IDENTIFYING POTENTIAL NITROGEN HOTSPOTS IN A FARMING LANDSCAPE THAT THREATEN A RIPARIAN AREA.

R. A. Lawes and N. Raisbeck-Brown
CSIRO Sustainable Ecosystems, Wembley, Western Australia, 6913. roger.lawes@csiro.au

INTRODUCTION

Agriculture is the dominant industry in the South West Coast of Western Australia, where cereals, oilseeds and legumes are grown in conjunction with legume and grass based pastures. The pastures are occasionally grazed by either cattle or sheep. Agricultural systems developed when the existing perennial vegetation was cleared. Large quantities of N and P fertilisers have been applied across the landscape to rejuvenate the naturally impoverished soils and allow agricultural crops to flourish.

Unfortunately this has led to an increase in the amount of nutrients entering the wetlands, estuaries and river ways of the South Coast Region that can result in algal blooms and fish kills (Hodgkin and Hamilton 1993). To mitigate these environmental problems, the source of the nutrients must be identified and managed to prevent them entering the waterway.

Recent advances in yield monitoring and logging equipment attached to grain harvesters allow farmers to map the spatial variation of crop yield across a farm. Assuming fields are uniformly fertilised, this variation in crop yield may cause variations in the amount of nutrients remaining in a field once the crop has been harvested. This may lead to spatial variation in the amount of nutrients remaining in a field that may then enter the adjacent waterway. We explore the scale and extent of variations in crop yield on one farm in the Young River Catchment using simple yield-nutrient balance relationships to predict the location of nutrient hot-spots on the farm. Nutrients are more likely to enter waterways if they are applied on sloping land adjacent to streams and we account for the impact topography and the distance from the river have on the area of nutrient hot-spots that may threaten water quality.

MATERIALS AND METHODS

The study was conducted on a 5000 ha farm at Cascade, 125 km north-west of Esperance in the South East South Coast of the West Australian Wheatbelt (mean annual rainfall 375mm). 3700 ha were cropped in 2007 to wheat, barley, canola and lupins. Cereals are grown in rotation with canola and lupins. The fields border a tributary that flows into the Young River and a delicate estuarine habitat.

If nutrients were applied evenly across a field with a relatively uniform level of fertility to satisfy the demands of a 3 t/ha crop, those regions that produce considerably less than 3 t/ha will have high levels of nutrients remaining after harvest. Yield information was extracted from the farmer's combine harvester from 2005, 2006 and 2007. Yield maps were produced from each field in every year that it was cropped to a cereal. Four of the nine fields were cropped to cereals twice and a composite yield map was produced, where at each location the maximum yield was chosen from either year.

For N load, we assume there is 20 kg/ha in the soil and a further 100 kg/ha of N is applied for a 3 t/ha crop.

$$\text{N remaining (kg/ha)} = 120 \text{ kg/N} - \text{Crop yield (t/ha)} * 40 \text{ kg/ha} \qquad (1)$$

The effect this might have on the river system was subsequently modified to include overland flow of water. Overland flow was calculated by applying the focal length function in Arc GIS to a digital elevation model of the farm. Focal length equates to the distance water will flow across the landscape unimpeded into the riparian zone and takes into account the effect of topography assuming constant flow velocities.

$$\text{N risk} = \text{N remaining (kg/ha)} * 1/(1 + \text{focal length}/100) \qquad (2)$$

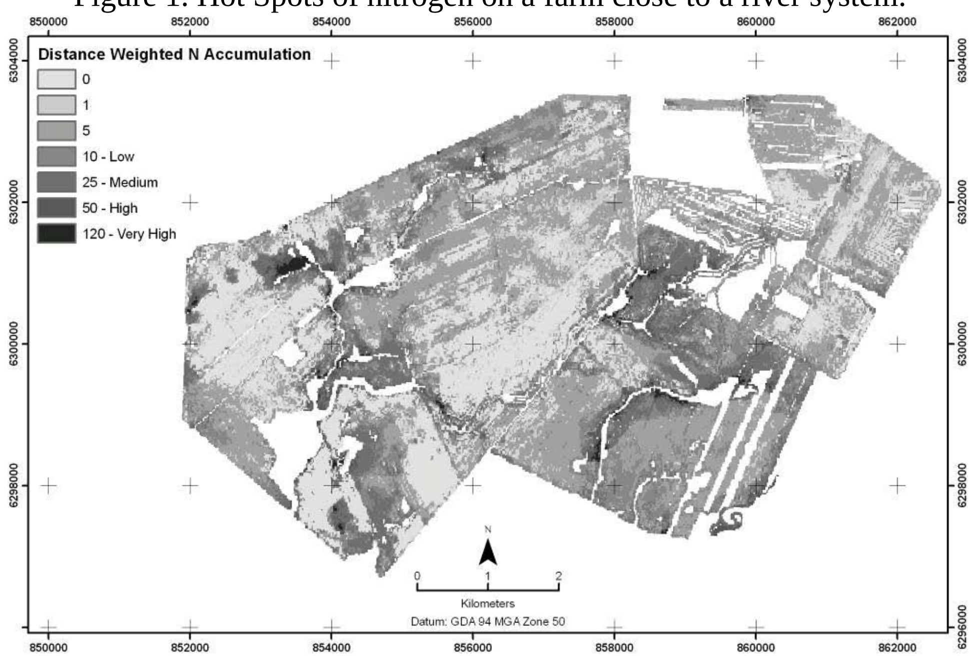
RESULTS AND DISCUSSION

Forty four percent of the farmed area yielded 3 t/ha or more and it is unlikely that residual N would exist in these regions. An additional 38% of the farmed area yielded between 2 t/ha and 3 t/ha and these areas would have relatively low levels of residual N following a cropping programme. The remaining 18% of the farmed area that yielded less than 2 t/ha would have high levels of residual N if the land is fertilised for an expected yield of 3 t/ha. The geographic location of poor yields directly translates into zones that potentially have more residual N than other areas. Twenty five percent of the total farmed area had moderate to high levels of residual N of 50 kg/ha or more. These regions were tightly grouped, and were not randomly spaced throughout fields or the farm.

The potential for ecological problems caused by excess N was sensitive to distance water will travel unimpeded to the riparian zone. In the first scenario, derived from equation 2, where distance was highly important in reducing the impact of N, the area of farmland with high levels of Residual N declined from 25.1% to just 1% (Figure 1). Areas very close to the river and low yielding were identified as threats, but the other low yielding areas would have a minimal impact on the ecosystem as nutrients were unable to move laterally across the landscape into the riparian zone (Figure 1).

In conclusion, the amount of fertiliser applied to the low yielding areas could easily be reduced with little or no economic loss to the farmer. Moreover, the method employed here can be extended to other farms and catchments, providing they have access to yield monitoring equipment and can access or produce a digital elevation model. This information could then be used to inform policy decision on land management at a regional scale that would have a negligible economic impact on the farmer.

Figure 1. Hot Spots of nitrogen on a farm close to a river system.



REFERENCES

Hodgkin EP and Hamilton BH (1993) Fertilisers and eutrophication in south western Australia: Setting the scene. Fert. Res., 36, 95-103.