# Grids & Datums

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## THE REPUBLIC OF IRELAND

The Grids & Datums column has completed an exploration of every country on the Earth. For those who did not get to enjoy this world tour the first time, *PE&RS* is reprinting prior articles from the column. This month's article on the Republic of Ireland was originally printed in 1999 but contains updates to their coordinate system since then.

This month's topic features both the Republic of Ireland and Northern Ireland. The island was invaded by the Celts around 500 *BC*, and was converted to Christianity in the 5th century *AD* by Saint Patrick. Boundary maps in Ireland were made to accompany the "terriers" (property records) of the surveys in 1636-40 by order of Lord Strafford, Viceroy of Ireland. In 1654-59, the "Down Survey" comprised maps of the "townlands" averaging 300 acres each and baronies totaling over two-thirds of the surface of Ireland, about 20,000,000 acres. The Ordnance Survey was established in 1791 to produce national mapping, this included all of Ireland. The need for an accurate map of Ireland was brought to the fore in the 1800's by problems with a local tax, known as the "County Cess." In 1824, the committee chaired by Thomas Spring Rice recommended to the (British) House of Commons that a survey of Ireland was required to provide a definitive indication of acreages and ratable values for the purpose of establishing local taxes in Ireland. That same year, Colonel (later Major General) Thomas Colby of the Ordnance Survey received orders to proceed with the work of triangulation and Six Inch (6" = 1 mile) topographical surveys for all of Ireland.



"Reaction to the Engineers bythe local people was mixed but generally they were regarded with suspicion. A particular nuisance was the removal by local people of the poles, set up as targets on mountains, before the surveyors had a chance to observe them and, in one case, the observers were attacked. However, by contrast, in Glenomara, County Clare, the people climbed the


mountain with them in a great crowd, with flutes, pipes and fiddles, treating the building of the trigonometrical station as a festive occasion."

The initial baseline for the Irish survey was selected by Colby at the Plain of Magelligan near Lough Foyle in Londonderry. Colby decided to use the principle of compensation for the manufacture of the baseline measuring apparatus. The principle was to use two metal bars, one of brass and one of iron, which were placed 11/8 inches apart but joined rigidly to each other at their centers. The bars were allowed to expand or contract freely, with pivoted steel tongues fixed to both bars at their ends. These were marked with silver pins, and although the length of the bars changed with temperature, the distance between the two pins remained constant. Six sets of bars were made, each just over 10 feet long. The baseline of nearly 8 miles was measured over 1827-1828. The

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Lough Foyle Base was remeasured in 1960 using electronic distance measuring equipment, with a difference found to Colby's original measurement of only 1 inch!

The One Inch Map (1" = 1 mile) of Ireland was cast on the ellipsoidal Bonne projection in 1850 which was the projection in vogue throughout Europe at the time. Also used for the ½ inch series and some 9 inch sheets, the Latitude of Origin ($\varphi_o$) = 53° 30´ North, and the Central Meridian ($\lambda_o$) = 8° 00´ West of Greenwich. The Airy 1830 ellipsoid was used where a = 6,377,563.396 meters and $^1/_f$ = 299.3. The radius of the mean parallel used for the Bonne was 13,361,612.2 feet.

The topographic surveying demanded greater accuracy than the methods used for the One Inch Map. Colby issued an instruction (specifications) in what became known as the "Colonel's Blue Book." Note that in the United States, the current (1999) specifications for note keeping for acceptance of data by the Federal Geodetic Control Committee is based on the "Blue Book." However, Colby's annual reports were also termed the same. In 1838, with the Irish survey on a firm footing, Colby returned to England and turned his attention to the survey of Great Britain. Sir Thomas A. Larcom, KCB was the Officer in Charge at Mountjoy, Dublin from 1828 to 1846. The final cost was £820,000 (more than twice the original estimate of time and money), but the Survey of Ireland served as a model for the remainder of Great Britain.

In 1858, Captain Alexander Ross Clarke (the same fellow that computed his ellipsoids of 1858, 1866, and 1880), selected the observations to be used in the adjustment. Clarke's interlocking network of "well conditioned" triangles is now known as the "Principal Triangulation of Ireland (1824-1832)." Clarke rigorously adjusted the observations by the method of least squares in 21 independently computed but connected blocks with the aid of an average of 8 computers (persons). Note that in 1881, Colonel A. R. Clarke, R.E. received a forced retirement from the Ordnance Survey of Great Britain rather than accept a post to the island of Mauritius which was this column's topic last month. Clarke was 52 years old at the time. For the remaining 30 years of his life, he published no further scientific work.

In the meantime, some form of framework was required on which to control the new mapping at the scale of six inches to one mile. Six Inch Map control was therefore based on a network of secondary and tertiary blocks of triangulation, begun in 1832 and completed in 1841, just ahead of the chain survey teams who were surveying the detail. One Inch Map control began in 1852, and 25 Inch Map control began in 1888. Although these lower order control points included five of Clarke's points, they were based only on provisional coordinates. In Northern Ireland, the coordinates of the origins of Counties Down and Armagh were in general agreement with the values deduced from the Principal Triangulation. In the other four counties they were about 80 feet too far south and 25 feet too far west. Unlike the aphylactic sheet system used in the United States with the Polyconic Projection, each Irish County had its own central meridian as a true "Grid" about a single point of origin. There were 26 County Cassini-Soldner Grids in what is now the Republic of Ireland, and an additional 6 were in Northern Ireland. Of these coordinate origins, 16 were based on church towers and spires, two were observatories, two were "round towers" (ancient defensive stone structures from various wars), and a number were on mountains and at monuments. Printed sheets had neither grid nor graticule. This system of local (county) Cassini-Soldner coordinates was also used in England, and was later adopted for the "Meridional Circuits" of New Zealand. An observation on the practicality of this seemingly haphazard method of mapping stated: *"When the map of Ireland is picked up and shaken, it is only the mathematician who hears the rattle."* This system of provisional coordinates resulted in the County Coordinates being in active use for over one hundred years. The Irish Grid, based on a single Cassini-Soldner projection for the entire island was used from 1936 to 1956.

The Ordnance Survey of Northern Ireland (U.K.) was set up in 1921, and the Irish Free State occupying five sixths of the number of counties was established in 1922. The boundary between the two was settled in 1925. Eire declared itself completely independent in 1937, and was renamed the Republic of Ireland in 1949. The funds for first and second order re-triangulations of Northern Ireland were authorized in 1947 and the survey was completed in 1956. The first order re-triangulation of Ireland was carried out between 1962 and 1964. Ordnance Survey of Northern Ireland (Belfast) did not adopt the 1965 adjustment values for subsequent mapping, whereas Ordnance Survey of Ireland (Dublin) did. A fascinating result of the adjustments was the "Airy Modified" ellipsoid where the semi-major axis was changed to 6,377,340.189 meters! This was done to best accommodate previous published maps and coordinates, and, thus, the ellipsoid was reduced by 35 parts per million. In the days when Grid-to-Graticule Tables were used, this was very important. The Gauss-Krüger Transverse Mercator projection Irish National Grid was adopted as a replacement for the old Cassini-Soldner Irish Grid. The defining parameters include No and 8o being the same as the old Bonne (and Cassini-Soldner) Grids, False Easting = 200 km., False Northing = 250 km., and the Scale Factor at Origin ($m_o$) = 1.000035. (Notice the "35" in the scale factor.)

A subsequent adjustment was performed in 1975 which was designed to provide a common coordinate system for the whole of Ireland for mapping purposes. The Northern Ireland primary stations were held completely fixed. The Ireland Datum of 1975 origin is at Slieve Donard (new) where: $\Phi_o$ = 54° 10´ 48.262˝ North, and $\Lambda_o$ = 05° 55´ 11.898˝ West of Greenwich. Various other datums used for scientific purposes include: the Ordnance Survey of Great Britain Scientific Network of 1970 (OGSB SN 1970), OGSB (SN) 80, ED50, ED87, and WGS84. The latest major campaign, IRENET 95, provides European Terrestrial Reference Frame (ETRF 89) coordinates for a network throughout Ireland.

Compatibility between the existing Irish National Grid and ETRF 89 has been developed in three levels. The first level will provide a simple Easting and Northing coordinate shift between the old Grid and the new Grid and have an accuracy of better than ±5 meters relative to the new geodetic framework. The second level will provide a 7-parameter

Helmert (geocentric) transformation estimated to be better than ±2 meters relative to the new geodetic framework. The third level will be a polynomial algorithm with an accuracy of better than ±0.2 meters relative to the new geodetic framework. A new National Grid is contemplated based on the GRS80 ellipsoid, and may be the UTM (Zones 29 & 30).

The Malin Head Vertical Datum of 1970 is the current system for all 1:50,000 mapping in Ireland. Earlier maps used the low water mark of the spring tide on the 8th of April, 1837 at Poolbeg Lighthouse, Dublin Bay. The Malin Head (County Donegal) Datum is approximately 2.71 meters above the Poolbeg Lighthouse Datum. All large scale mapping in Northern Ireland uses mean sea level at Belfast which is 0.037 meters below the Malin Head Datum.

# Update

The Ordnance Survey of Ireland now has a Co-ordnate (sic) Converter that will interactively convert the following co-ordinate reference systems: WGS84 (World Geodetic System 1984) / ETRF89 (European Terrestrial Reference Frame 1989), Irish Grid, ITM (Irish Transverse Mercator), UTM (Universal Transverse Mercator). OSGM15 and OSTN15 have updated transformations for UK and Ireland. The Ordnance Survey of Great Britain (OSGB), Ireland (OSi) and Land & Property Services (LPS – Formerly OSNI) have collaborated again to improve the OSGM02 geoid model covering the United Kingdom and Ireland. A new Geoid model OSGM15 was launched on the 26th of August 2016.

The polynomial transformation for Ireland and Northern Ireland has not changed however there are solutions available for download. Grid Inquest II took over from Grid Inquest I on the 26th of August 2016.

Windows32-GridInQuestII-0100

Windows64-GridInQuestII-0100

OSX-GridInQuestII-0100

Linux32-GridInQuestII-0100

Linux64-GridInQuestII-0100

There is also a developers pack available to download.

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**Book Review**

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and monitoring of wetlands. Chapters Six through Ten in Section Two (*"Summaries of Remote Sensing technologies and Their Application for Mapping Wetlands"*) are each devoted to summarizing remote sensing technologies applied to wetland mapping – such as SAR, InSAR, radar/optical image fusion, OBIA and the use of the now pervasive UAS for wetland mapping, and present a solid treatment of the theoretical underpinnings of each technology.

Section Three (*"Applications of Remote Sensing for Mapping Specific Wetland Habitats"*) contains Chapters Eleven through Twenty-Four and presents examples of case studies, specific and focused applications of remote sensing methods to a highly diverse number of wetland systems – e.g. from prairie potholes to Amazonian wetlands to wetlands in the Permafrost, and from mangrove forests to coastal wetlands to peatlands, understandably spanning geographies covering most continents. The techniques featured include lidar (e.g. bathymetric), radar, passive microwave, and multispectral imagery at moderate resolution; sensors on aerial and satellite platforms are addressed. Hydrology, geology and soils information come into play in models utilizing sensor data. The fusion of geomorphic and terrain derivative data with optical and radar data, and the use of advanced classification algorithms – notably random forests, are exemplified. The potentials and limitations of each approach are explored in detail and supported adequately with charts and graphs, in addition to maps.

Taking a look at the immediate future, Chapter Twenty-Five – *"Promising Developments and Future Challenges for Remote Sensing of Wetlands"*, makes up Section Four in its entirety. In this chapter the authors take a brief look at each of the most promising sensors and methodologies, some of which were touched upon in previous chapters. Several areas that need attention and development are also identified, such as for example automated classification techniques and algorithms, emerging sensors and platforms, wetland water regime detection and the possibilities for a unified wetland classification system.

This book represents an erudite compendium and also a very readable exposition of the current body of knowledge on this topic, making it valuable both as a course textbook and as a reference for research. *"Remote Sensing of Wetlands – Applications and Advances"* is a very suitable primer for the person new to this domain, but should be required as a definitive cornerstone for the development of academic programs dealing with wetland mapping. The depth and breadth of coverage achieved by the editors make this volume indispensable and essential to any scholarly effort aimed at applying remote sensing to the mapping, study, understanding and preservation of these complex, valuable and endangered ecosystems.