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Assessing positional and areal accuracy for environmental compliance monitoring at Coleambally Irrigation Area

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Introduction

- RS/GIS is intrinsically linked to positional accuracy and uncertainty
- Without knowledge of positional accuracy, management decisions based on spatial data:
 - cannot be made with confidence,
 - cannot be justified scientifically, and
 - spatial models developed from the data are potentially misleading

Definitions

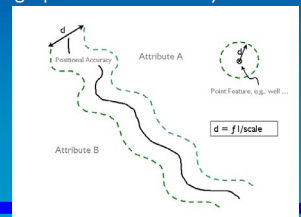
Positional Accuracy or Uncertainty: A deviation in the position of a feature in a GIS or on a map compared to the feature's real world position.

Accuracy = magnitude of deviation is **known**

Uncertainty = magnitude of deviation is **unknown**

Positional Accuracy/Uncertainty

The growing importance placed on understanding and identifying spatial uncertainty or accuracy imposes new ways of conceptualising spatial data for many users ...



Map Accuracy

National Mapping Council of Australia Standards of Map Accuracy

The National Mapping Council of Australia (NMCA) has set standards for map accuracy (NMCA, 1975) in the following form:

"The horizontal accuracy of standard published maps shall be consistent within the criterion that not more than 10% of points tested shall be in error by more than 0.5 millimetres. This limit of accuracy shall apply in all cases to positions of well-defined points only. "Well defined" points are those that are easily visible or recoverable on the ground. In general what is "well defined" will also be determined by what is **plottable** on the scale of the map within 0.25 millimetres."

Map Accuracy

Allowable distances calculated for common map scales by Australian and U.S. map accuracy standard specifications.

Map Scale	Allowable Distance (m)	
	Australia	USA
1:10,000	5.00	8.47
1:20,000	10.00	10.16
1:24,000*	12.00	12.19
1:50,000	25.00	25.40
1:100,000	50.00	50.80
1:250,000	125.00	127.00
1:1,000,000	500.00	508.00
1:2,000,000*	1,000.00	1,016.00
1:2,500,000	1,250.00	1,270.00

* common scale in USA

Environmental Compliance

Determining the amount of rice planted by each farmer in relation to water usage and soil properties. This database is used to verify environmental compliance standards, which are:

- 1) no more than 30% or 69 hectares of a farm can be planted in rice; and
- 2) rice must be planted only in areas deemed suitable (Tiwari, 2000).

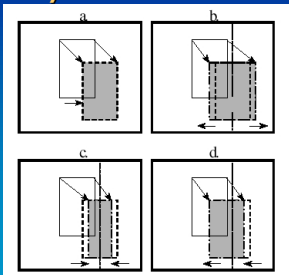
There are three classes of soil suitability:

- 1) suitable;
- 2) marginal (can be grown 1 year in 4); and
- 3) unsuitable (Tiwari, 2000).

Relevant Data

- 1) DTDB Reference Data (considered reliable as it is produced by the Australian LIC)
- 2) Digital Aerial Photography
 - a) derived (improved) photography

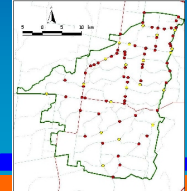
Influence of Positional Accuracy on Areal Accuracy



Methods

Horizontal Accuracy Assessment

- A Horizontal Accuracy Extension to ArcView was created and is available on the internet
- The output report meets the horizontal positional accuracy requirements for both the Australian and New Zealand Land Information Council (ANZLIC) metadata standards and the Federal Geographic Data Committee (FGDC) metadata standards.



Methods

Horizontal Accuracy Assessment

Accuracy assessment was run for:

- 1) the DTDB roads GIS dataset;
- 2) the image mosaic of the 36 subset tiles, denoted 'Mosaic';
 - 2a) the re-registered mosaic of subset tiles, denoted 'Mosaic/Re-Registered'; and
 - 2b) the second re-registered mosaic of subset tiles with independent north and south processing, denoted 'Mosaic/Re-Registered N. and S.'.

Results

Horizontal Accuracy Assessment

Name	Mean Difference ⁵ (m)	RMS Difference ⁶ (m)	RMS X ⁷ (m)	RMS Y ⁸ (m)	NSSDA 95% ⁹ (m)	Number Exceeded ¹⁰	Percent Exceeded ¹¹
DTDB Road Intersections ⁴	32.18	39.26	24.02	31.05	67.95	21 of 39	53.85
Mosaic ²	20.00	23.01	16.96	15.56	39.83	10 of 21	47.62
Mosaic/Re-Registered ³	13.51	15.43	8.19	13.08	26.71	2 of 21	9.52
Mosaic/Re-Registered N. and S. ⁴	8.07	9.12	6.23	6.66	15.78	0 of 21	0.00

Results

Horizontal Accuracy Assessment

Before

After

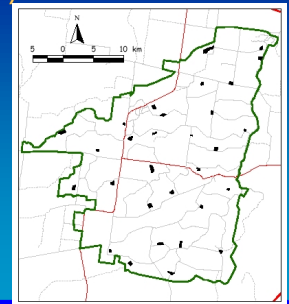


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Methods

Areal Accuracy Assessment

$$Accuracy_{areal} = \frac{\sum_{i=1}^n (EM_{areal} - IM_{areal})}{n} \times 100$$



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Results

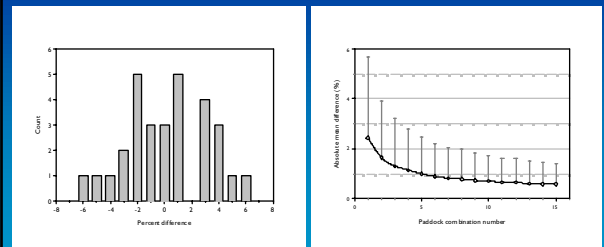
Areal Accuracy Assessment

- The cumulative EM31 area = 7,534,780.66 m² while the cumulative image area = 7,551,581.74 m² (99.78 % areal accuracy).
- This statistic is reported as the analysis of area accuracy by many previous authors (Fang et al., 1998; McCloy et al., 1987; Okamoto and Kawashima, 1999; Quarmby et al., 1992).
- However, due to errors of **underestimation** and **overestimation** cancelling each other out, this cumulative area percentage statistic has minimal relevance for this application.

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Results

Areal Accuracy Assessment



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Recommendations

Based on the error calculated from the 95% confidence interval, paddock area measurements from the improved GIS baseline cannot be considered greater than 69 ha until they exceed:

- 73.14 ha for a single paddock;
- 71.76 ha for the combined area of 2 paddocks;
- 71.07 ha for the combined area of 3 to 5 paddocks; and
- 70.38 ha for the combined area of 6 or more paddocks.

When the area measurements made from the improved baseline data exceed these values, it is recommended that CL staff measure the area of the in question paddocks using a Differential Global Positioning System (DGPS) and discuss results with the appropriate farmer(s).

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Conclusions

Calculation of positional and areal accuracy of baseline GIS data can increase both management effectiveness and confidence in the decisions made from the data.

Increasing the accuracy of the baseline dataset expanded the utility of GIS greatly for monitoring environmental compliance. Quantified accuracies allowed for the proper use of the data as well as justification for specific management decisions made from that data.

We expect that this application of the assessment of positional and areal accuracy is relevant to many agri-environmental and forestry GIS data custodians because of the widespread use of GIS and the impact of spatial accuracy on management of these systems.

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Research Directions

Year	Research	Status	Publications
1 (2000)	1. Literature Review	Complete	• CRC Tech Report submitted
	2. Positional Accuracy	Complete	• CRC Tech Report published • AIEA paper submitted
2 (2001)	3. Rice Crop Identification and Areal Assessment	Started	
	4. Hyperspectral Remote Sensing a. Summer Crop Type Mapping (Rice/Soybean/Maize) b. Plant Dry N c. Available Soil N.	Started	
	5. LWMP Assessment	Planning	
3 (2002)	6. Regional Water Use Efficiency (WUE) Propagation Assessment	Defined	
	7. Regional WUE Uncertainty/Error	Not Started	

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The horizontal accuracy extension and the pdf version of the technical report are downloadable at <http://www.ricecrc.org/>. Please note, any mention of commercial products in this work does not imply an endorsement of the product by either CSIRO or Coleambally Irrigation Limited.

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