Results of researching on building the long-term data of sloping land from elevation data of world data (ASTER GDEM) to serve estimating the land potentiality of Thai Nguyen province

Truong Thanh Nam, Nguyen Thuy Linh
Faculty of Resources Management, Thai Nguyen University Agriculture and Forestry, Viet Nam

Abstract: The results of this study are the slop databases which include maps, and attribution data of the sloping terrain of Thai Nguyen province based on the use of Mapinfo, Vertical Mapper, ArcGIS softwares and high altitude data model (DEM) from global altitude data source (ASTER GDEM). Graded slope maps are constructed with the scale of 1/50,000 and the database of quantitative properties, area divided by land boundaries, by administrative units. The result of building the slope database reached 138,819 land areas with the smallest area of 0.2ha, the largest area with the area of 16.02 ha, total area of 352,664ha, including 8 levels of slope. Level I (<30) covers an area of 62,020ha, level II (3-80) with an area of 114.201ha, level III (8-150) with an area of 72,020ha and level IV (15-200) with an area of 37,590ha. It has an area of 27,716 ha, level VI (25 – 300) with an area of 17,770 ha, a level of VII (30 – 350) with an area of 10,213ha and level VIII (> 350). The study on the construction of a sloping terrain database has important implications in the formulation and planning of agro-forestry development and socio-economic development planning. Research results are needed when applying geographic information system (GIS) in overlapping monolithic maps when evaluating land potential and sustainable land use orientation for Thai Nguyen, Viet Nam.

1. Introduction

Sloping land is defined as land with a slope of 10 or more, sloping land plays an important role in reducing the effect of clear greenhouse effect. Especially when rising sea levels affect to the vast area deltas [10]. However, Sloping land is often affected by the erosion of soil erosion, leading to land degradation, poor soil fertility and the structure of soil [3].

Thai Nguyen is a province in northeastern Vietnam, adjacent to the capital Hanoi and a province in the planning area of the capital Hanoi. Thai Nguyen is a major socio-economic center of the northeastern region or the midland and mountainous areas of the north. Thai Nguyen province is also a strategic defense area, the headquarters of the High Command, and many other units of the Military Region 1[7]. It has a total natural area of 352,644.00 ha [8], which is the 38/63 provinces and cities directly under the Central Government and accounts for 1.07% of the country's area [8]. The northern mountainous structure is predominantly heavily weathered rocks, forming many caves and small valleys. In general, Thai Nguyen province has favorable conditions for agro-forestry and socio-economic development compared to other provinces and other mountainous and mountainous areas [9].

ASTER GDEM (Advanced Spaceborne Thermal Emission and Reflection radiometer Global Digital Elevation Model)[11] is produced by a collaboration between the Ministry of Economy, Trade, Industry, Japan and the United States Aerospace and Defense Agency, which was developed for the second time in 2011. ASTER GDEM uses an advanced algorithm to improve the digital elevation model, increase the resolution and horizontal and vertical accuracy of the observation device that provides high altitude model data (DEM ) for users around the world [2,11,12].

The study on the construction of a sloping terrain database including slope maps and slope attribute data from global altitude data sources (ASTER GDEM) has important implications for construction and planning, agro-forestry development, socio-economic.

2. Aims of study

* Construction of a slope database including slope maps and slope attribute data, from the digital elevation model (DEM) exploited from ASTER GDEM.
* Analyze the distribution of land area by slope, by district level and by using the main land groups in the whole province of Thai Nguyen. This will be the basis for assessing the land potential, planning strategies for agro-forestry development and socio-economic development in a sustainable and effective manner and protecting land resources.
3. Methods and materials research

3.1. Materials

Current land use map based on inventory results 2016, land statistics 2016[8], global altitude data extracted from ASTER GDEM.

Software used for research and presentation of results: Mapinfo Professional, Vertical Mapper, Global Mapper, ArcGIS, Microsoft Word, Microsoft Excel.

3.2. Methods

The method of data collection
- Collection of spatial database: land use status map, land statistical result in 2016, map of administrative boundary 364CT. Digital elevation model (DEM) exploits data from ASTER GDEM global altitude data system.
- Collection of attribute databases: natural conditions, natural resources, socio-economic conditions, technical infrastructure system, management situation in the study area.
- Collection of relevant documents and data: Decisions, regulations, implementing guidelines, relevant studies. Survey data, field comparison to verify the accuracy of collected documents, data, check construction results and accuracy of information on collected and constructed content. Statistical methods, data processing and mapping: Using Mapinfo software, Vertical Mapper, Global Mapper, ArcGIS Analyzer, Overlapping, Splitting Information and Spatial Relationship Analysis and Properties of Objects.

Consult experts: Consult experts in the field of GIS, mapping, land resource management, etc.

To determine the steps taken:
- Step 1. Determining administrative boundaries, map mathematical bases, map ratios, coordinates and longitudinal meridians of studied areas according to regulations [1,7,8].
- Step 2. Digitizing the digital elevation data (DEM) from online data source ASTER GDEM. Slope classification according to standard [5,6] to standardize the data.
- Step 3. The terrain sloping database statistics include map data, attribute data by administrative units. Editing, finishing topographic slope and attribute data.
- Step 4. Comments on the results of construction of sloping terrain database and proposed direction of use.

4. Results and discussion

4.1. Natural and socio-economic conditions of the study area

Thai Nguyen has 9 administrative units: Thai Nguyen city, Song Cong city, Pho Yen town and 6 districts. A total of 180 communes, 125 of which are mountainous, the rest are lowland and midland communes [8]. Total land area of Thai Nguyen province is 352,664ha, of which agricultural land is 303,239.0 ha, accounting for 85.99%, non-agricultural land has 44,645ha, and accounting for 12.66% and unused land is 4,780.0 ha, accounting for 1.36%. The results are showed at Table 1.

<table>
<thead>
<tr>
<th>TT</th>
<th>Units</th>
<th>Total Areas</th>
<th>Agricultural land</th>
<th>Non-agricultural land</th>
<th>Non-used land</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Thai Nguyen city</td>
<td>17,050.0</td>
<td>10752.0</td>
<td>6,148.0</td>
<td>150.0</td>
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<td>2</td>
<td>Song Cong city</td>
<td>9,673.0</td>
<td>7,539.0</td>
<td>2,118.0</td>
<td>16.0</td>
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<td>3</td>
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<td>47,743.0</td>
<td>3,295.0</td>
<td>315.0</td>
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<td>Phu Luong district</td>
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<td>30,034.0</td>
<td>6,452.0</td>
<td>276.0</td>
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<td>4,908.0</td>
<td>677.0</td>
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<td>6</td>
<td>Vo Nhai district</td>
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<td>7,843.0</td>
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<td>8</td>
<td>Pho Yen Town</td>
<td>25,892.0</td>
<td>19,362.0</td>
<td>6,507.0</td>
<td>23.0</td>
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<tr>
<td>9</td>
<td>Phu Binh district</td>
<td>25,221.0</td>
<td>21,117.0</td>
<td>4,097.0</td>
<td>7.0</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>352,664.0</strong></td>
<td><strong>303,239.0</strong></td>
<td><strong>44,645.0</strong></td>
<td><strong>4,780.0</strong></td>
<td></td>
</tr>
</tbody>
</table>

Source: Land statistics to 31/12/2016 of Thai Nguyen PPC[8], unit: ha
The climate of the province is divided into two distinct seasons, rainy season from May to October and dry season from October to May. Average annual rainfall is about 2,000 to 2,500 mm; highest in August and lowest in January. The temperature difference between the hottest months (June: 28.9 °C) and the coldest month (January: 15.2 °C) is 13.7 °C. The total number of sunshine hours in the year ranges from 1,300 to 1,750 hours and distributes relatively evenly throughout the year. He socio-economic situation of the province in recent years has many advantages in production and business, some key industries have increased in production capacity; All economic sectors have been growing, especially the non-state economy, which has affirmed its position in the multi-sector economy[7]. Construction of sloping terrain land databases

* Determine the location coordinates of the study area and extract data from ASTER GDEM.

**Figure 1. Thai Nguyen's Digital elevation model (DEM) from ASTER GDEM**

The location of the study area is determined based on the administrative boundaries of Thai Nguyen province in 2016[8]. Using the VN2000 national coordinate system and coordinate system with the axis coordinate map 106030', Elliptic WSG-84 with a large axial dimension of 6,378,137m, flatness of 1/298, 257223563[1,4]. Based on the coordinates of the administrative boundaries of the identified study area, use Global Mapper software to exploit the online data from ASTER GDEM (Figure 1), the result is a DEM data with a resolution of 30m / pixel.

* Decentralized, built-in slope database.

**Figure 2. Construction of a slope database hierarchically organized into 8 levels**
From the DEM data extracted, a standard deviation from the Vertical Mapper software for the study area was performed. Including 8 levels of slope Level I (<30) covers an area of 62,020ha, level II (3-80) with an area of 114.201ha, level III (8-150) with an area of 72,020ha and level IV (15-200) with an area of 37,590ha. It has an area of 27,716 ha, level VI (25 – 300) with an area of 17,770 ha, a level of VII (30 – 350) with an area of 10,213ha and level VIII (> 350). The results of the database construction on the slope Vertical Mapper reached 138,819 land zoned with a total area of 352,664ha, the smallest area of 0.2ha, the largest area of 16.02 hectares.

* Statistical data of sloping land by administrative units in the province.

Based on administrative boundaries [7], an analysis of the slope database by district-level administrative units was performed on ArcGIS software (Figure 4). Analysis results and database of slope by administrative units in the province show that the total area of sloping land is 352,644ha distributed over 9 district-level administrative units (Table 2).

<table>
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<th>Don vj</th>
<th>&lt;3°</th>
<th>3°-8°</th>
<th>8°-15°</th>
<th>15°-20°</th>
<th>20°-25°</th>
<th>25°-30°</th>
<th>30°-35°</th>
<th>&gt;35°</th>
<th>Summary</th>
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<td>36.8</td>
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<td>911.4</td>
<td>296.8</td>
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<td>1,744.4</td>
<td>5,988.6</td>
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<td>10,136.4</td>
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<td>994.4</td>
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<td>15,392.6</td>
<td>11,318.7</td>
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<td>3,733.8</td>
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<td>12,964.1</td>
<td>20,643.4</td>
<td>14,915.4</td>
<td>12,569.1</td>
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<td>Dai Tu district</td>
<td>8748.6</td>
<td>18,274.8</td>
<td>11,611.0</td>
<td>5,309.7</td>
<td>4,229.1</td>
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<td>10,525.0</td>
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<td>1,244.0</td>
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<td>88.0</td>
<td>18.5</td>
<td>1.1</td>
<td>-</td>
<td>25,221</td>
</tr>
</tbody>
</table>

| Total            | 62,020 | 114,201 | 72,020 | 37,590 | 27,716 | 17,770 | 10,213 | 11,133 | 352,664 |

Note: Including specialized surface water and river soil, canals, canals, streams and streams; Unit of calculation: ha

* Editing, finalizing the slope database.

After analyzing the slope database according to the administrative units in the study area, to edit and complete the data on Mapinfo software. Editing and finalizing content includes improving the slope database of the study area, completing geographical elements on a 1 / 50,000 slope map with two main contents.
Editing the basic geographic elements: Hydrology and land with specialized water surfaces (expressing rivers, streams and areas with special-use water surfaces in localities). Traffic (showing traffic distribution, national highways, provincial roads, inter-district and inter-commune roads). Administrative boundaries (showing administrative boundaries of districts, boundaries between communes in the locality). Place (name of place, area, name of mountain, name of river).

**Figure 5. Map of slope hierarchy in Thai Nguyen**

- Editing thematic elements and attribute data slope: The slope color level reflects the 8 levels. Slope attribute data is organized into 9 administrative units in the study area.

4.2. Comment on the results of the sloping land database and propose direction of use

*Results of the database construction slope.* The results of a slope land database consist of a spatial database (slope map) and an attribute database (slope, area, ). The slope map of Thai Nguyen province was constructed at a scale of 1 / 50,000, using a cylindrical projection grid at the same angle to the projection 30 with coefficient of adjustment of the length deformation ratio \( k = 0.9999 \), longitudinal axis map 106030 'national coordinates Vietnam VN2000. Maps show geographic features including river systems, lakes, canals, transport systems, places and administrative units at all levels. The slope hierarchy on the map is reflected in color and is associated with an attribute database.
consisting of eight levels (Figure 5). The slope attribute database of Thai Nguyen province was analyzed as 352,664ha allocated over 138,819 land areas with the smallest land area of 0.2ha and the largest area of 16.02ha. Slope levels were built into 8 levels including Level I (<30) covers an area of 62,020ha, level II (3-80) with an area of 114,201ha, level III (8-150) with an area of 72,020ha and level IV (15-200) with an area of 37,590ha. It has an area of 27,716 ha, level VI (25 – 300) with an area of 17,770 ha, a level of VII (30 – 350) with an area of 10,213ha and level VIII (> 350). The study results are a slope database consisting of a spatial database (1 / 50,000 slope map) and an attribute database (slope classification, unit area This is the source of data needed for land mapping or the application of geographic information system (GIS) in overlapping single-unit maps to assess the land potential of the Thai Nguyen province.

* Proposed sloping land use in land management.

Due to its topographic features, it is indispensable for Thai Nguyen province to use sloping land in the locality, based on the results of the database development and the slope map obtained. Select appropriate cropping systems, reasonable farming solutions to utilize land resources. The basic aim of sustainable farming in sloping lands is to use rotational methods, reuse of crop residues and animal manure, reduction of chemical use in agriculture, improve the application of cover species to protect the soil. Consideration should be given to the development of biomass maximization techniques, ground cover and continuity of the cover to prevent soil erosion, enhance biological activity, enhance nutrient regeneration, Recreate basic soil properties such as soil texture, organic content, porosity, biological activity, pH.

With regarding to the results of the development of a sloping land database in the province, agroforestry solutions are considered to be a reasonable land use system on sloping land due to the combination of woody plants and annual agricultural crops or fodder plant or both sides of the same piece of land, alternatively or alternately with the purpose of maximizing the product and maintaining durable production. The agro-forestry system creates a stable, long-term ecosystem that is suitable for household economic conditions, the proposed models of integrated sloping land cultivation include:

- The area of land with the slope of 3-80 is currently 114,201ha, which is used in combination with conditions of soil properties and irrigation conditions to determine suitable areas for many short and long-term plants. Arranging alternating between short-day and long-term crops to suit the characteristics and soil requirements of the crops and ensure regular harvest.

- Area of land with slope of 8-150 has 72,020 ha, slope 15-200 has 37,590ha, area of land 20-250 has 27,716ha so can arrange tea, fruit trees, perennial industrial trees. We can arranged in the direction of agroforestry combined cattle, the harmonious combination between breeding and cultivation in this model not only create food sources but also create a source of fertilizer to provide crops.

- The area land with the slope of 25-300 has 17,770 ha, the slope of 30-350,213ha, and > 350 are 11,133 ha, which is suitable for use in forestry, should be paid attention. Protection, investment in forest plantation to increase land cover, erosion control. In this case, it can be arranged in the direction of integrated development, combining small-scale plantation with food production. Appropriate land use structure is defined as 40% for agriculture and 60% for forestry. With this model can protect, maintain the forest resources and ensure the ecological balance.

5. Conclusion and discussion

Thai Nguyen province has a total natural land area of 352,664ha, of which 303,239.0ha of agricultural land, 44,645.0ha of non-agricultural land, 4,780.0ha of unused land allocated to 9 administrative units district.

Spatial database: Thai Nguyen slope gradation map at 1 / 50,000 scale. The map shows gradation, stratification and geographic features (including river systems, ponds, canals, traffic systems, place names, administrative units) in the study area. Slope level, terrain elevation stratification is reflected in color and associated with attribute database including 8 slope levels.

Attribute database: Detailed province-level slope data to district-level administrative units are indexed according to the land boundary associated with the slope level of the spatial database. The result of building the slope database reached 138,819 land areas with the smallest area of 0.2ha, the largest area with the area of 16.02 ha, total area of 352.664ha, including 8 levels of slope. Level I (<30) covers an area of 62,020ha, level II (3-80) with an area of 114,201ha, level III (8-150) with an area of 72,020ha and level IV (15-200) with an area of 37,590ha. It has an area of 27,716 ha, level VI (25 – 300) with an area of 17,770 ha, a level of VII (30 – 350) with an area of 10,213ha and level VIII (> 350). Based on the results of the construction of the sloping land database, it is necessary to continue researching to evaluate the characteristics and properties of land and assess the land potential of Thai Nguyen province in order to bring into play the advantages.

6. References

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7. The People’s Committee of Thai Nguyen Province (2016), The report on the adjustment of land use planning up to 2020 and the land use plan for the period of 2016-2020, Thai Nguyen.