

Management of Salinity and Sodic Soils under Irrigation

John Williams

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Services Pty Ltd**



SODIC SOILS

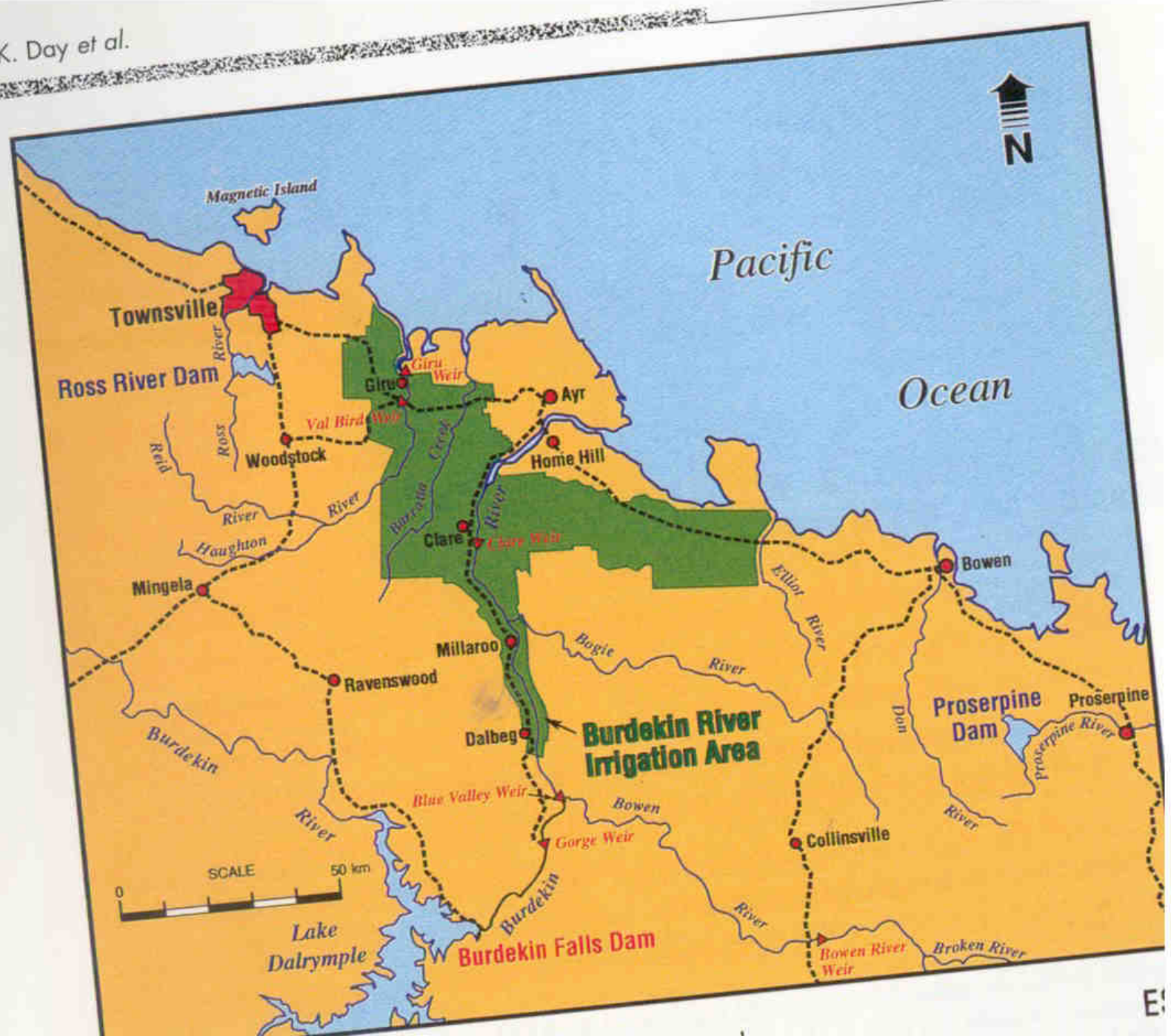
**Distribution, Properties, Management,
and Environmental Consequences**

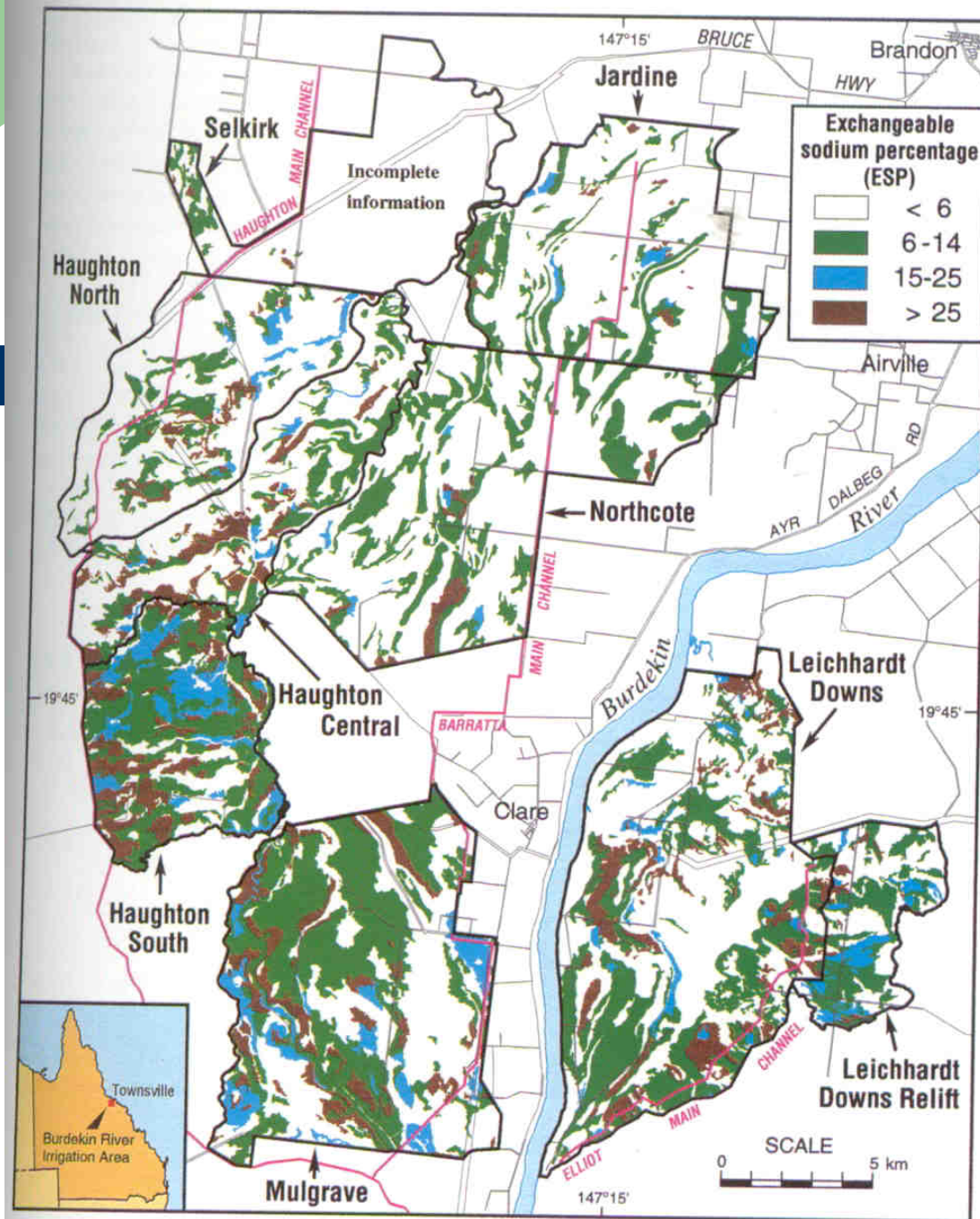
Edited by
Malcolm E. Sumner
Ravendra Naidu

AUSTRALIAN SODIC SOILS
**Distribution, properties
and management**



editors
**R. NAIDU, M.E. SUMNER
AND P. RENGASAMY**





Day et al. 1995

Fig. 2. Distribution of sodic soils with variable exchangeable sodium percentage (ESP) at 0.2–0.3 m depth within part of the Burdekin River Irrigation Area.

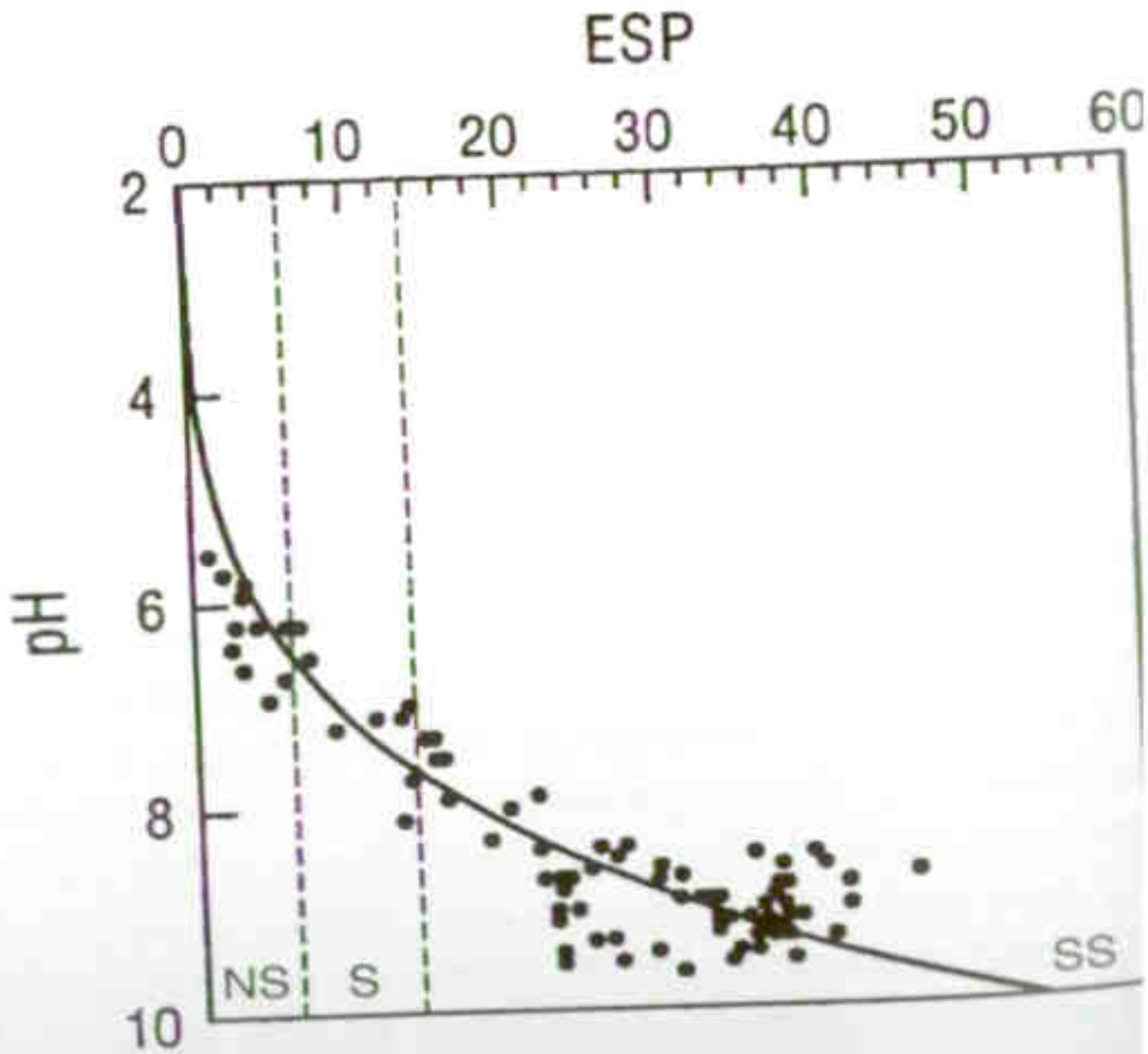
Table 1. Criteria used in the BRIA to assess the sodicity limitation for sugarcane based on field pH and predicted ESP for Vertosols and Sodosols

Predicted ESP (%)	Field pH at 0.3 m		Yield reduction (%)	Sugarcane sodicity sub
	Vertosols	Sodosols		
<6	<8.0	<6.5	negligible	
6–14	8.0–9.5	6.5–8.0	10–25	S02
15–25		8.0–8.5	25–50	S03
>25		>8.5	>50	S04

Day et al. 1995

Table 6. The extent (ha and %) of Sodosols in Survey Sections of the BRIA

Survey Section	Area (ha) and % of each Section with ESP (0.3 m) of		
	6–14	15–25	>25
Haughton North (5036 ha)	1150 (23%)	109 (2%)	201 (4%)
Haughton Central (4378 ha)	713 (16%)	294 (7%)	718 (16%)
Haughton South (4148 ha)	1204 (29%)	491 (12%)	906 (22%)
Jardine (5730 ha)	1219 (21%)	221 (4%)	183 (3%)
Northcote (7820 ha)	2485 (32%)	97 (1%)	200 (3%)
Mulgrave (8580 ha)	1428 (17%)	761 (9%)	995 (12%)
Leichhardt Downs (9650 ha)	1672 (17%)	232 (2%)	941 (10%)
Leichhardt Downs Relift (1968 ha)	442 (22%)	70 (4%)	233 (12%)
Total 47 310 ha	10 313	2275	4377
Percent of total	(22%)	(5%)	(9%)



7.1 IRRIGATION AND SODICITY: AN OVERVIEW

P. Rengasamy^A and K.A. Olsson^B

ABSTRACT

The productivity of irrigated agriculture in Australia is low for most crops and important factors are the physical and chemical constraints caused by sodicity in the rootzone. Over 80% of the irrigated soils are sodic and have a degraded structure which limits water and gas transport and root growth. Irrigation, without appropriate drainage, leads to the buildup of salts in soil solutions with increased sodium adsorption ratio and can develop perched watertables due to a very low leaching fraction of the soil layers exacerbated by sodicity. Therefore, irrigation management in Australia is closely linked with the management of soil sodicity.

The inevitable consequence of continued irrigation of crops and pastures with saline-sodic water without careful management is the further sodification of soil layers and concentration of salt in the rootzone. This will increase the possibility of dissolving toxic elements from soil minerals. The yields of crops can be far below the potential yields determined by climate. The cost of continued use of amendments and fertilizers to maintain normal yields will increase under saline-sodic irrigation.

Most of the irrigated soils in Australia need reclamation of sodicity of soil layers at least in the rootzone. The management of these sodic soils involves the application of gypsum, suitable tillage and the maintenance of structure by the buildup of organic matter and biological activity over time. Then artificial drainage, an essential component of the management of irrigated sodic soils, is possible. By following these soil management practices, irrigated agriculture in Australia will become sustainable with increased yields and high economic returns.

Keywords: irrigated soils, sodicity, sodification, Na balance, sodic soils, soil management

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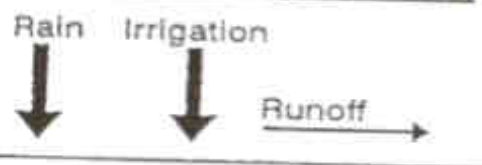
Keywords: irrigated soils, sodicity, sodification, Na balance, sodic soils, soil management

Sodic Soils



$SAR_{1:3} > 3$
 $EC_{1:3} < 0.4 \text{ dS m}^{-1}$
 $LF < 0.1$
Strength $> 1 \text{ MPa}$
Aeration Porosity $< 15\%$
Matrix water retention $< 12 \text{ mm dm}^{-1}$

Ameliorated Soils



$SAR_{1:3} < 3$
 $EC_{1:3} \sim 0.4 \text{ dS m}^{-1}$
 $LF > 0.1$
Strength $< 1.0 \text{ MPa}$
Aeration Porosity $> 15\%$
Matrix water retention $> 12 \text{ mm dm}^{-1}$

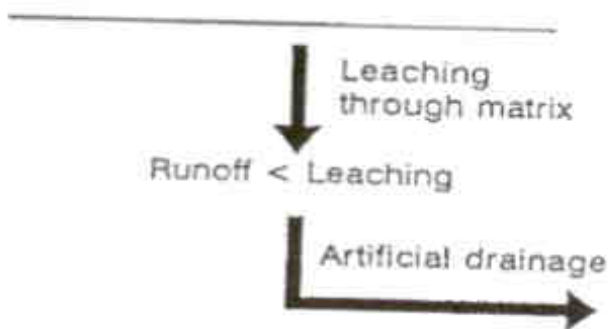
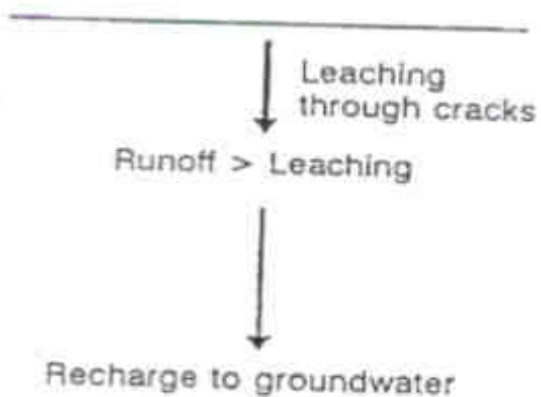


Fig. 4. Specification of hydrologic components and soil parameters for sodic and ameliorated soils.

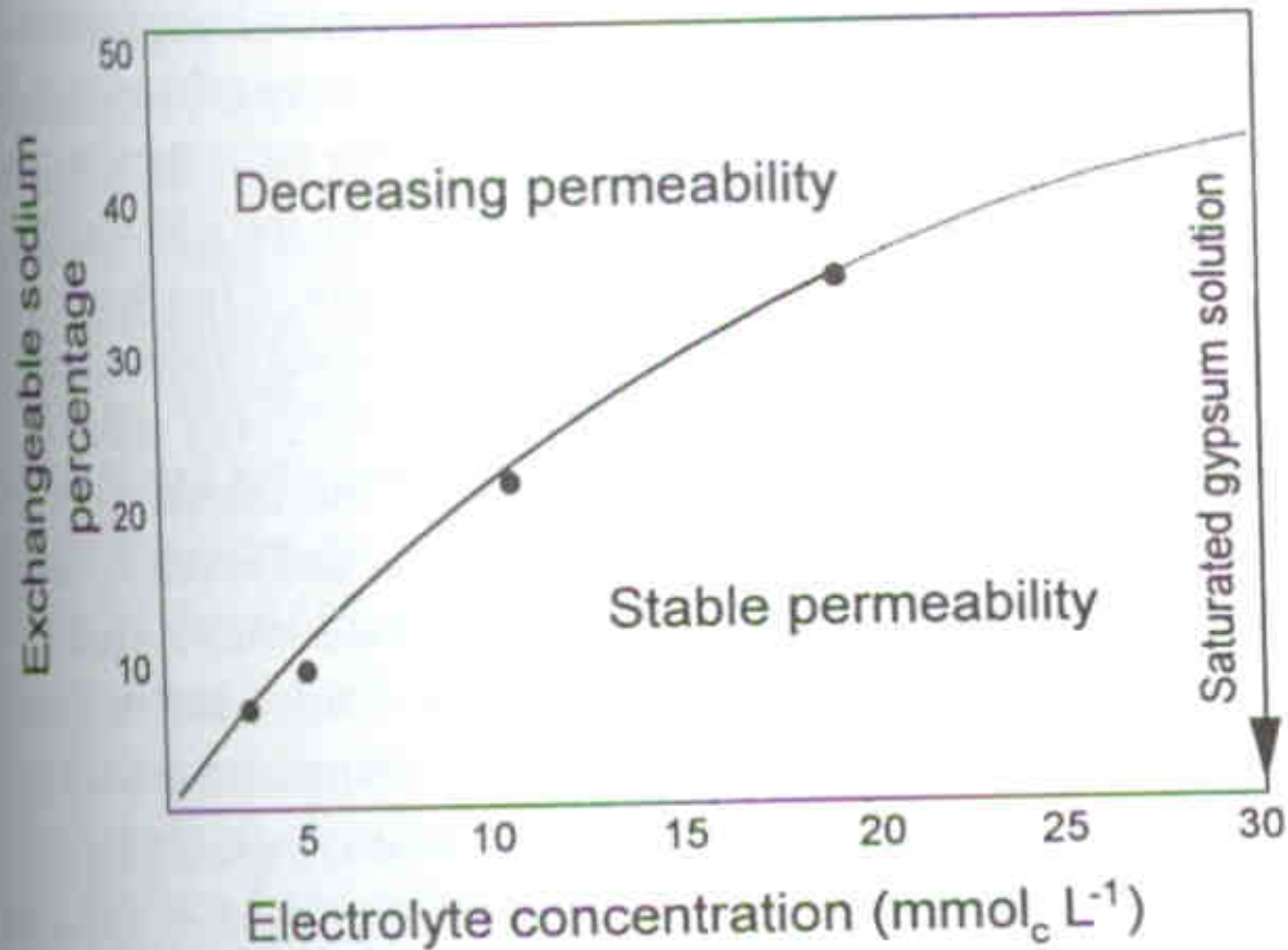
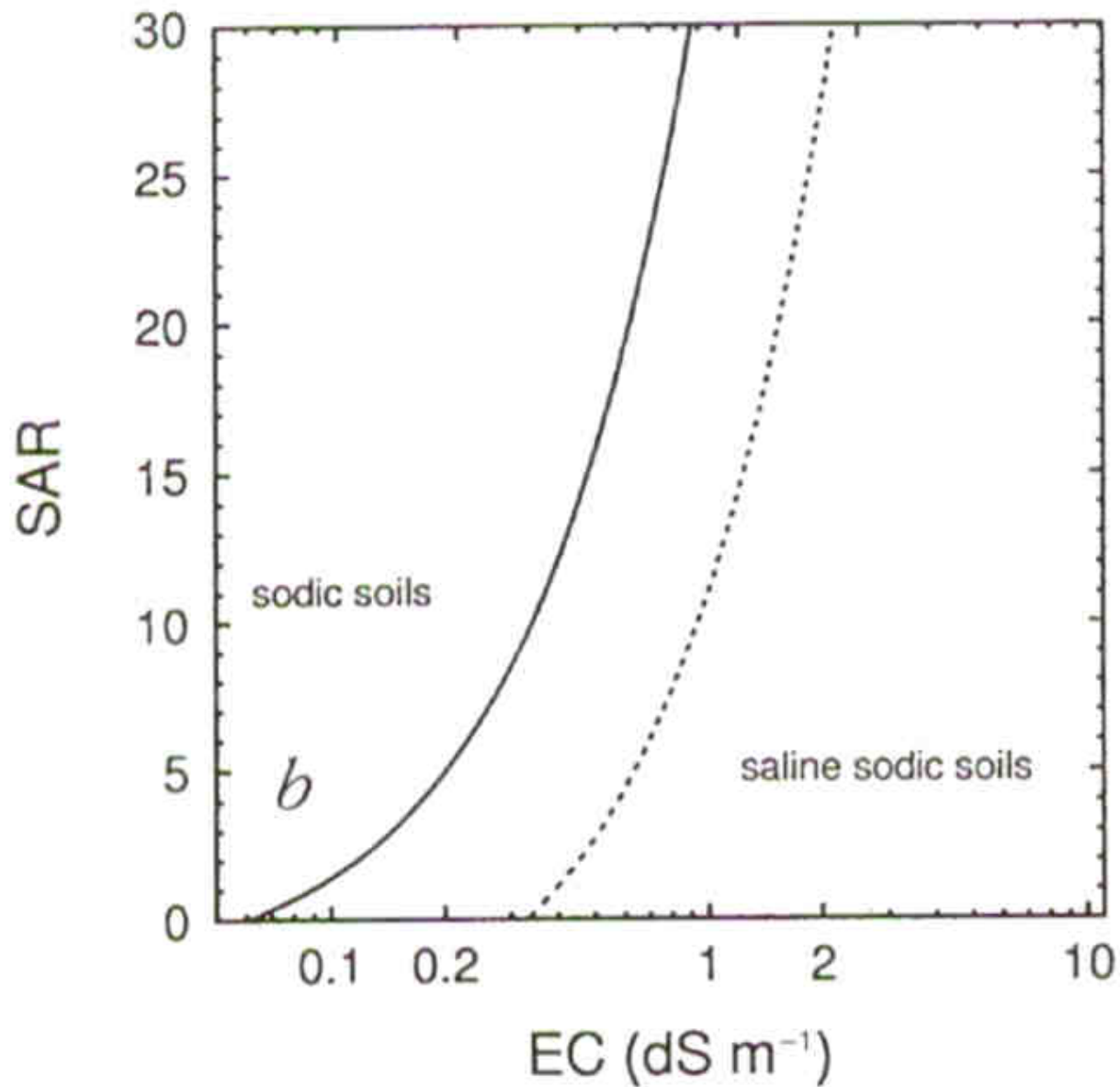
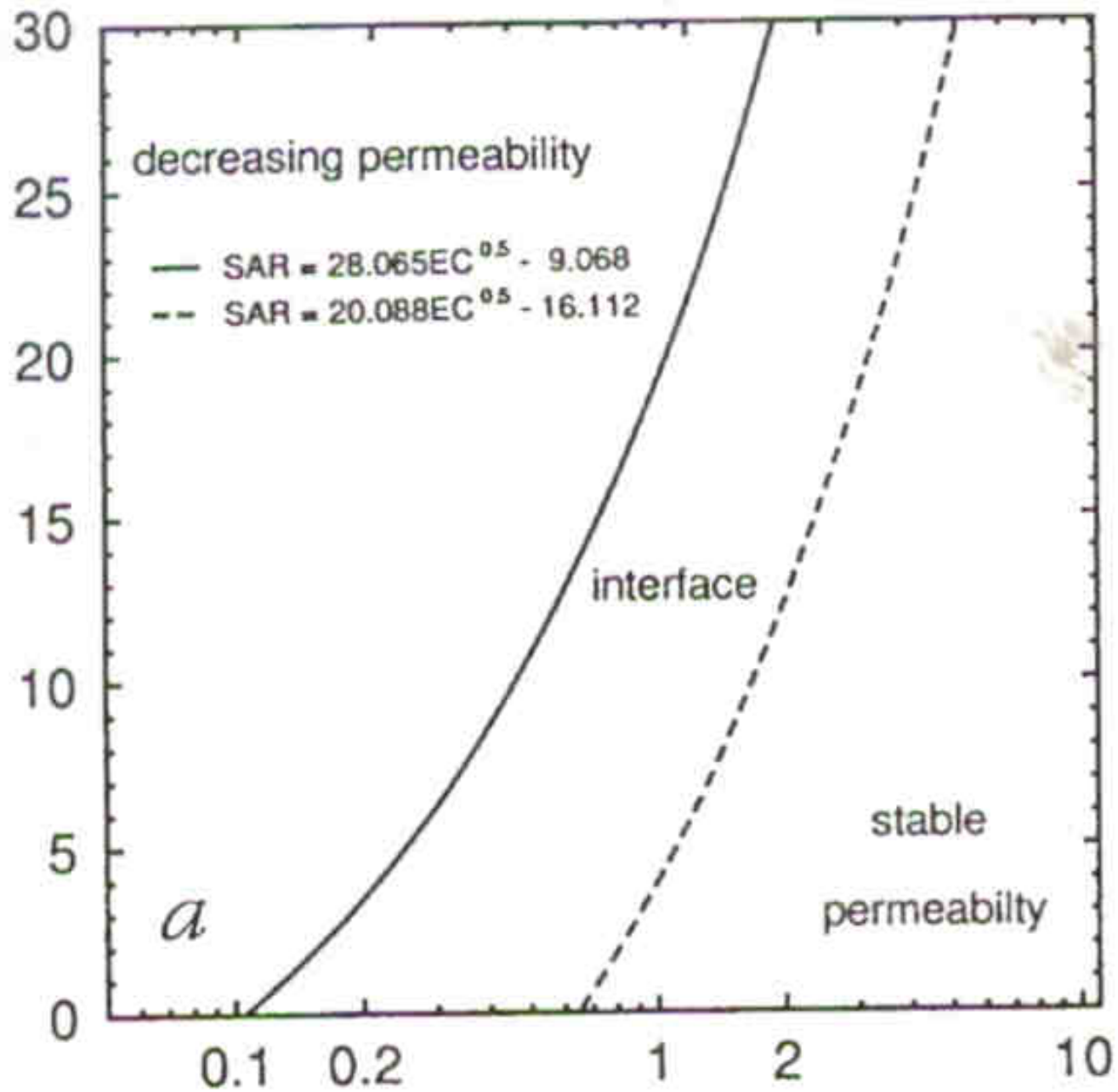


Figure 1.3 Threshold electrolyte concentration (TEC) curve illustrating zones of stable and unstable permeability [Quirk and Schofield, *J. Soil Sci.* 6:163-178, (1955)].



- $EC = 0.056SAR + 0.06$ for spontaneous dispersion
- ... $EC = 0.121SAR + 0.33$ for mechanical dispersion

SAR



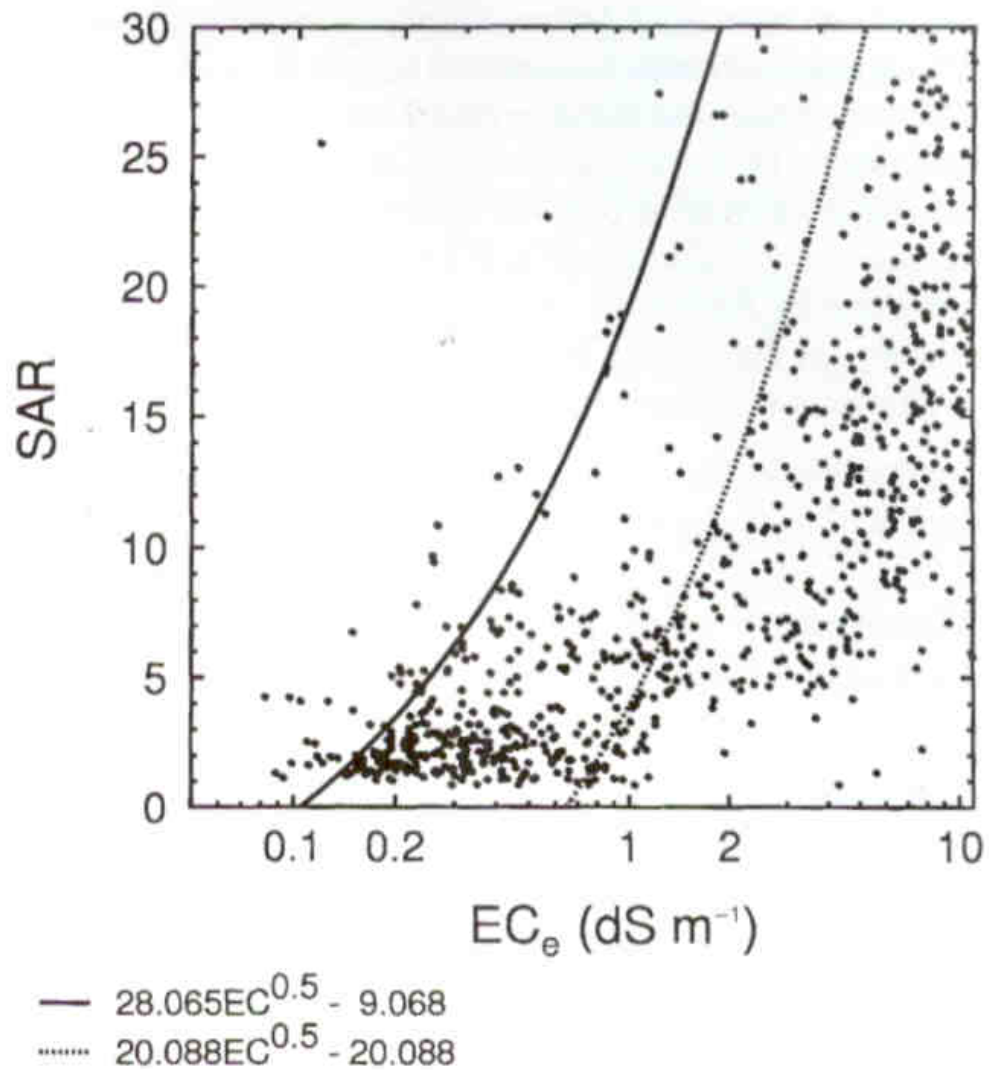


Fig. 13. Soil profile data for the 0.9 m depth for some 900 soil profiles from Queensland plotted against the relationships of Ayers and Westcot (1985) as described in Figure 12a.

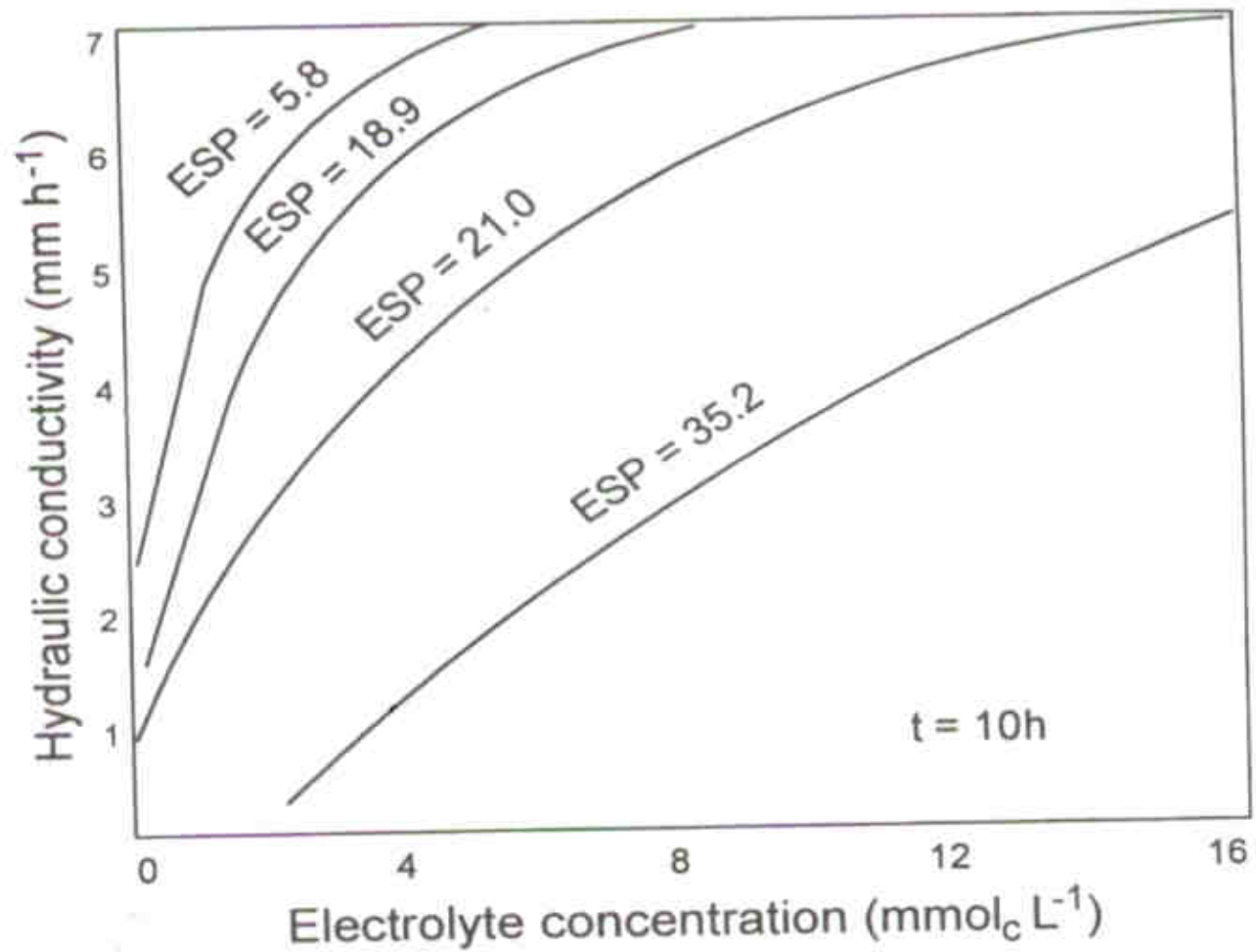


Figure 1.4 Hydraulic conductivity of silty loam soil (Sawyers Field 1, Rothamsted Farm, England) as a function of electrolyte concentration for several levels of exchangeable sodium percentage (ESP) [Reeve, *Trans. 5th Int. Congr. Agric. Eng.* no. 21-32. (1958)].

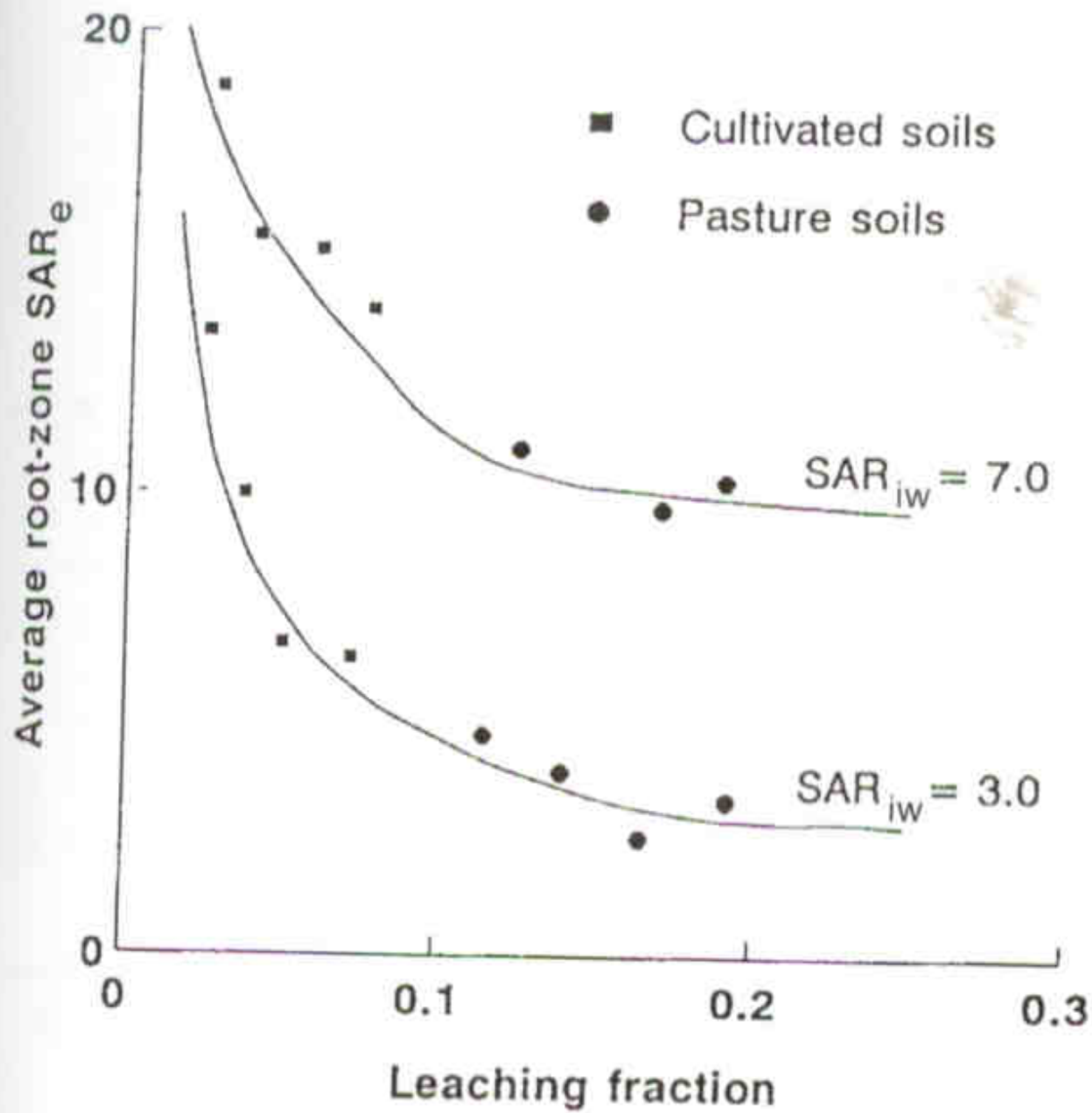


Fig. 3. Average rootzone SAR_e as influenced by leaching fraction and SAR_{iw} .

Sodic Soils



$$SAR_{1.5} > 3$$

$$EC_{1.5} < 0.4 \text{ dS m}^{-1}$$

$$LF < 0.1$$

$$\text{Strength} > 1 \text{ MPa}$$

$$\text{Aeration Porosity} < 15\%$$

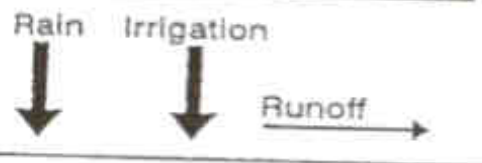
$$\text{Matrix water retention} < 12 \text{ mm dm}^{-1}$$

↓ Leaching through cracks

Runoff > Leaching

↓ Recharge to groundwater

Ameliorated Soils



$$SAR_{1.5} < 3$$

$$EC_{1.5} \sim 0.4 \text{ dS m}^{-1}$$

$$LF > 0.1$$

$$\text{Strength} < 1.0 \text{ MPa}$$

$$\text{Aeration Porosity} > 15\%$$

$$\text{Matrix water retention} > 12 \text{ mm dm}^{-1}$$

↓ Leaching through matrix

Runoff < Leaching

↓ Artificial drainage →

Fig. 4. Specification of hydrologic components and soil parameters for sodic and ameliorated soils.

The evidence from best management of surface soils through stubble retention and minimum till indicates that these managements will maximize water storage. This is at the cost of greater water movement below the root zone and for some landscapes degradation due to salinity and/or waterlogging. Some quantitative research on the interaction of surface soil protection and implications for soil and landscape hydrology is needed.

Shaw et al. 1995

CLIMATE SHIFT and CHANGE
Rainfall

IRRIGATION

GROUNDWATER

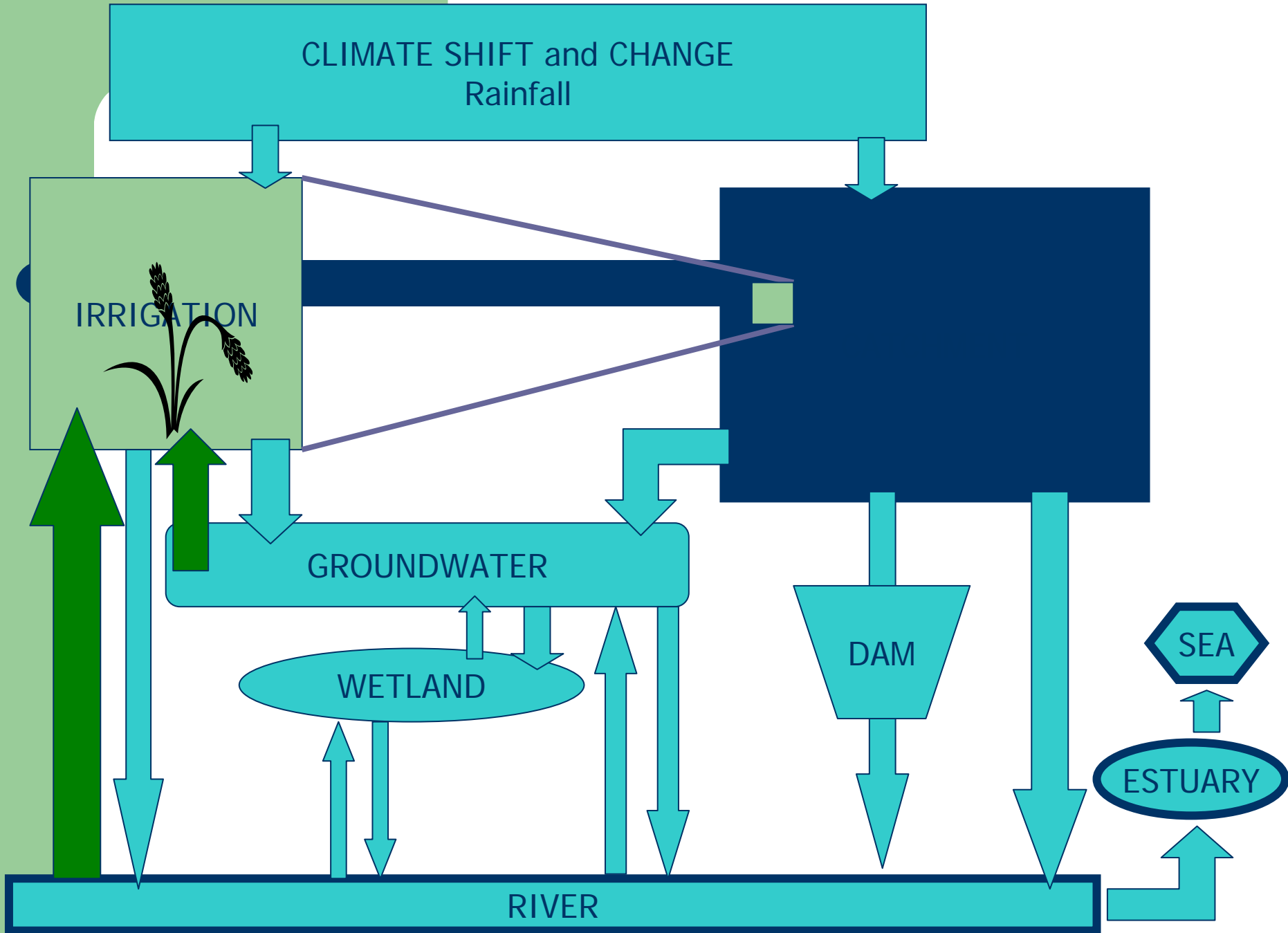
WETLAND

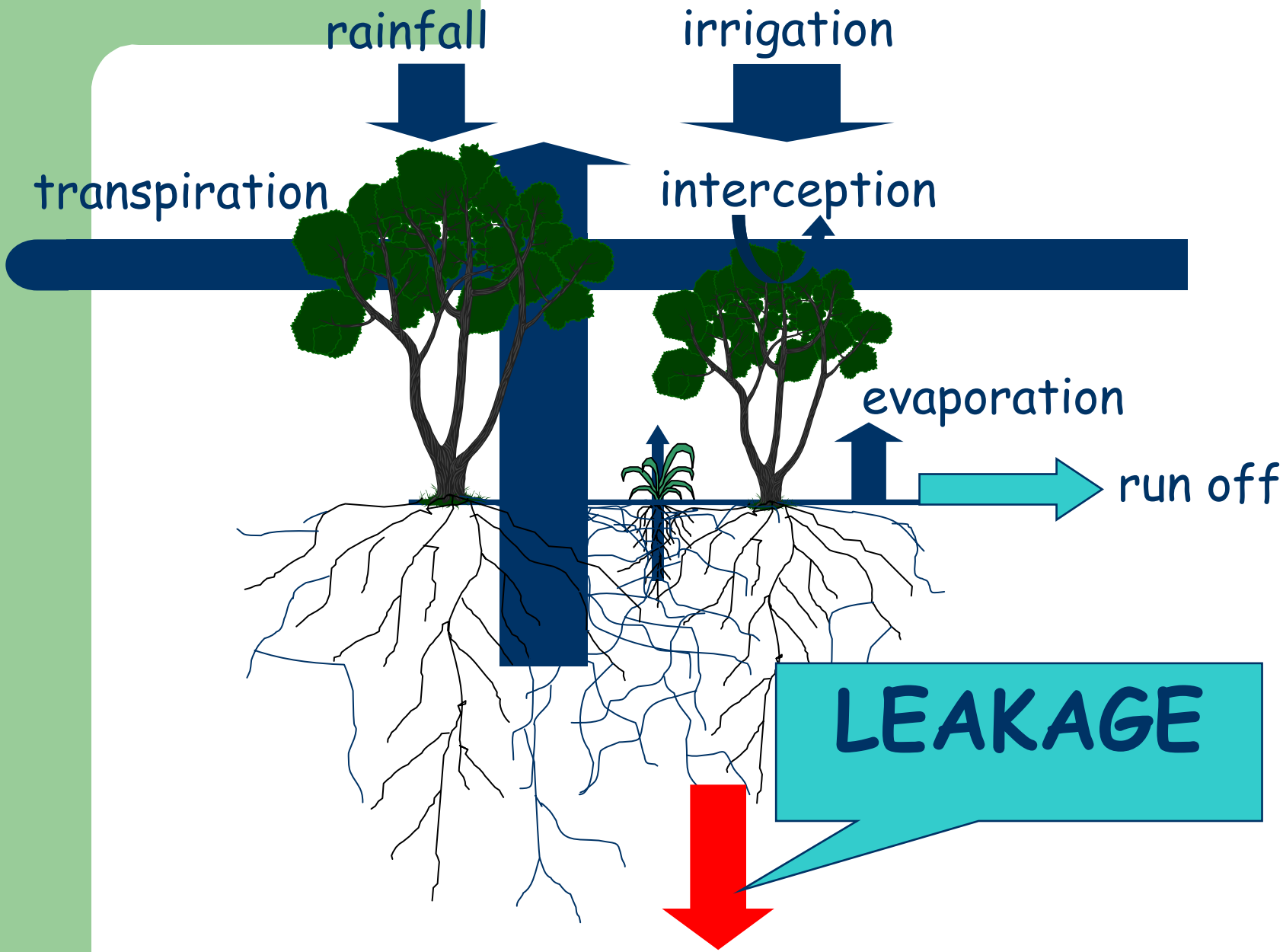
DAM

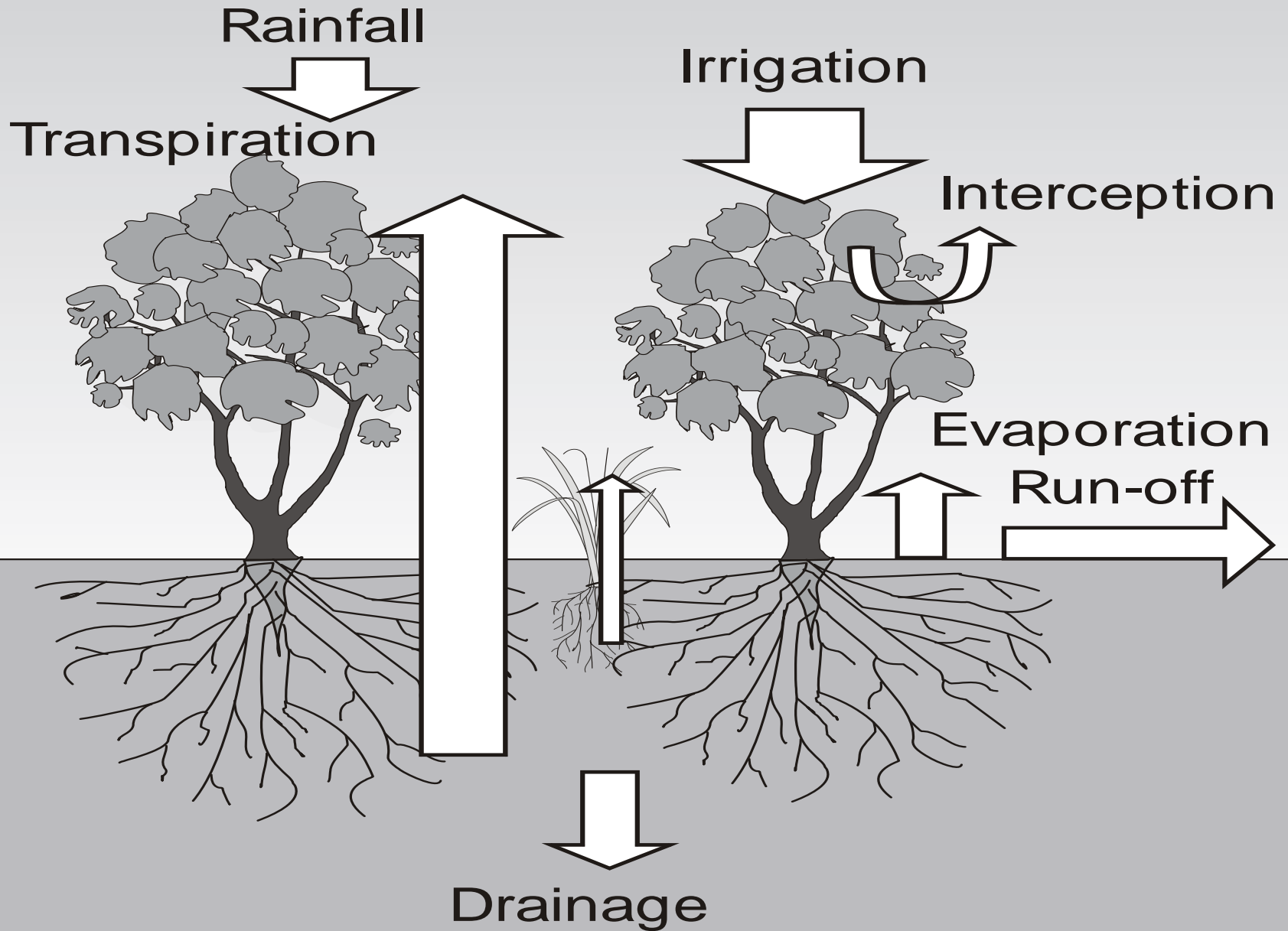
ESTUARY

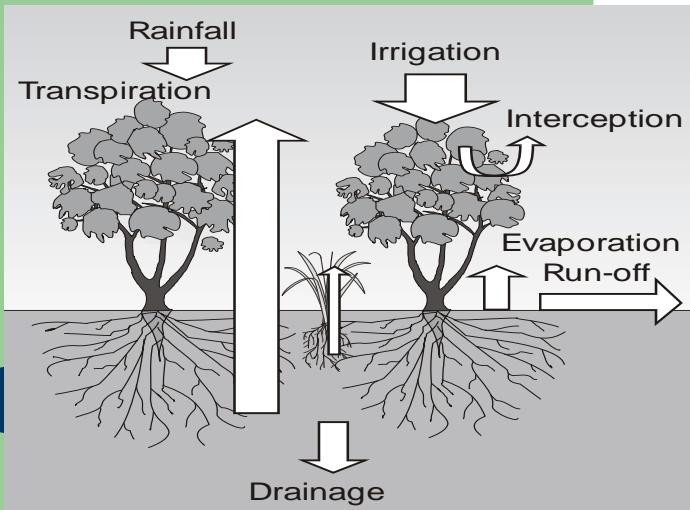
SEA

RIVER



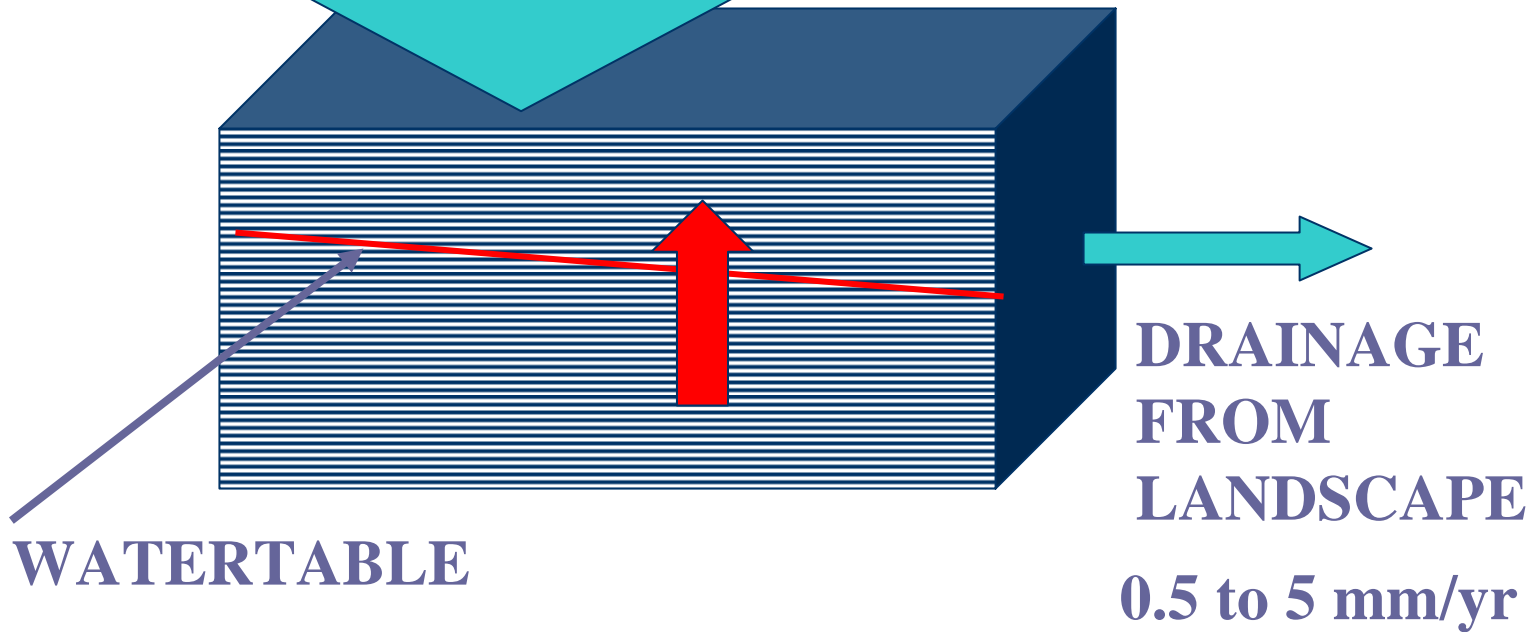


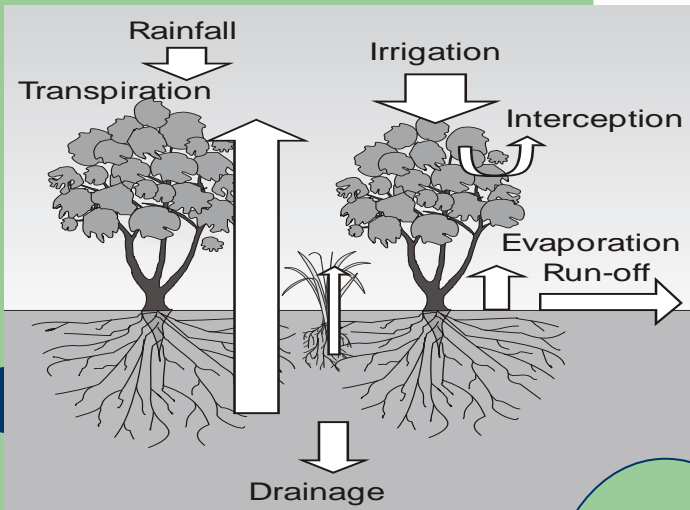




**LEAKAGE INTO
LANDSCAPE
FROM
BENEATH AGRICULTURE**

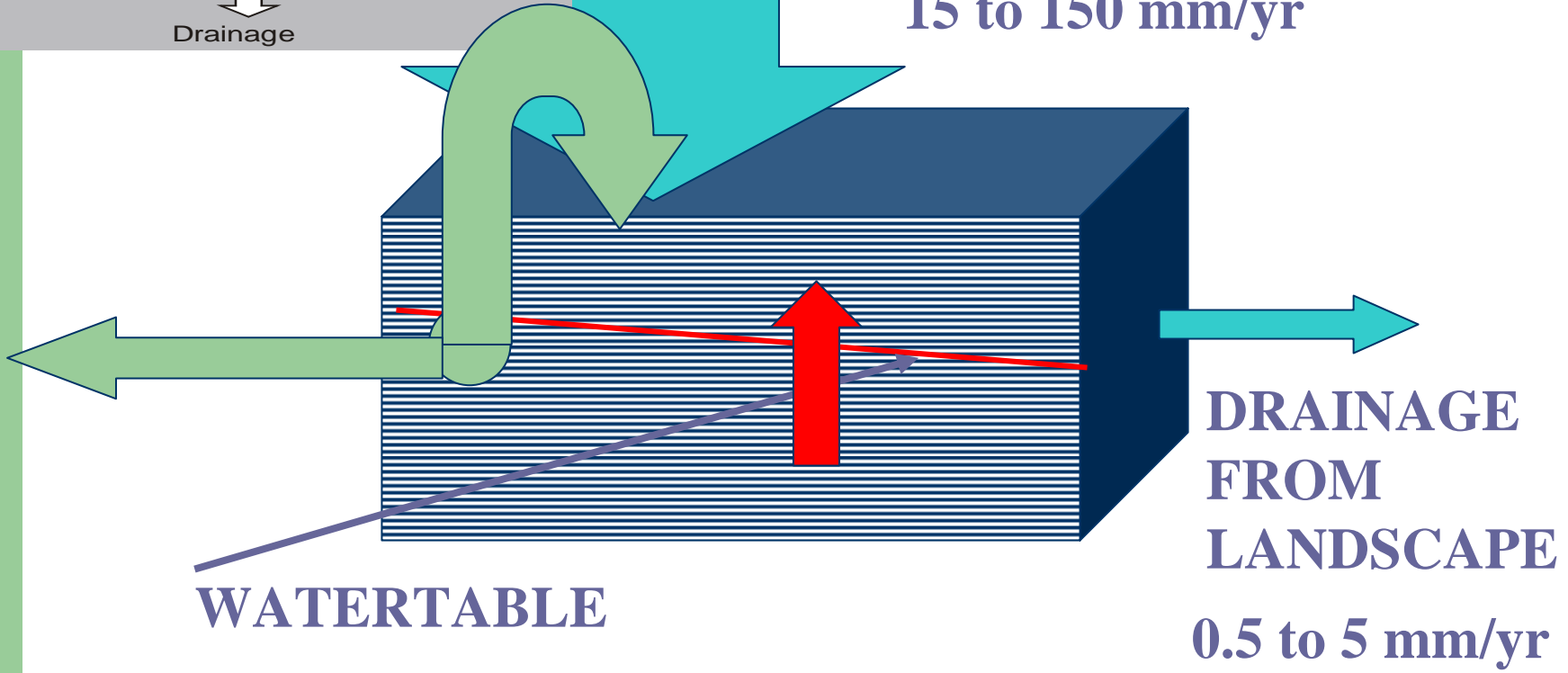
15 to 150 mm/yr





**LEAKAGE INTO
LANDSCAPE
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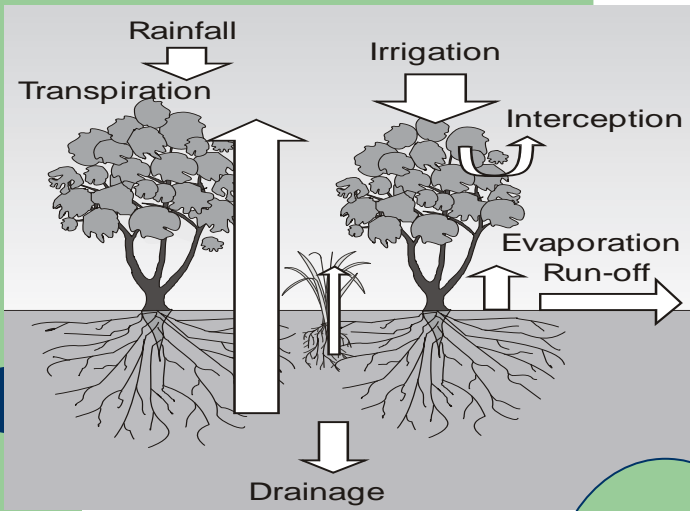
15 to 150 mm/yr



**DRAINAGE
FROM
LANDSCAPE**

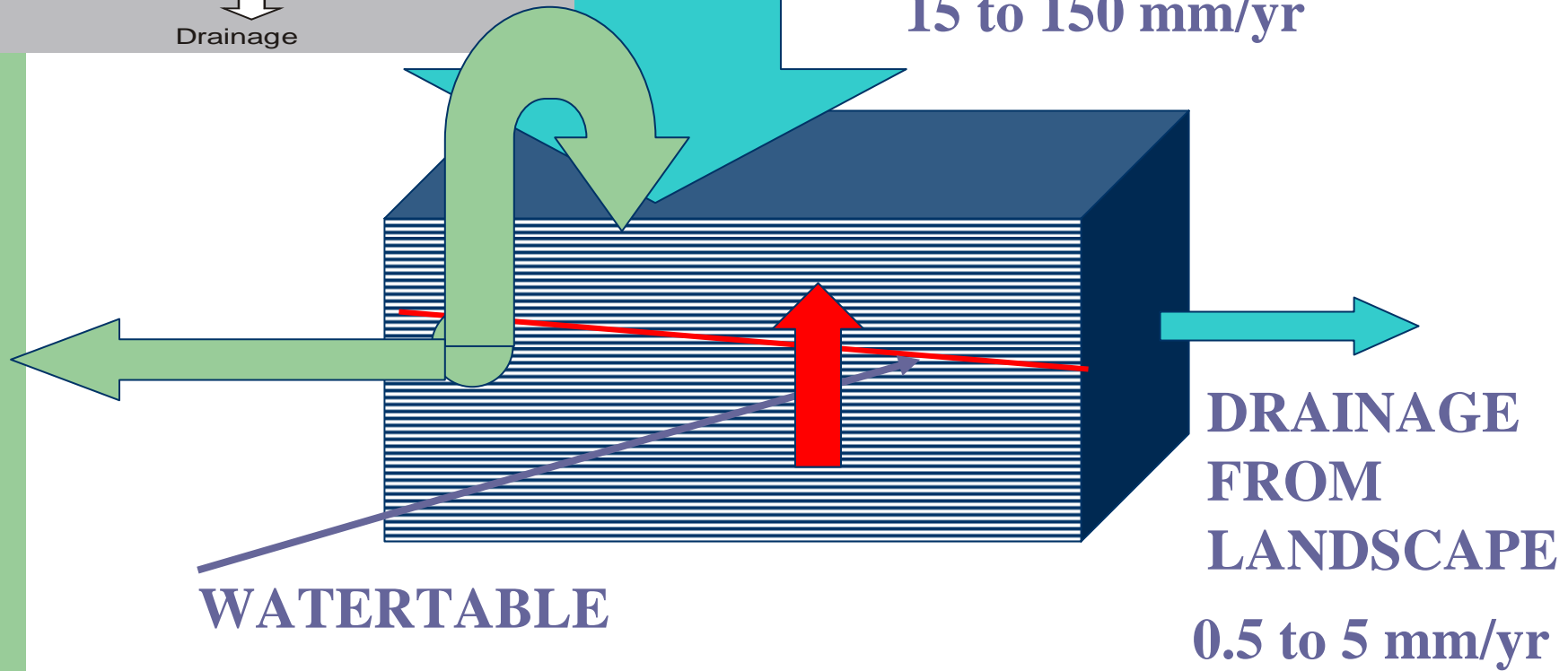
0.5 to 5 mm/yr

WATERTABLE



**LEAKAGE INTO
LANDSCAPE
FROM
BENEATH AGRICULTURE**

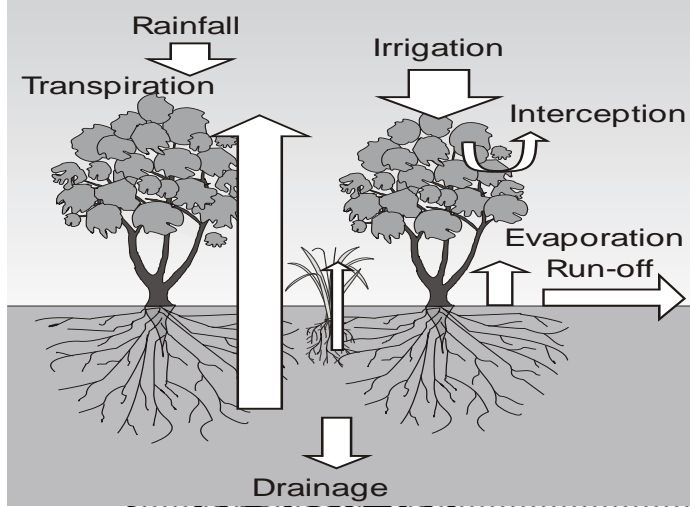
15 to 150 mm/yr



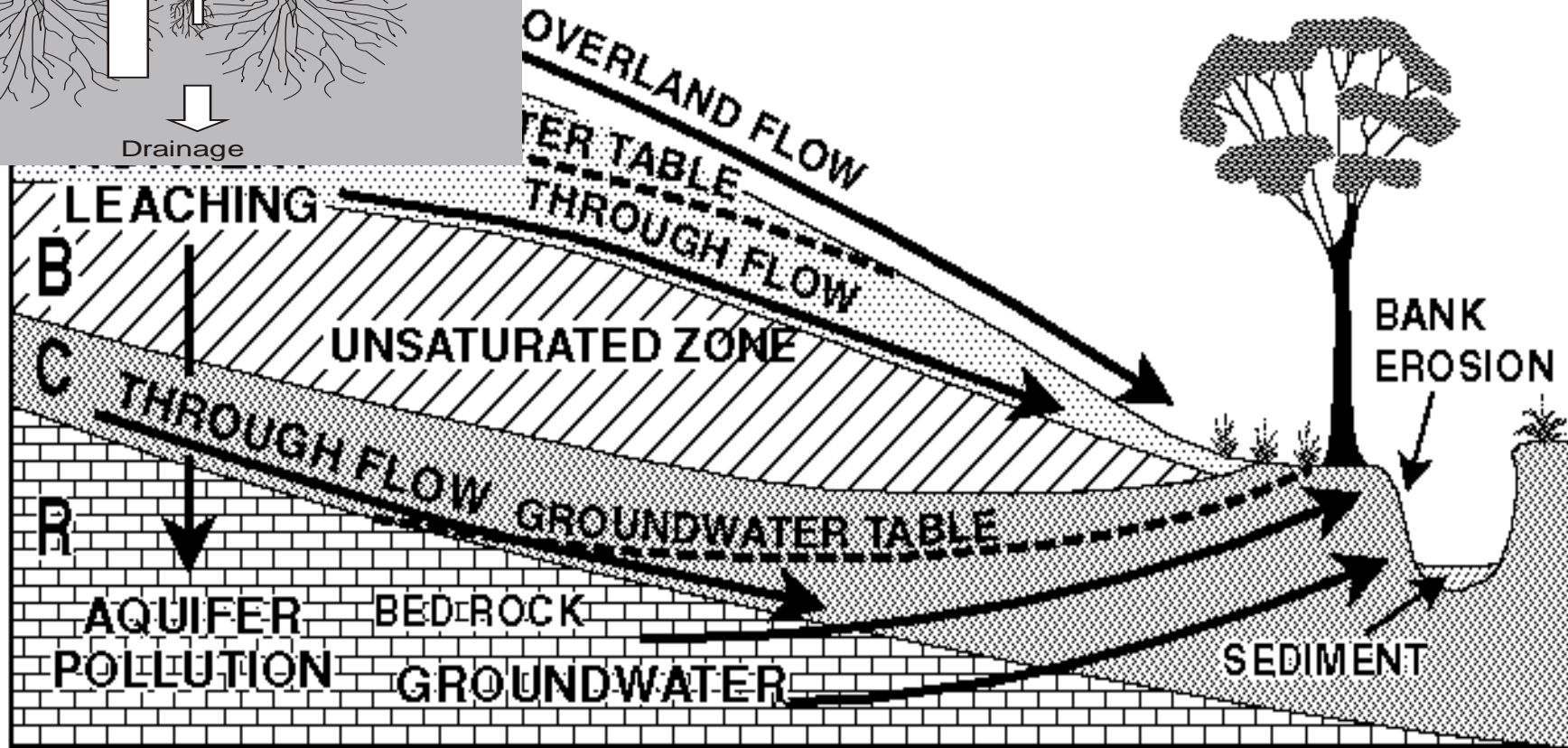


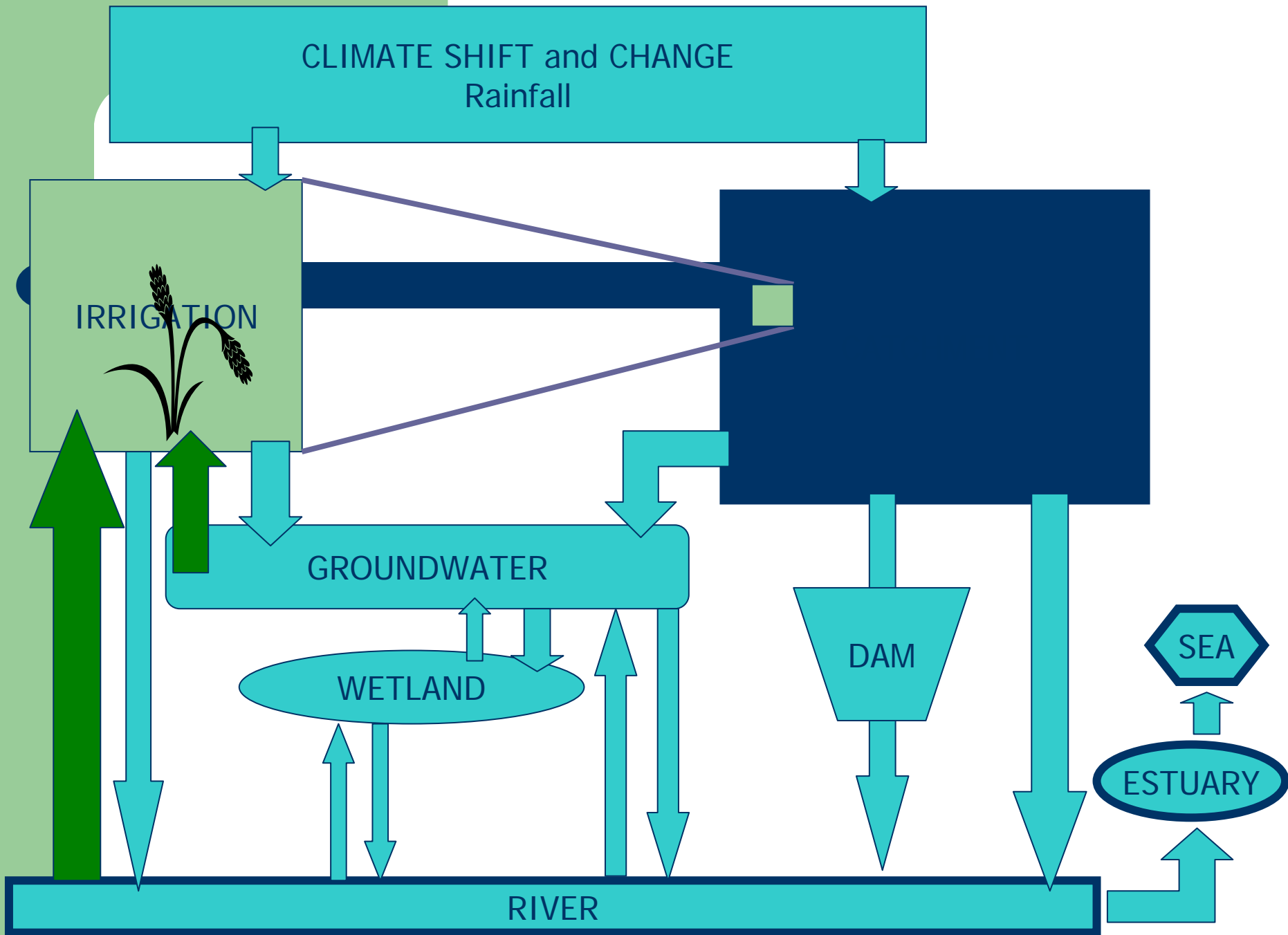
**Leakage of water drives leaching of
nutrient and accelerated
acidification as well as salinity**

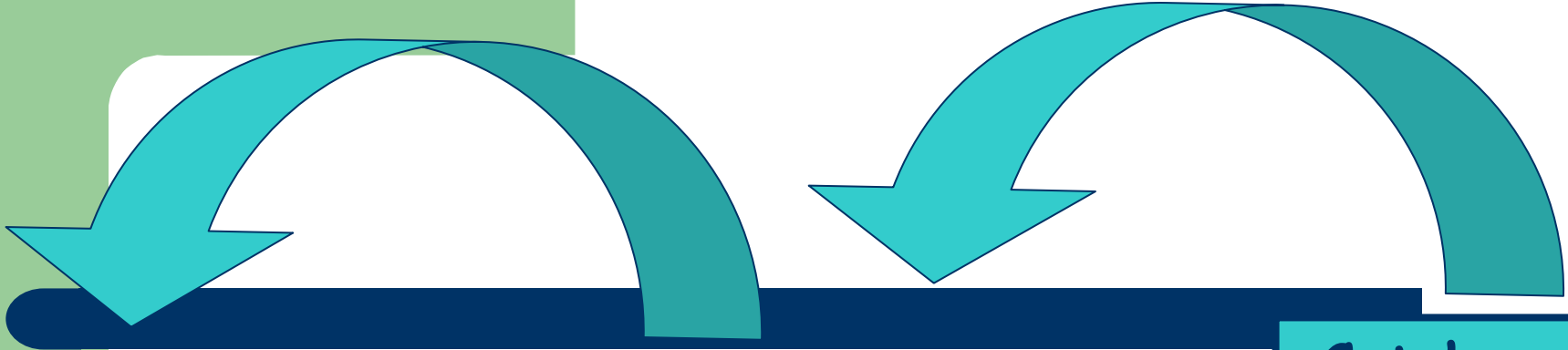
GENERALISED NUTRIENT TRANSPORT IN CATCHMENTS



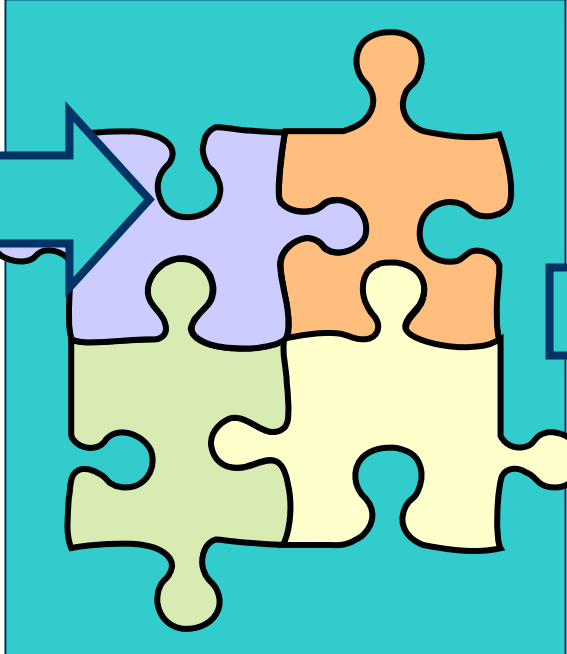
WATER RETENTION & SUBSURFACE FLOW



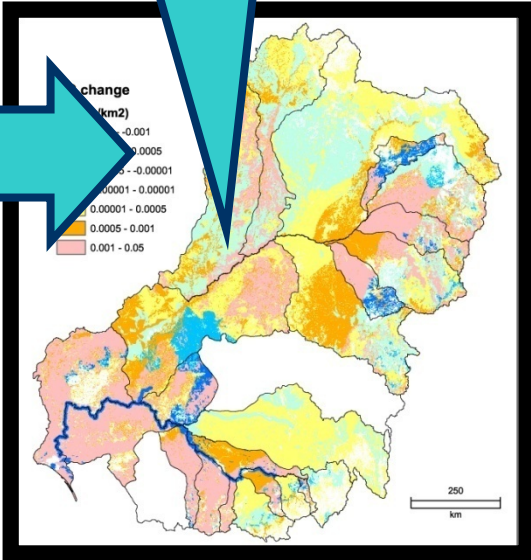




Landcare Farming



Catchment Action Plan



Sustainable Irrigation in Australia

- Management of Sodic Soils
- Management of salt...mobilisation, storage and transport to where it came from...the sea
- Balancing water entry, storage and leakage from soil along with salt, nutrients and pesticides
- Management must address paddock to farm to catchment...whole system