

UNIVERSITY OF SOUTHERN QUEENSLAND



**GEOGRAPHIC INFORMATION SYSTEM BASED
MANURE APPLICATION PLANNING**

A Dissertation submitted by
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CERTIFICATE OF DISSERTATION

I certify that the ideas, investigations, analysis, results, discussions, and conclusions reported in this dissertation are entirely my own work, except where otherwise acknowledged. I also certify that the work is original and has not been previously used to earn academic awards.

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ABSTRACT

The disposal of animal waste has become a problem in many parts of the world due to the rapid growth in the number and the size of intensive animal industries. Safe waste disposal sites are rarely available and the relocation and/or treatment of animal waste is seldom economically viable. The reuse of animal waste for energy recovery and re-feeding is also not popular. Animal waste is a valuable source of plant nutrients and a very good soil conditioner, and has been commonly applied as fertiliser to agricultural fields. However, due to the increasing oversupply of animal waste in recent years, it has often been applied in excess to the agricultural fields.

Excessive application of animal waste, without due consideration of its implications, is a serious concern. The run-off and leaching losses of nutrients from the fields fertilised with animal waste have contributed significantly to the eutrophication and toxic blue-green algae blooms in surface water systems and nitrification of ground water systems. It has also led to nutrient imbalances in the soils and odour pollution to the surrounding communities. The animal waste, which is a valuable source of plant nutrients, has thus become both an economic and environmental burden, and there is a need to develop a strategy for its sensible use as a fertiliser in agricultural fields.

Sensible use of animal waste involves the consideration of all the agricultural, environmental, social, and economical limitations. A rational method of achieving this is to restrict the use of animal waste to sites suitable for such uses, identify areas

where it can be relocated and applied economically, limit the application rates to a safe level, and observe appropriate manure management practices. This study addressed each of these components by developing a comprehensive manure application plan (MAP) for the site-specific use of animal waste as fertiliser in agricultural fields.

Various geographic information systems (GIS) based techniques, including a weighted linear combination model and map algebra based cartographic modelling, were employed to achieve the goal. The appropriateness of the existing techniques and procedures were evaluated and modified to meet the current input requirements. New methods of analysis were devised as necessary. The Westbrook sub-catchment of the Condamine River catchment in south-east Queensland was selected as the study area. The sub-catchment covers 24,903 hectares and contains 39 intensive animal industries. The catchment is also a part of the Murray-Darling Basin, which has been suffering from toxic blue green algae blooms recurrently since 1991.

This study identified that only about one-fifth of the sub-catchment area is suitable for animal waste application. Depending on the method of site suitability analysis and the number of input factors used the suitable area ranged between 16 and 22 percent. This comparatively small area is mainly due to the presence of a large proportion of non-agricultural areas in the sub-catchment. The suitable areas were also found to have various degrees of suitability for waste application. However, the degree of site suitability was affected by the number of input factors used in the analysis, the weighting of the factors, and the method of factor attribute standardisation.

Conventional methods of weighting input factors were found to be cumbersome and not particularly suitable. Hence, this study developed a new 'objective oriented comparison' method of factor weighting. Standardisation of input factors using a continuous, rather than discrete, classification (ie fuzzy set) method was found to be more consistent in degree of suitability determination. The discrete classification of factor attributes into classes of different numbers and sizes, and the weighting of classes to a sum of one, were identified as a limitation in using this standardisation method. A new 'weight adjustment' method was devised and demonstrated to reduce factor-weighting biases.

The suitable sites, degree of site suitability, and other relevant spatial and non-spatial information were processed within a GIS framework to develop a comprehensive manure application plan. The inherently high presence of available phosphorus in the soils of the study area was recognised and the P_2O_5 content in the manure was used as the basis for determining manure application rates. A complimentary nitrogen supply map was also generated. Manure management practices applicable to the areas with a lower degree of suitability were also suggested.

LIST OF PUBLICATIONS ARISING FROM THIS WORK

Basnet, B B, Apan, A A and Raine, S R (2000). Selecting Sites Suitable for Animal Waste Application Using a Vector GIS. Proceedings of the Society of Engineering in Agriculture (SEAg) Conference, 2-5 April, Adelaide, Australia.

Basnet, B B, Apan, A A and Raine, S R (2001). Selecting Suitable Sites for Animal Waste Application using a Raster GIS. Environmental Management, 28 (4), p.519-531. DOI: 10.1007/s002670010241.

Basnet, B B, Apan, A A and Raine, S R (in press). Geographic Information System Based Manure Application Plan. Journal of Environmental Management, volume 64. DOI: 10.1006/jema.2001.0484

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