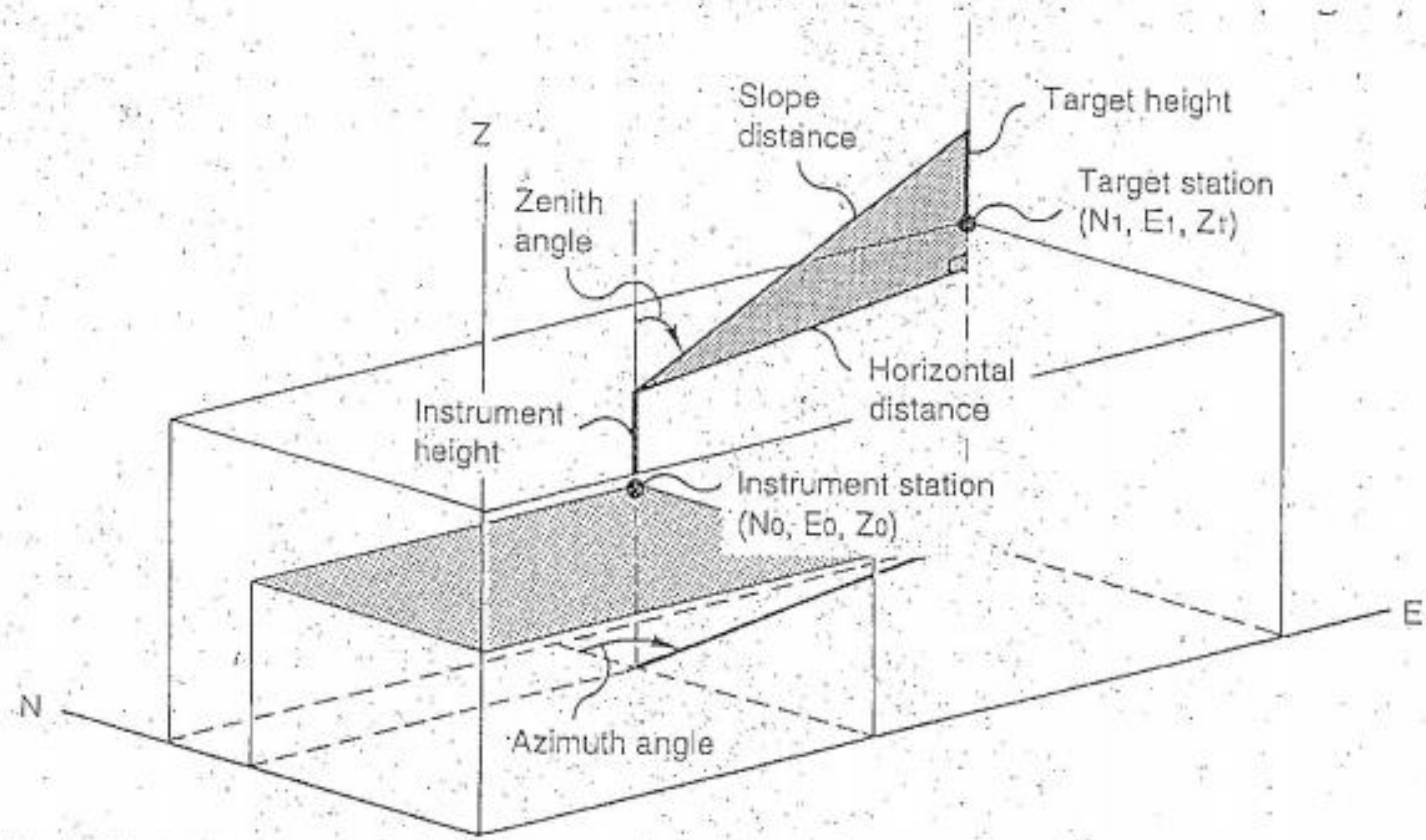
Distancias


R.R.
(Rod Reading)
Rod
S (Measured Slope Distance)
α
V
B
hi
H
A
S
V
α
H
V = S • sin α

Ángulos


Zenith Direction
Zenith Angle
Plus Vertical Angle
Horizontal Line
Horizon Direction
Horizon Direction
Minus Vertical Angle
90°
Nadir Angle
Theodolite
Ground Surface
Vertical Line
Nadir Direction


Az = 181°10′06″
Az = 82°08′48″
Begin at B
C
262° 08′48″
149°13′12″
B
80°58′42″
231°22′00″
Az = 51° 22′00″
N 51°22′00″ E
(Given)
Az = 244°50′54″
152°46′12″
A
101° 24′12″
116° 19′12″
361° 10′06″
D
64°50′54″ or 424°50′54″
92° 04′42″
E
Az = 332°46′12″
Clockwise Approach
Subtract the Interior Angle from the Back Azimuth of the Previous Course



$N_1 = N_0 + S \times \sin\theta z \times \cos\theta h$

$E_1 = E_0 + S \times \sin\theta z \times \sin\theta h$

$Z_1 = Z_0 + Mh + S \times \cos\theta z - Ph$

(N_0, E_0, Z_0): Instrument station coordinates

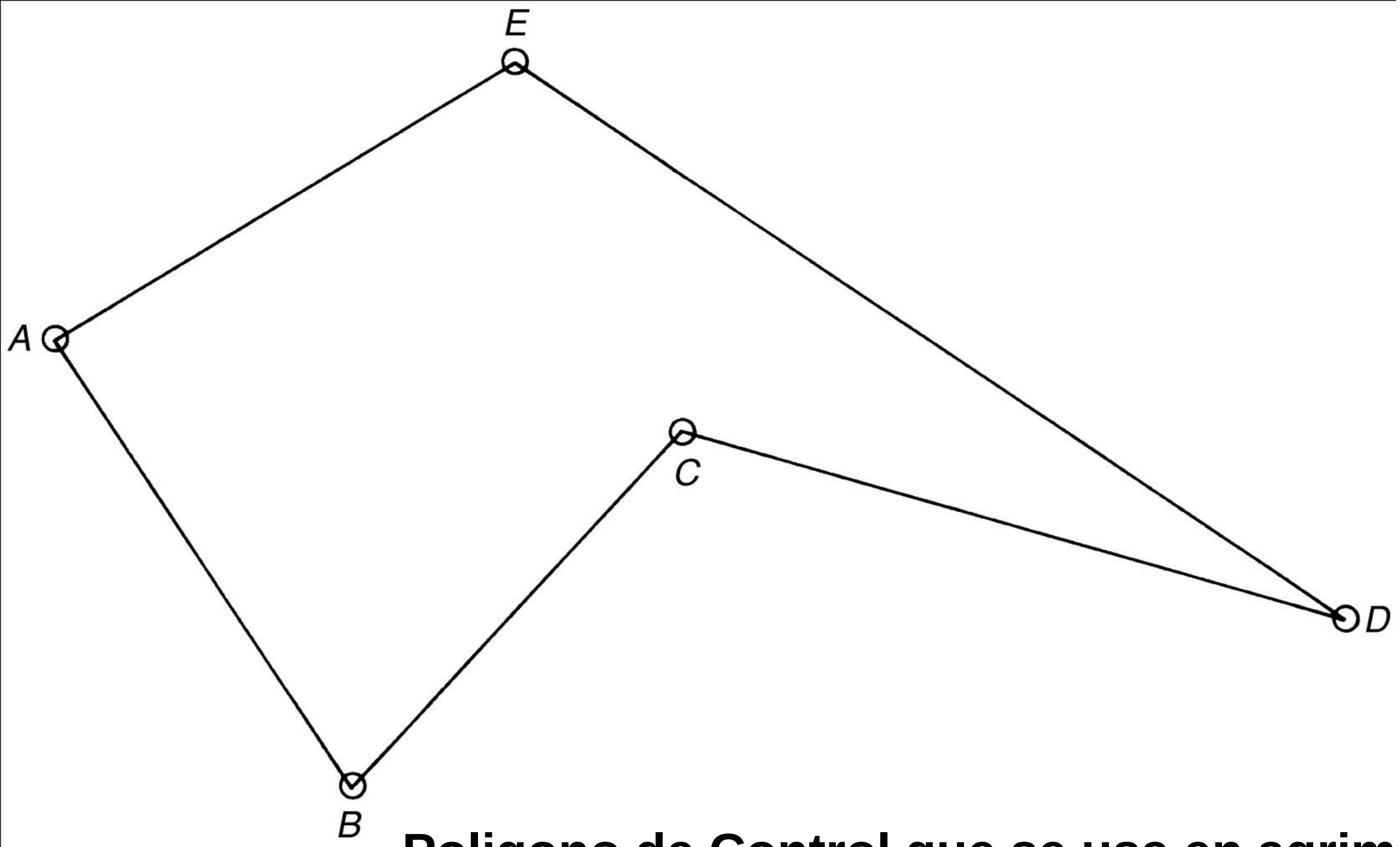
S: Slope distance

θz: Zenith angle

θh: Azimuth angle

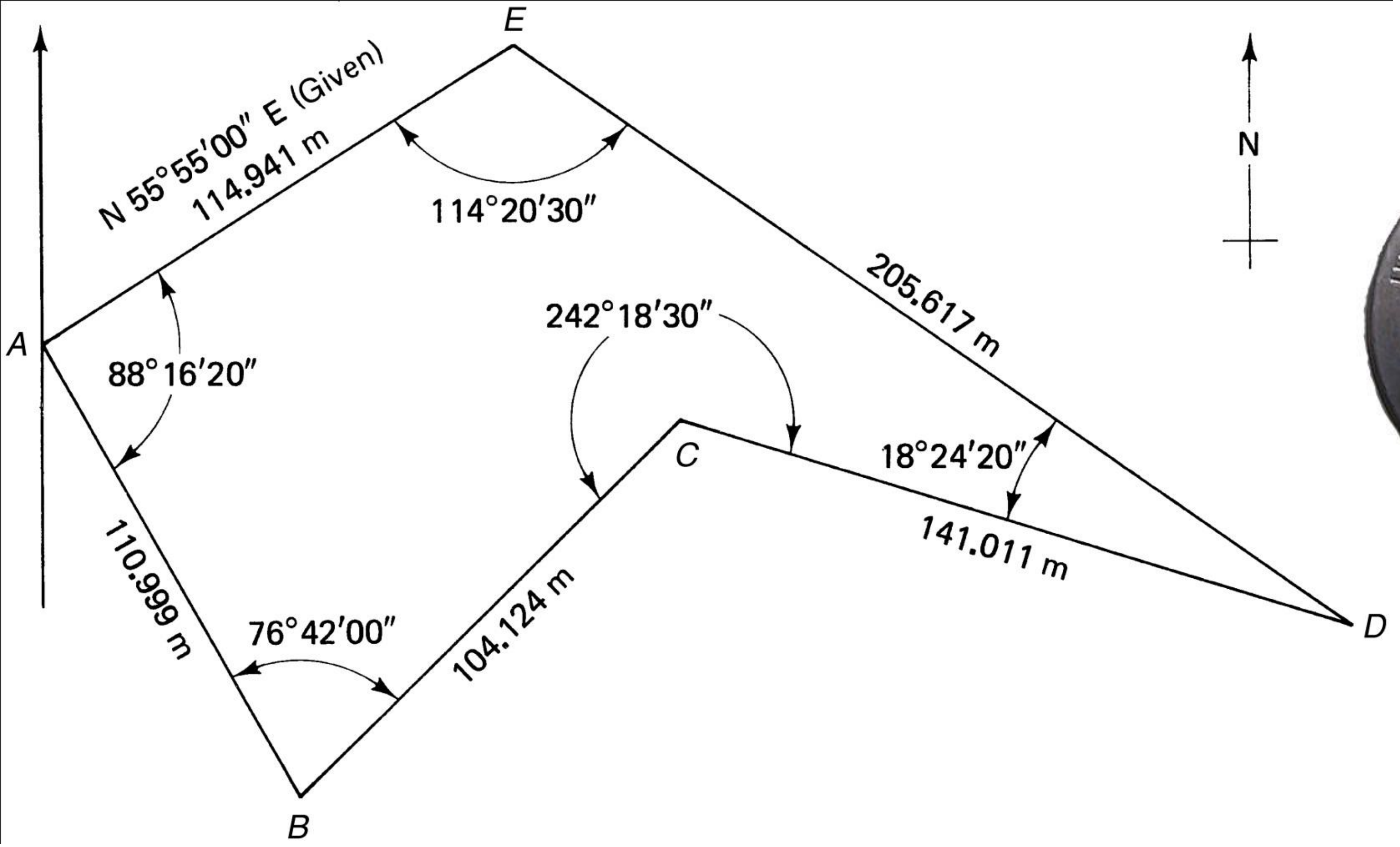
Mh: Instrument height

Ph: Target height



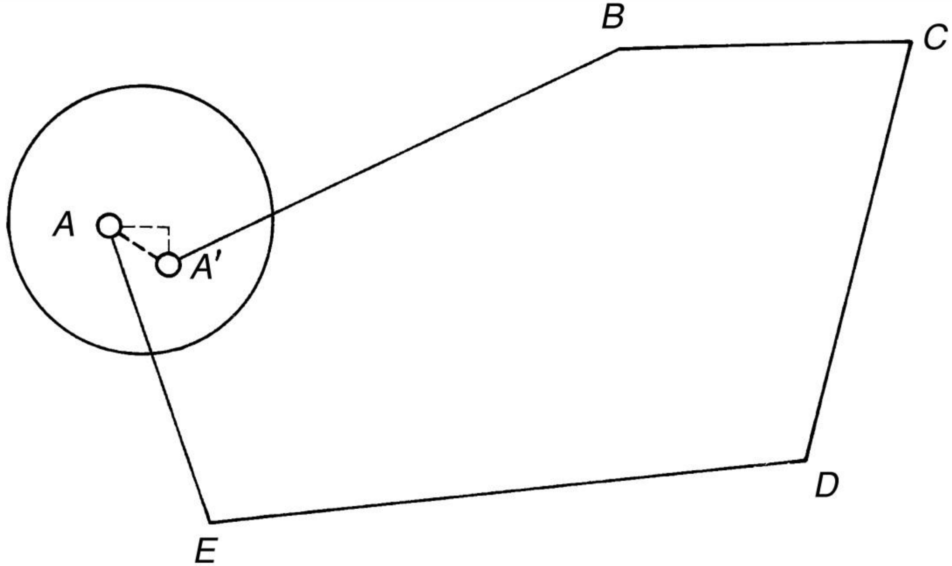
Poligono de Control que se usa en agrimensura; existen poligonos cerrados, o poligonos abiertos, o lineas bases o un punto. Los mas optimos son los poligonos cerrados por la redundancia que ofrecen.

Se denominan de control pues es un control o referencia para obtener los datos necesarios para hacer el levantamiento de los datos necesarios para hacer nuestro diseño



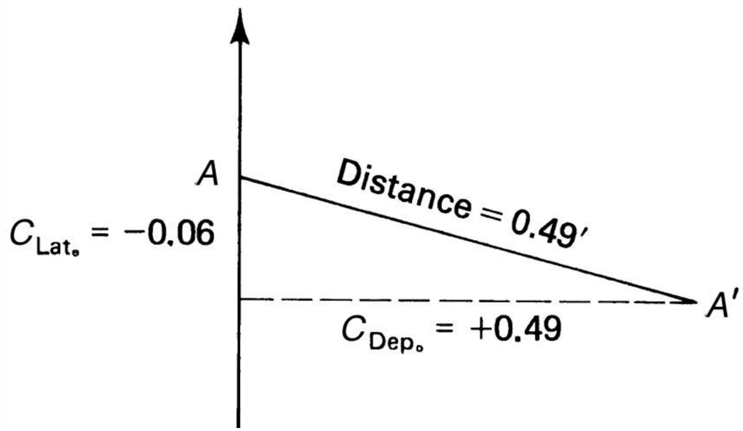
En los vertices del Poligono de Control debe existir una marca Permanente que se denomina PUNTO DE CONTROL, muchos Agrimensores usan varillas de acero.

Se procede a medir los angulos interiores del poligono cerrado y Las distancias entre dichos vertices, y con estos datos se procede a ajustar esos datos (angulos interiores y distancias)



Closure Error = $A'A$

Closure Correction = AA'



$$A'A = \sqrt{C_{Lat_o}{}^2 + C_{Dep_o}{}^2} = 0.494'$$

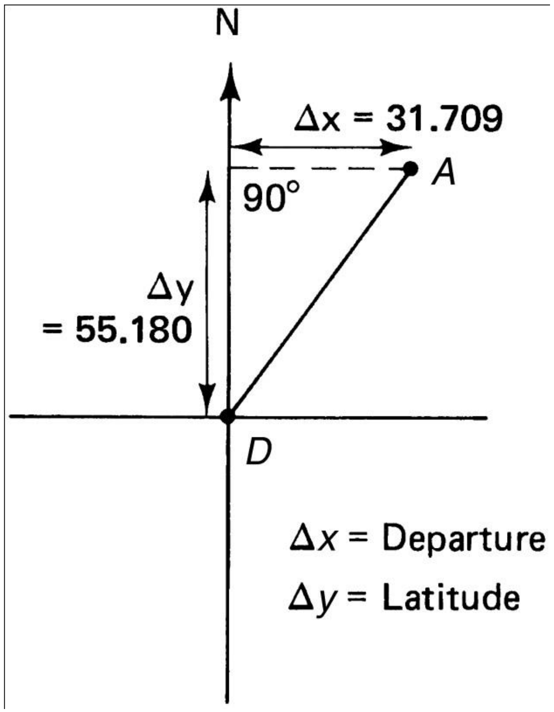
Bearing of $A'A$ can be Computed from the Relationship:

$$\tan \text{Bearing} = \frac{C_{Dep.}}{C_{Lat.}} = \frac{0.49}{-0.06}$$

Bearing Angle = 83.0189° = 83°01′

Bearing $A\,A'$ = S 83°01′E

Datos sin ajustar nos dan una diferencia en la ubicación de A A'



Las coordenadas se calculan usando los "Balanced Latitude" y "Balance Departure". Estos son los componentes en Y y X ajustados por eso “Balanced”

La coordenada X de un punto es igual a la coordenada X del punto anterior más el "Balanced Departure" entre esos puntos.

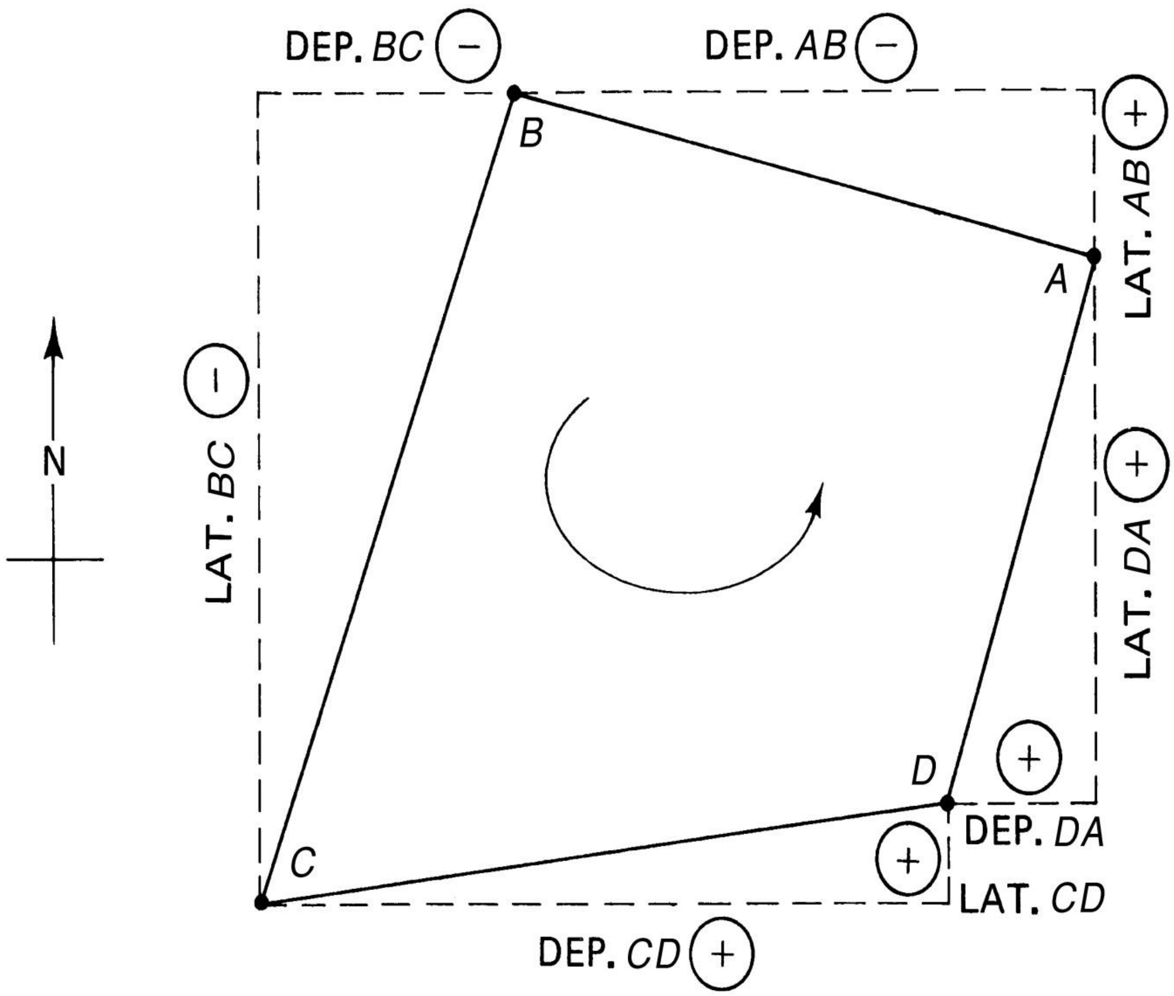
La coordenada Y de un punto es igual a la coordenada Y del punto anterior más el "Balanced Latitude" entre esos puntos.

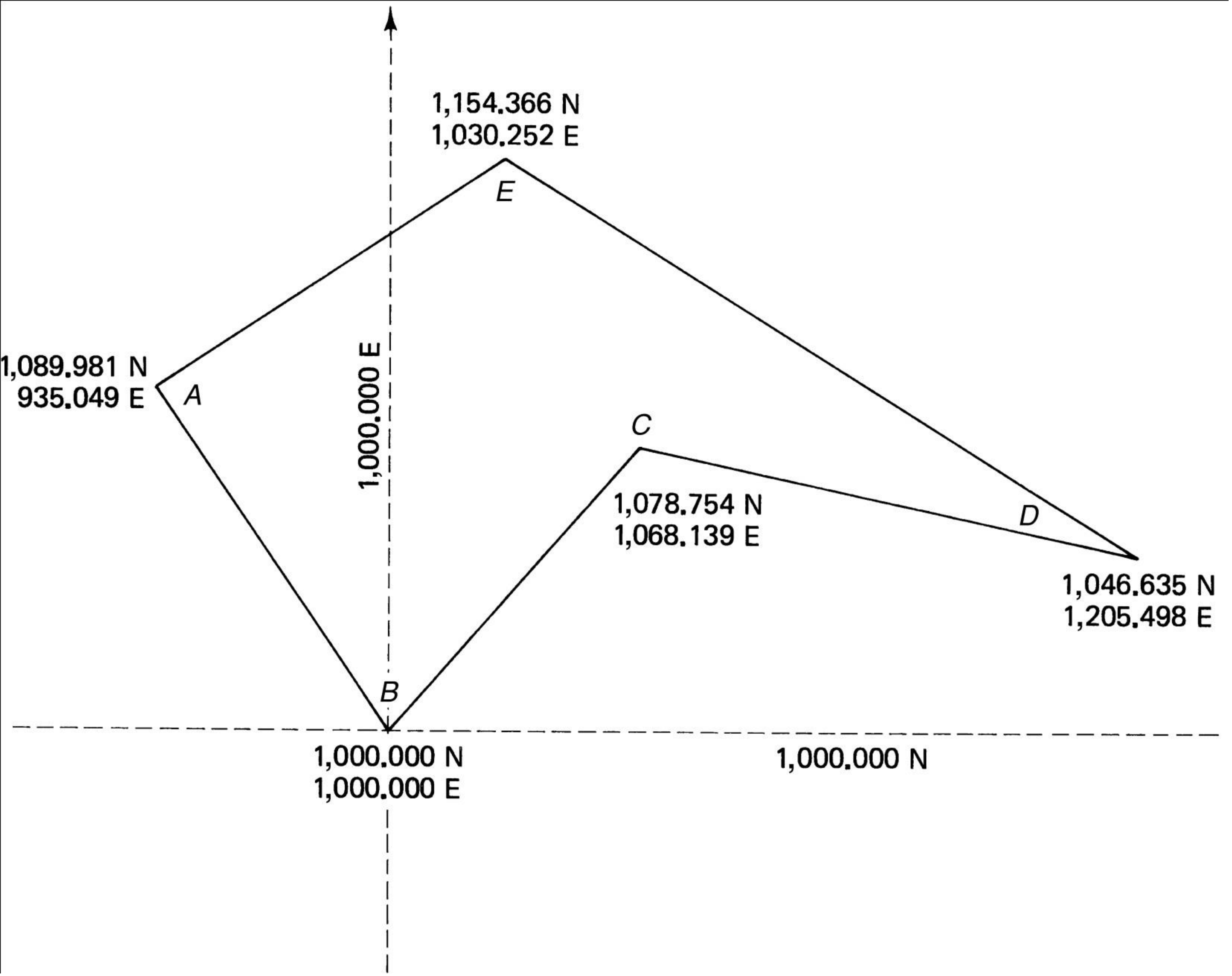
Esto es:

$$\mathbf{X_n = X_{n-1} + \text{"Balanced Departure”}_{(n\ @\ n-1)}}$$

$$\mathbf{Y_n = Y_{n-1} + \text{"Balanced Latitude”}_{(n\ @\ n-1)}}$$

Si usamos la analogia del vector y sus componentes en X & Y; el vector es uno del lados de la poligonal y su componente en X es del Departure y el componente en el eje de Y es el Latitude, refierase al poligono ABCD ilustrado a continuacion:





El Ajuste de los datos se puede hacer con uno de varios metodos disponibles, que cada uno de ellos pondera una u otras de los observaciones que se hagan.

Cartografía

- Definición:
  - Ciencia, Arte y Tecnología de hacer mapas junto con su estudio como documento científico y trabajo de arte. Los mapas son una representación de la tierra o parte de ella a **escala.**
  - La escala es la relación entre el tamaño real del área y la porción reducida que aparece en el mapa. Son productos cartográficos, los planos, secciones transversales, modelos en tercera dimensión, entre otros.

Escala

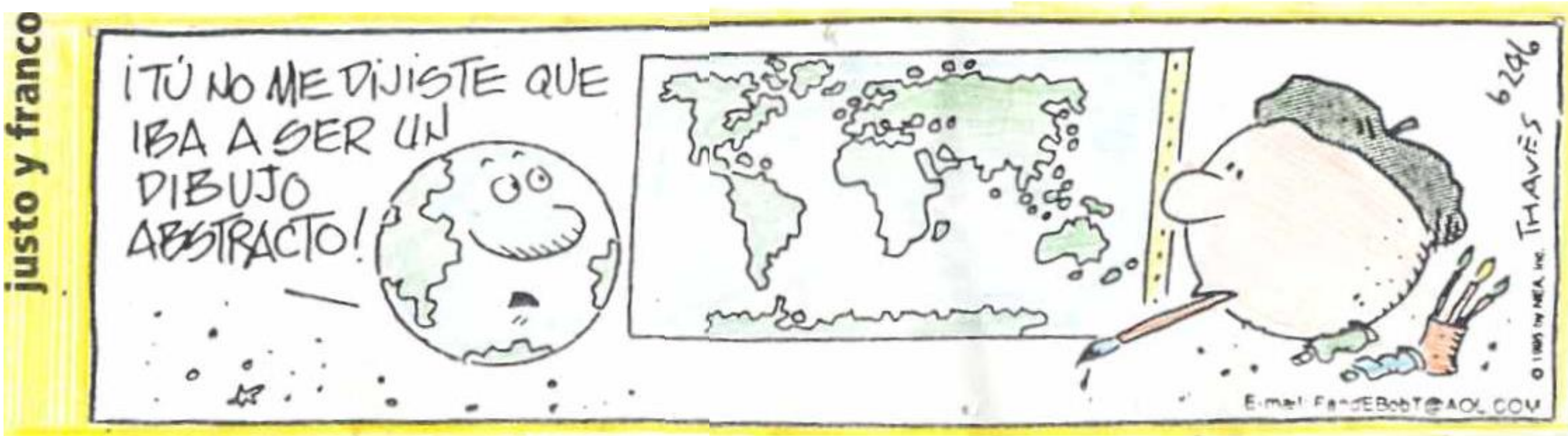
Escala como fracción representativa:

Una razón, tal como 1:1,000,000. Si se asume que el mapa esta en centímetros, significa que un centímetro en el mapa es igual a un millón de centímetros en la Tierra.

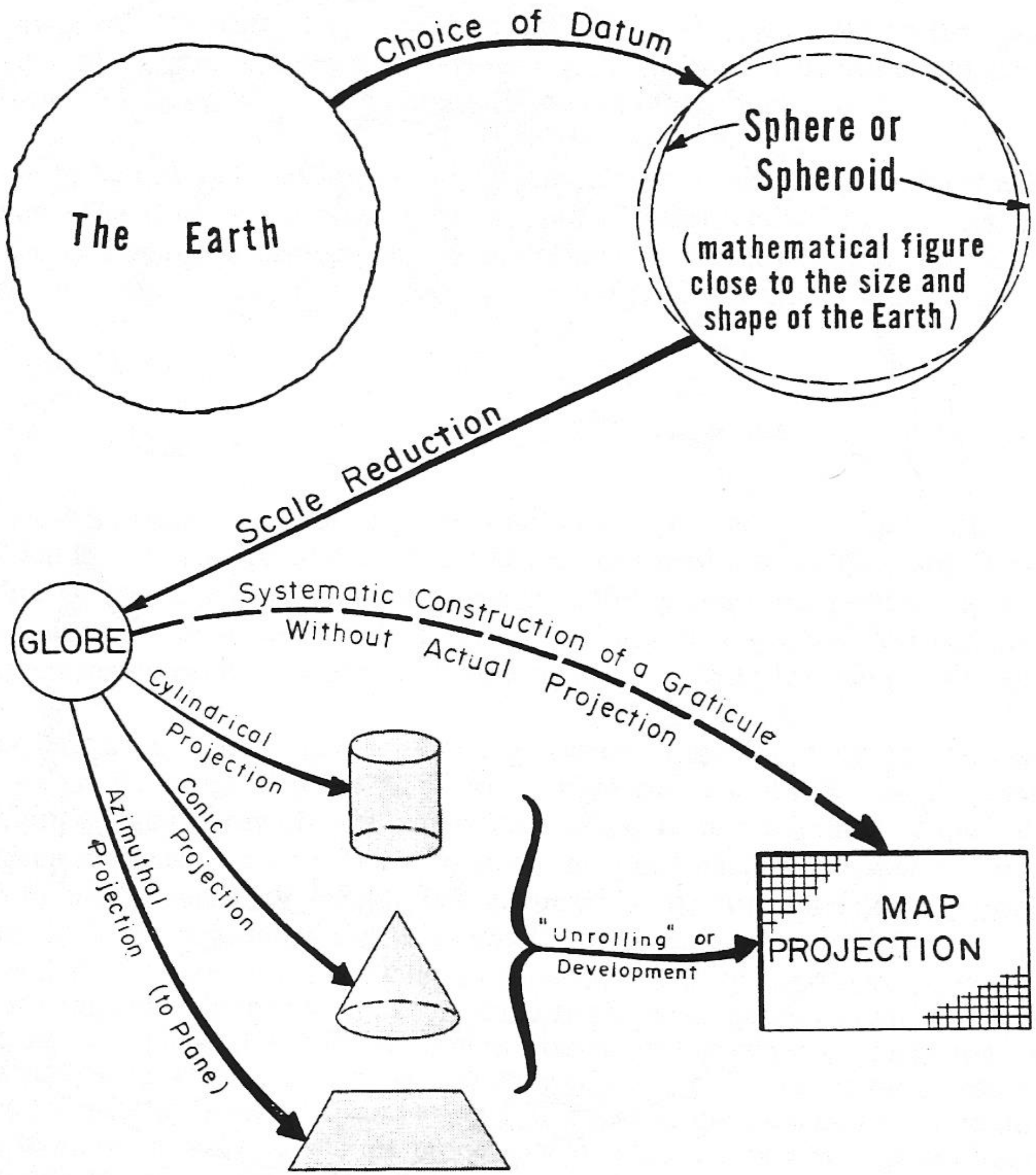
Esta escala se podría también escribir como fracción proporcional (1/1,000,000).


Erie St
River North
Ontario St
Grand Ave
Illinois St
Near North
Dearborn St
State St
Wabash Ave
Rush St
Erie St
St. Clair St
Fairbanks Ct
Ohio St
McClurg Ct
Illinois St
Hubbard St
Kinzie St
Water St
N. Water St
Wells St
North Branch Chicago R.
N. Milwaukee Ave
Chicago R.
Wacker Dr
Centennial Fountain & Arc
S. Water St
Lake St
Field Blvd
Olive Park
Navy Pier Park
Navy Pier
River Esplanade Park
41
Chicago
Randolph St
Clinton St
Canal St
La Salle St
Franklin St
Washington Blvd
Garland Ct
Madison St
Wacker Dr
The Loop
Monroe St
Adams St
Clark St
Dearborn St
State St
Wabash Ave
Michigan Ave
Monroe Dr
Grant Park
Lake Michigan
Chicago Harbor
Sears Tower
Jackson Blvd
De Paul Univ.
Jackson Dr
Van Buren St
Lincoln Statue
EISENHOWER EXPY
290
Congress Pkwy
Buckingham Fountain
Harrison St
Balbo Dr
Polk St
Wells St
La Salle St
South
8th St
9th St
South Branch Chicago R.
Columbus Dr
Lake Shore Dr
Taylor St
Roosevelt Rd
Adler Planetarium & Astronomy Mus.
Solidarity Dr
Northerly Island
Clinton
Canal
Clark St
Plymouth Ct
13th St
McFetridge Dr
Northerly Island Park
14th St
N
0
0.5 mi
©2000 Maps.com


Waukegan
94
North Chicago
Mundelein
Lake Michigan
Buffalo Grove
Highland Park
94
Wheeling
Northbrook
294
Mount Prospect
Glenview
Wilmette
90
Skokie
Elgin
Des Plaines
Evanston
Schaumburg
Niles
Bartlett
Itasca
Hanover Park
90
290
Glendale Heights
355
294
94
Elmhurst
90
St. Charles
Oak Park
Maywood
Chicago
290
Berwyn
Wheaton
Glen Ellyn
55
88
Downers Grove
La Grange
Aurora
Naperville
355
90
Oak Lawn
Bolingbrook
294
57
94
N
Orland Park
55
Tinley Park
294
90
80
80
94
Chicago Heights
ILLINOIS
INDIANA
57
©2000 Maps.com



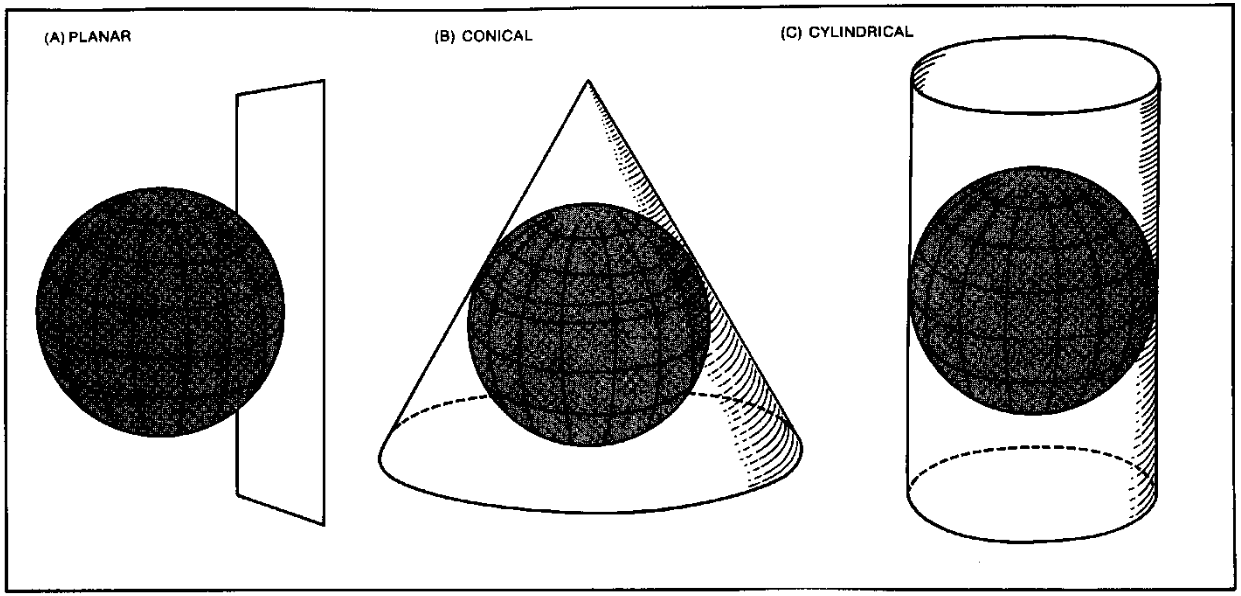
LAS PROYECCIONES CARTOGRAFICAS SON UNA ABSTRACCION MATEMATICA DE LA REALIDAD



Choice of Datum
The Earth
Sphere or
Spheroid
(mathematical figure
close to the size and
shape of the Earth)
Scale Reduction
GLOBE
Systematic Construction of a Graticule
Without Actual Projection
Cylindrical
Projection
Conic
Projection
Azimuthal
Projection
(to Plane)
"Unrolling" or
Development
MAP
PROJECTION

Superficies Desarrollables

- son superficies que se desarrollan en un plano, fundamentales para las Proyecciones Cartograficas. Ellas son:
  - el cono
  - el cilindro y
  - el plano



Clasificación de Proyecciones Cartográficas

CLASES	**V A R I E D A D E S**		
	CONSIDERACIONES	*EXTRINSECAS*	
NATURALEZA	PLANA / AZIMUTAL	CONICA	CILINDRICA
COINCIDENCIA	TANGENTE	SECANTE	POLISUPERFICIAL
POSICION	NORMAL	TRANSVERSAL	OBLICUA
	CONSIDERACIONES	*INTRINSECAS*	
PROPIEDAD	EQUIDISTANTE	EQUIVALENTE	CONFORME
GENERACION	GEOMETRICA	SEMI-GEOMETRICA	MATEMATICA

Sistema de Coordenadas Planas Estatales

- El gobierno federal desarrollo el Sistema de Coordenadas Planas Estatales (SPCS)para cada estado y sus territorios.
- En el caso en particular de Puerto Rico e Islas Virgenes se usa la proyección conforme cónica Lambert con dos paralelos standard, teniendo los siguientes parametros para el NAD 83:

$\varphi_N = 18°\text{-}26'$ N; $\varphi_S = 18°\text{-}02'$ N; $\varphi_0 = 17°\text{-}50'$ N;

$\lambda_0 = 66°\text{-}\ 26'$ W; $N_b = 200{,}000.\text{m}$; $E_0 = 200{,}000.\text{m}$

Sistema de Coordenadas Planas Estatales

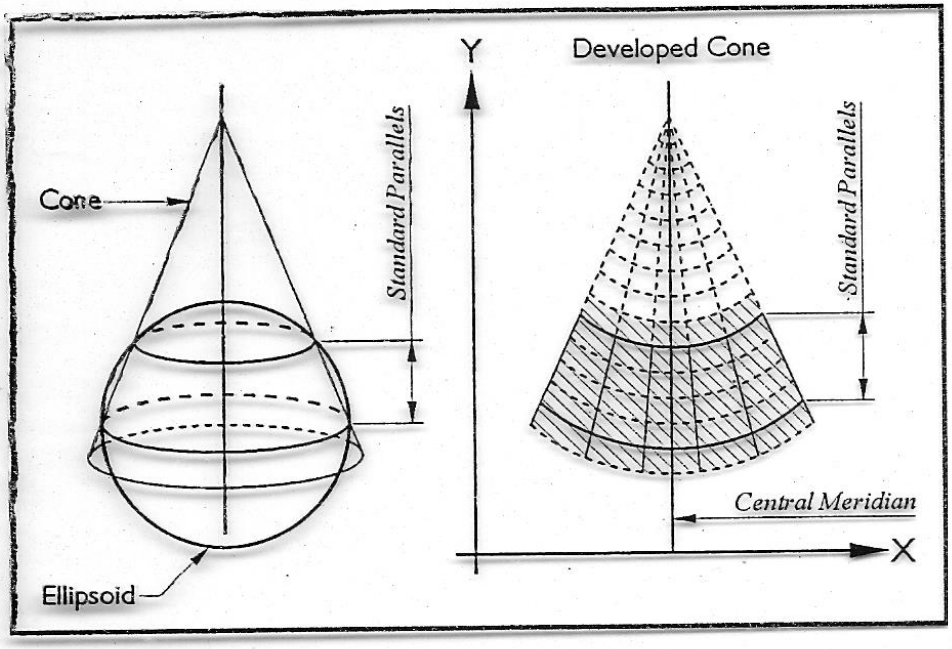


Figure 5.7. Lambert Conic Projection.

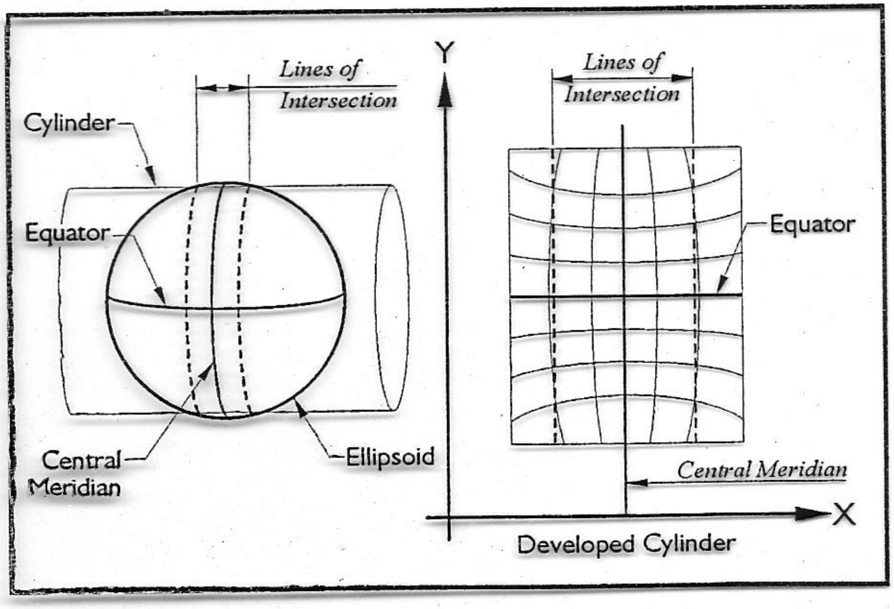


Figure 5.8. Transverse Mercator Projection.

Limites de las zonas son 158 millas

Sistema de Coordenadas Planas Estatales

Lambert system		Transverse mercator system		Both
Arkansas	North Dakota	Alabama	Mississippi	Alaska
California	Ohio	Arizona	Missouri	Florida
Colorado	Oklahoma	Delaware	Nevada	New York
Connecticut	Oregon	Georgia	New Hampshire	
Iowa	Pennsylvania	Hawaii	New Jersey	
Kansas	South Carolina	Idaho	New Mexico	
Kentucky	South Dakota	Illinois	Rhode Island	
Louisiana	Tennessee	Indiana	Vermont	
Maryland	Texas	Maine	Wyoming	
Massachusetts	Utah			
Michigan	Virginia			
Minnesota	Washington			
Montana	West Virginia			
Nebraska	Wisconsin			
North Carolina				

Sistema de Coordenadas Planas Estatales

$X = f(\varphi, \lambda)$ $Y = f(\varphi, \lambda)$

DESIGNATION - VÉLEZ
PID - DE5545
COUNTRY - PUERTO RICO

NAD 83(2002)- 18 26 41.28060(N) 067 08 48.93357(W) ADJUSTED

	North	East	Units	Scale	Converg.
SPC PRVI -	267,825.241	124,618.857	MT	1.00000071	-0 13 23.8
UTM 19 -	2,040,399.173	695,701.034	MT	1.00007349	+0 35 11.3

Universal Transversa Mercator

- Para el sistema Universal Transversa Mercator, mejor conocido por sus siglas en ingles UTM, el globo esta dividido en 60 zonas.
  - Se asume que el esferoide del DATUM es una esfera
- Cada zona se extiende seis grados de longitud, con un solape de 30 minutos con las zonas adyacentes.
- Cada zona tiene su propio meridiano central del cual se extiende 3 grados al este y 3 grados al oeste

Universal Transversa Mercator

- Las coordenadas de este sistemas están en metros.
- El origen de cada zona es en el ecuador y en su meridiano central.
- El valor dado al meridiano central es un "falso este" igual a 500,000 metros.

Universal Transversa Mercator

- La cuadrícula del sistema UTM se extiende alrededor del globo desde la latitud 80° N a la 80° S.
- Cada zona en el Ecuador tiene dos falsos nortes 0 metros para la mitad norte y 10,000,000 metros en la mitad sur.
  - Lo cual significa que cada localización en el Ecuador tiene dos conjuntos de coordenadas UTM

U

T

M

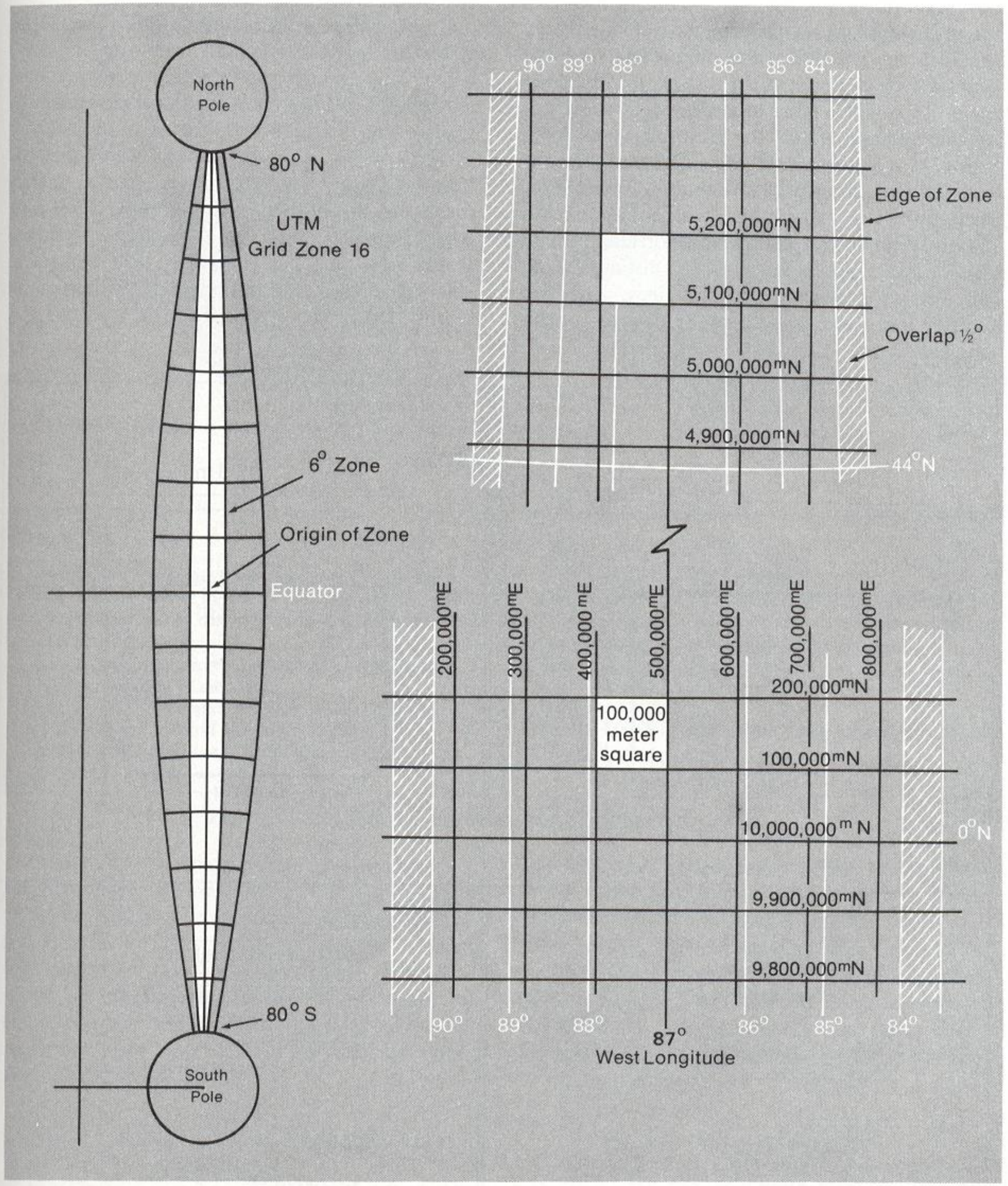
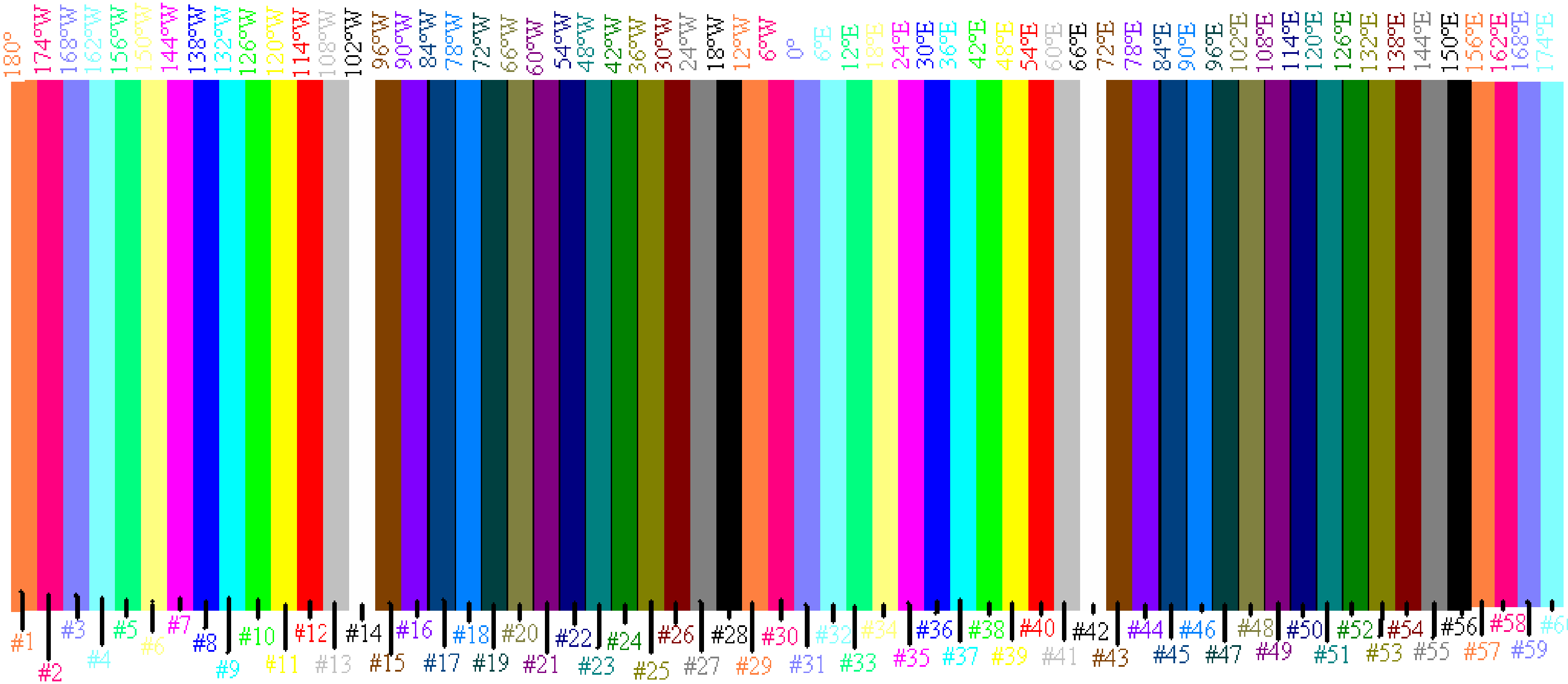


Figure 3.8 Universal Transverse Mercator coordinates in selected portions of zone 16.

60 Zonas del Sistema UTM

Estas zonas dependen de la Longitud



 # de Zona = $(180° - \lambda_W)/6$

para Longitudes al Oeste (λ_W) del Meridiano de Greenwich

 # de Zona = $(180° + \lambda_E)/6$

para Longitudes al Este (λ_E) del Meridiano de Greenwich

Si el resultado de la ecuación no es un entero se designa el entero proximo como el número de zona

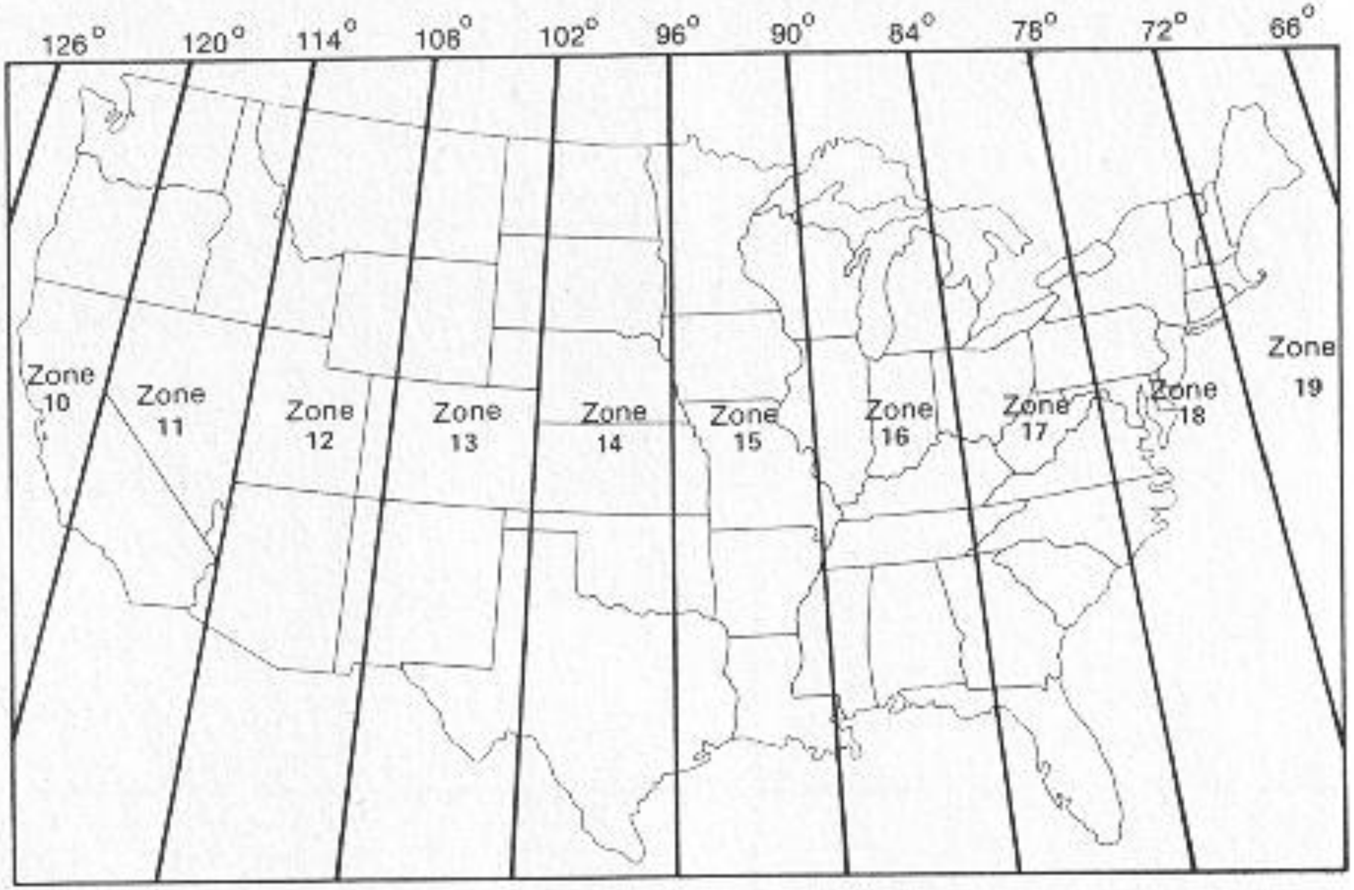


Figure 3.7 Zones of the Universal Transverse Mercator Grid in the United States.

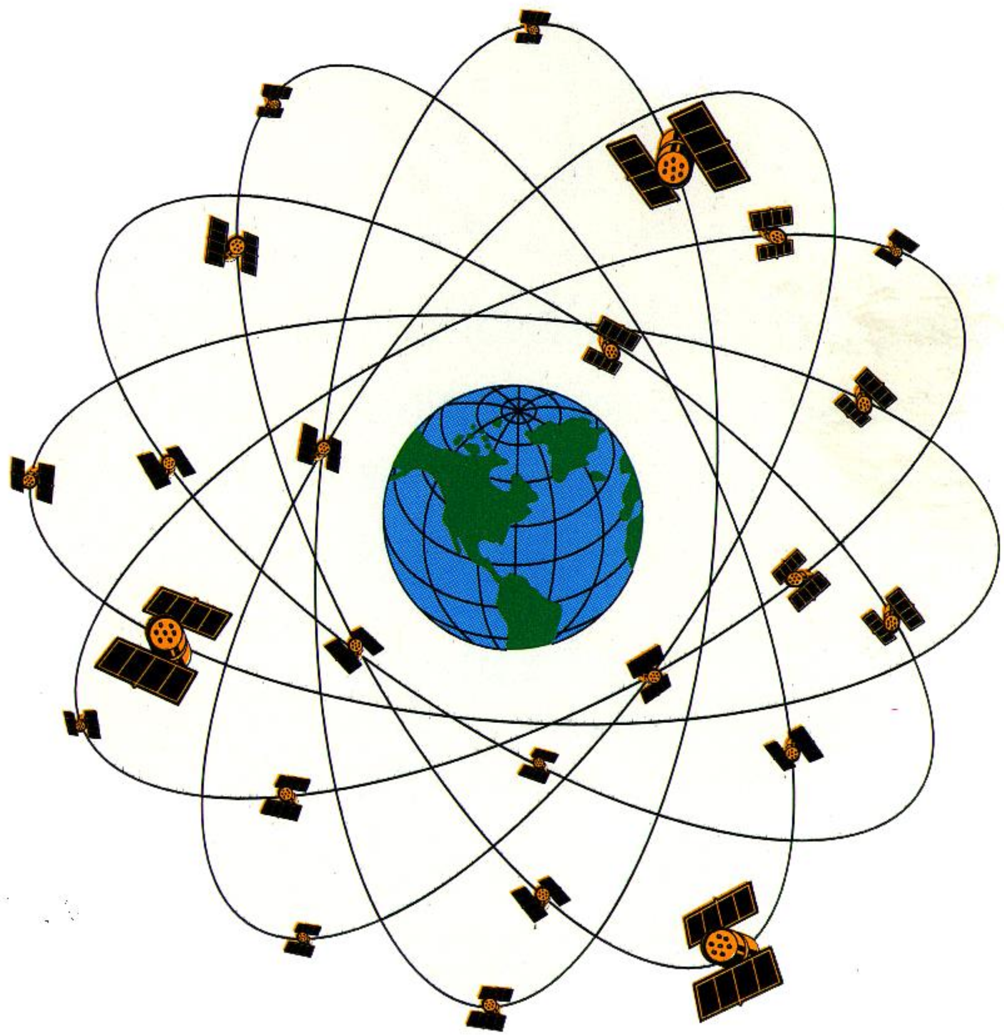
Puerto Rico esta en las zonas 19 y 20 del sistema UTM

Posiciones

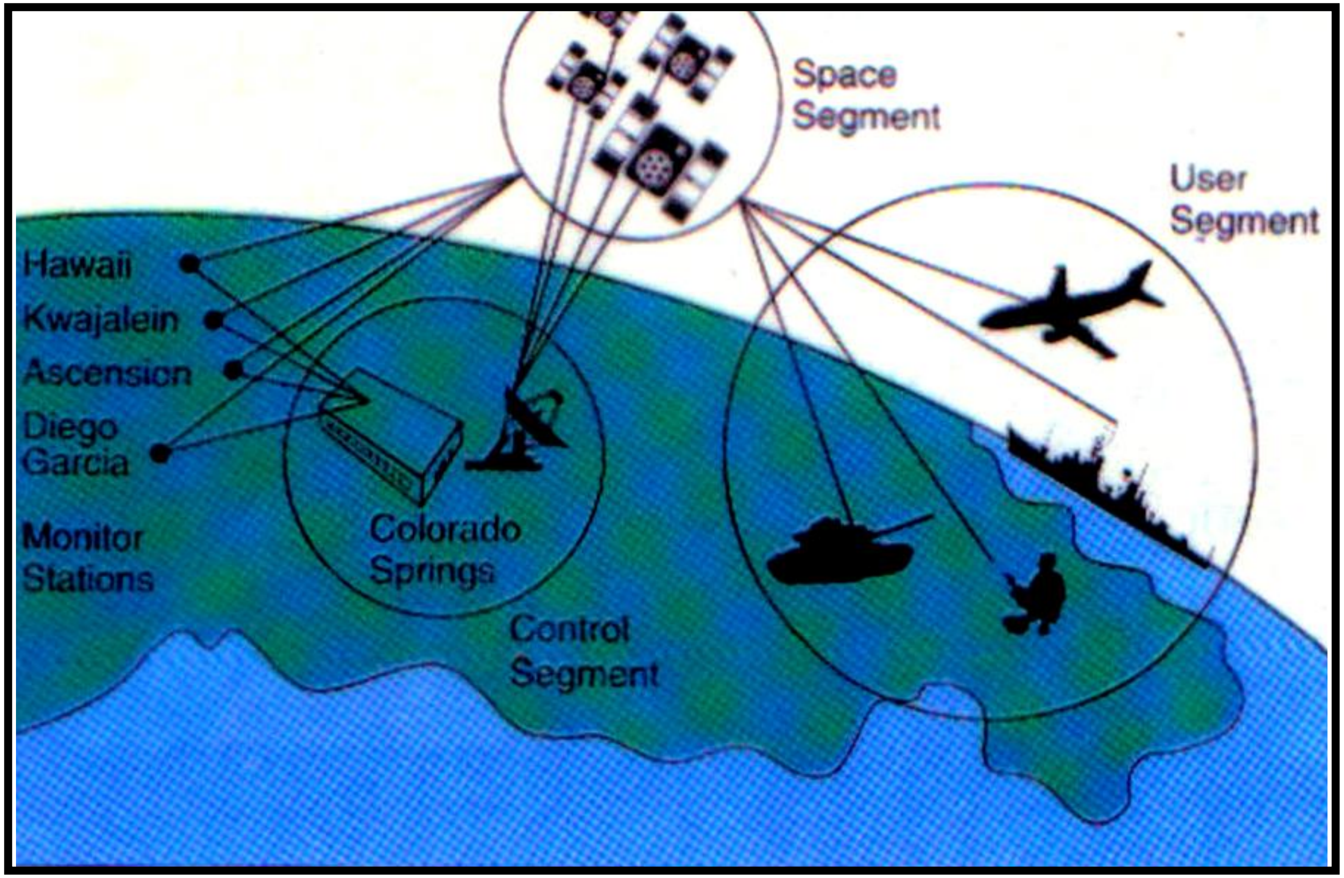
- Horizontal φ, λ o X,Y
- Vertical $\varphi, \lambda, \underline{h}$ o $X,Y,\underline{Z}$
- Temporal Δt

Master a Coordinates Systems Show at the NGS Datasheet

Los GPS (Sistemas de Posicionamiento Global)

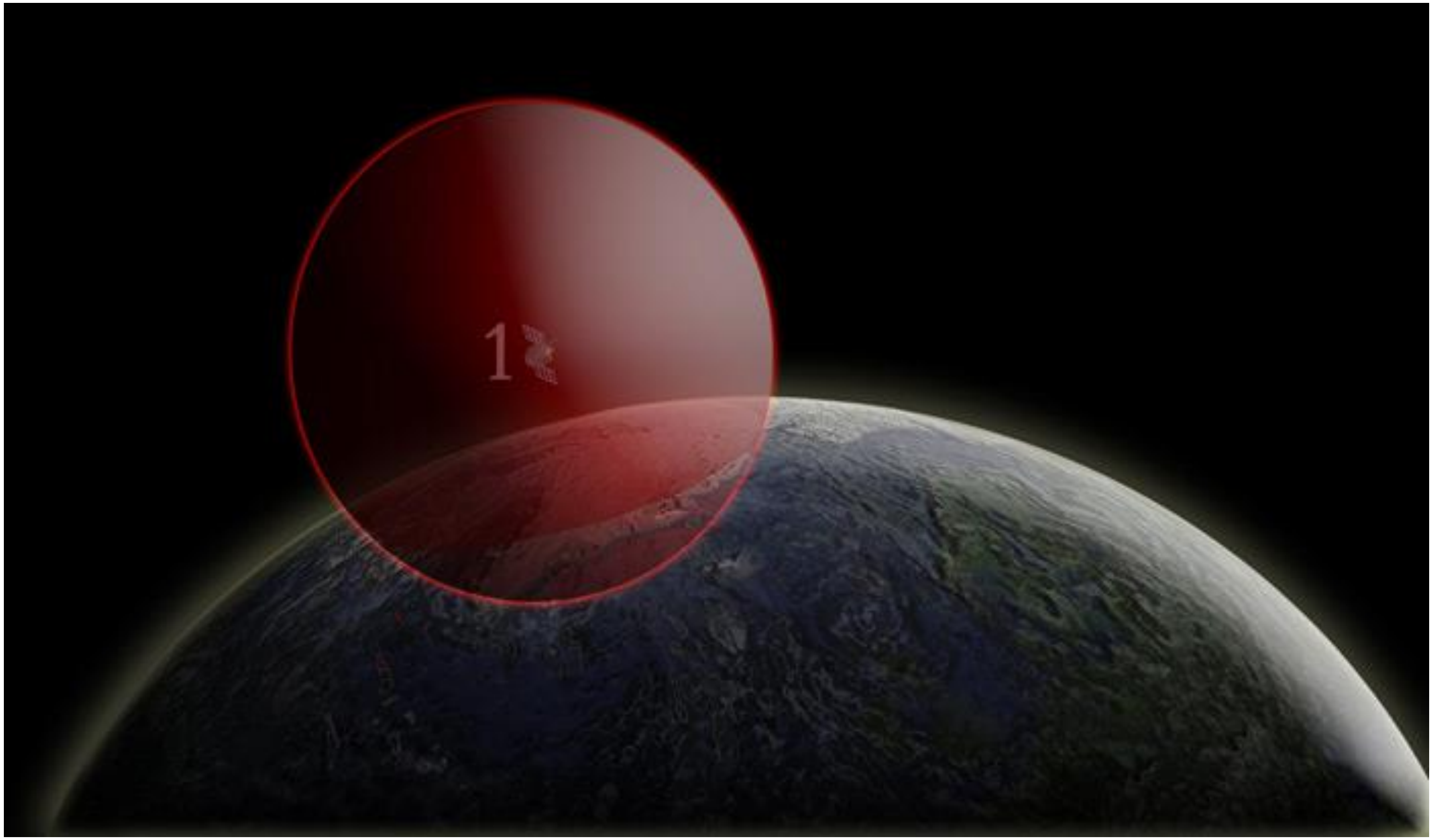


Segmentos que componen el sistema GPS

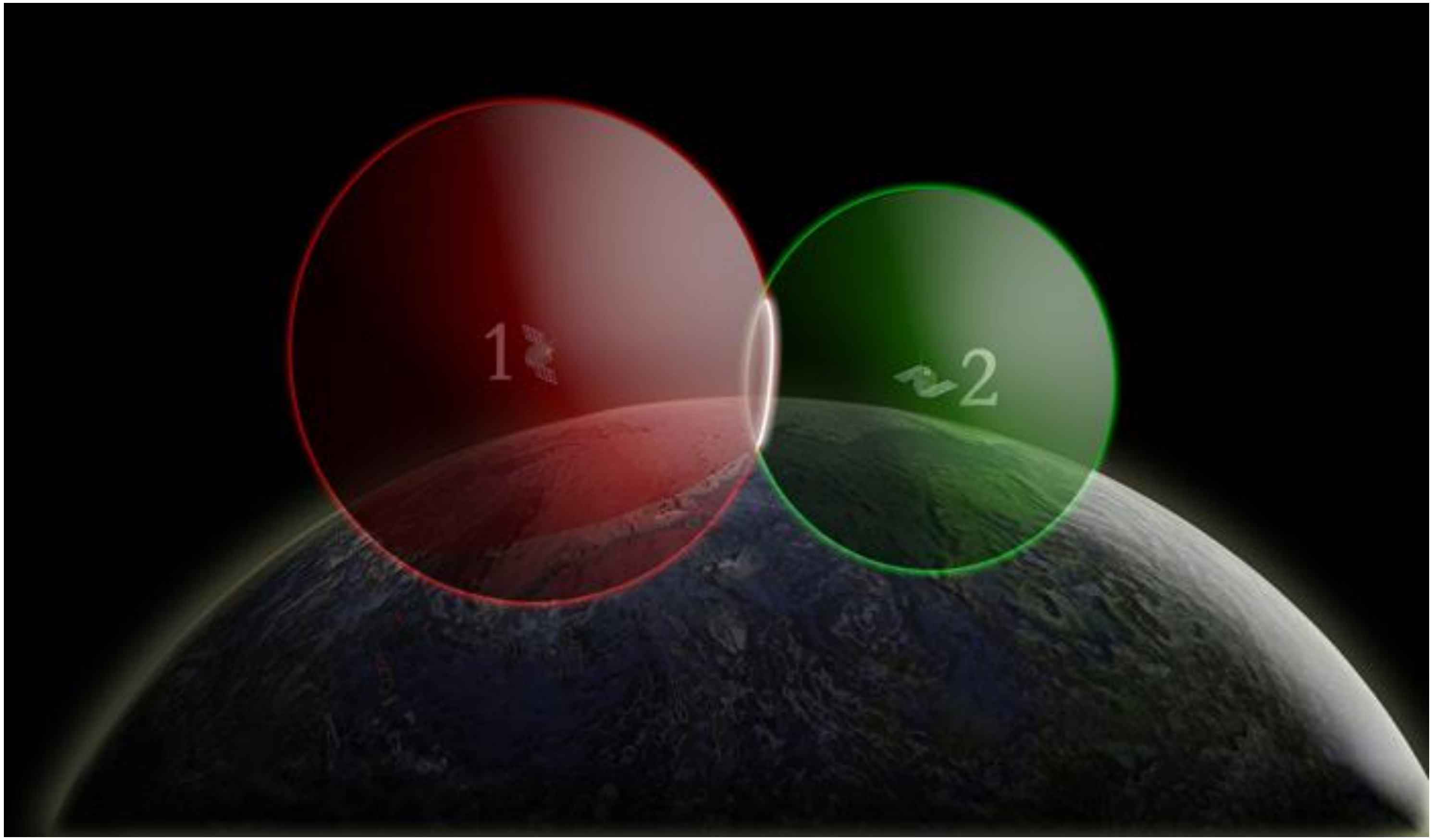


Civil GPS Use

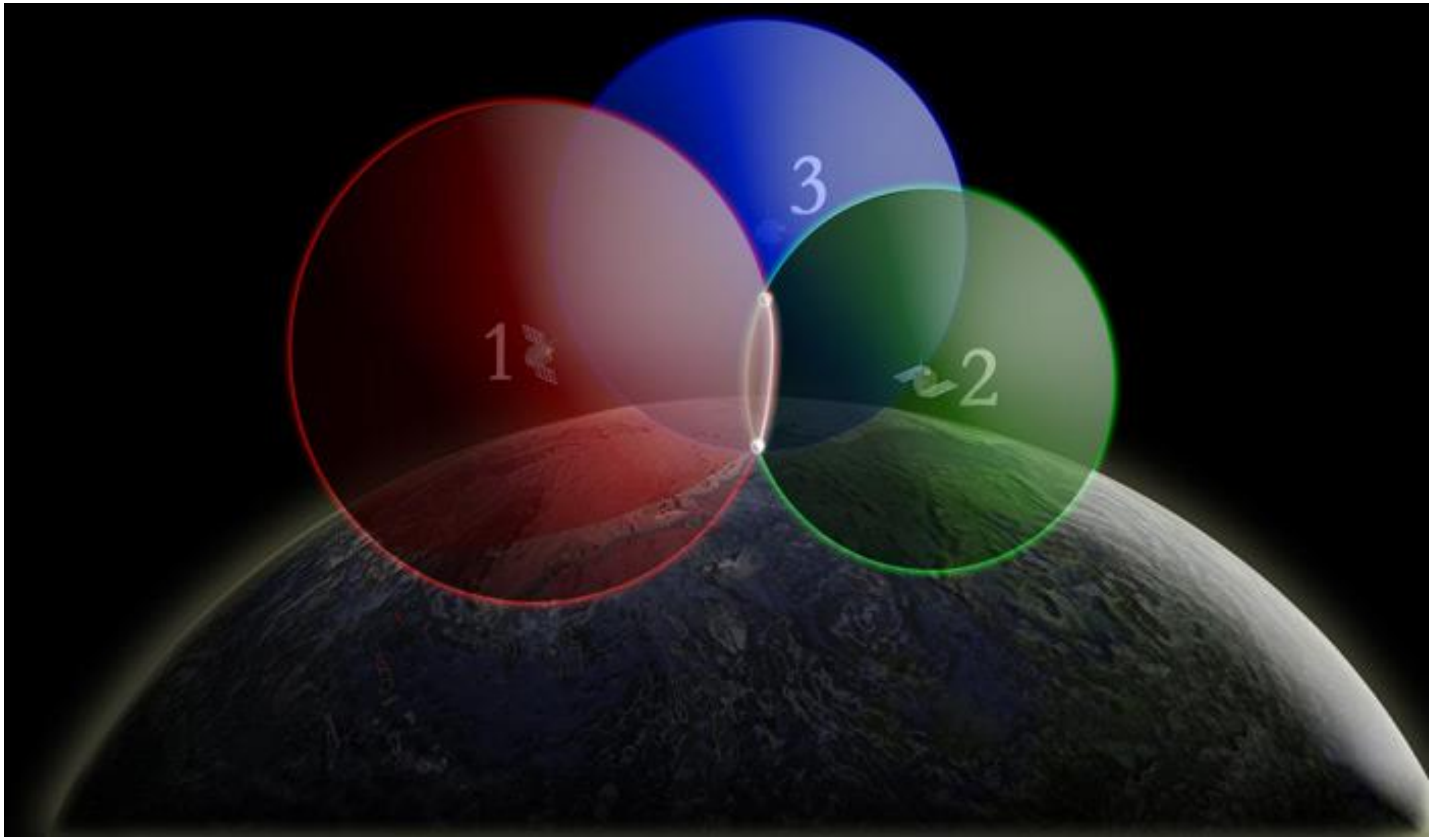
Un Satelite



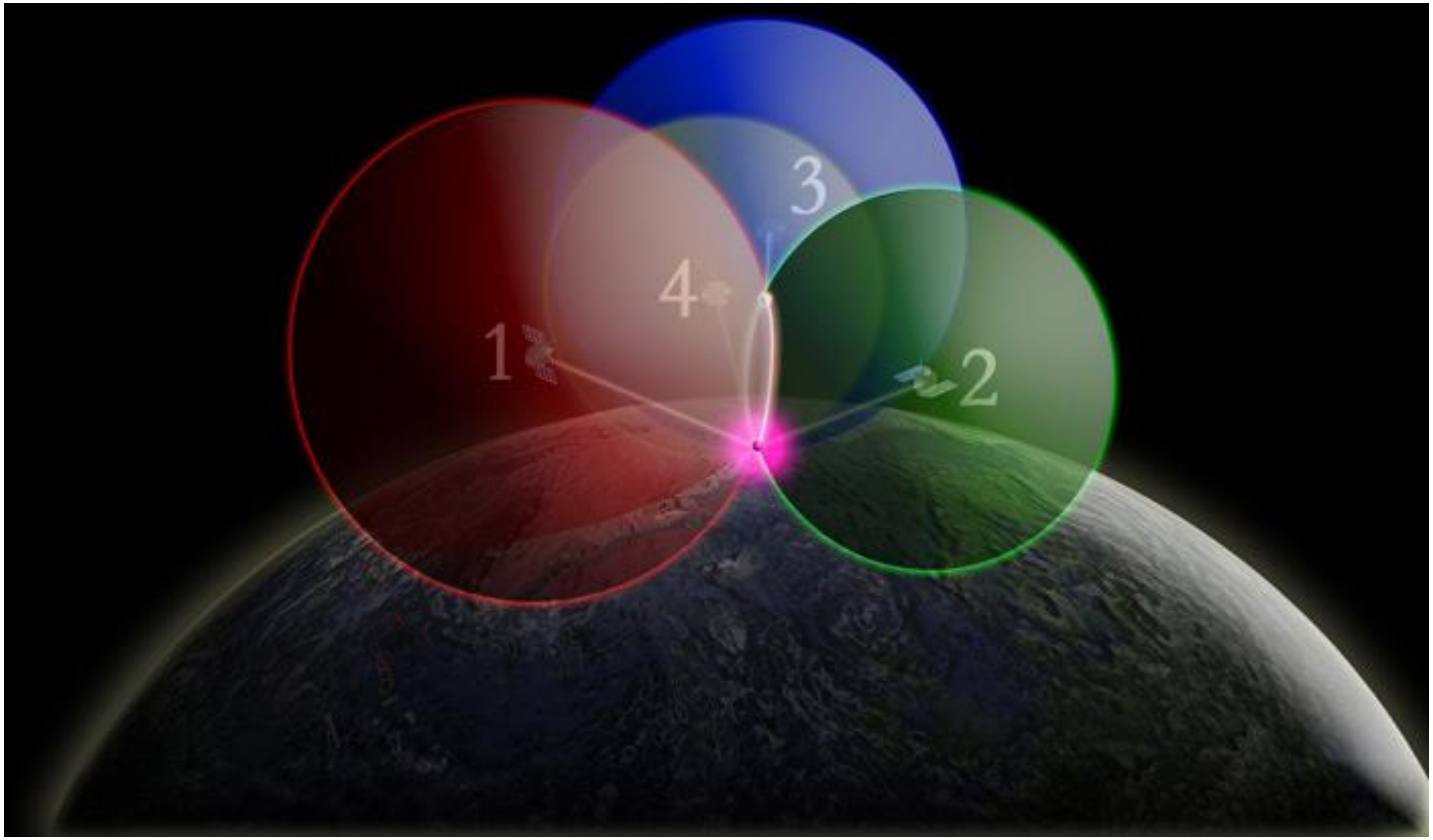
Dos Satelites

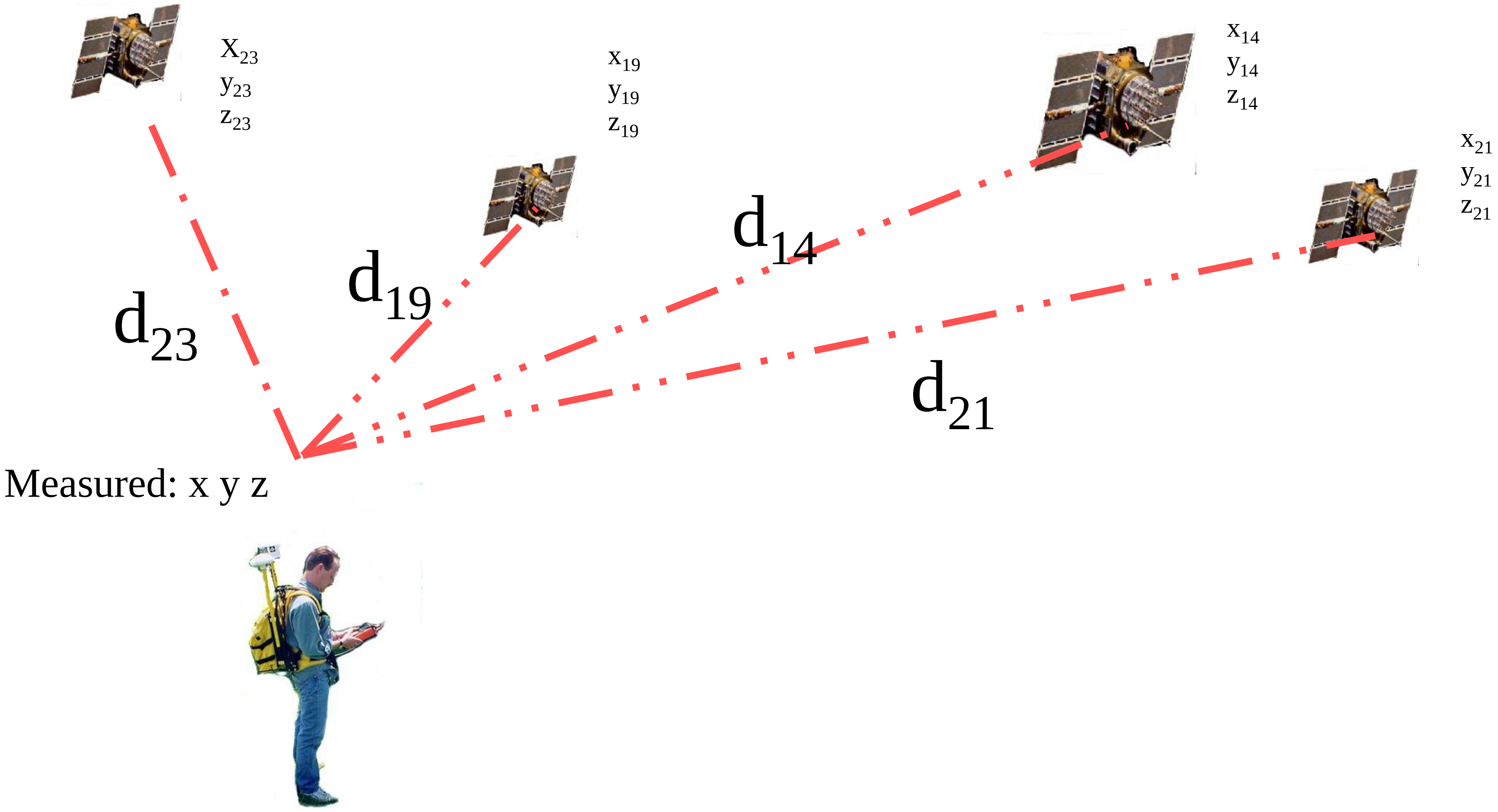


Tres Satelites



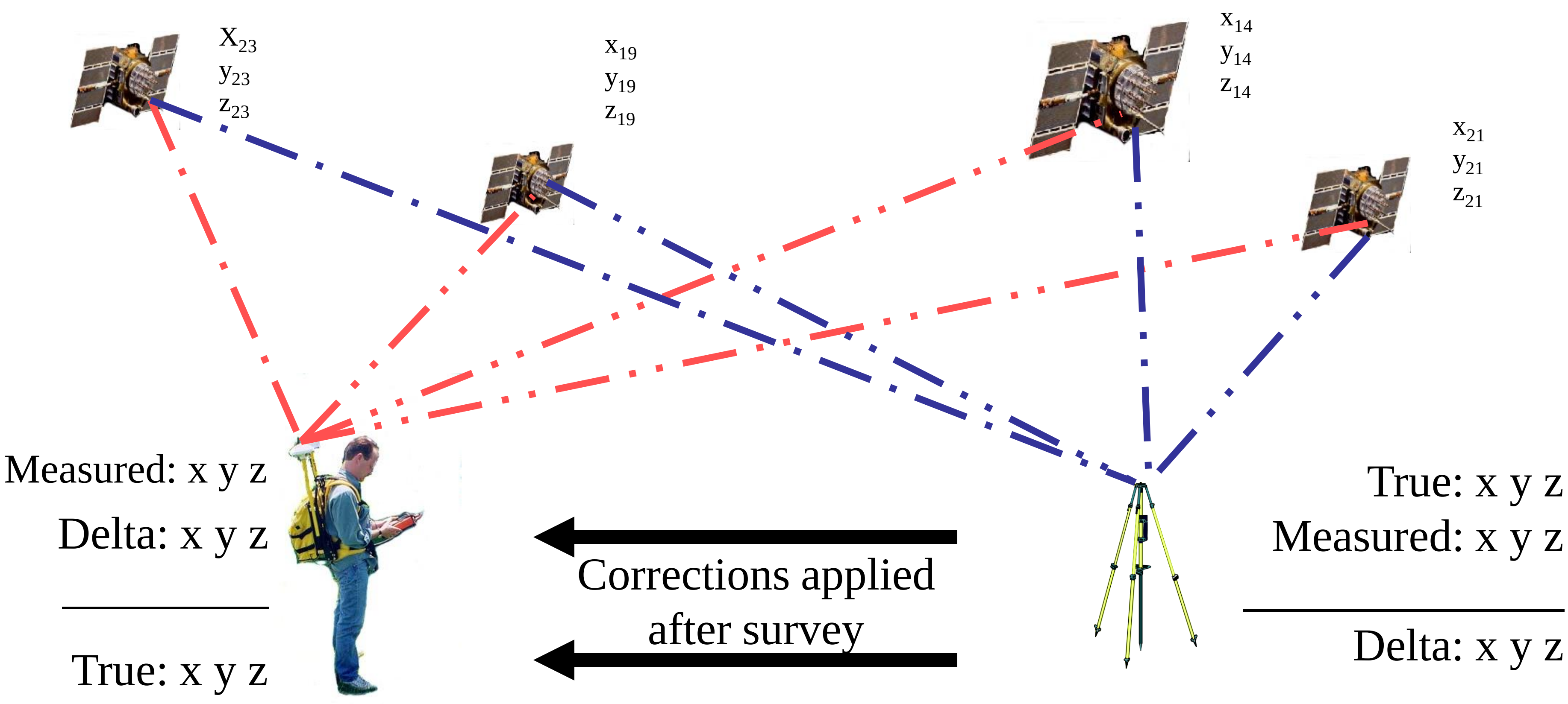
Cuatro Satelites



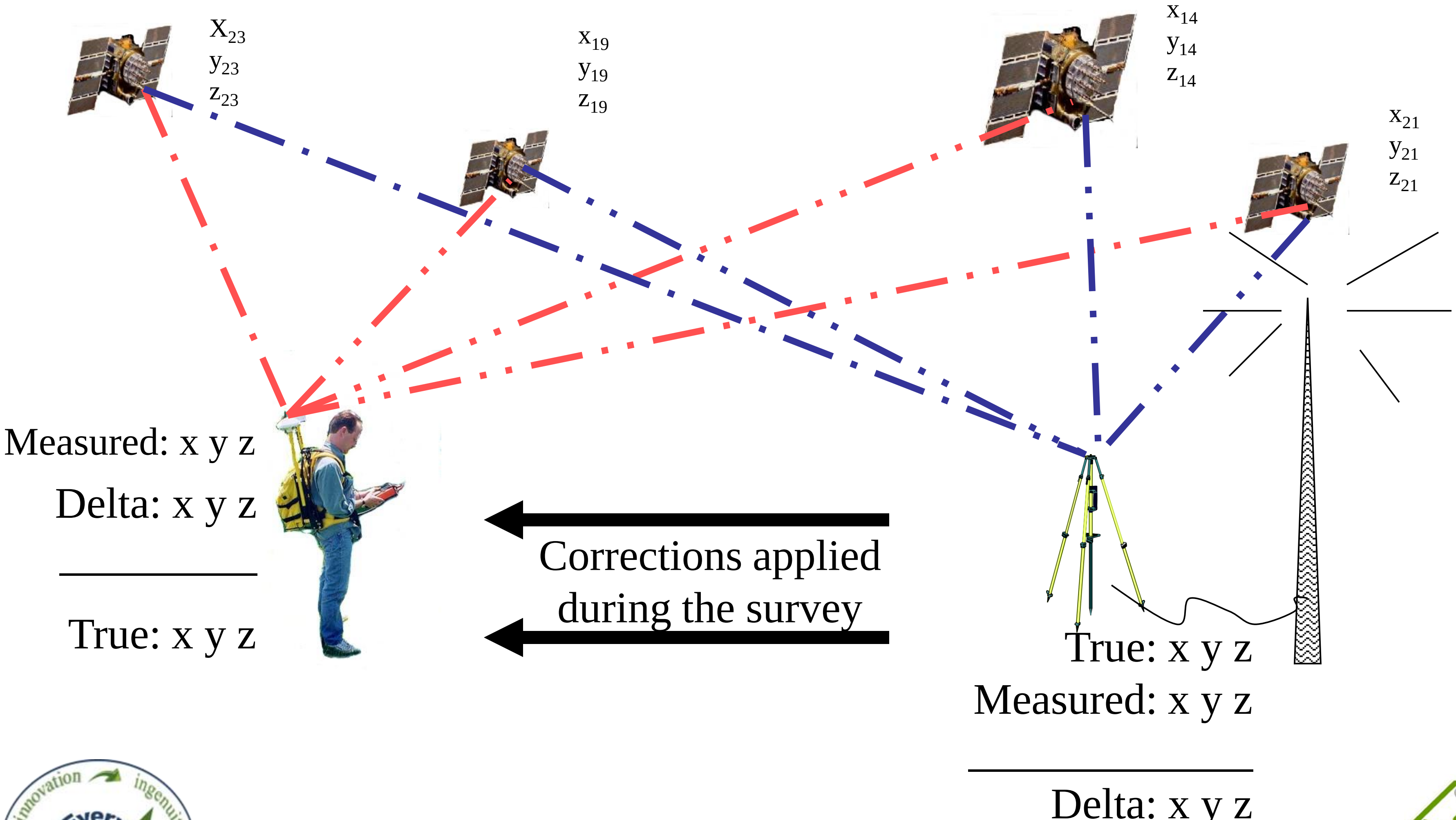


Non-Differential GPS

(Autonomous or Stand-alone)



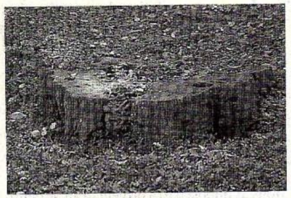
Differential GPS



Real-Time Differential GPS

Locating The Lincoln Boundary Oak For Posterity

by Vic McCauley and Frank Fowler

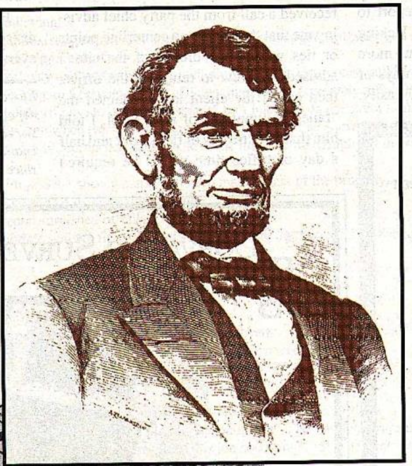


The Boundary Oak Stump.

"Beginning at a large white oak 13 poles above the Sinking Spring or Rock Spring, running thence N 9 1/2 E, 310 poles to ....." This was the beginning of the description of a tract of land of Thomas Lincoln, father of Abraham Lincoln.

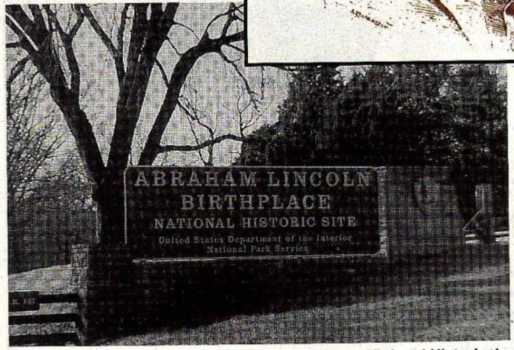
Abraham Lincoln, 16th President of the United States, was, to use his words, born "in the most humble walks of life," on February 12, 1809, in a log cabin about three miles south of Hodgen's Mill on what was known as the Sinking Spring Farm in Hardin (now Larue) County, Kentucky. Until he was seven, the family lived in a picturesque spot on Knob Creek about eight miles from his birthplace. Throughout his life, Lincoln fondly recalled memories of his Kentucky home, including the "boundary oak" that stood less than 150 yards from the cabin where he was born, and which his father pointed out as marking the boundary of his land.

Legend has it that a boundary dispute was at least part of the reason for the family's migration to Indiana.

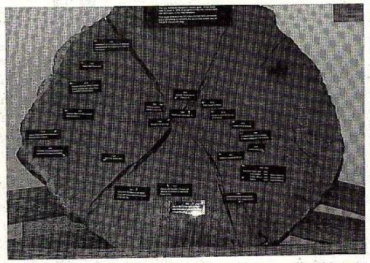


The exact location of the oak was recorded about 20 years later when, on December 4, 1837, Hardin County Deputy Surveyor John Duncan began a survey (to settle a controversy) at a large "White Oak, thirteen poles above the Sinking or Rock Spring." Hence the oak tree that helped mark Abraham's birthplace was put on record in an official survey—the first known documentation of the "Boundary Oak."

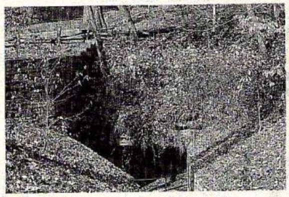
President William Howard Taft dedicated the Lincoln birthplace site as a national memorial in 1911. By that time, however, the Lincoln cabin had already been disassembled and moved around the country for display. Many rumors still exist concerning the authenticity of the cabin, but the Boundary Oak remained, undaunted amidst the turmoil. In 1933, the National Park Service took over management of the site, which it still maintains. Each year, nearly 250,000 visitors pay homage to Lincoln at the park.



The entrance to the Abraham Lincoln Birthplace, National Historical Site, near Hodgenville, Kentucky.

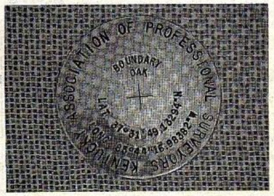


Cross-section of the Boundary Oak on display at the site.



The "Sinking or Rock Spring."

An informational plaque .



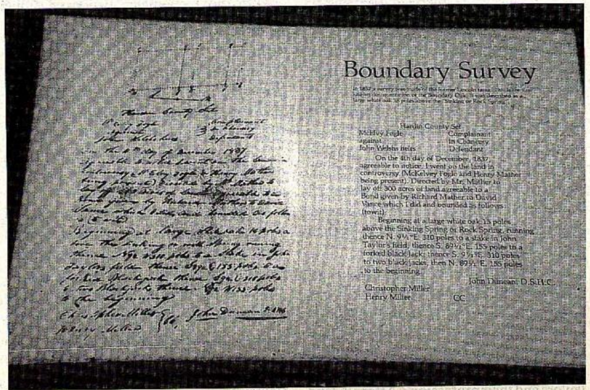
Survey disk .

The Boundary Oak stood as a living link to Lincoln until its death in 1976 at an estimated age of 195. At the time of its death, it was nearly six feet in diameter, stood 90 feet tall and spread its crown 115 feet across. Its remains were placed in storage in 1986, but brought out in 1990 because of continued decline in the condition of its wood. A cross section from its trunk remains on display at the site.

The tree's stump still marks the original location, but Park Manager Carolyn Link, concerned about advancing decay, decided she wanted to somehow preserve the tree's exact location. Researching park records, she discovered that a local surveyor, Ed Pence, had monumented the park boundary in 1970, and had used the Boundary Oak to establish one of the lines. Link contacted him and explained the problem.

Pence, a member of The Kentucky Association of Professional Surveyors (KAPS), contacted Frank Fowler, who is chairman of the association's local Falls of the Ohio Chapter. Fowler, who is with the U.S. Army Corps of Engineers' Louisville District, said he would be happy to help organize the project. A GPS surveyor with the Corps, Fowler obtained authorization to use the Corps' receivers. Beginning last October, Fowler and Bobby Lambert, another Corps member, started the GPS survey while Pence, Jim Krauth, Steve Hibbs, Vic McCauley and Ray Leigh began solar observations and traversing to the stump. Once the exact position (NAD 83) of the stump was determined, Fowler contacted Berntsen International, Inc., which donated the disk used to monument the stump. The official dedication took place on February 12 as part of Kentucky's bicentennial celebration and the KAPS 25th Anniversary, and as a tribute to the 133rd anniversary of President Lincoln's birth. Participating dignitaries included Charles Tapley, NSPS past president; David Atwell, NSPS Area 3 director; Al Matherly, NSPS governor from Kentucky; John Harper, member of the Kentucky House of Representatives; Jim Riney, KAPS president; Vic McCauley, KAPS president-elect; Peggy Fortney, chair of the Falls of the Ohio Chapter, and Carolyn Link and Gary Talley of the National Park Service.

The purpose of the survey was to perpetuate the exact location of the Boundary Oak, which might otherwise have been lost due to rotting of the stump. Since it is tied to the National Network of Geodetic Control, the position of the oak will always be known, regardless of what happens to the area. The surveyors who participated in the project felt that they were contributing to the preservation of an important national monument. Just as it did when it was young and strong, the Boundary Oak will provide future generations with a concrete link to the birthplace of one of our nation's most treasured figures. **PS**



The 1837 Boundary Survey performed by John Duncan, Deputy Surveyor, Hardin County, Kentucky.

__Vic McCauley__ is a registered surveyor employed with H.E. Rudy Engineers of Louisville, Kentucky, and is 1992 president of the Kentucky Association of Professional Surveyors. __Frank Fowler__ is a registered surveyor employed with the Louisville District Army Corps of Engineers, is past chairman of the Falls of the Ohio chapter of KAPS, and is on the Board of Directors of the Kentucky Association of Professional Surveyors.

GPS

- Los datos obtenidos con los receptores de GPS se pueden incorporar a los mapas topográficos en formato digital, si estos estan en el mismo datum y sistemas de coordenadas.
- Como aplicacion, si obtenemos las coordenadas de los límites municipales de los cuadrángulos estos límites se pueden establecer sobre el terreno usando GPS

TRANSFORMACION

Se define como una función que relaciona coordenadas en un sistema de coordenadas con otro sistema de coordenadas.

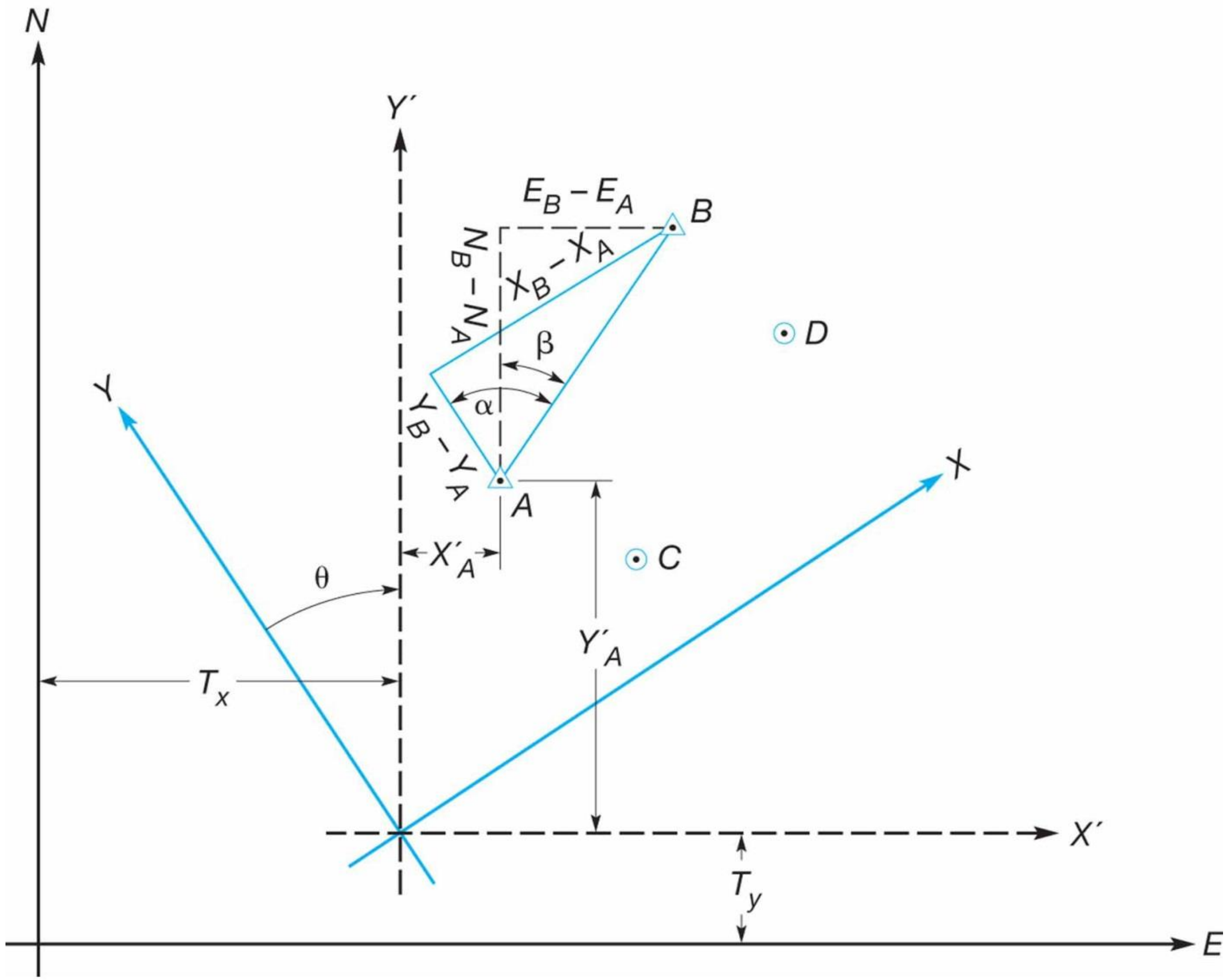
Usualmente envuelve cambios en traslación, rotación y/o escala.

- “affine transformation”

- “conformal transformation”

Transformación de Coordenadas

- El procedimiento para transformar unas coordenadas consiste de tres partes:
  - Escala
  - Rotación
  - Traslación
- Se tiene un listado de coordenadas planas y se conocen las coordenadas planas del sistema al que se transformará en dos o más puntos.


N
Y′
$E_B - E_A$
B
$N_B - N_A$
$X_B - X_A$
D
β
Y
α
$Y_B - Y_A$
X
A
C
X'_A
θ
Y'_A
T_x
X′
T_y
E

Ejemplo de Transformacion usando TrasnCoord

Project information		Coordinate System	
Name:	C:\Users\Linda L. Velez\Documents\Trimble Business Center\Gas_Hernandez_Naranjales.vce	Name:	US State Plane 1983
Size:	101 KB	Datum:	NAD 1983 (Conus)
Modified:	8/17/2010 11:31:18 PM	Zone:	Puerto Rico/Virgin Is 5200
Reference number:		Geoid:	GEOID03 (Puerto Rico)
Description:		Vertical datum:	

Point List

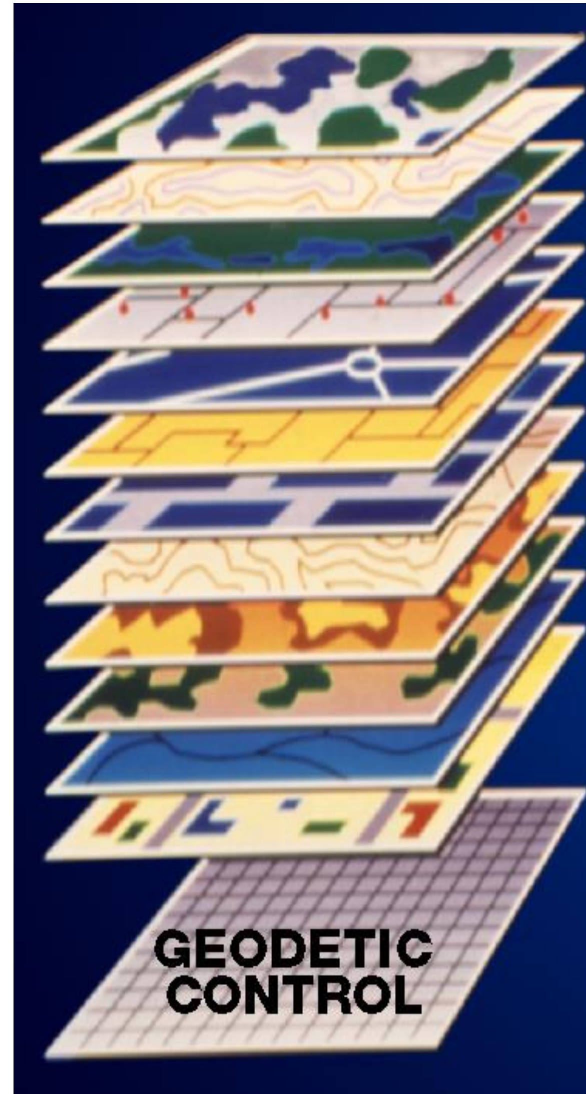
ID	Northing (Meter)	Easting (Meter)	Elevation (Meter)	Feature Code
1	241625.858	133910.982	325.270	
2	241647.576	133880.807	328.164	

8/20/2010 9:51:16 PM	C:\Users\Linda L. Velez\Documents\Trimble Business Center\Gas_Hernandez_Naranjales.vce	Trimble Business Center

Matriz del GIS de Puerto Rico

	Base Maps	Assessments	Communications Facilities	Crime Statistics	Demographics	Economic Statistics	Electrical Plant	Environmental Data	Financial Data	Government Buildings	Hazards	Hazardous Waste Sites	Hydrology	Immigration Data	Import/Export Data	Land Parcels	Land Use Data	Licences	Natural Resources	Ownership/Occupancy Data	Permits	Private Utilities	Recreation Facilities	Res., Com., Industrial	Roads/Sidewalks	Sewer/Water Facilities	Social Services Data	Soils	Street Lighting	Taxes	Topographical	Transportation Facilities	Water Shed/Drainage	Zoning
Planning Board	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
AEP (Public Building Authority)	●	●	●		●	●	●	●	●	●	●	●	●			●	●				●	●			●	●		●			●	●	●	●
ARPE	●	●	●		●		●	●	●	●	●	●	●			●	●		●	●	●	●	●	●	●			●			●	●	●	●
Civil Defense	●		●	●	●		●	●		●	●	●	●			●	●		●	●		●	●	●	●	●	●		●		●	●	●	●
Department of Agriculture	●					●	●	●		●	●	●	●	●	●	●	●		●		●	●		●	●	●		●			●	●	●	●
Economic Development Administration	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●			●	●	●	●	●
Federal Department of Commerce	●				●	●			●					●	●				●								●							
General Services Administration	●	●	●				●	●	●	●	●	●	●			●	●				●	●		●										●
Government Development Bank	●				●	●			●					●	●				●					●		●	●		●					
Municipalities	●	●	●	●	●	●	●	●	●	●	●	●	●			●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
National Guard	●		●	●	●		●	●		●	●	●	●				●			●		●		●	●	●	●		●		●	●	●	
P.R. Aqueduct & Sewer Authority	●		●		●	●	●	●	●	●	●	●	●			●	●		●	●	●	●	●	●	●	●		●			●		●	●
P.R. Communications Authority	●	●	●		●	●	●	●	●	●	●	●	●			●	●		●	●	●	●	●	●	●	●		●			●		●	●
P.R. Department of Commerce	●	●	●	●	●	●	●		●	●		●		●	●	●	●	●	●	●		●	●	●	●	●	●	●		●	●	●	●	●
P.R. Department of Natural Resources	●					●		●	●		●	●	●	●	●	●		●	●	●				●			●			●			●	●
P.R. Department of Transportation & P.W.	●		●		●	●	●	●	●	●	●	●	●			●	●		●		●	●		●	●	●		●	●		●	●	●	●
P.R. Electrical Power Authority	●		●		●	●	●	●	●	●	●	●	●			●	●		●	●	●	●	●	●	●	●		●	●		●		●	●
P.R. Industrial Development Company	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●			●	●	●	●	●
P.R. Department of Public Health	●				●			●			●	●	●			●		●	●		●		●	●		●	●	●				●	●	
P.R. Telephone Company	●		●		●	●	●	●	●	●	●	●	●			●	●		●	●	●	●	●	●	●	●		●			●		●	●
Environmental Quality Board	●		●		●		●	●		●	●	●	●			●	●		●	●		●	●	●	●	●		●			●		●	
Social Services	●			●	●	●			●	●													●	●			●					●		
State Police Department	●		●	●	●		●	●		●	●	●	●			●		●	●	●	●	●	●	●	●	●	●		●		●	●		
Tourism Board	●			●	●	●		●										●					●	●	●							●		
Treasury Department	●	●			●	●			●	●				●	●	●	●	●	●	●		●	●	●			●			●				●
Universtiy of Puerto Rico	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●			●	●	●	●

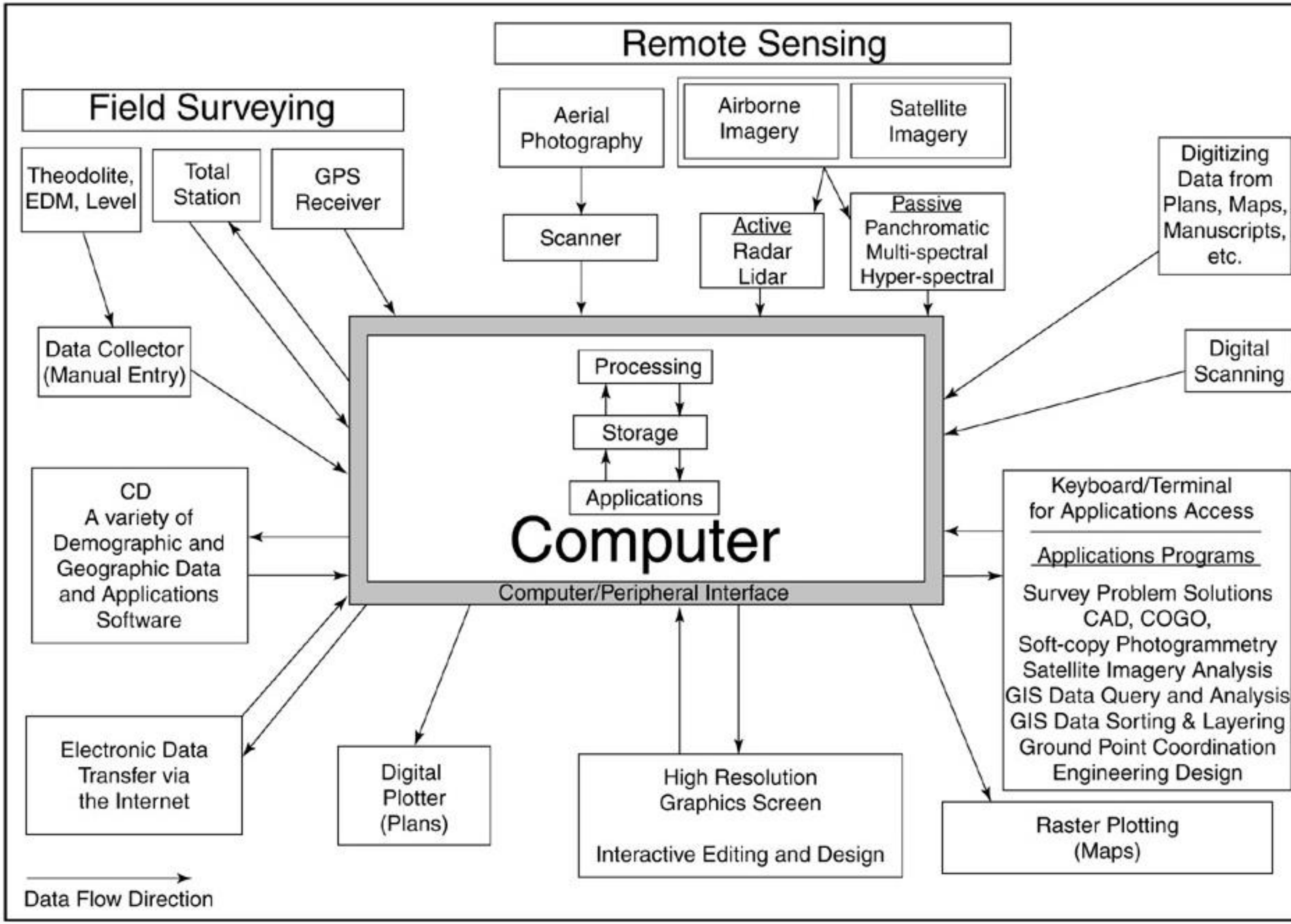
Sistema Nacional de Referencia Espacial “National Spatial Reference System” (NSRS)



De esto consiste el Sistema Nacional de Referencia Espacial de varias Coordenadas junto con:

- **Latitud**
- **Longitud**
- **Altura**
- **Escala**
- **Gravedad**
- **Orientación**

Y como estos valores cambian con el tiempo



Variedad de fuentes de datos geo-espaciales – OJO con GI-GO

Datos de Infraestructura

- Localización Geográfica
- Carreteras
- Aceras
- Servicios de Agua
- Servicios de Alcantarillado Sanitarios
- Luminarias en Calles
- Servicios Electricos
- Tuberías (pipelines)
- Facilidades de Comunicación
- Servicios de Control de Trafico
- Facilidades de Parques/Recreación
- Carriles (lanes)
- Escuelas
- Inventario de Arboles/Arbustos
- Estacionamiento
- Puentes
- Utilidades extranjeras
- Red/Facilidades de Carreteras (Viales)

Infraestructura y Atributos

- Carreteras
  - Tipo
  - Superficie
  - Fecha de Construcción
  - Propietario
  - Fecha del Ultimo Mantenimiento
  - Número de Carriles
  - Ancho
  - Profundidad
- Aceras
  - Tipo
  - Superficie
  - Fecha de Construcción
  - Propietario
  - Fecha del Ultimo Mantenimiento
  - Ancho/Profundidad

Infraestructura y Atributos

– Luminarias en Calles
  - Postes
  - Transformadores
  - Alambrado
  - Edad
  - Profundidad

– Servicios de Control de Trafico
  - Tipo
  - Activo/Pasivo
  - Fecha de Instalación
  - Fecha del Ultimo Mantenimiento

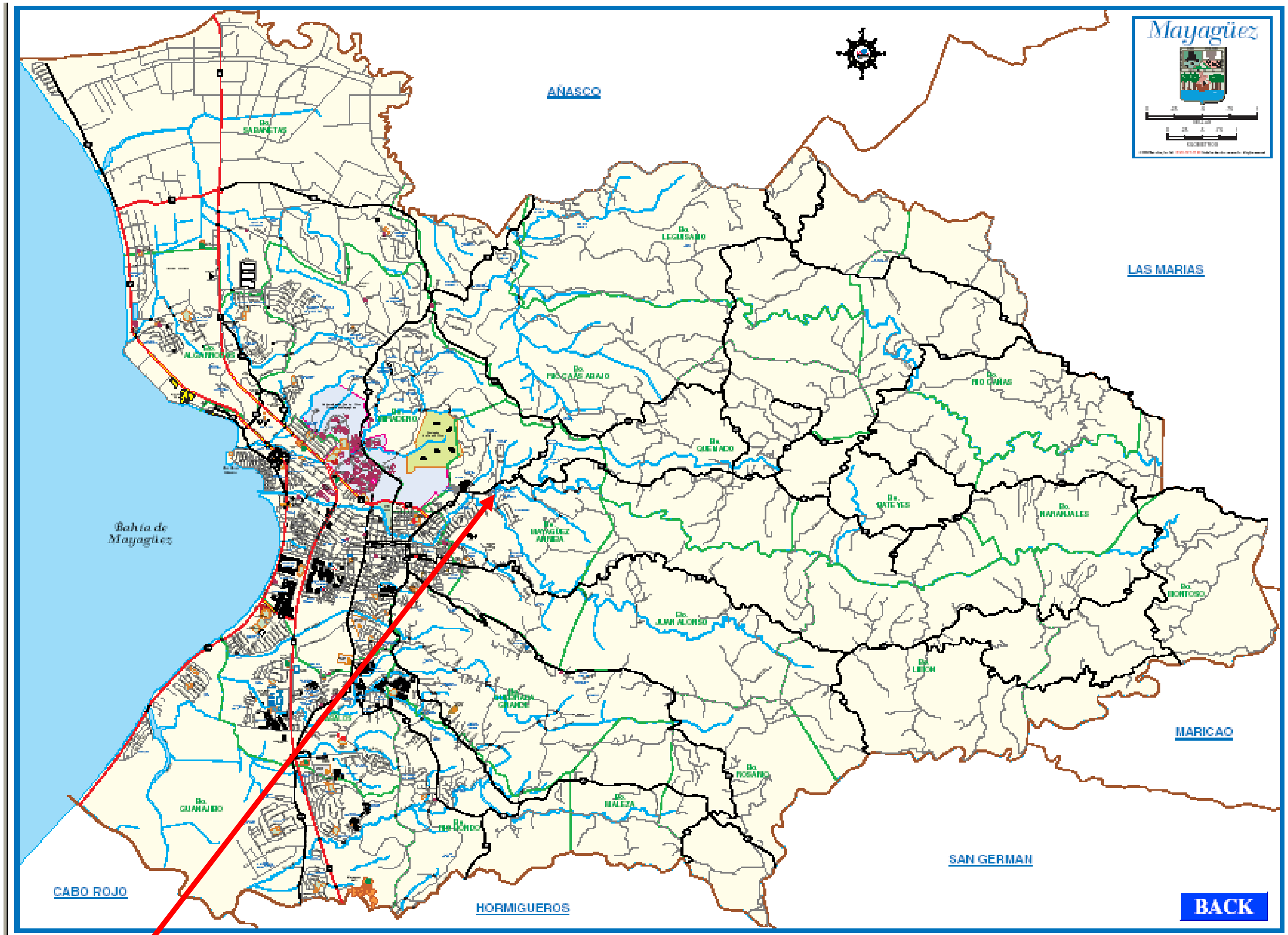
Infraestructura y Atributos

- Puentes
  - Tipo
  - Superficie
  - Fecha de Construcción
  - Número de Carriles
  - Fecha del Ultimo Mantenimiento
- Utilidades extranjeras
  - Cablevision
  - Propietario
  - Localizacion de Planta
  - Tuberías
  - Propietario
  - Capacidad
  - Localizacion de Planta
  - Caracteristicas Especiales
  - Profundidad
- Redes Viales
  - Tipo
  - Ruta
  - Rasgos Especiales
  - Facilidades
- Carriles (lanes)
  - Localización
  - Tipo
  - Superficie
  - Propietario
  - Dimensiones Fisicas

Infraestructura y Atributos

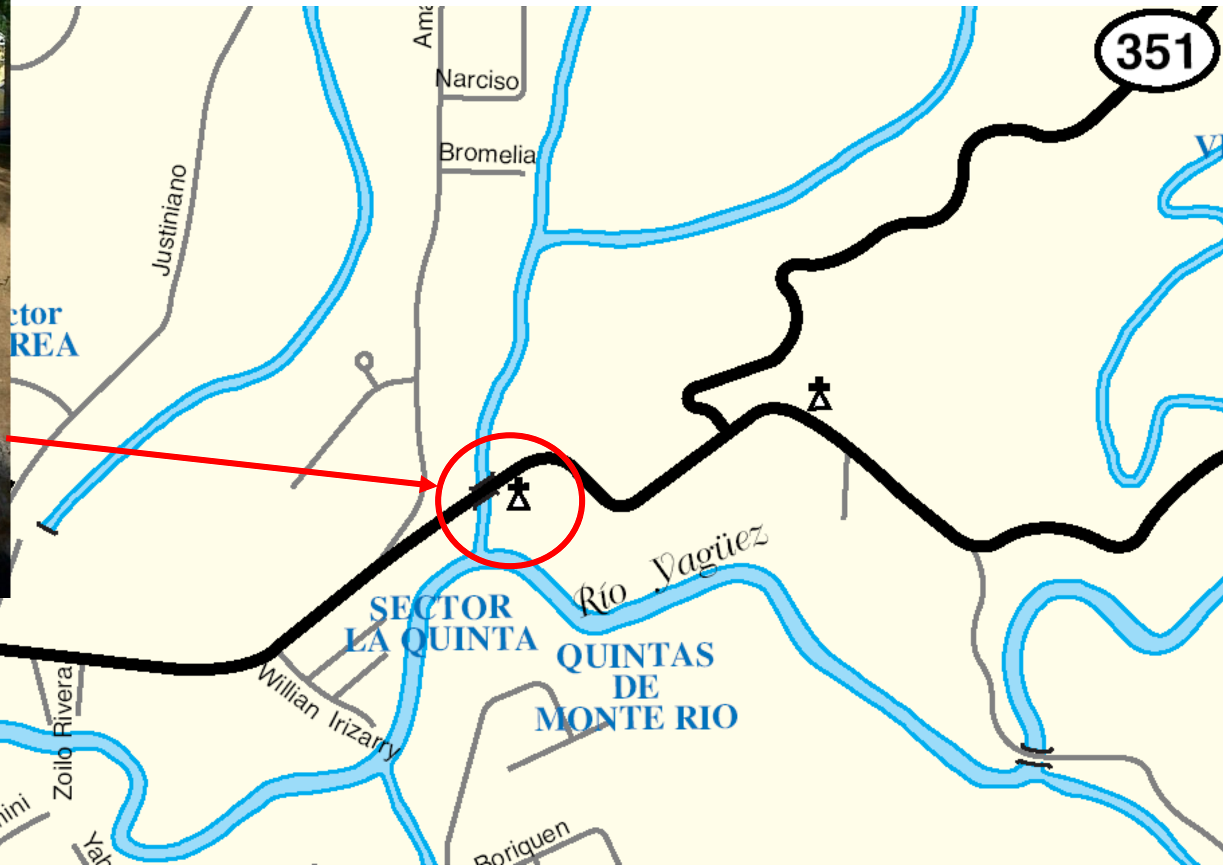
– Servicios de Agua
  - Hidrantes
  - Capacidad
  - Válvulas
  - Líneas
  - Presión/Edad
  - **Profundidad**
  - Fecha de Instalación
  - Fecha de Ultimo Mantenimiento
  - Estaciones de Bombeo

– Servicios de Alcantarillado Sanitarios
  - Líneas
  - Válvulas
  - **Profundidad**
  - Estaciones de Bombeo
  - Tipos

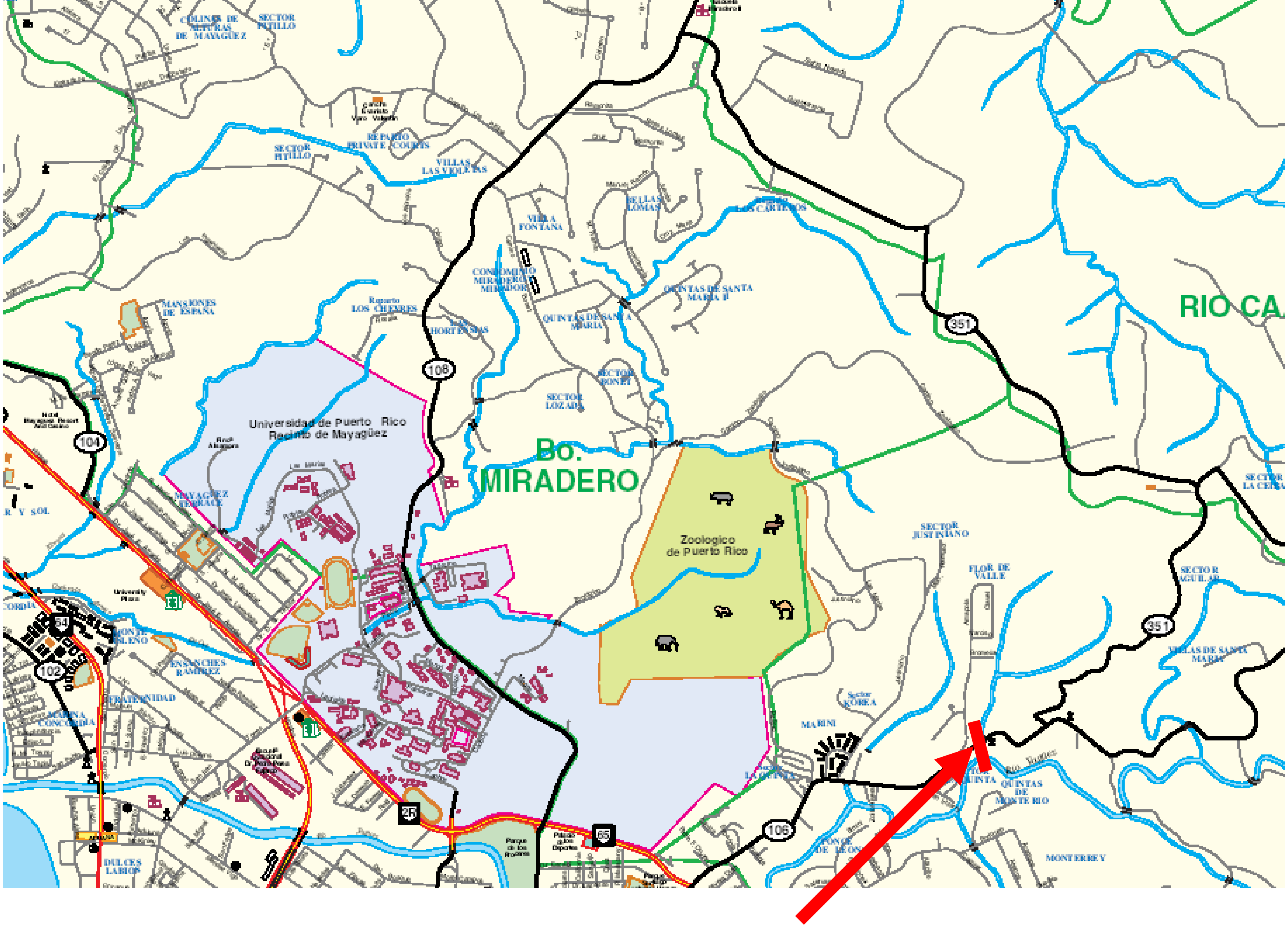


Carretera PR-106 cerrada en el Km 1.6 por Puente Roto desde comienzos de marzo de 2012, luego de estar en ese lugar cerrado un carril, por mas de 12 meses, al comenzar los trabajos colapsa el carril que servia. Desvio Oficial por PR-351 a la PR-108

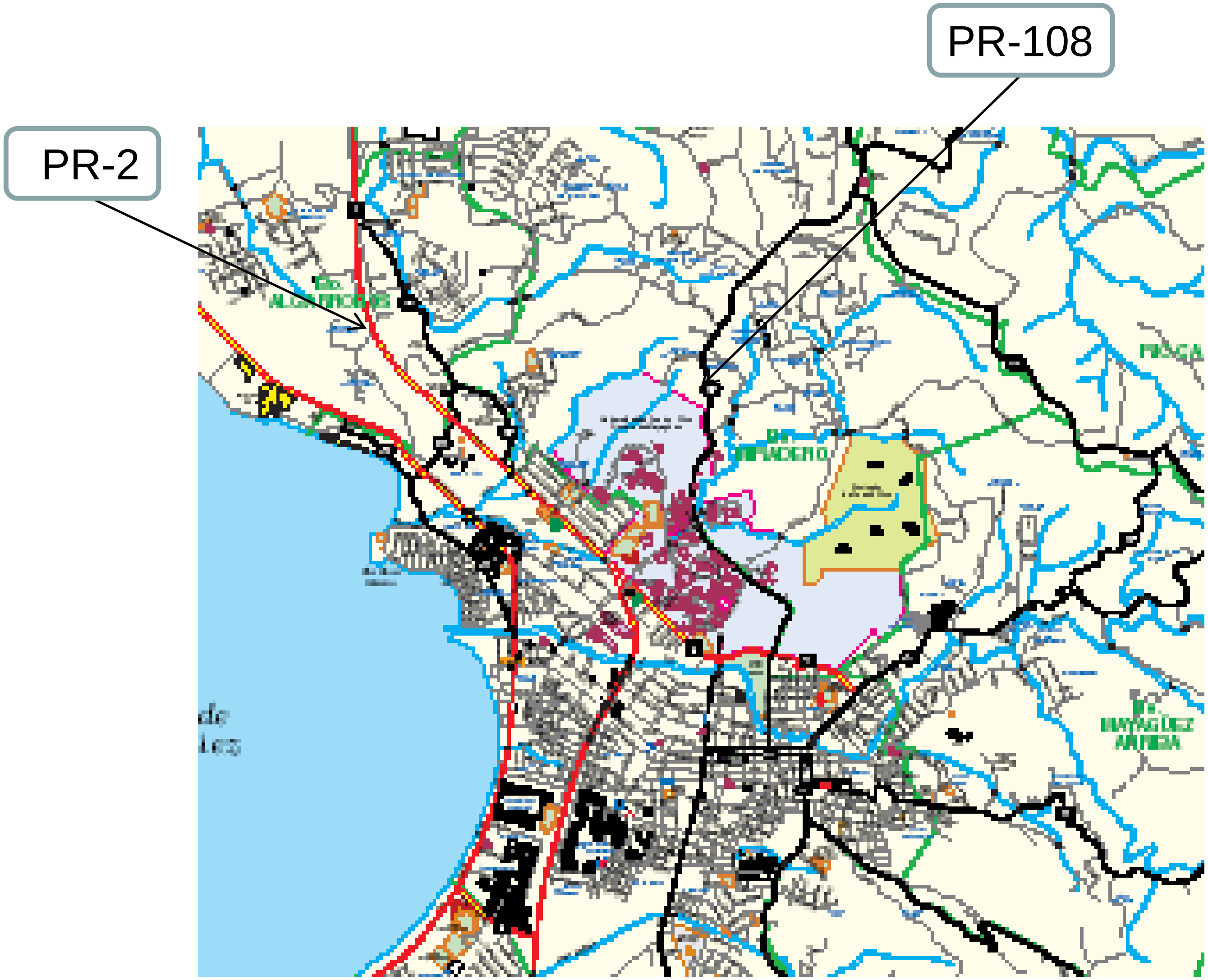
PR-106 Km 1.6 CERRADA


351
Narciso
Bromelia
Justiniano
SECTOR
LA QUINTA
QUINTAS
DE
MONTE RIO
Río Yagüez
Willian Irizarry
Zoilo Rivera
Bimini
Boriquen
QUINTA
106


CARRETERAS
Proyecto de Reconstrucción
de Carreteras
Unidad II Región Oeste
Mayagüez, Maricao y Las Marias, Fondos ARRA
Inversión:
dtop
http://www.dtop.gov.p

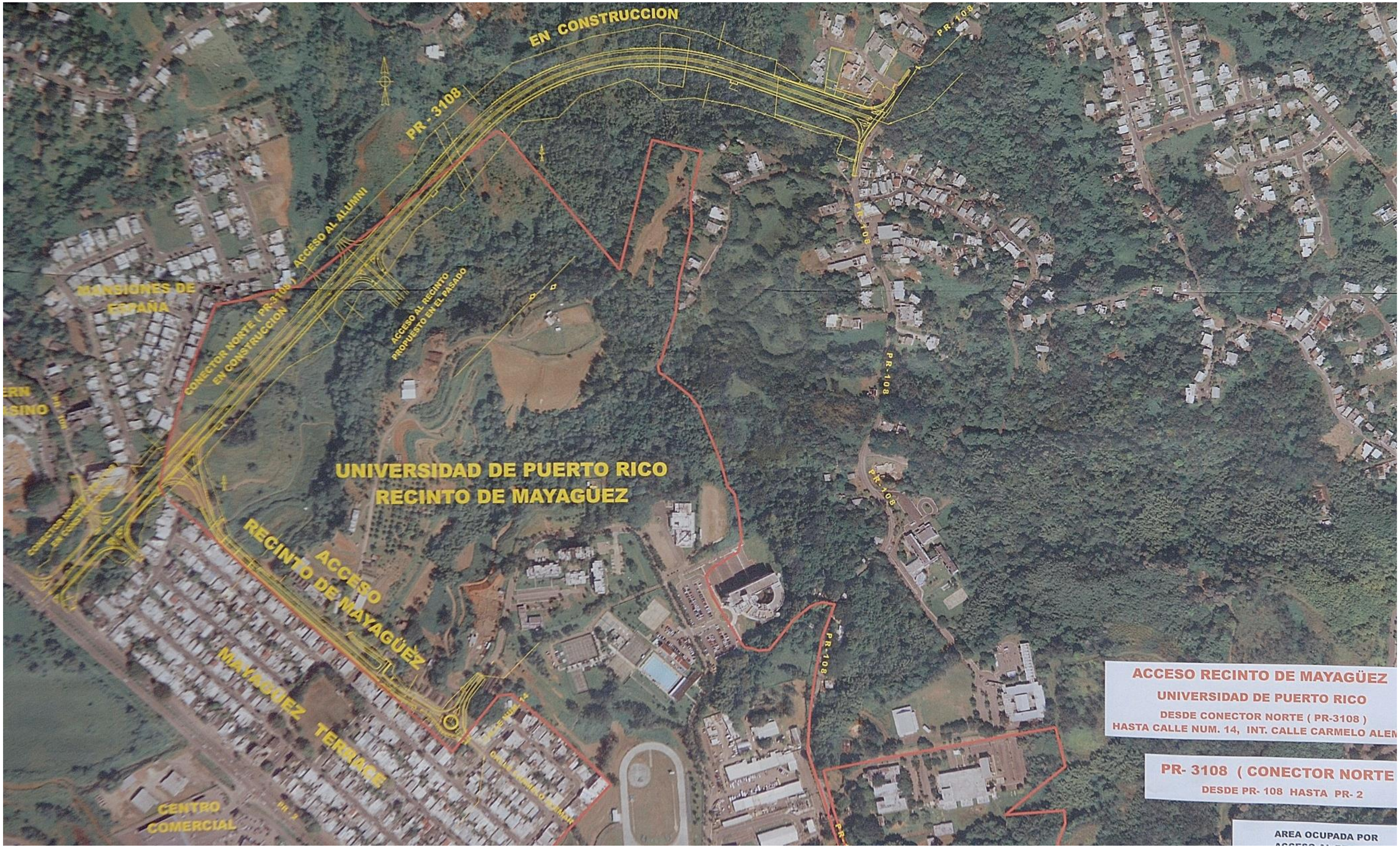


Puente Colapsado en PR-106 Km.1.6
desde Marzo del 2012-Desvio Oficial PR-351

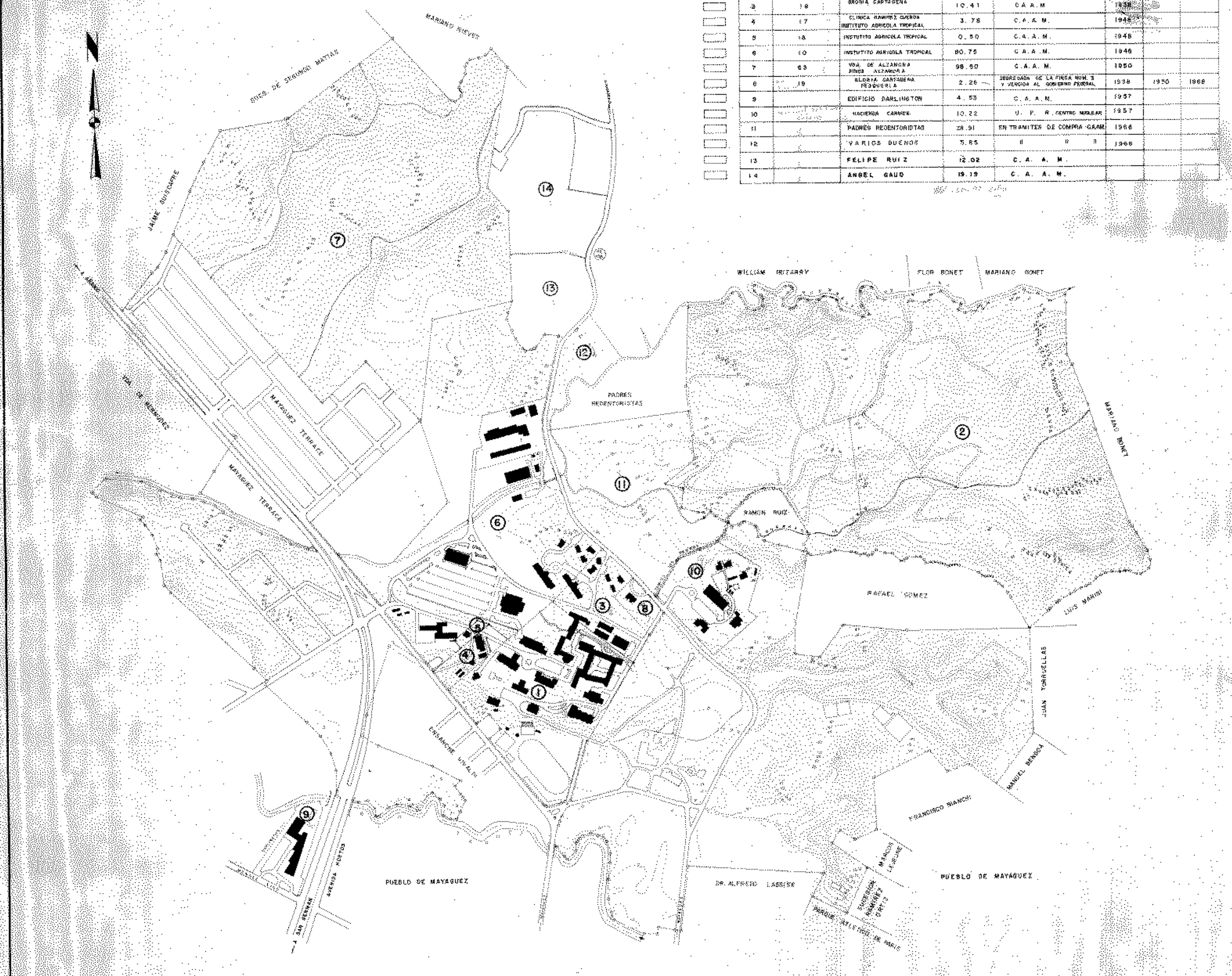


El conector de las carreteras PR-2 y PR-108 busca convertir eventualmente un tramo de la PR-108 en transito local en el Recinto Universitario de Mayaguez de la Universidad de Puerto Rico

PR-3108 – Conecta la PR-2 y PR-108



CLAVE	NUM.	FILE NUM.	NOMBRE DEL DUEÑO ORIGINAL & NOMBRE ORIGINAL DE FINCA	CABIDAS EN CUERDAS	COMENTARIOS	FECHA DE ADQUIRIDA	FECHA VENDIDA O TRASPASADO	FECHA DE RE-ADQUIRIDA
	1	5 - A	SUCN. CARTAGENA FINCA CARTAGENA	30.00	C.A.A.M.	1926		
	2	5 - B	SUCN. CARTAGENA FINCA CARTAGENA (LAS CORCETAS)	92.00	TRASPASADO A PARQUE Y RECREOS PUBLICOS - USADOS COMO ZOOLOGICO	1926	1960	
	3	16	GLORIA CARTAGENA	10.41	C.A.A.M.	1938		
	4	17	CLINICA RAMIREZ CUEBAS INSTITUTO AGRICOLA TROPICAL	3.78	C.A.A.M.	1942		
	5	18	INSTITUTO AGRICOLA TROPICAL	0.50	C.A.A.M.	1946		
	6	10	INSTITUTO AGRICOLA TROPICAL	80.75	C.A.A.M.	1948		
	7	63	VDA. DE ALZAMORA FINCA ALZAMORA	98.50	C.A.A.M.	1950		
	8	19	GLORIA CARTAGENA PEDREGUERA	2.26	SEGREGADA DE LA FINCA NUM. 3 Y VENDIDA AL GOBIERNO FEDERAL	1938	1950	1966
	9		EDIFICIO DARLINGTON	4.53	C.A.A.M.	1957		
	10		HACIENDA CARMEN	10.22	U. P. R. CENTRO NUCLEAR	1957		
	11		PADRES REDENTORISTAS	28.91	EN TRAMITES DE COMPRA C.A.A.M.	1966		
	12		VARIOS DUEÑOS	5.85	" " "	1966		
	13		FELIPE RUIZ	12.02	C. A. A. M.			
	14		ANGEL GAUD	19.19	C. A. A. M.			



MAPA HISTORICO C.A.A.M.

SEÑALANDO LA ADQUISICION DE TERRENOS POR EL RECINTO A TRAVES DEL TIEMPO, HASTA EL PRESENTE

OFICINA DE PLANIFICACION
RECINTO UNIVERSITARIO DE MAYAGUEZ
U. P. R.

PRESENTADO POR ROBERT L. BRT REVISIONES FECHAS
APROBADO POR
DIBUJADO POR
FECHA MAYO - 1966 ESCALA 1:4000

Control Vertical
Designación Q1015
PR-204 intersección
con PR-30 en Las Piedras, P.R.

Linda Velez< linda.velez@upr.edu>

Datos de Control vertical en PR-204, Las Piedras, PR
5 messages

Juan Moyet Rodriguez< JMoyet@dtop.gov.pr> Tue, Sep 18, 2012 at 10:53 AM
To: linda.velez@upr.edu

Buenos dias Prof. Vélez:

Nuestra oficina de Ingenieria de Tránsito está realizando un diseño de mejoras a la carretera PR-204 en Las Piedras. En el tramo del proyecto y en especifico

en el puente de la PR-204 sobre la PR-30 se encuentra un marcador de control vertical del National Geodesy Survey. Dado que se va a construir una acera en el lado en que está este control es necesario resetear el mismo. Quisiera saber si la National Geodesy Survey tiene una hoja de datos con las coordenadas de este control para poder indicarlo en el plano.

Cualquier dato adicional sobre estos controles que no estemos tomando en consideración nos los puede indicar como por ejemplo si tenemos que coordinar con el National Geodesy Survey para el reseteo u otra información que tengamos que indicar en los planos.

Gracias por la ayuda que nos pueda brindar.

Juan Moyet Rodriguez, EIT

División de Diseño y Administración de Semáforos

Area de Ingeniería de Tránsito

T. 787-721-8787exts. 2812 / 2869

D. 787-729-1527

F. 787-729-8969

AUTORIDAD DE CARRETERAS Y TRANSPORTACIÓN

Linda Velez< linda.velez@upr.edu> Tue, Sep 18, 2012 at 5:09 PM
To: Juan Moyet Rodriguez <JMoyet@dtop.gov.pr>

Estimado ingeniero Moyet

Para darles datos en particular necesito la designacion de la marca o BM (Bench Mark), esto esta en la chapa. Si pudieran prteger la marca mucho mejor, esto es no perturvarla y dejarla donde esta, a lo mejor con un tubo y su tapon de rosca como los sanitarios en las casa. Estas marcas y el trabajo que representan son muy valiosas y el re-localizarlas implica perder toda la inversion.

Por favor envieme una foto de la marca con el detalle del nombre y la busacre en el NSRS del NGS o National Geodetic Survey.

Gracias

Linda L Velez
Catedratica
NGS Geodetic Laison
UPR - RUM
Mayaguez, PR 00781-9000

787-313-4740

RELOCALIZACIÓN DE
Control Vertical por mejoras a Intersección

innovation ingenuity Every Day Counts imagination invention

1986-2014


VALENCIANO
BO. CEIBA
HUMACAO
TABUCOA


Caribbean Cinemas

www.ngs.noaa.gov

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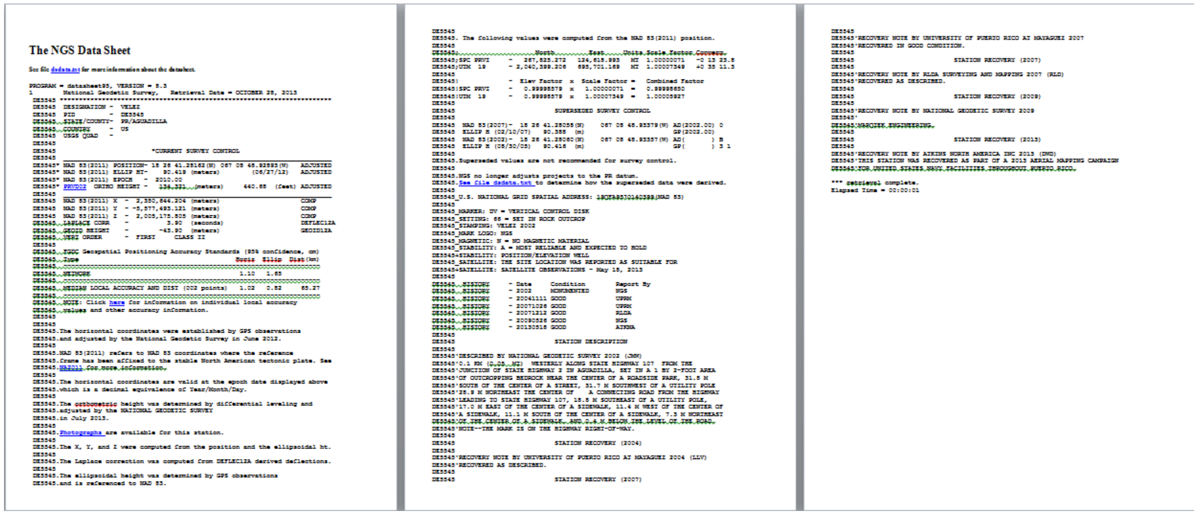
www.gitpr.org

Master a Coordinates Systems Show at the NGS Datasheet

Adail Rivera Nieves
INCI 4085
Proyecciones Cartográficas
Prof. Linda Vélez

National Geodetic Survey (NGS) Datasheet

- Los NGS “datasheet” son documentos en linea preparados por el NGS que proporcionan las coordenadas de posición y otra información geodésica para estaciones de control que forman parte del Sistema Nacional de referencia espacial (NSRS por sus siglas en ingles).


The NGS Data Sheet

NGS Datasheet cont.

- En ellos podemos encontrar:
  - Designación y Point ID (PID)
  - DATUM
  - Sistemas de Coordenadas
  - Monumentación
  - Descripción del punto
  - Descripción de su localización

Designation y PID

- Desgnation es el nombre del punto.
- PID es el numero de identificación permanente del NGS.
- Un control puede cambiar de nombre o pueden haber varios con el mismo nombre.
- Por otro lado el designation ayuda al NGS a saber que punto es quien ya que se le asigna uno diferente a cada uno.

```
DE5545  ******************************
DE5545  DESIGNATION -  VELEZ
DE5545  PID         -  DE5545
DE5545  STATE/COUNTY-  PR/AGUADILLA
DE5545  COUNTRY     -  US
DE5545  USGS QUAD   -
```

Descripción del Punto

- Es el lugar donde podemos conseguir como se hicieron las observaciones horizontales y verticales. De el control tener fotografías también son encontradas en esta parte.

```
DE5545.The horizontal coordinates were established by GPS observations
DE5545.and adjusted by the National Geodetic Survey in June 2012.
DE5545
DE5545.NAD 83(2011) refers to NAD 83 coordinates where the reference
DE5545.frame has been affixed to the stable North American tectonic plate. See
DE5545.NA2011 for more information.
DE5545
DE5545.The horizontal coordinates are valid at the epoch date displayed above
DE5545.which is a decimal equivalence of Year/Month/Day.
DE5545
DE5545.The orthometric height was determined by differential leveling and
DE5545.adjusted by the NATIONAL GEODETIC SURVEY
DE5545.in July 2013.
DE5545
DE5545.Photographs are available for this station.
DE5545
DE5545.The X, Y, and Z were computed from the position and the ellipsoidal ht.
DE5545
DE5545.The Laplace correction was computed from DEFLEC12A derived deflections.
DE5545
DE5545.The ellipsoidal height was determined by GPS observations
DE5545.and is referenced to NAD 83.
```

DATUM

- Un DATUM es un conjunto de parámetros que definen un sistema de coordenadas y un conjunto de puntos de control cuya relación geométrica es conocida ya sea por medidas o cálculos

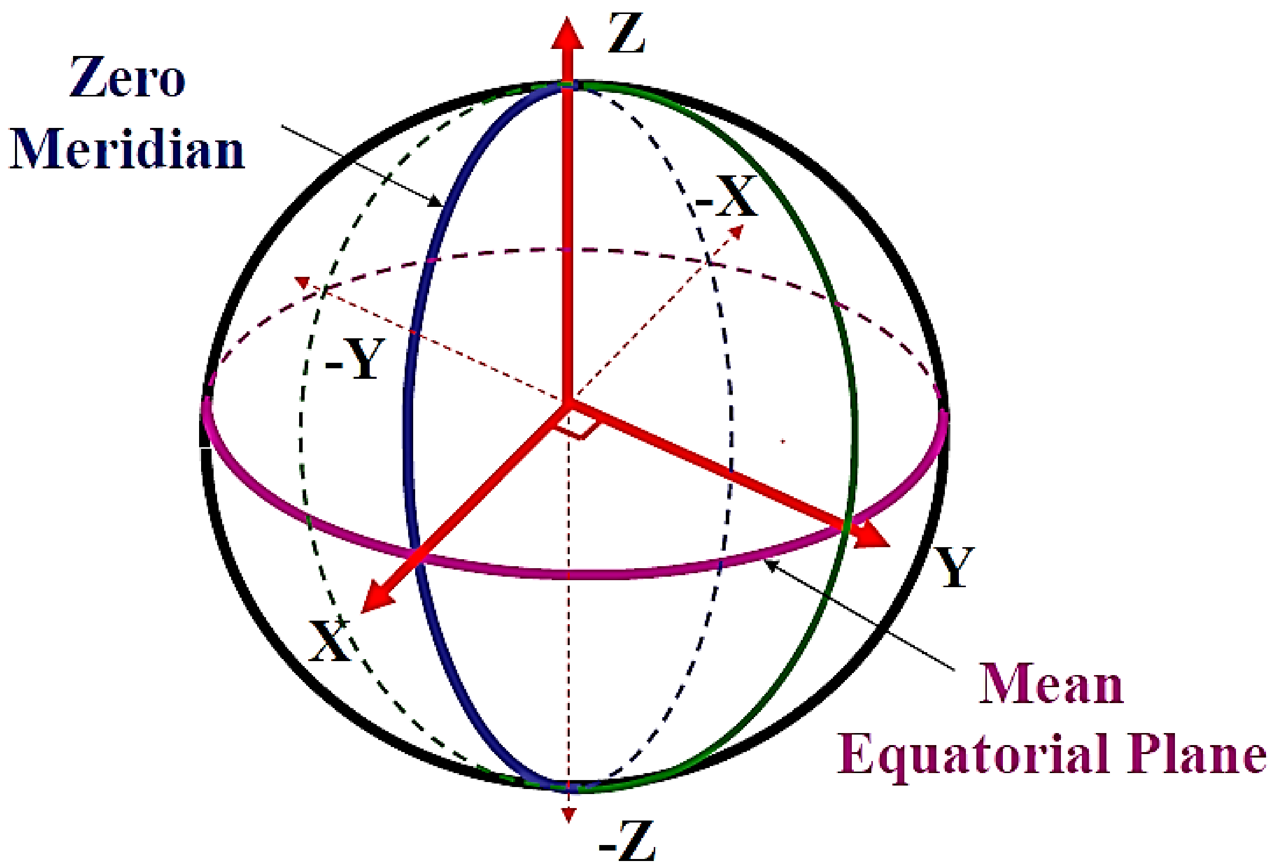
  –Dewhurst, 1990

- Todos lo Datums se basan en un elipsoide de revolución, el cual aproxima la forma de la tierra.

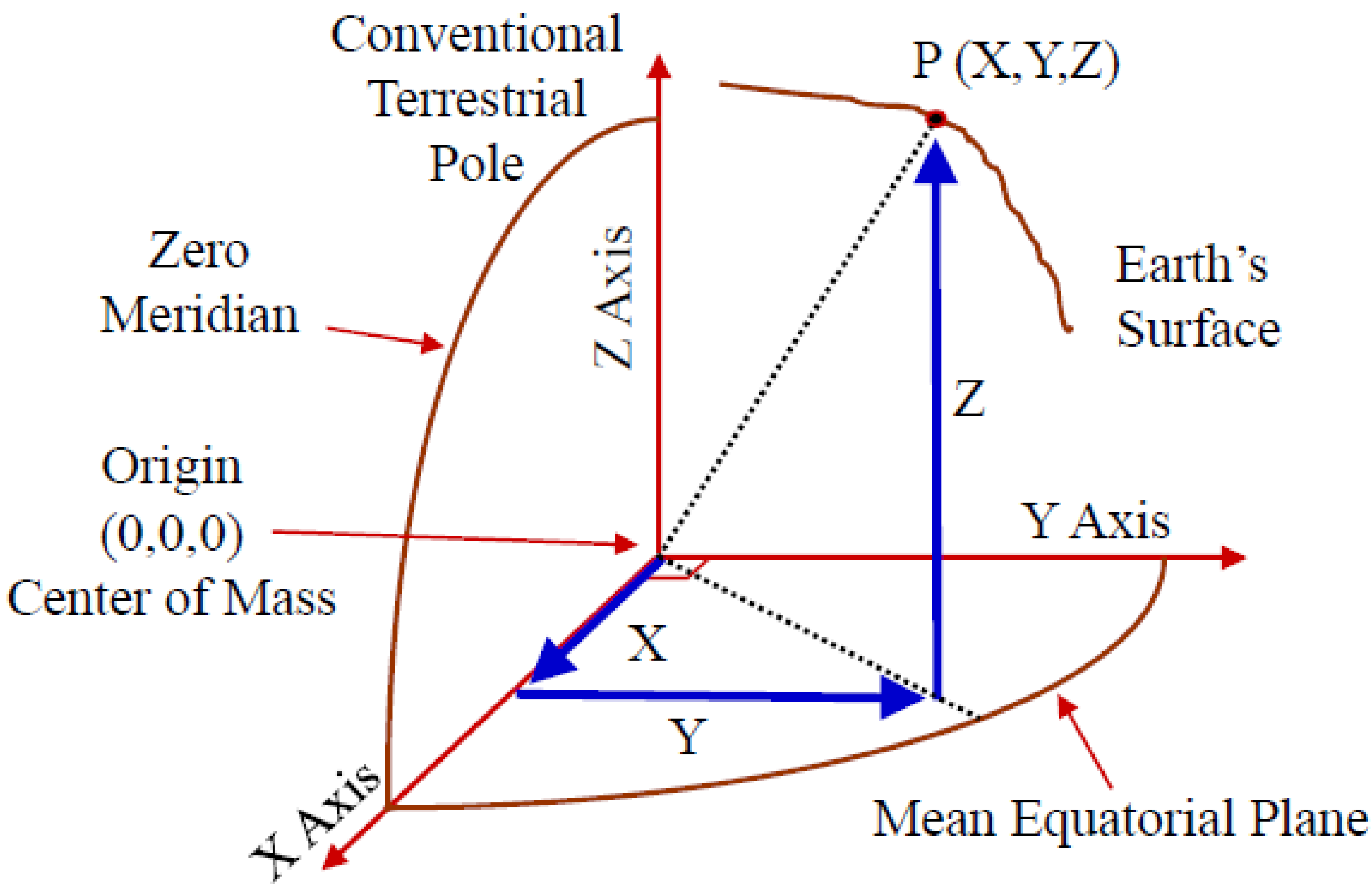
DATUMS Geodésicos

- clásico
  - Horizontal – 2 D (Latitud y Longitud) (por ejemplo, NAD 27, NAD 83 (1986))
  - Vertical – 1 D (Ortométrica) (por ejemplo NGVD 29, NAVD 88)
- contemporáneo
  - Práctico – 3 D (Latitud, Longitud y Altura Elipsoidal) fijo y estable – Coordenadas raramente cambian (por ejemplo, NAD 83 (1996) o NAD 83 (NSR 2007))
  - Científico – 4 D (Latitud, Longitud, Altura Elipsoidal, Velocidad) – Coordina cambian con el tiempo (por ejemplo, ITRF00, ITRF05)

Sistema de Coordenadas Geocentrico
Earth-Center Earth-Fixed (ECEF)
Coordenadas Cartesianas



Sistema de Coordenadas Geocentrico
Earth-Center Earth-Fixed (ECEF)
Coordenadas Cartesianas



Sistema de Coordenadas Geocentrico

Earth-Center Earth-Fixed (ECEF)

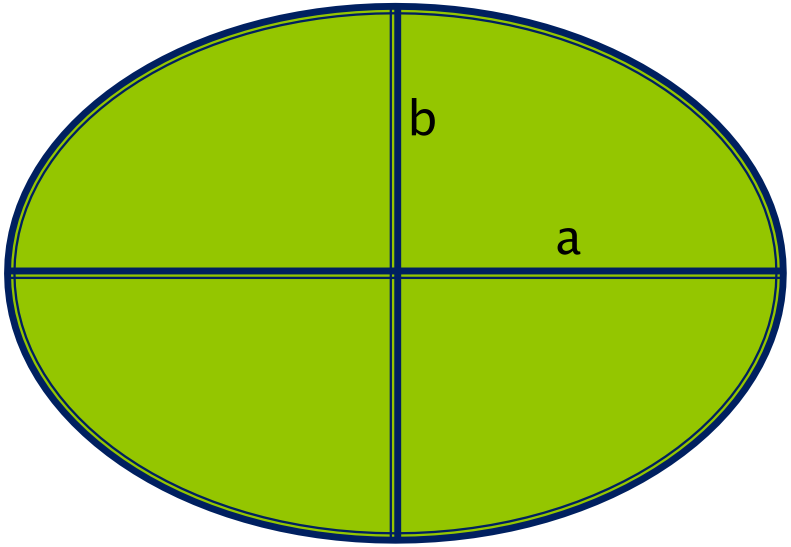
Coordenadas Cartesianas

```
DE5545                               *CURRENT SURVEY CONTROL
DE5545
DE5545* NAD 83(2011) POSITION- 18 26 41.28162(N) 067 08 48.92893(W)   ADJUSTED
DE5545* NAD 83(2011) ELLIP HT-    90.419 (meters)        (06/27/12)   ADJUSTED
DE5545* NAD 83(2011) EPOCH    -  2010.00
DE5545* PRVD02  ORTHO HEIGHT -   134.321  (meters)     440.68  (feet) ADJUSTED
DE5545
DE5545  NAD 83(2011) X   -  2,350,644.204 (meters)                    COMP
DE5545  NAD 83(2011) Y   - -5,577,493.121 (meters)                    COMP
DE5545  NAD 83(2011) Z   -  2,005,175.805 (meters)                    COMP
```

- ECEF XYZ no es práctico para la visualización de puntos en la Superficie de la Tierra.
- ECEF XYZ es la fundación de cada datum geodésico moderno.

Sistema de Coordenadas Geodésico

Superficie Elipsoidal 3D



a = Semieje mayor

b = semieje menor

f = (a-b) / a = Achatamiento

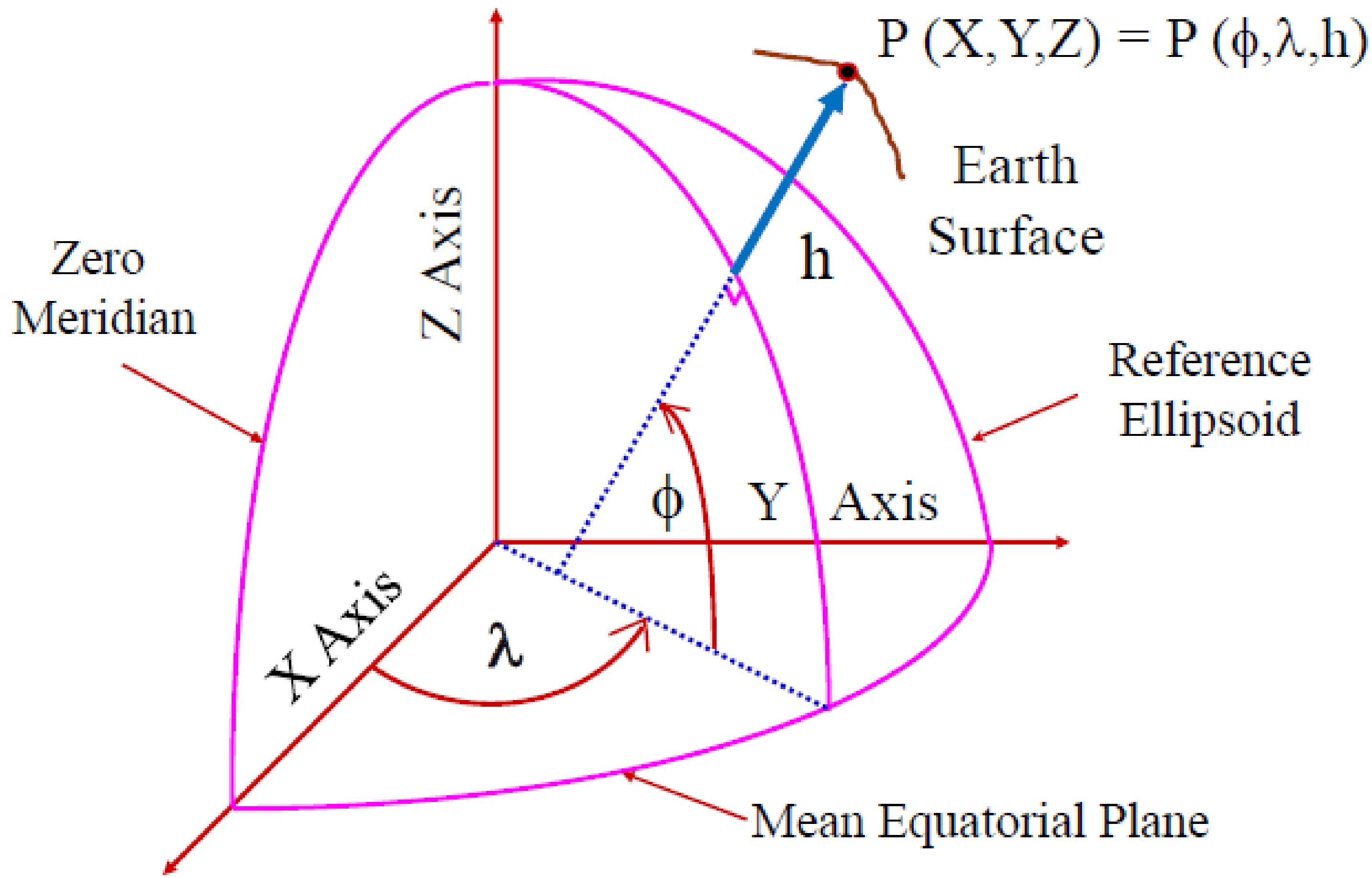
Sistema Geodésico de Referencia 1980

a = 6,378,137.000 metros (semieje mayor)

b = 6,356,752.3141403 m (semieje menor)

1 / f = 298.25722210088 (Achatamiento)

Elementos Geocéntricos y Geodésicos

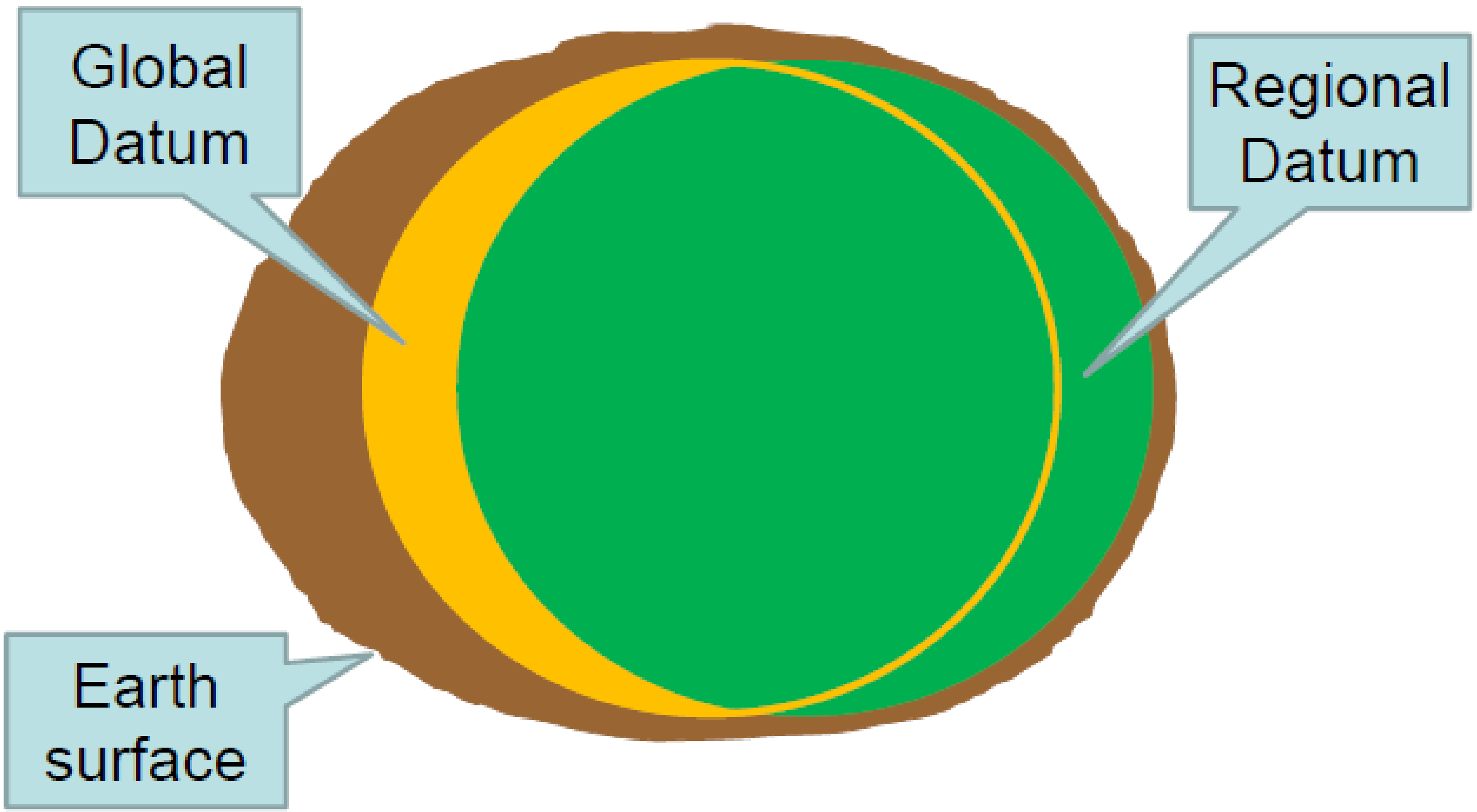


Coordenadas Geodésicas

```
DE5545                           *CURRENT SURVEY CONTROL
DE5545
DE5545* NAD 83(2011) POSITION- 18 26 41.28162(N) 067 08 48.92893(W)   ADJUSTED
DE5545* NAD 83(2011) ELLIP HT-    90.419 (meters)         (06/27/12)   ADJUSTED
DE5545* NAD 83(2011) EPOCH   -  2010.00
DE5545* PRVD02  ORTHO HEIGHT -   134.321  (meters)     440.68   (feet) ADJUSTED
DE5545
DE5545  NAD 83(2011) X  -  2,350,644.204 (meters)                      COMP
DE5545  NAD 83(2011) Y  - -5,577,493.121 (meters)                      COMP
DE5545  NAD 83(2011) Z  -  2,005,175.805 (meters)                      COMP
```

- Coordenadas geodésicas en agrimensura e ingeniería requieren el uso de trigonometría esférica.

Datums: Globales y Regionales



Versiones del NAD83

- Tenga en cuenta la versión de datum en uso!
- Mezclar coordenadas de múltiples ajustes no funcionará.
- No pregunte "¿Dónde estoy?"
- Pregunte "Cuando estoy?"

- 1986 lanzamiento original
  - Basado en datos terrestres solamente
- ajuste de 1997
  - Basado en datos terrestres y de GPS combinados
- ajuste de 2007
  - Basado en posiciones GPS solamente
  - Arreglado a la red de CORS
- Ajuste de 2011
  - Basado en la red de CORS actualizados

DATUM Vertical

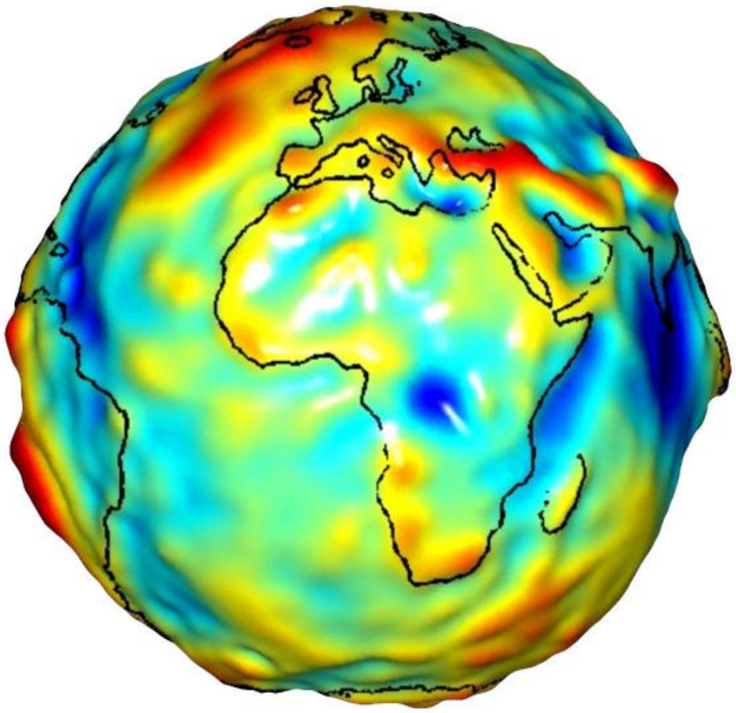
- Un datum vertical es técnicamente, una superficie de elevación cero a la que alturas de diversos puntos se denominan con el fin que esas alturas estén en un sistema coherente. En términos más generales, un datum vertical es todo el sistema de la superficie y los métodos para determinar alturas relativas a la superficie de elevación cero. A través de los años, se han utilizado muchos tipos de datums verticales. Los tipos más dominantes hoy en día son los datums de mareas y los datums geodésicos.

Puerto Rico Vertical Datum of 2002 (PRVD02)

- Puerto Rico Vertical Datum of 2002 (PRVD02) consists of a leveling network on the island of Puerto Rico affixed to a single origin point on the island:
  - Tide Station & Location = 9755371 –San Juan
  - PID = TV1513
  - VM = 1386
  - Bench Mark = 975 5371 A TIDAL
  - Height above LMSL(meters) = 1.334

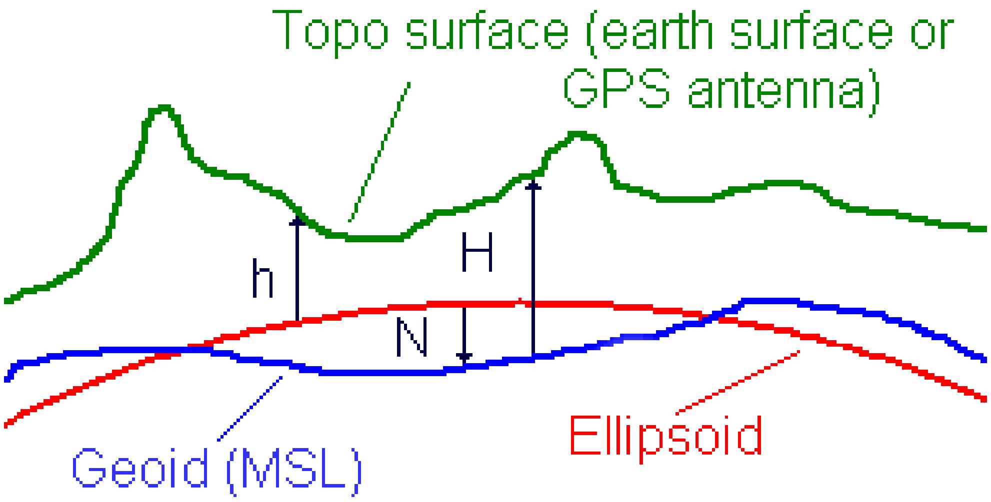
Geoide

- El Geoide es la superficie natural que responde a la atracción de la gravedad, la cual se usa como superficie de referencia pues coincide teóricamente con lo que se denomina el nivel promedio del mar o “mean sea level” (MSL), es decir que nuestras coordenadas que representan las elevaciones se miden desde esa referencia.



Relación de las 3 Superficies

$$h=H+N$$



h=ellipsoid height
H=orthometric height
N=geoid height

Elevaciones

```
DE5545                                *CURRENT SURVEY CONTROL
DE5545
DE5545* NAD 83(2011) POSITION- 18 26 41.28162(N) 067 08 48.92893(W)    ADJUSTED
DE5545* NAD 83(2011) ELLIP HT-     90.419 (meters)         (06/27/12)    ADJUSTED
DE5545* NAD 83(2011) EPOCH    -   2010.00
DE5545* PRVD02   ORTHO HEIGHT -    134.321  (meters)      440.68   (feet) ADJUSTED
DE5545
DE5545  NAD 83(2011) X  -   2,350,644.204 (meters)                       COMP
DE5545  NAD 83(2011) Y  - -5,577,493.121 (meters)                       COMP
DE5545  NAD 83(2011) Z  -   2,005,175.805 (meters)                       COMP
DE5545  LAPLACE CORR    -               3.90  (seconds)                  DEFLEC12A
DE5545  GEOID HEIGHT    -             -43.90  (meters)                   GEOID12A
DE5545  VERT ORDER      -   FIRST     CLASS II
```

$$h = H + N$$

$$90.419 \approx 134.321 + (-43.90) = 90.421$$

Sistemas de Coordenadas

- Por definición son cantidades lineales o angulares, o ambas, que designa la posición de un punto relativo a un marco de referencia.
- Se dividen en agrimensura generalmente en dos:
  - Polares
  - Rectangulares
- Se subdividen en tres clases de coordenadas:
  - Planas
  - Esféricas
  - Espaciales

Sistema de Coordenadas Planas Estatales

El gobierno federal desarrollo el sistema de coordenadas planas estatales para cada estado y sus territorios.

Lambert system		Transverse mercator system		Both
Arkansas	North Dakota	Alabama	Mississippi	Alaska
California	Ohio	Arizona	Missouri	Florida
Colorado	Oklahoma	Delaware	Nevada	New York
Connecticut	Oregon	Georgia	New Hampshire	
Iowa	Pennsylvania	Hawaii	New Jersey	
Kansas	South Carolina	Idaho	New Mexico	
Kentucky	South Dakota	Illinois	Rhode Island	
Louisiana	Tennessee	Indiana	Vermont	
Maryland	Texas	Maine	Wyoming	
Massachusetts	Utah			
Michigan	Virginia			
Minnesota	Washington			
Montana	West Virginia			
Nebraska	Wisconsin			
North Carolina				

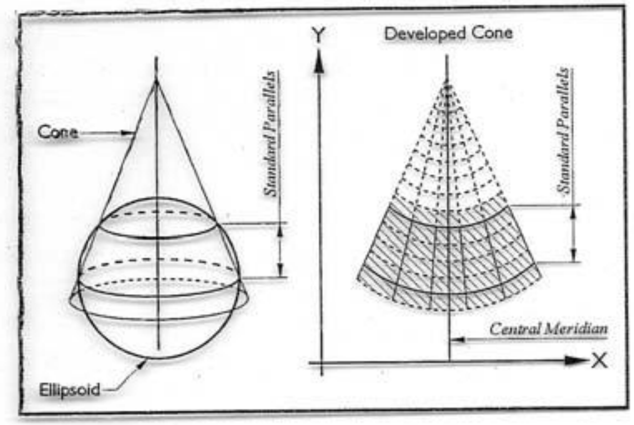


Figure 5.7. Lambert Conic Projection.

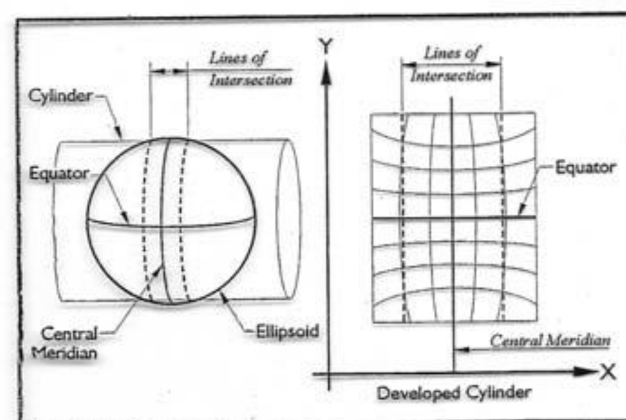


Figure 5.8. Transverse Mercator Projection.

Sistema de Coordenadas Planas Estatales

- En el caso en particular de Puerto Rico e Islas Virgenes se usa la proyección conforme cónica Lambert con dos paralelos standard, teniendo los siguientes parametros para el NAD 83:

$$\phi_N = 18°\text{–}26' \text{ N}$$

$$\phi_S = 18°\text{–}02' \text{ N}$$

$$\phi_0 = 17°\text{–}50' \text{ N}$$

$$\lambda_0 = 66°\text{– } 26' \text{ W}$$

$$N_b = 200{,}000.0 \text{ m}$$

$$E_0 = 200{,}000.0 \text{ m}$$

Universal Transversa Mercator

- Para el sistema Universal Transversa Mercator, mejor conocido por sus siglas en ingles UTM, el globo esta dividido en 60 zonas.
- Cada zona tiene su propio meridiano central del cual se extiende 3 grados al este y 3 grados al oeste. Solapando 30 minutos con las zonas adyacentes.
- El origen de cada zona es en el ecuador y en su meridiano central.
  - El valor dado al meridiano central es un "falso este" igual a 500,000 metros.
  - Cada zona en el Ecuador tiene dos falsos nortes 0 metros para la mitad norte y 10,000,000 metros en la mitad sur.

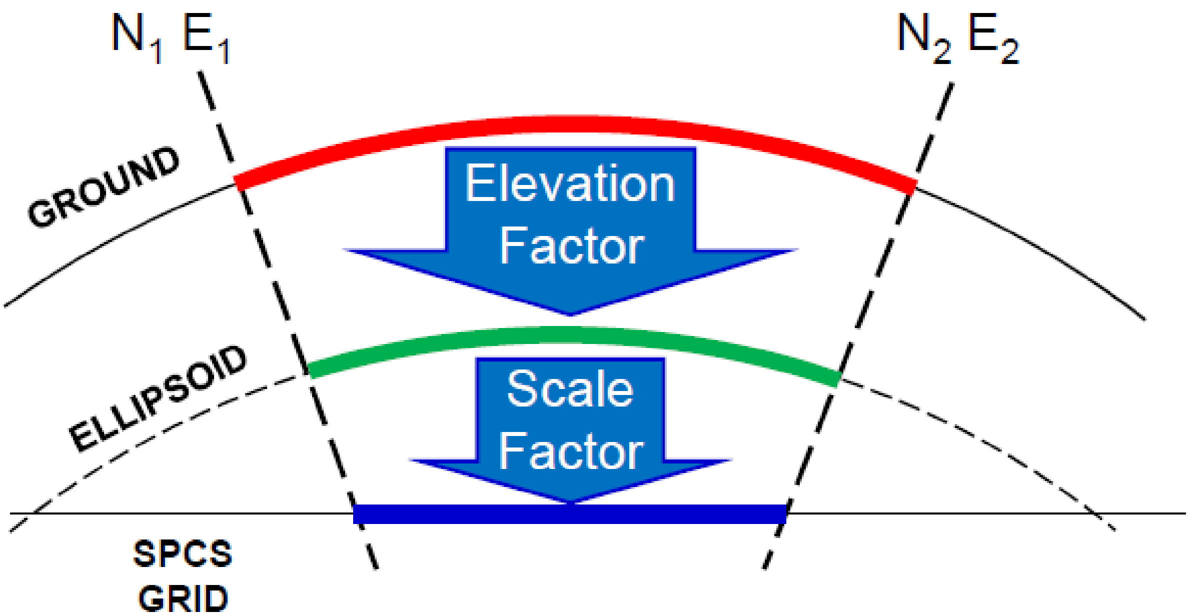
Coordenadas Planas

```
DE5545;                        North          East       Units  Scale Factor Converg.
DE5545;SPC PRVI      -    267,825.272   124,618.993     MT   1.00000071    -0 13 23.8
DE5545;UTM  19       -  2,040,399.206   695,701.169     MT   1.00007349    +0 35 11.3
DE5545
DE5545!              -   Elev Factor  x  Scale Factor  =  Combined Factor
DE5545!SPC PRVI      -    0.99998579  x   1.00000071   =  0.99998650
DE5545!UTM  19       -    0.99998579  x   1.00007349   =  1.00005927
DE5545
```

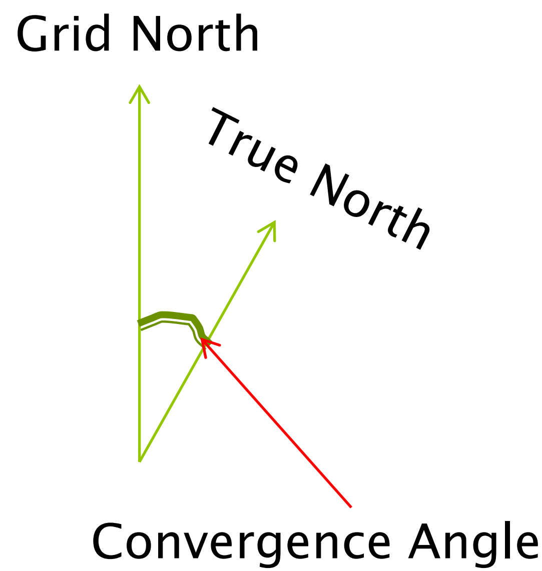
SPCS

UTM

Parámetros de Proyecciones



Ground distance X combined factor = Grid distance



Estudio de Caso

- Miradero
  - Este es un control Horizontal que fue observado por métodos tradicionales. Este fue ajustado por el NGS en el 1997.
  - Su elevación fue obtenida haciendo una nivelación trigonométrica.
  - Su Datum Horizontal es el NAD83(1997).
  - Su Datum Vertical es un Datum local que existía antes del PRVD02 por eso el LMSL (Local Mean Sea Level).
  - En este podemos encontrar dos sistemas de coordenadas el cual es el SPCS y el UTM.

Estudio de Caso Cont.

- GPS 28
  - Este es un control vertical.
  - Las coordenadas horizontales que aparecen fueron obtenidas usando un GPS de mano y tienen una precisión de ± 3m.
  - La elevación fue obtenida con una nivelación diferencial.
  - Su datum horizontal es el NAD83(1986) esto se debe a que el NGS no lo ajusto debido a su precisión.
  - Su datum vertical es el PRVD02.
  - En este caso solo podemos encontrar las coordenadas SPCS.

Estudio de Caso Cont.

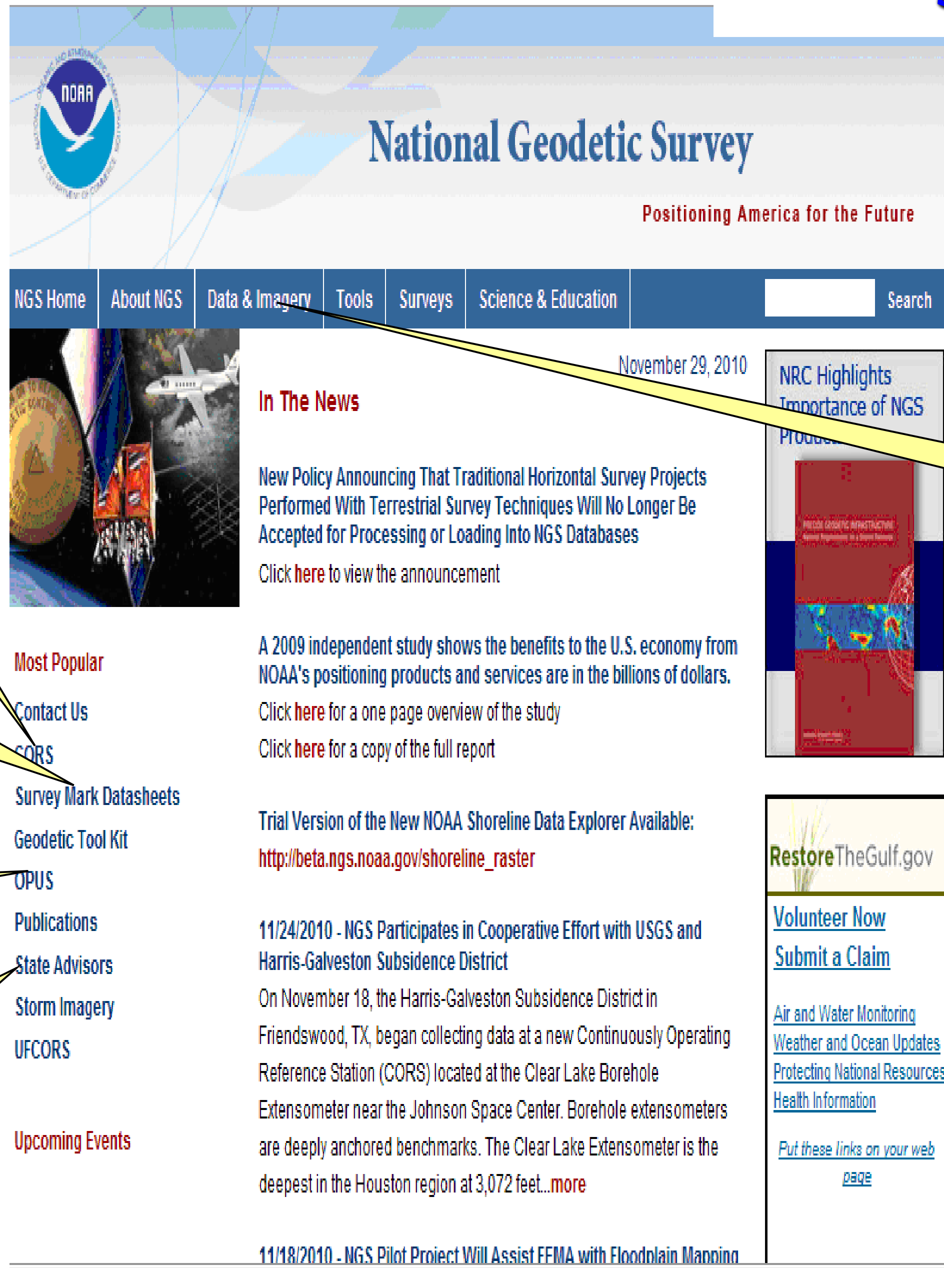
- VELEZ
  - Es un control Horizontal y Vertical.
  - Su elevación fue obtenida realizando una nivelación diferencial.
  - Sus coordenadas fueron obtenidas realizando observaciones de GPS, esta ultima incluye la altura elipsoidal.
  - Su datum vertical es el PRVD02
  - Su datum horizontal es el NAD83(2011)
  - Podemos encontrar los sistemas de coordenadas SPCS y UTM.
  - Un dato interesante es que este control era solamente un control vertical es decir que su precisión era como la de GPS 28, pero con la tecnología de GPS se pudo convertir en un control dual.

Referencias

- http://www.iplsa.org/docs/handouts/S1015B_Horton_NAD83.pdf
- http://www.revistatp.com/
- http://geodesy.noaa.gov/

¿Preguntas?
¡FELIZ NAVIDAD!

www.ngs.noaa.gov



CORS

Data Sheets

OPUS

State Advisors

Data

National Geodetic Survey Home Page

www.ngs.noaa.gov

NGS Data Sheet

NGS DATASHEET PAGE

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updated:11/02/10.14:51:22

Part of the mission of the National Geodetic Survey, is to provide the public with survey control information, such as ***Latitude, Longitude, Height and Gravity Data***. This is done for publishable stations in the form of DATASHEETS.

Click here to see what a DATASHEET looks like.
(or check out the *Tell me more...* link below)

Last change to datasheet format was made on 10/01/07

Click here for information about the similarities and differences between NAD83(NSRS2007) and NAD 83(CORS96)

Retrieval Links	Info Links
DATASHEETS	Tell me more about DATASHEETS
Shapefiles	Tell me more about ShapeFiles
SDTS	Tell me more about SDTS
TIDAL BENCH MARK	Tell me more about TIDAL BENCH MARKS
ARCHIVED DATASHEETS	Tell me more about ARCHIVED DATASHEETS
ARCHIVED ShapeFiles by STATE	Tell me more about ARCHIVED ShapeFiles

Data Sheet Retrieval Page

NGS DATASHEET RETRIEVAL PAGE

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updated:11/02/10.14:51:22

Tell me more about DATASHEET

Retrieval Methods

- PIDs - Permanent Identifiers
- CORS SiteID - CORS Site IDs
- Radial Search - provide center coordinates and radius in Miles
- Rectangular Search - provide min/max coordinates
- Station Name
- Project Identifier
- USGS Quad
- COUNTY
- Load Date
- Map Search - Interactive MAP retrieval.

Data Sheet Retrieval Page

datasheet->BY COUNTY

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updated:11/02/10.14:51:23

Data Sheets can be retrieved by County.

Select a State to get a County listing...

Pick a State:

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OHIO
OKLAHOMA
OREGON
PENNSYLVANIA
PUERTO RICO

Get County List | Reset

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Web site owner: National Geodetic Survey (NGS),
National Oceanic & Atmospheric Administration (NOAA)

Data Sheet Retrieval Page

Pick a County

ST	Cty	County Name
PR	001	ADJUNTAS
PR	003	AGUADA
PR	005	AGUADILLA
PR	007	AGUAS BUENAS
PR	009	AIBONITO
PR	011	ANASCO
PR	013	ARECIBO
PR	015	ARROYO

Data Type Desired:

Any Horz. and/or Vert. Control
GPS Sites Only
Any Horizontal Control
Horizontal Order-A

Stability Desired:

Any Stability
Stability A only
Stability B or better
Stability C or better

Output in East Longitude.
Include suspect heights in subsidence areas
Browse Mode

Get Marks

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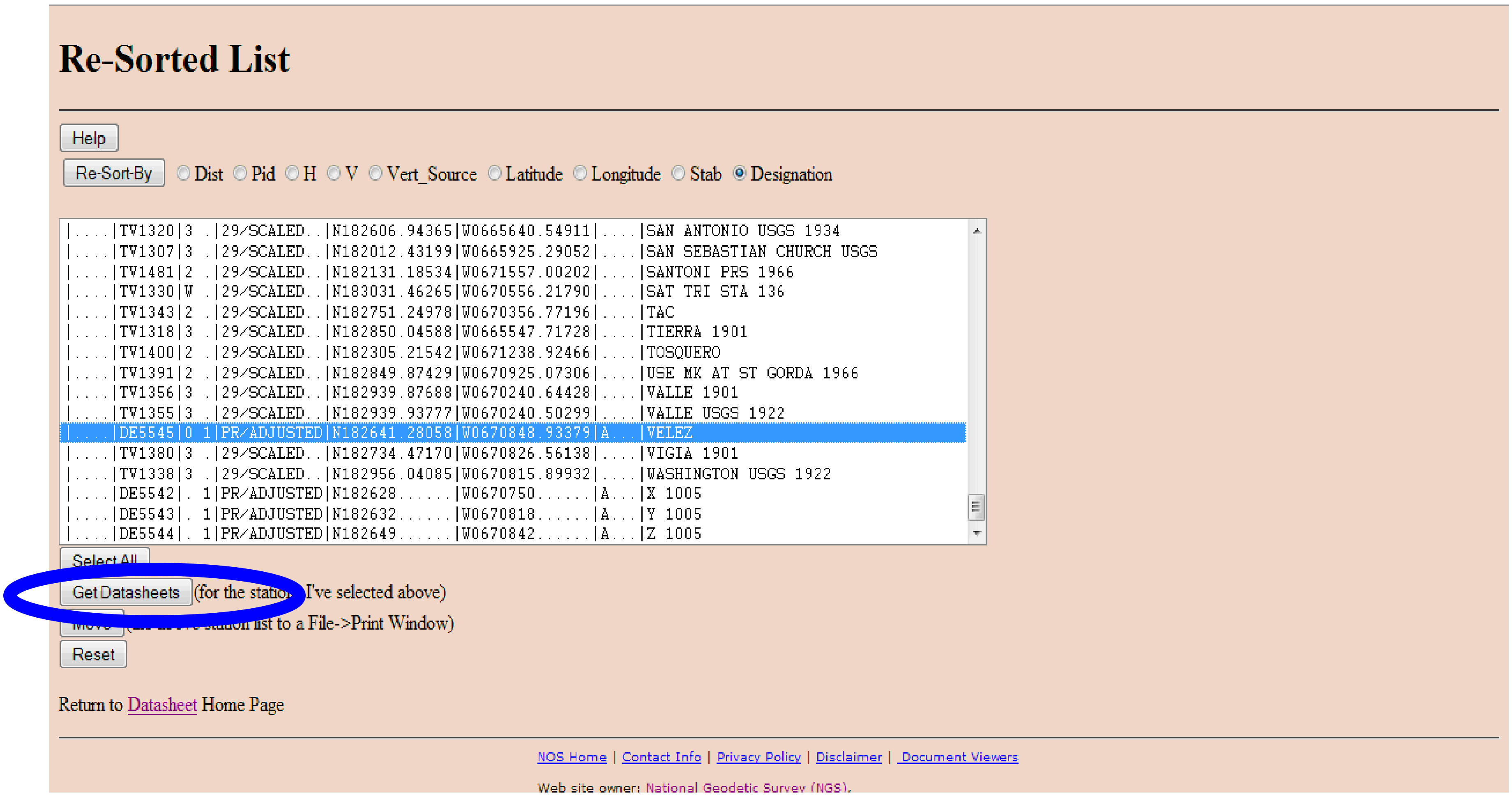
Data Sheet Retrieval Page



The NGS Data Sheet

See file dsdata.txt for more information about the datasheet.

```
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1        National Geodetic Survey,   Retrieval Date = OCTOBER 28, 2013
 DE5545 ***********************************************************************
 DE5545  DESIGNATION -  VELEZ
 DE5545  PID         -  DE5545
 DE5545  STATE/COUNTY-  PR/AGUADILLA
 DE5545  COUNTRY     -  US
 DE5545  USGS QUAD   -
 DE5545
 DE5545                       *CURRENT SURVEY CONTROL
 DE5545  ______________________________________________________________________
 DE5545* NAD 83(2011) POSITION- 18 26 41.28162(N) 067 08 48.92893(W)   ADJUSTED
 DE5545* NAD 83(2011) ELLIP HT-    90.419 (meters)        (06/27/12)   ADJUSTED
 DE5545* NAD 83(2011) EPOCH    -  2010.00
 DE5545* PRVD02  ORTHO HEIGHT -   134.321  (meters)     440.68  (feet) ADJUSTED
 DE5545  ______________________________________________________________________
 DE5545  NAD 83(2011) X  -  2,350,644.204 (meters)                     COMP
 DE5545  NAD 83(2011) Y  - -5,577,493.121 (meters)                     COMP
 DE5545  NAD 83(2011) Z  -  2,005,175.805 (meters)                     COMP
 DE5545  LAPLACE CORR    -          3.90  (seconds)                    DEFLEC12A
 DE5545  GEOID HEIGHT    -        -43.90  (meters)                     GEOID12A
 DE5545  VERT ORDER      -  FIRST     CLASS II
 DE5545
 DE5545  FGDC Geospatial Positioning Accuracy Standards (95% confidence, cm)
 DE5545  Type                                          Horiz  Ellip  Dist(km)
 DE5545  -------------------------------------------------------------------
 DE5545  NETWORK                                        1.10   1.65
 DE5545  -------------------------------------------------------------------
 DE5545  MEDIAN LOCAL ACCURACY AND DIST (002 points)    1.02   0.82     65.27
 DE5545  -------------------------------------------------------------------
 DE5545  NOTE: Click here for information on individual local accuracy
 DE5545  values and other accuracy information.
 DE5545
```
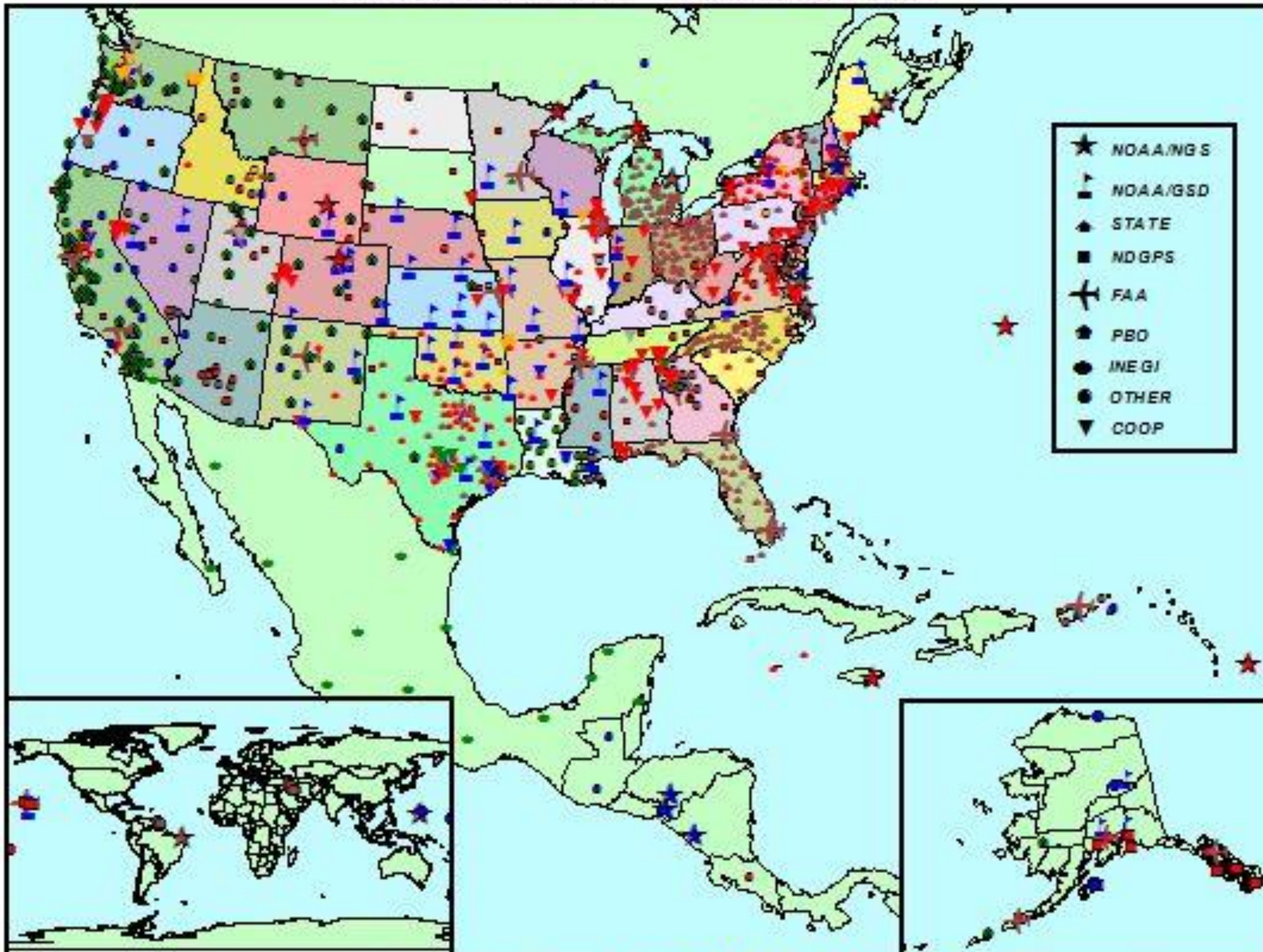

The NGS Data Sheet

See file dsdata.txt for more information about the datasheet.

```
PROGRAM = datasheet95, VERSION = 8.3
1        National Geodetic Survey,   Retrieval Date = OCTOBER 28, 2013
 DE5545 ***********************************************************************
 DE5545  DESIGNATION -  VELEZ
 DE5545  PID         -  DE5545
 DE5545  STATE/COUNTY-  PR/AGUADILLA
 DE5545  COUNTRY     -  US
 DE5545  USGS QUAD   -
 DE5545
 DE5545                        *CURRENT SURVEY CONTROL
 DE5545  ______________________________________________________________________
 DE5545* NAD 83(2011) POSITION- 18 26 41.28162(N) 067 08 48.92893(W)   ADJUSTED
 DE5545* NAD 83(2011) ELLIP HT-    90.419 (meters)        (06/27/12)   ADJUSTED
 DE5545* NAD 83(2011) EPOCH   -  2010.00
 DE5545* PRVD02  ORTHO HEIGHT -   134.321  (meters)     440.68  (feet) ADJUSTED
 DE5545  ______________________________________________________________________
 DE5545  NAD 83(2011) X  -  2,350,644.204 (meters)                     COMP
 DE5545  NAD 83(2011) Y  - -5,577,493.121 (meters)                     COMP
 DE5545  NAD 83(2011) Z  -  2,005,175.805 (meters)                     COMP
 DE5545  LAPLACE CORR    -          3.90  (seconds)                    DEFLEC12A
 DE5545  GEOID HEIGHT    -        -43.90  (meters)                     GEOID12A
 DE5545  VERT ORDER      -  FIRST     CLASS II
 DE5545
 DE5545  FGDC Geospatial Positioning Accuracy Standards (95% confidence, cm)
 DE5545  Type                                        Horiz  Ellip  Dist(km)
 DE5545  -------------------------------------------------------------------
 DE5545  NETWORK                                      1.10   1.65
 DE5545  -------------------------------------------------------------------
 DE5545  MEDIAN LOCAL ACCURACY AND DIST (002 points)  1.02   0.82     65.27
 DE5545  -------------------------------------------------------------------
 DE5545  NOTE: Click here for information on individual local accuracy
 DE5545  values and other accuracy information.
 DE5545
 DE5545
 DE5545.The horizontal coordinates were established by GPS observations
 DE5545.and adjusted by the National Geodetic Survey in June 2012.
 DE5545
 DE5545.NAD 83(2011) refers to NAD 83 coordinates where the reference
 DE5545.frame has been affixed to the stable North American tectonic plate. See
 DE5545.NA2011 for more information.
 DE5545
 DE5545.The horizontal coordinates are valid at the epoch date displayed above
 DE5545.which is a decimal equivalence of Year/Month/Day.
 DE5545
 DE5545.The orthometric height was determined by differential leveling and
 DE5545.adjusted by the NATIONAL GEODETIC SURVEY
 DE5545.in July 2013.
 DE5545
 DE5545.Photographs are available for this station.
 DE5545
 DE5545.The X, Y, and Z were computed from the position and the ellipsoidal ht.
 DE5545
 DE5545.The Laplace correction was computed from DEFLEC12A derived deflections.
 DE5545
 DE5545.The ellipsoidal height was determined by GPS observations
 DE5545.and is referenced to NAD 83.
 DE5545
 DE5545. The following values were computed from the NAD 83(2011) position.
```

```
orth         East      Units Scale Factor Converg.
825.272   124,618.993   MT  1.00000071   -0 13 23.8
399.206   695,701.169   MT  1.00007349   +0 35 11.3

Factor  x  Scale Factor =   Combined Factor
998579  x   1.00000071  =   0.99998650
998579  x   1.00007349  =   1.00005927

    SUPERSEDED SURVEY CONTROL

 41.28058(N)    067 08 48.93379(W) AD(2002.00) 0
 90.388  (m)                       GP(2002.00)
 41.28060(N)    067 08 48.93357(W) AD(        ) B
 90.416  (m)                       GP(        ) 3 1

 not recommended for survey control.

 projects to the PR datum.
o determine how the superseded data were derived.

ATIAL ADDRESS: 19QFA9570140399(NAD 83)                              AIGN

 CONTROL DISK
ROCK OUTCROP


ETIC MATERIAL
ELIABLE AND EXPECTED TO HOLD
LEVATION WELL
OCATION WAS REPORTED AS SUITABLE FOR
OBSERVATIONS - May 18, 2013

   Condition        Report By
   MONUMENTED       NGS
11 GOOD             UPRM
26 GOOD             UPRM
12 GOOD             RLDA
26 GOOD             NGS
18 GOOD             ATKNA

    STATION DESCRIPTION

 GEODETIC SURVEY 2002 (JMW)
STERLY ALONG STATE HIGHWAY 107  FROM THE
HWAY 2 IN AGUADILLA, SET IN A 1 BY 2-FOOT AREA
K NEAR THE CENTER OF A ROADSIDE PARK, 31.8 M
F A STREET, 31.7 M SOUTHWEST OF A UTILITY POLE
CENTER OF    A CONNECTING ROAD FROM THE HIGHWAY
WAY 107, 18.8 M SOUTHEAST OF A UTILITY POLE,
NTER OF A SIDEWALK, 11.4 M WEST OF THE CENTER OF
UTH OF THE CENTER OF A SIDEWALK, 7.3 M NORTHEAST
DEWALK, AND 0.4 M BELOW THE LEVEL OF THE ROAD.
THE HIGHWAY RIGHT-OF-WAY.

    STATION RECOVERY (2004)

ERSITY OF PUERTO RICO AT MAYAGUEZ 2004 (LLV)
D.

    STATION RECOVERY (2007)

DE5545'RECOVERY NOTE BY UNIVERSITY OF PUERTO RICO AT MAYAGUEZ 2007
```

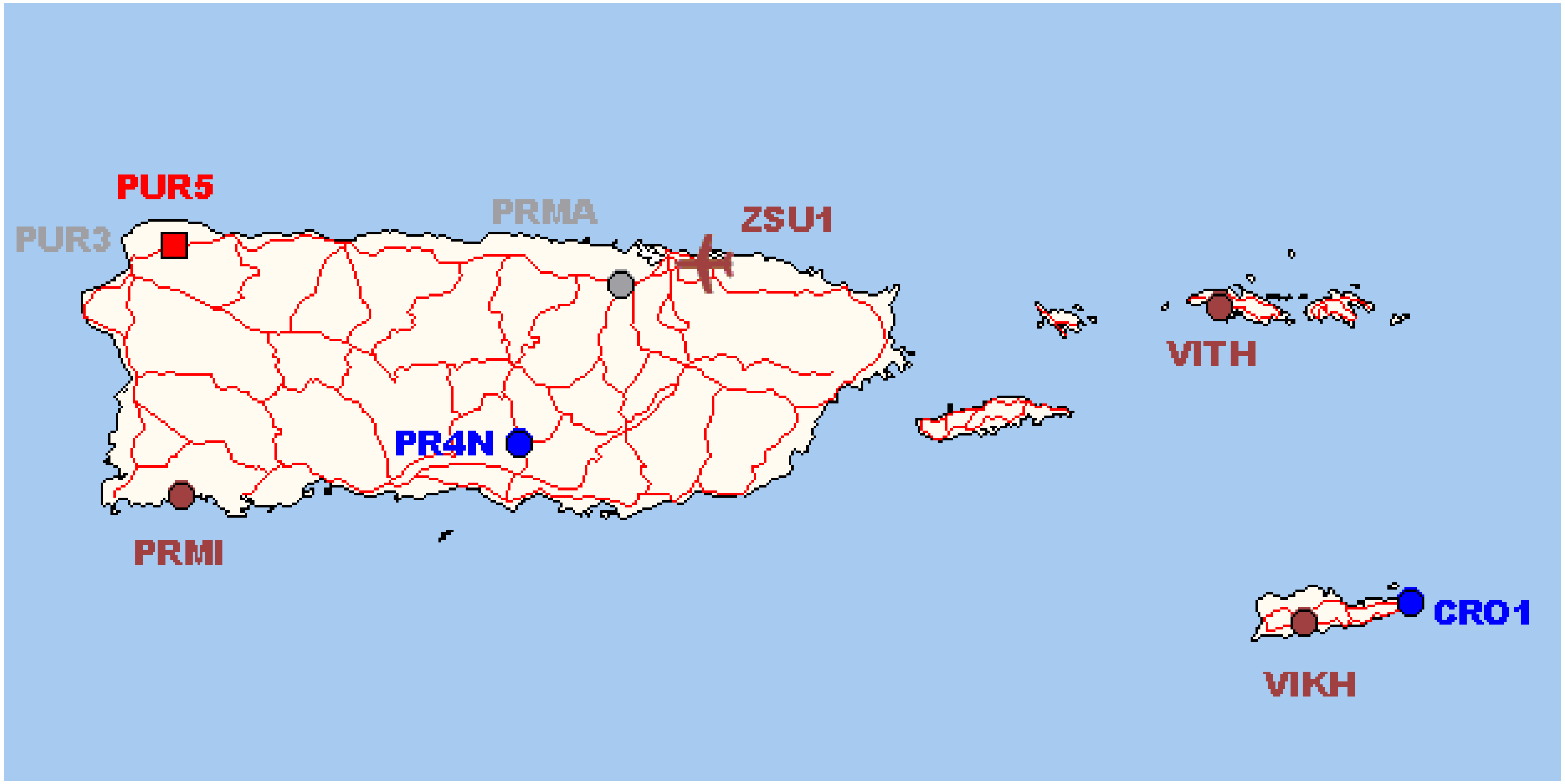
CORS Coverage - February 2007



Symbol color denotes sampling rates:(1 sec)(5 sec)(10 sec)(15 sec)(30 sec)(Decommissioned)

Craig 2/15/2007

REGIONAL CORS NETWORK




CORS Map
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Surveys
Science & Education
Search
Sampling Rate Map
Help
Show/Hide Legend
Zoom to CORS:
Site ID:
Go
Cursor Lat/Lon :
17.19128 , -63.63491
Three Nearest Sites :
SMRT 109.96 km
CRO1 118.83 km
VIKH 136.64 km
Enter a location
Go
Place X
17.1913,-63.6349
Map
Satellite
250 km radius
** To filter sites click on icons **
GPS
GNSS
All
1 sec rate
5 sec rate
15 sec rate
30 sec rate
All Active
All Non-Operational
Decommissioned
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Isabela
Arecibo
Manati
San Juan
Aguadilla
Bayamón
Carolina
Desecheo National Wildlife Refuge
Castaner
Caguas
Naguabo
Hormigueros
Yauco
Humacao
Yabucoa
Ponce
Charlotte Amalie
British Virgin Islands
Virgin Islands
Basseterre
Google
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VRS-Virtual Reference Station

UTILIZA 7 ESTACIONES DE CORS, LOCALIZADAS ALREDEDOR DE LA ISLA
STATIONS ID: PRN4, PRHL, PRAR, PRJC, PRLP, PRLT & PRGY.

VRS-Virtual Reference Station

PRN4 – COAMO, PR

LATITUD:18° 04’ 42.92575”N
LONGITUD:66 ° 22’ 08.70442” W
ALTURA ELIPSOIDAL: 129.182 m

VRS-Virtual Reference Station

PRHL – BAYAMON, PR

LATITUD:18 ° 22’ 48.10181” N
LONGITUD:66 ° 09’ 12.81178” W
ALTURA ELIPSOIDAL = -24.417 m

VRS-Virtual Reference Station

PRAR – ARECIBO, PR

LATITUD:18 ° 27’ 01.71569” N
LONGITUD:66 ° 38’ 50.72314” W
ALTURA ELIPSOIDAL = -20.436 m

VRS-Virtual Reference Station

PRJC – SAN SEBASTIAN, PR

LATITUD:18 ° 20’ 32.03448” N
LONGITUD:66 ° 59’ 58.19397” W
ALTURA ELIPSOIDAL = 22.850 m

VRS-Virtual Reference Station

PRLP – LAS PIEDRAS, PR

LATITUD:18° 11’ 41.63831” N
LONGITUD:65 ° 52’ 05.75000” W
ALTURA ELIPSOIDAL: 57.012 m

VRS-Virtual Reference Station

PRLT – CABO ROJO, PR

LATITUD:18° 03’ 35.41040” N
LONGITUD:67 ° 11’ 20.88131” W
ALTURA ELIPSOIDAL: -15.238 m

VRS-Virtual Reference Station

PRGY – GUAYANILLA, PR

LATITUD:18° 03’ 03.42137” N

LONGITUD: 66 ° 48’ 51.96843” W

ALTURA ELIPSOIDAL: 33.862 m

National Geodetic Survey Home Page

www.ngs.noaa.gov

What is OPUS?

- On-Line Positioning User Service
- Processes GPS data
- Global availability (masked)
- 3 goals:
  - Simplicity
  - Consistency
  - Reliability

OPUS: Online Positioning User Service

upload | view | about

compute an accurate position for your GPS data file

1. enter your em[…]
2. attach your D[…]
   Seleccionar arc[…]
3. select your an[…]
   NONE
4. add your ante[…]
   0.0

You've got mail!

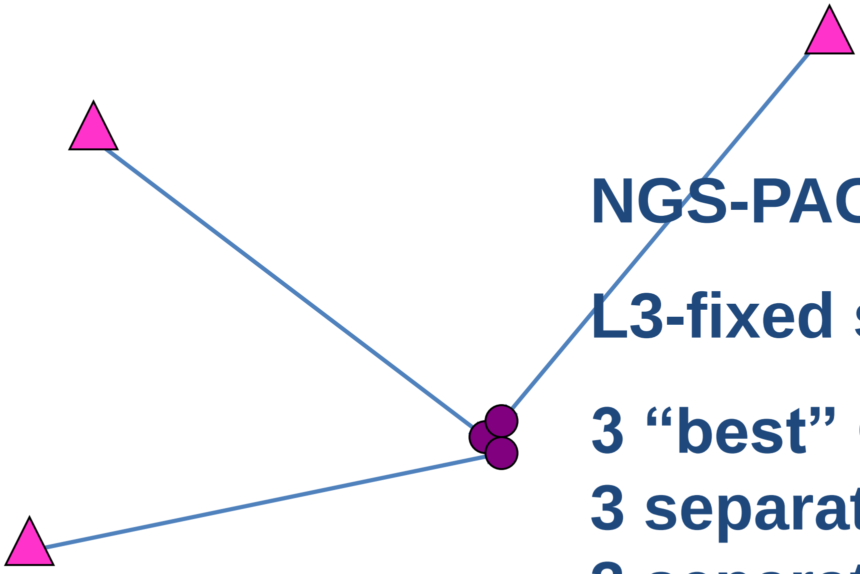
OPUS solution

5b. choose a processor

Upload to RAPID-STATIC for data > 15 min. < 2 hrs.

Upload to STATIC for data > 2 hrs. < 48 hrs.

How Does OPUS Compute Position?



NGS-PAGES software used

L3-fixed solution w/ tropo adjusted

3 “best” CORS selected
3 separate baselines computed
3 separate positions averaged

Position differences also include any errors in CORS coordinates