# THE INTEGRATION OF GPS AND GIS
# TO CORRECT DEM DATA OF ASTER IMAGE

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## ABSTRACT

*DEM (Digital Elevation Model) data of the area of Kon Ha Thanh River, Binh Dinh province plays the very important role for flood monitoring, ASTER images can provide the important information for creating DEM of this area in flood forecast modeling. However, DEM data of ASTER image is not suitable for local elevation in BINH DINH province, this paper introduces how to integrate the GPS and GIS for correcting the DEM of ASTER image by the proposed method and the results show that the suggested technique is easy to get the appropriate DEM for flood monitoring by using DEM data of ASTER image.*

## 1. INTRODUCTION

Center of Viet Nam usually has storm and flood. It used to bear many losses of human being and properties. Creating a flooded map is a quite necessary work to provide the information such as: where the flooded zone? How deep is the flood? And based on this map, the authorities will choose the safe place to build important projects as well as in case of happen catastrophe; the local people will be evacuated rapidly to the safest places.

From the facts listed above, National Center for Hydrometeorology, Ministry of Natural Resources and Environment, Viet Nam, together with Information & Science Techno-System Co., Ltd (ISTS), Earth Remote Sensing Data Analysis Center (ERSDAC), JAPAN have carried out the project: "The joint study on application techniques of remote sensing data for flood hazards prediction and mitigation".

The objective of this project is to research a method basing on using remote sensing data, technology of GPS (Global Position System), GIS (Geographic Information System) data and hydrological modeling to auto-establish flooding map, and then use GIS tool to analyze, monitor and warn natural disasters. The researching area is Kon - Ha Thanh river valley in Binh Đinh province.


**Fig. 1 Location map of study area.**

The study area has a very complex river-network with short rivers and high-slope. Therefore, the suitable hydrological model is chosen in this case study to be VRSAP (Vietnamese River System and Plain) that is also rather familiar to many Vietnamese organizations.

Remote sensing data used is ASTER image that collected in April 2003. It can provide DEM data level 3A01, VNIR (Visible Near Infrared), band DEMZV, in the WGS84 coordinate system that can be used to create contour lines, basins, elevations, average slopes to provide input parameters for VRSAP model. With the high spatial resolution (15m - VNIR), ASTER image is suitable to provide basic information for establishing flooding maps.

GIS data of study area are registered in the coordinate system of Viet Nam (HN72). The output data of VRSAP model is water levels that can cause a threat to human life and economic activity that are represented on base map for establishing the flood hazard prediction map. Therefore, all data of ASTER image, ground control points (GCP were measured by GPS during field survey time) are registered at the same coordinate system as GIS data. These data should satisfy these three followings: **(A)** Have a sufficient accuracy for hydrological model; **(B)** Reference coordinates on HN72 coordinate system; **(C)** Reference elevation on local geoids Viet Nam.

In this paper, we apply the proposed technique to a correction of DEM data using ASTER image, GPS and GIS data so that the flood hazard prediction map is established in local reference coordinates system.

## 2. PROBLEMS WITH DEM DATA PROCESSING

The elevation **h** in DEM data is the height that is referred to ellipsoid. To establish flooding map, it's necessary to determine the value of real elevation **H** on the local geoid of Viet Nam. The relationship between **H** and **h** is defined as follows:

$$\mathbf{h} = \mathbf{H} + \mathbf{N} \tag{1}$$

With **N** as deviation between geoid and ellipsoid (geoidal undulation).

The component **N** is random and different at different positions.

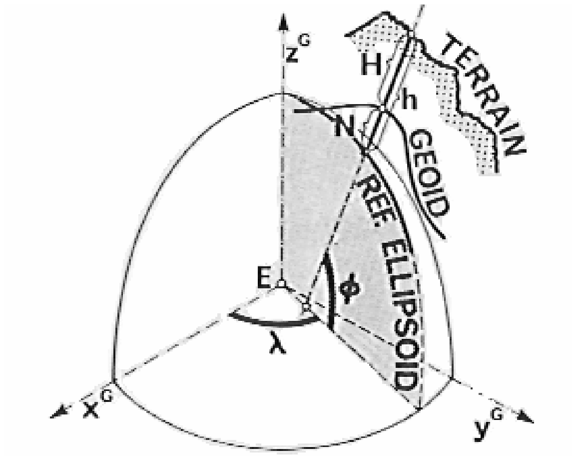


**Fig. 2 The relationship between geoid and ellipsoid.**

To make a valuation of the DEM data of ASTER image, we had done fieldwork in Binh Dinh province. The topography map used and 28 ground control points (GCP) were measured by GPS instrument for checking DEM data. We have some following comments:

- DEM data of ASTER image of Binh Dinh province has an accuracy of 20m. At hill and mountain area, DEM data is more accurate than that at plain area.
- There is a great difference between the elevation calculating from GPS instrument and from DEM data in the two areas (hill and plain); especially in plain area the difference exceeds 30m.
- The digital topography map (1:25000 and stored in GIS, with an accuracy of 3m for elevation) is used to interpolate the difference elevation of two positions. There is a great difference between the elevation calculating from digital topography map and DEM data.

These results show that the difference of the component **N** between local geoid and ellipsoid is rather high in Binh Dinh province. Therefore, we need to integrate the GPS and GIS for correcting the DEM of ASTER image and by the following proposed technique we are easy to get the appropriate DEM for flood monitoring by using DEM data of ASTER image.

## 3. PROPOSED SOLUTION

For adjusting DEM data in HN72 coordinate system and has the local geoid height, it should be carried out in two steps:

- Step 1: Reregister co-ordinate for DEM data. Use 10 GCP points which have co-ordinates in WGS84 system, and also in HN72 system. The co-ordinates of GCPs are defined by GPS equipment.
- Step 2: Carry out to adjust the height. Use 50 GCPs, which have the height correlating on the local geoid of Viet Nam. The heights of GCPs are interpolated in the digital topography map, which are provided by GIS.

The more GCPs, the more exact adjustment of DEM data is. The GCPs chosen must be in diffuse points in the area. For adjusting, we use the auto-rectify function in PCI Geomatica version 9.0 software, module OrthoEngine, and rational function.

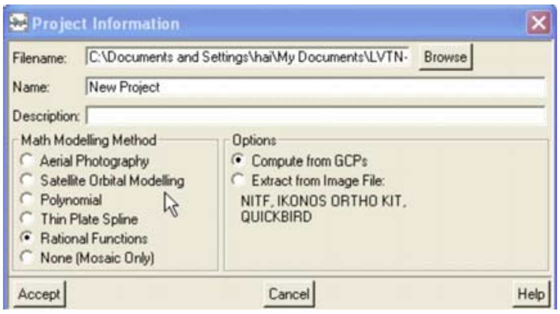


**Fig. 3 Rational Function in OrthoEngine.**

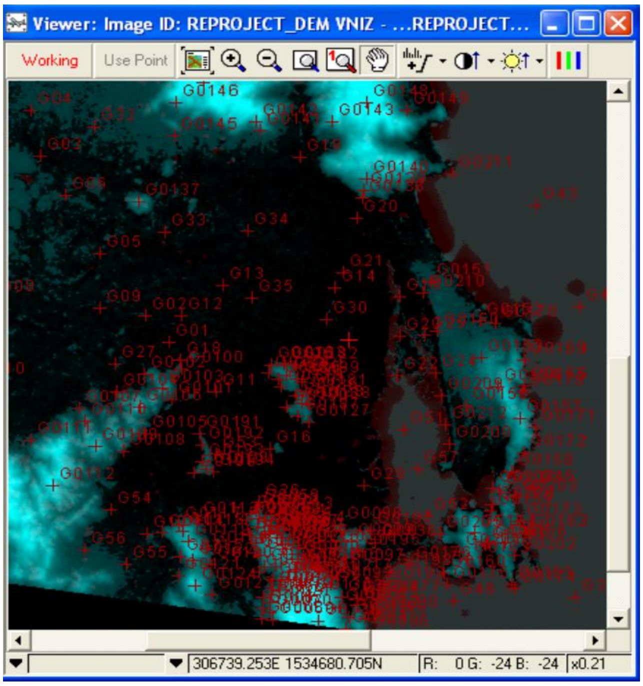


**Fig. 4 Ground Control Points of height.**

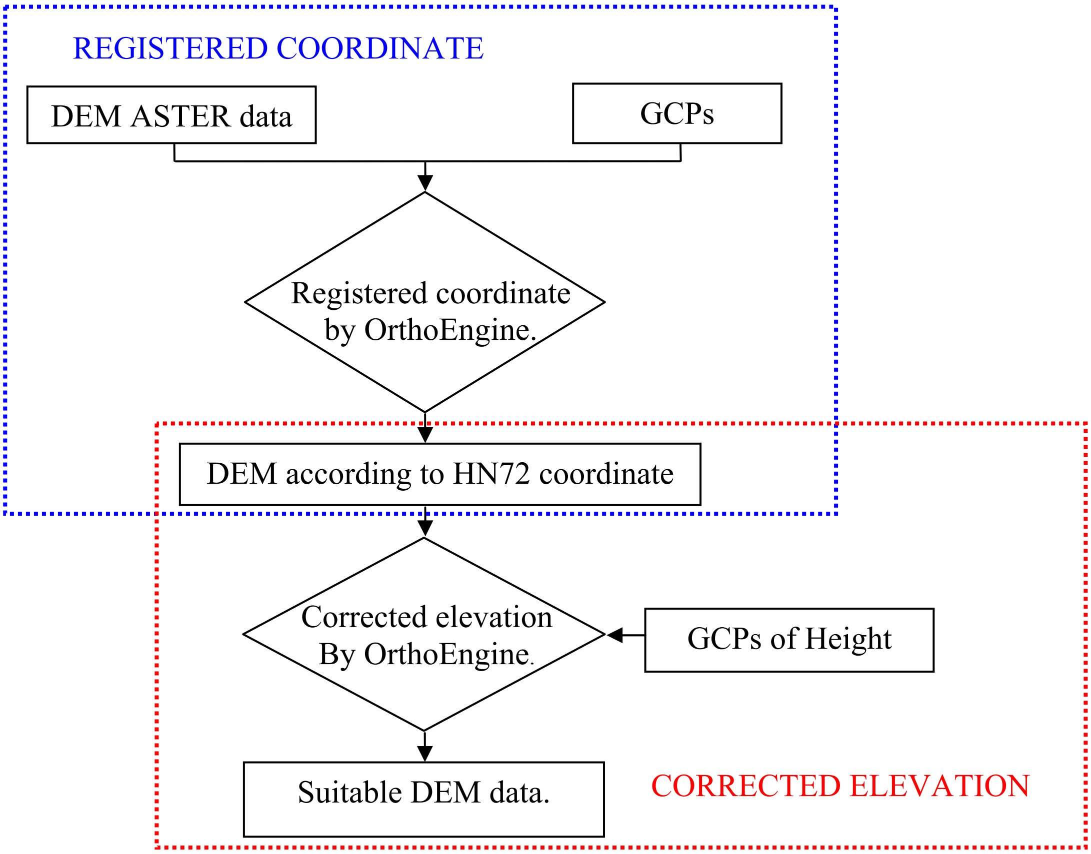


**Fig. 5 Procedure for correcting DEM data.**

## 4. RESULTS

DEM data after the adjustment are different at the two areas:

- At the nature areas like forests, mountains, rivers, lakes… after adjustment, DEM data are at high-accuracy. These areas cover nearly the whole researching zone.
- At some plain areas that have man - made factors such as field, village, urbanization... DEM data after adjustment are at low- accuracy. It is due to random error of DEM data, the height of these areas is not the same as the real height in the local geoid height. To have a better result, we use adjusting handicraft function of OrthoEngine to change the height of these areas. The way carrying out is to: localize areas that need to change the height (made polygon); provide new height, which are provided by GIS; then the software will assign the new height to the whole areas inside the polygons just created.

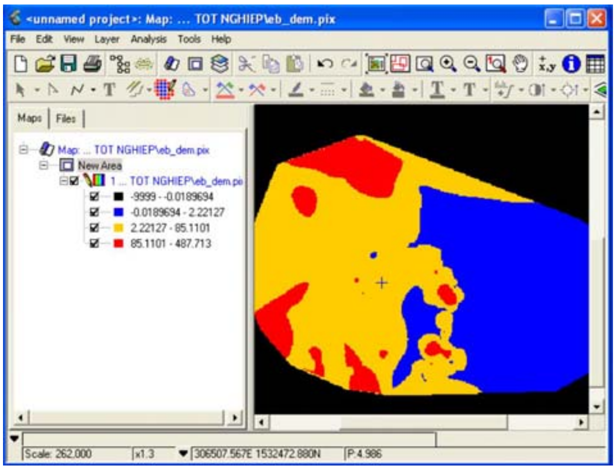


**Fig. 6  DEM data after correct.**

After adjusting, DEM data must be checked whether it's accurate. We use digital topography map, which is provided by GIS to choose accidentally 25 points that have the height in order to check adjusted DEM data.

| Point number | X (m) | Y (m) | [1] Height from corrected DEM data (m) | [2] Height from digital topography map (m) | The deviation l[1]-[2]l (m) |
|---|---|---|---|---|---|
| 1 | 315687.111 | 1534579.900 | 0 | 0 | 0 |
| 2 | 306346.512 | 1525233.553 | 9.72100 | 10 | 0.279 |
| 3 | 298339.811 | 1532961.073 | 8.12565 | 8 | 0.12565 |
| 4 | 311894.109 | 1519842.403 | 9.64321 | 10 | 0.35679 |
| 5 | 297127.598 | 1546209.562 | 15.0483 | 13 | 2.0483 |
| 6 | 305748.657 | 1540385.827 | 5.05536 | 5 | 0.05536 |
| 7 | 306028.137 | 1536646.256 | 2.72595 | 3 | 0.27405 |
| 8 | 336276.137 | 1529480.636 | 0 | 0 | 0 |
| 9 | 321946.649 | 1541836.665 | 0 | 0 | 0 |
| 10 | 315854.123 | 1524503.115 | 1.71122 | 0 | 1.71122 |
| 11 | 303943.865 | 1527965.263 | 9.81404 | 10 | 0.18596 |
| 12 | 296602.274 | 1522554.621 | 24.9514 | 28 | 3.0486 |
| 13 | 297127.567 | 1546209.236 | 15.0483 | 13 | 2.0483 |
| 14 | 308754.235 | 1532011.985 | 3.57723 | 2 | 1.57723 |
| 15 | 311119.132 | 1538071.365 | 0.27391 | 0.2 | 0.07391 |
| 16 | 311846.245 | 1541109.268 | 0.47537 | 0.5 | 0.02463 |
| 17 | 308675.621 | 1544516.752 | 11.1561 | 8 | 3.1561 |
| 18 | 301997.219 | 1533160.125 | 5.54909 | 5 | 0.54909 |
| 19 | 300087.124 | 1523500.923 | 8.05664 | 8 | 0.05664 |
| 20 | 306984.125 | 1528236.546 | 4.10497 | 4 | 0.10497 |
| 21 | 302029.125 | 1535604.562 | 6.10167 | 6 | 0.10167 |
| 22 | 290972.145 | 1532072.142 | 14.9325 | 15 | 0.0675 |
| 23 | 291496.124 | 1536676.953 | 11.9339 | 12 | 0.0661 |
| 24 | 293640.644 | 1547148.465 | 16.7902 | 14 | 2.7902 |
| 25 | 294182.356 | 1544593.356 | 10.3131 | 10 | 0.3131 |

**Table 1: Test results for DEM data correcting.**

The result shows that the values of declinations are all lower than 3m. Nevertheless, only at the two points: 12 and 17 have the highest value of declination of 3.05m and 3.16m. This proves that DEM data after adjustment get an appropriate accuracy and suitable for flood monitoring.

## 5. CONCLUSION

It certainly will have more researches to be studied to affirm the usefulness of DEM ASTER data in many other fields. However, in this study, we can conclude that integrating GPS and GIS can correct DEM data of ASTER suitable with the surface of terrains in Kon - Ha Thanh River - Binh Đinh province.

The accuracy of DEM data after correct can get 3m in comparison with digital topography map. Therefore, the useful information extracted from DEM data is necessary input parameters for hydrological model and suitable to use for flood monitoring.

In this case study, we also realize that ASTER image is very useful to provide basic information for establishing the flood hazard prediction map and application techniques of remote sensing data for flood hazards prediction and mitigation can obtain an appropriate accuracy, short a time and low cost.

## 6. REFERENCES


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