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The extent and cost of waterlogging

By Don McFarlane¹ and Buddy Wheaton², Division of Resource Management
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Waterlogging is an underrated and not widely recognized problem in our cropping areas. Before we can tackle the problem through drainage and alternative cropping systems, we need to know its extent and how much crop yield is lost. The effect of waterlogging on pasture growth is also poorly known.

Symptoms of waterlogging

Unless the soil profile is saturated to the surface, waterlogged soils may not be apparent. Plant symptoms of waterlogging (yellowing or reddening of the older leaves) may be confused with nutrient deficiency or crop diseases. (See ‘Waterlogging: how it reduces plant growth and how plants can overcome its effects’ on page 51.)

To the naked eye, the canopies of mildly waterlogged crops appear similar to those of non-waterlogged crops. However, when a crop is seen in the infrared part of the spectrum (for example, from a satellite or with infrared film in a camera), the waterlogging is obvious. Crops which have been slightly waterlogged early in the season may appear to recover and the reduced yield at harvest may not be noticed, or if noticed, not attributed to the earlier wet period.

Which parts of the landscape are most susceptible to waterlogging?

More than 200 shallow wells were placed throughout the eastern part of the Murray River Catchment. Almost all of the soils in the 70,000 ha monitored are duplex (sandy topsoil over a clayey subsoil. (See ‘The causes of waterlogging’ on page 58.) About 60 per cent of the wells had perched water within 30 cm of the soil surface at least once during 1987 and 1988.

The flat floodplain areas around the major rivers (Figure 1) were most susceptible to waterlogging; 90 per cent of the wells contained perched water. Surprisingly, 15 per cent of the soils on top of gravel hills had perched water close to the surface.

About three-quarters of the main landform, sloping duplex soils, had shallow perched water as a result of perching on the relatively impermeable clay subsoil close to the surface. Fortunately, these soils can be drained using seepage interceptors (see ‘Seepage interceptor drains for reducing waterlogging and salinity’ on page 66).

The effect of rainfall on crop yield

Crop and rainfall statistics can be compared to see how rain at different times of the year affects yield.

In the Upper Great Southern, wheat yields decline by about 150 kg/ha for every 10 mm of rain in August (Figure 2). The yield decline is caused by waterlogging, diseases and loss of nitrogen by leaching and denitrification (conversion of nitrate to nitrogen oxide gases).

Rain in April and May increases cereal yields in the Upper Great Southern because crops can be planted early, which lengthens the growing season.
The rain in April and May is beneficial, even if the later months are also wet. Early rain results in cereal plants being at an advanced stage of growth before waterlogging is a problem. Once cereal plants have developed tillers and nodal roots they are more able to withstand waterlogging (see ‘Waterlogging: how it reduces plant growth and how plants can overcome its effects’ on page 51).

June and August rain decreases yields as it is in excess of the crops’ requirements and damages the plants if soil drainage is poor.

Rain in July barely affects cereal yields as temperatures are low and crops do not grow quickly. Anaerobic conditions also develop slowly when soils are cold.

**Estimating the loss in cereal yield caused by waterlogging in the Upper Great Southern**

Two methods were used to estimate the loss in cereal yield caused by waterlogging in the Upper Great Southern: the relationship between rainfall and yield, and satellite mapping of waterlogged areas using remote sensing data.

The effect of excess rainfall in August on crop yield was used to estimate the losses caused by waterlogging in dry, average and wet years. The estimates are likely to be low as only August rainfall is considered and average yields are used, not the yield from waterlogged parts of paddocks.

This method estimates that the average annual loss in yield exceeds $13 million in the Shires of Brookton, Pingelly, Cuballing, Narrogin, Wagin, Corrigin, Wickepin and Dumbleyung. The losses for individual cereals are at least $11 million from wheat, $1.6 million from oats and $500,000 from lupins. In very wet years (one year in ten), cereal crop losses are at least $50 million.

In 1988, satellite remote sensing was used to map waterlogged areas in a 27,000 ha catchment east of Yornaning in the Shire of Cuballing. The method was found to be very accurate (see ‘Mapping the extent of waterlogged crop using satellite imagery’ on page 48). Rainfall in 1988 was slightly above the average and would be exceeded in three years out of ten on average.
Figure 1. Schematic cross-section of the landscape in the lower Lynn River section of the study area. The landscape is divided into several categories: gravel, rocky hillslopes, river valleys, and uplands. The diagram shows the distribution of these categories with areas shaded in different colors.

The table below summarizes the percentage of area that each landscape category represents:

<table>
<thead>
<tr>
<th>Landscape Type</th>
<th>% of Landscape</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gravel</td>
<td>10</td>
</tr>
<tr>
<td>Rocky Hillslopes</td>
<td>18</td>
</tr>
<tr>
<td>River Valleys</td>
<td>16</td>
</tr>
<tr>
<td>Uplands</td>
<td>18</td>
</tr>
<tr>
<td>Waterlogged</td>
<td>93</td>
</tr>
</tbody>
</table>

The waterlogged area is significantly greater than the other landscape types, accounting for 93% of the total area.
About 30 per cent of the catchment was cropped to cereals and about 32 per cent of this cropped area was moderately to severely affected by waterlogging. Grain yields in the waterlogged sites averaged 0.53 t/ha while those from nearby non-waterlogged sites averaged 3.16 t/ha, an average loss of 83 per cent (Figure 3). A further 3 per cent of the crops were very severely affected and had no yield (see photo on facing page).

The loss from the 27,000 ha area was estimated to be $1.1 million. Extrapolation of data from the Shire of Cuballing to the surrounding four shires of Brookton, Pingelly, Narrogin and Wagin gives an estimated loss of more than $23 million.

The remote sensing method is more accurate than the statistical method mentioned previously. Moreover, remote sensing can identify where the losses are in individual paddocks. However, the statistical method indicates how the losses are affected by wet and dry years. Both methods show that waterlogging reduces cereal yields in the Upper Great Southern by tens of millions of dollars in most years.

The effect of waterlogging on pasture growth
Pasture growth can also be affected by waterlogging, depending on the composition of the pasture and the timing and severity of waterlogging.

In 1987, mild waterlogging reduced pasture growth during early and late winter by about half at two sites in the Upper Great Southern. The waterlogged areas had increased spring growth which partially or completely compensated for the reduced early growth.

However, the marginal value of pasture in September is a third that of growth in June, and half that of August. Therefore, the loss of early pasture growth from waterlogging is significant.

In the middle of winter, pasture growth was similar in waterlogged and non-waterlogged areas probably because low temperatures limited growth.

At one site in the Upper Great Southern, severe waterlogging reduced pasture growth except at the very beginning and end of the growing season. In contrast, in a dry part of the Upper Great Southern where water was limiting pasture growth, mild waterlogging resulted in increased growth throughout the year.

In summary, severe waterlogging decreased pasture growth throughout almost the entire year, moderate waterlogging decreased winter growth and increased spring growth, while mild waterlogging increased pasture growth in dry areas.

As well as decreasing the quantity of pasture, waterlogged areas had a much higher percentage of grasses and a lower percentage of clover than non-waterlogged areas.

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