Selecting Site Suitable for Animal Waste Application using a Vector GIS

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Introduction

Due to the increase in the number and size of intensive animal industries (IAI) in many parts of the world including Australia, the disposal of animal waste has become a pressing environmental problem. Frequently the wastes generated at IAI are conveniently, favourably, and cost-effectively applied to the nearby agricultural fields to recycle manure nutrients. However, excessive application of wastes in the nearby fields without due consideration of site-specific factors (eg. slope, soil, and watercourses) has resulted in the run-off and leaching losses of manure nutrients causing agricultural non-point source (NPS) pollution (He and Shi, 1998). The agricultural NPS pollution has contributed significantly to the eutrophication and toxic blue green algae blooms in many river systems including Murray-Darling, where world's largest toxic riverine algal bloom was recorded in 1991 (Kuhn, 1993). Hence it has become crucial to develop an animal waste application guide (i.e. a site suitability map) by considering biophysical and socio-economic factors to minimise the environmental hazards. Developing such a map requires consideration of many factors and their spatial variability. Geographic information system (GIS) offers site suitability analysis techniques that are capable of processing large volumes of spatial data (Davis, 1996). The objective of this study is to develop a suitability map using a vector GIS, and to evaluate the factor sensitivity and aptness of this technique in selecting suitable sites for animal waste application.

Research Methods

Biophysical and socio-economic parameters affecting animal waste re-use in agricultural fields were identified and the relevant data sets were acquired for the Westbrook sub-catchment of the Murray Darling Basin (MDB) in south-east Queensland. Using ARC/INFO 7.2.1 (ESRI, 1997), nine thematic maps were processed separately to create input coverages. Areas totally unsuitable for animal waste application were removed from the soil, land use, land cover and slope coverages. Towns, streams, roads and IAI coverages were buffered to exclude areas unsafe for animal waste application. No areal restriction was imposed on the fertility coverage. These vector coverages were then combined using binary intersection operation to create a site suitability map. A second suitability map was also produced using more stringent buffering criteria to evaluate their effects on total suitable area. The suitability map produced using this method (i.e. binary intersection operation) was compared and contrasted with the one prepared earlier using a GRID-based weighted linear combination method (Basnet et.al, submitted).

Results

The GIS-based vector overlay method produced a site suitability map showing twenty-percent areas suitable for animal waste application in the Westbrook sub-catchment (Figure 1).

Suitable area generally decreased as the number of input factors increased. Increasing the buffer widths on input factors also decreased the total suitable areas. The input factor with no buffered and/or excluded areas (eg. fertility) had no effect on the total suitable area. On the whole, the total suitable area for animal waste application was found dependent on the number of input factors and the constraints imposed by each factor.

The comparison between the suitability maps produced by vector and GRID-based (raster) methods revealed the distinct advantage of GRID-based method in terms of differentiating suitable areas into various degree of suitability (eg. low, medium, and high). Due to inherent differences in data structure, raster-based method slightly underestimated the total suitable area.

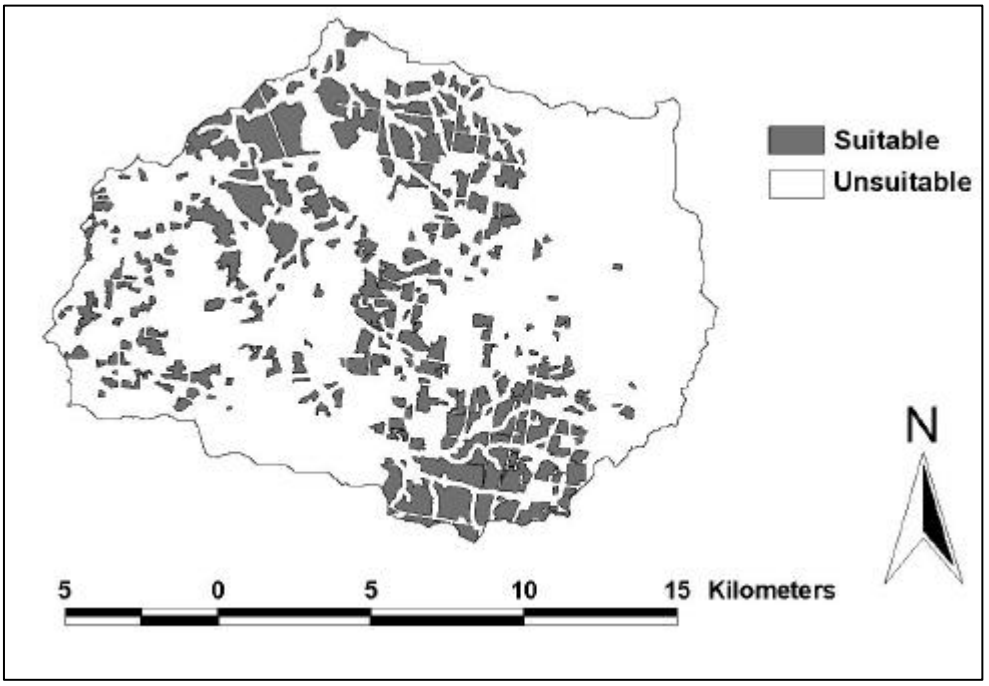

Figure 1. Site suitable for animal waste application in the Westbrook sub-catchment

Conclusions

The vector overlay method is useful in producing a map that differentiates suitable and unsuitable areas. Such map could be a valuable guide for the safe use of animal waste in agricultural fields.

Total suitable area estimated by the vector overlay method is generally dependent on the number of input factors and the areal constraints imposed by each factor. A factor without areal constraint has no effect in the total suitable area.

While vector overlay method could yield a map depicting suitable sites, the GRID-based (raster) method should be considered when there is a need to classify areas into various degrees of suitability.

References

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