Integrated Application of RS and GIS to Agriculture Land Use Planning

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1 Guidelines of land use planning

In parametric method, land characteristics that affect the suitability of land for a certain use are given a rating. Then a mathematical formula is designed when an overall score or index of suitability is calculated, for each land use combination. The formulas used in parametric methods range from very simple additions and multiplications to complex ones.

In land classification according to its suitability, four categories are recognized, i.e. land suitability order, land suitability classes, suitability subclasses, and land suitability units. Then a hierarchical system of classification is described as follows:

1) Suitability orders(letter symbols):
   S = suitable land(current or potential, according to various requirements). This is land on which sustained use of the type under consideration is expected to yield benefits justifying the cost.
   N = not suitable land. This is land on which sustained use of the type under consideration is not expected to yield benefits justifying the cost, and/or would entail unacceptable risks of damage to land resources. N has two classes: N1 = currently not suitable, and N2 = permanently not suitable.

2) Suitability classes(number symbols)
   1 = highly suitable
   2 = moderately suitable
   3 = marginally suitable

3) Suitability subclasses(letter symbols)
   l = lightly
   m = moderately
   e = extremely

4) Suitability units(number symbols)
   1 = highly

KEY WORDS  land; land use suitability; land use planning; integrated application

ABSTRACT  This paper gives some guidelines of land use planning firstly. A framework of agriculture land use planning is designed based on land use suitability evaluation using integrated technologies of RS and GIS. Further work expected is also given.
Structures of land suitability classifications and their categories can be seen in Reference [1].

2 Case study

Bantul district is one of the districts in Yogyakarta Province, south to Yogyakarta city in Indonesia. Most of the region is flat with two rivers along its boundary, two hills separately on the north-east and north-west and Indian Ocean to the south. It has 17 kecamatans (sub-districts). The population is about 739,810 and the area covers about 498.0 km².

The main objective of the case study is providing a framework for agriculture land use planning involving the integrated application of RS and GIS and assessment of environment conservation. The data for the use include air photos (at scale 1:50,000, 1993), topographic maps (contours' interval 25 m, scale 1:50,000, 1964) and digital maps (soil characteristics, such as soil type, soil depth, soil texture, soil fertility, rainfall, slope, disaster, main road and river net, population density and administration).

The field work was carried out on 3 Oct., 2001. The route and test spots were determined according to interpretation of air photographs, topographic maps and digital maps before we started. On these spots soil characteristics and present land use were verified. Handy GPS was used to locate our position and an equipment was used to measure slope angles. Information about cultivation, irrigation, disaster and average productivities per year was also gained. Fig. 1 illustrates the route of field work with bold black lines and the spots in field with black dots.

3 Data analysis

3.1 Data processing flow chart

In this case study, the parametric method was chosen to evaluate land use suitability according to the allocated scores and weights to each of land use units. Fig. 2 shows the flow chart of data processing.

3.2 Scores and weights assigning

Scores and weights are assigned to every land use combination unit taking into account the administration, population density, conservation, existing land use, air photos and topographic maps. The
score is higher when the condition of land use combination unit is better for agriculture and vice versa. Table 1 gives the details.

![Diagram](image)

### Table 1: Score and weight allocating

| Note                  | Score | Weight | Note                  | Score | Weight |
|-----------------------|-------|--------|-----------------------|-------|--------|
| < 2.0                 | 4     | 3      | Aluvial               | 7     | 1      |
| 2.0-15.0              | 3     | 3      | Latosol               | 6     | 1      |
| 15.0-40.0             | 2     | 3      | Mediterranean         | 5     | 1      |
| > 40.0                | 1     | 3      | Soil type             |         |        |
| > 1,900               | 8     | 1      | Regosol               | 3     | 1      |
| 1,800-1,900           | 7     | 1      | Rendzina              | 2     | 1      |
| 1,700-1,800           | 6     | 1      | Lithosol              | 1     | 1      |
| 1,600-1,700           | 5     | 1      | High                  | 4     | 2      |
| 1,500-1,600           | 4     | 1      | Soil fertility        |         |        |
| 1,400-1,500           | 3     | 1      | Moderate-high         | 3     | 2      |
| 1,300-1,400           | 2     | 1      | Moderate              | 2     | 2      |
| < 1,300               | 1     | 1      | Low                   | 1     | 2      |
| 6-7                   | 4     | 1      | Clay-loam             | 5     | 1      |
| 7-25                  | 3     | 1      | Silty clay            | 4     | 1      |
| 25-100                | 2     | 1      | Silty sand            | 2     | 1      |
| > 100                 | 1     | 1      | Sandy                 | 1     | 1      |
| Safety                | 5     | 1      | Thick                 | 6     | 2      |
| Flood                 | 3     | 1      | Moderate-thick        | 5     | 2      |
| > 1                   | 1     | 1      | Moderate              | 4     | 2      |
| Landslide(m)          | 2     | 1      | Moderate-thin         | 3     | 2      |
| Land slide(h)         | 1     | 1      | Thin                  | 2     | 2      |
| Ablation & abration   | 1     | 1      | Very thin             | 1     | 2      |

### 3.3 Classification

The total score for every land use combination unit can be calculated by the following formula:

\[
\text{Total score} = \sum_{i=1}^{8} \text{score} \times \text{weight}
\]

It ranges from 12 to 61. Then a classification cri-
4 Result and discussion

The data processing in computer was performed by Arc/Info and ArcView softwares. The map of land use suitability for agriculture was produced with attribute tables (Fig. 3, Table 3).

According to Table 3, the average score of soil texture in S2 classification is less than that in S3 and some others. It means that the land use suitability classification is a result comprehensively taking into account available factors, not a result just from a single factor. And if there are more available data, the result will be better.

### Table 2  Land use suitability classification

| Land use class | Description                       | Total score |
|---------------|-----------------------------------|-------------|
| S1            | Highly suitable for agriculture   | >52         |
| S2            | Moderately suitable for agriculture | 43-51       |
| S3            | Marginally suitable for agriculture | 33-42       |
| N1            | Currently not suitable for agriculture | 24-32       |
| N2            | Permanently not suitable for agriculture | <24         |

In addition, the soil type in the area is mainly regosol, which is not very good for agriculture. But S1, S2 and S3 are dominant land suitability classes here and the present land use is mainly for agriculture.

Table 3 also gives the area of green belt in N1.
and N2 land units where moderate and extreme land sliding hazards occurred and the main soil type is silty sand.

Some supplemental illustration can be discovered from the maps and details in the above tables. Slope is not high, fertility is moderate, and rainfall is moderate, etc. All these factors can draft a frame of local agriculture land use planning (Table 4).

### Table 4  Frame of agriculture land use planning in Bantul

| Class | Land use planning |
|-------|-------------------|
| S1    | Main crops (rice, corn, bean, etc.) |
| S2    | Main crops (rice, corn, bean, etc.) |
| S3    | Mixed garden |
| N1    | Grass, bush, sugar cane, etc. |
| N2    | Forest |

### 5 Conclusion and Future work

Apparently this land use planning for agriculture in Bantul district is just a framework because the available information is not complete and it is mainly based on physical aspects. But at least the conclusion can be drawn that the condition for agriculture in Bantul district is moderate by taking into account both good and bad factors. Other conclusions can also be drawn:

- Integration of RS and GIS is very useful and powerful to support land use planning;
- Land use planning is a comprehensive process involving many processes and diversified aspects. All plan at various scales should be done carefully.

Future work can be expected with more data available, and socio-economic impacts should also be considered.

### References

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