Research Projects

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Irrigation:
Getting the balance right

Australia's irrigated agricultural produce is worth $6 billion at the farm gate, with further value-adding lifting this to $24 billion. The downside is that the major irrigation areas of southern Australia now face the problem of shallow watertables. Irrigation also uses large volumes of water: about 90% of the total diverted in the Murray-Darling Basin.

Over-irrigation harms the environment because it raises the watertable and increases the chances of salinisation of the rootzone. Salt is brought into the rootzone from saline groundwater as water evaporates from the soil surface.

Controlling the amount of water reaching the watertable is essential to the long-term viability of an irrigation area. As water supplies become scarce, there will be increasing emphasis on matching the supply of irrigation water to crop water use.

A participative approach led by CSIRO Land and Water is helping irrigation managers and farmers come to terms with 'net recharge management'. The concept of net recharge management is about controlling the amount of water causing the rising watertable over an area and over time.

The aim is to match the amount of water going to the watertable, to the amount of water discharged from it. Water leaves the water-table through deep drainage, lateral spreading into shallow aquifers and discharge from the watertable through the soil surface.

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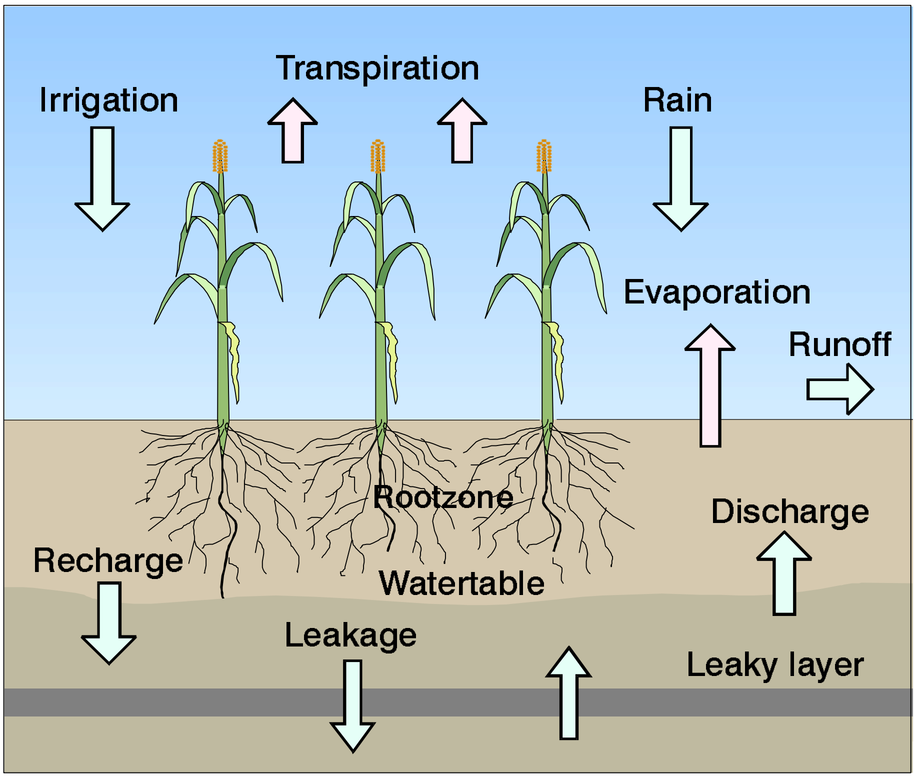

NET RECHARGE
equals
IRRIGATION +
RAINFALL +
CAPILLARY UPFLOW
minus
EVAPOTRANSPIRATION +
LEAKAGE +
RUNOFF +
CHANGE IN SOIL WATER CONTENT

The problem of net recharge management needs to be tackled on both a regional and farm front to ensure that irrigation areas remain sustainable. But getting the balance right means understanding a number of driving factors.

Working out the best balance

Predicting the future is difficult, yet that's exactly what this project is trying to achieve. It is vital that future scenarios are considered so that the likely impacts of irrigation can be addressed before it's too late.

To ensure that net recharge is managed carefully, three models have been developed to calculate the impacts of various practices at different scales:

- a groundwater model for the whole district
- a salt and water balance model for individual farms
- a policy model to gauge the financial impact of various decisions.

Across the district

The impact of all irrigation within a district can be calculated using a multi layered aquifer model. Testing various irrigation and drainage scenarios with this model allows the irrigation area managers to set targets to achieve control of the depth to the watertable. This information provides a guide to the sustainable recharge rate.

Reasonable targets for different areas can then be set so that the costs of watertable control can be minimised. The tradeoffs be-tween profitability and sustain-ability across the whole system can be examined.

On the farm

Irrigation farmers are striving for increasing profitability, together with improving the efficiency of water use and managing salt. The SWAGMAN® Farm model allows farmers to evaluate the consequences of their farming practices before the tractor is put into the paddock. By demonstrating the impact of their cropping rotations and water management options, farmers can see the likely physical as well as the financial outcomes of different farm practices.

An understanding and appreciation of the amount of water used by crops is critical to better farm management. Only with this information can the irrigation supply be more accurately matched to estimated crop water use so that recharge is kept to a minimal level required to keep the root zone free of salt.

Within the policy framework

In addition to the regional and farm-scale models, a model has been developed which assesses the economic impacts of different water pricing policy decisions on farm income. This will assist the managers of an area when making decisions, so that policy takes into account not only the sustainability of the system but also the effect on people within the area.

Irrigation of permanent beds is just one of the methods which must be included in evaluating net recharge management

Crop water use

Using daily weather data from the irrigation area, it is possible to calculate how much water is used by an ideal, vigorously growing crop similar to wheat or soybeans. However, not all crops use water at the same rate as the ideal 'reference crop', so this reference evapotranspiration (ET) is adjusted with a crop specific coefficient. Further adjustment of likely water use may be necessary if the actual crop is not particularly good.

By doing this it is possible to make reasonable estimates of how much water a particular crop needs to grow throughout the season. Ideal irrigation practice should aim to match water use as closely as possible to a crop's water needs, to minimise wastage and watertable recharge.

Three steps are required to estimate the water use of a crop:

- calculate the reference evapo-transpiration (ET_0)
- determine the crop coefficients
- estimate the actual crop evapo-transpiration (ET_C) from crop coefficients and ET.

The model combines not only crop water use, but also a complex range of other information including soils, current irrigation practices, leaching requirements, rainfall, leakage, depth to water table, capillary upflow, salt concentration of irrigation water, groundwater and the economic returns from various rotations.

CROP WATER USE
equals
ET_0* CROP CO-EFFICIENT

Actual on-farm water balance monitoring is being used to finetune models, testing and improving the accuracy of the predictions. The on-farm information will also be used to identify farming practices which limit recharge to the watertable, while maximising farm returns.

Project outputs

The results and information from this project are displayed by the *SWAGMAN® Farm* model in a user-friendly form so that the benefits of 'net recharge management' are easily understood by farmers. This can be seen in the following example.

Predicting the future

The application of the three models is helping in understanding the relationship between farming practices and the productive capacity of the land in the Coleambally and Murray Irrigation areas. A balance between short-run returns and long-term production sustain-ability needs to be established to ensure that irrigation areas remain viable.

Results of farm level model - SWAGMAN® Farm

John Smith has a 200-hectare farm and grows 30 hectares of rice, 40 hectares of wheat, 40 hectares of soy beans, 40 hectares of maize and 30 hectares of annual pastures. He uses 13 megaliters/ha for rice, 3 megalitres/ha for wheat, 7 megalitres/ha for soybeans, 9 megalitres/ha for maize and 3 megalitres/ha for annual pastures. John's farm has an annual allocation of 1300 megalitres, with the water table at 1.5 metres and groundwater salinity at 4.0 dS/m.

The model results of this scenario show that with 'average' irrigation efficiency, in an average rainfall year, the water table will rise by about 0.43 metres (43 centimetres) after contributing a net recharge of 221 megalitres (or 1.1 megalitres/ha). In growing the nominated crops, John Smith will have used all his annual water entitlement, and imported 123 tonnes of salt due to irrigation and rain, and 125 tonnes of salt due to upward flows from the groundwater. While the net leaching has removed some salt from the soil profile, there is an overall increase in soil salinity. This is a typical problem in shallow groundwater irrigation areas which needs special management practices.

Each of the crops that John Smith intends to grow has a cost of production and an expected return based on average yields. These figures are put into the SWAGMAN Farm so that an approximate total farm gross margin can be calculated. This figure will then be used by John Smith to assist him make a judgement between achieving an acceptable gross margin relative to the expected effects on water tables and salt levels that result from his cropping practices. To reach a sustainable balance, a different combination of crops can be grown, groundwater pumping needs to occur or irrigation efficiency has to increase.

All of these options can be evaluated by SWAGMAN Farm to examine their effect on net recharge, rootzone salinization and the total gross margin of the farm.

Change in the water table level	*0.43 metres*
Total irrigation water required	*1240 megalitres*
Total salt brought onto farm by irrigation	*123 tonnes*
Total salts moved into rootzone from water table	*125 tonnes*
Total salts removed by leaching	*209 tonnes*
Total net recharge on farm	*221 megalitres*
Total change in salt within the root zone	*+39 tonnes*
Change in soil salinity	*+0.1 dS/m*
Net recharge per hectare	*1.1 megaltires*
New watertable depth	*1.07 metres*
Total farm gross margin	*$83,247*

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For further information contact:
Dr Shahbaz Khan
CSIRO Land and Water
Griffith, NSW 2680
Tel: (02) 6960 1500 Fax: (02) 6960 1600
Email: shahbaz.khan@grf.clw.csiro.au
Web: www.clw.csiro.au/division/griffith

Produced by the Communication Group, CSIRO Land and Water