

# Policy on National Geodetic Control Points of Japan – From Triangulation Control Points to GEONET

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## SUMMARY

Geospatial Information Authority of Japan (GSI) has been maintaining Japanese geodetic reference frame from the beginning of Meiji era, 120 years ago. The reference frame was originally realized from triangulation surveys of triangulation control points. The surveys had been conducted over a hundred years and the number of the points reached 100,000 until the end of 20th century. However, appearance of a new space geodetic technique, global navigation satellite system (GNSS), changed the situation. GNSS enabled determination of three dimensional positions defined from the center of the earth, and horizontal positions can also be determined more accurately and efficiently by GNSS than by conventional triangulation and trilateration surveys. Considering the performance of GNSS, the GSI started GNSS continuous observation from the middle of 1990's. The observation has been gradually enhanced and the system, later named as GNSS Earth Observation Network System (GEONET), has grown to cover all Japanese islands with over 1,300 stations with 20 km average spacing. As a result of the development of GEONET, Japanese geodetic reference frame has been mainly realized and maintained by GEONET. The development of GEONET also gave a strong momentum for improving efficiency of surveying for control points. Although the surveying for public control points had been based on GNSS surveys with triangulation points, a new survey procedure, in which GNSS surveying can be conducted with only GEONET stations as reference points, was introduced on public survey in Japan on April 2002 in order to improve efficiency of surveying for control points. In this procedure, it became unnecessary for surveyors to access to reference points by themselves, because GEONET data, which cover Japanese islands with enough spatial density for GNSS surveying, are available from GSI website. The procedure will be also be introduced to cadastral survey from April 2015. Considering the GEONET performance and growing needs for GEONET stations as stable reference points, the GSI decided to switch main geodetic control points from triangulation points to GEONET stations in next 10 years and publicly announced the new direction at the end of June 2014. Not only for horizontal geodetic reference frame, GEONET is also already utilized for orthometric height determination by GNSS surveying. By utilizing hybrid geoid model of Japan, GSIGEO2011, to convert GNSS-derived three-dimensional positions to orthometric heights, GNSS survey can determine orthometric heights at the same precision-level of third-order leveling survey. The orthometric height determination by GNSS surveying has been applicable in public surveys as alternative to third-order leveling in Japan since April 1 2014. Annotation Public survey: surveys funded and implemented by public sectors in Japan such as government ministries, national institutes, local governments etc. Third-order leveling survey: leveling survey calcified to the lowest class of leveling survey in Japan, which is calcified into three classes, first, second and third-order. Expected accuracy range for third-order leveling, which is depending on length of leveling route, is 10mm per the square root of the length of leveling route in km.