DRYLAND SALINITY: THREATENING WATER RESOURCES IN THE SEMI-ARID WESTERN CAPE

Increased dryland salinity in the Swartland and Overberg regions poses a threat to the bread basket of the Western Cape, water resources in an already water-stressed area, water supply to the industrialised Saldanha region as well as the ecology of the Berg River system.

The Berg River, which flows between Franschhoek and Velddrif, is an important freshwater resource to the Western Cape. In the 1980s, the Department of Water Affairs (DWA) measured an increase in salt concentrations, particularly in the mid- to lower reaches of the river, thereby impacting on drinking water quality and agriculture.

Dryland salinity poses a major threat to water quality, particularly in semi-arid areas. It is usually associated with the mobilisation of inorganic salts from the landscape and the consequent increase in salt concentrations in receiving water bodies.

Dyland salinity is not new to this area. Wheat lands in the Swartland and Overberg regions are widely known to contain “brak kolle” (saline scalds) where the wheat will not germinate.

CAPTION: The Berg River near Velddrif. The river drains an area of approximately 9 000 km² and is an important source of water to the Boland and Cape Peninsula (source: Vernon Somerset, CSIR).

Are changes in land use the main cause?

Findings from several research projects in the semi-arid wheat lands of the Western Cape indicated that changes in land use over the last century or more, from extensive pastoral use to intensive cropping, may have triggered the same process of salt decantation that is so widespread in Australia. The key questions are whether the dryland salinity in catchments such as that of the Berg River is more intense now than it was several decades ago and whether it is still intensifying? If so, the consequences for the management of water quality and water supply could be enormous, since any current assessment of the salinity load, on the basis of which impoundments and canal schemes are planned, could be incorrect and may thus require costly adjustments in the future.

PREVIOUS RESEARCH TO ADDRESS THE ISSUE

Historical overview of research on this problem

A cycle of research projects has been initiated to investigate the salinisation of water resources and the issue of dryland salinity in the Berg River catchment.

- Dr Martin Fourie (1976) studied the distribution of salinity in the Berg River catchment, aiming to identify the origin of the salts. He identified the Malmesbury shales as being the main source of these salts.
- Since 1986 DWAF studied the salinisation trend in the Sandspruit River catchment, a tributary of the Berg River. In a publication from this work, Flügel (1995) indicated that water bodies within this catchment were investigated to identify and quantify their salinity dynamics. It was reported that groundwater and interflow from the weathered shale and soils contributed to river salination based on the findings that the bulk annual atmospheric deposition of salt accounted for only a third of the total salt output from the catchment.
- WRC project 1342/1/04 represented a pilot study to investigate the extent of dryland agricultural impacts on river salinity in the Berg River catchment. It was reported that dryland salinity is extensive and that it is likely to have a significant impact on the water quality of the Berg River.
- With WRC project TT 252/06 the influence of irrigation return-flow on the water quality of the Berg River was assessed and it was reported that its contribution to the salt levels in the Berg River was minimal when compared to the consequences of dryland salinisation.

It is therefore clear that dryland salinity is affecting the water quality in the Berg River catchment and that mitigation strategies need to be identified. Findings from previous research suggest that a thorough assessment of the influence of land use

practices, e.g. cultivation versus grazing, vegetation type, tillage practices, erosion control etc., on salt mobilisation is required.

CURRENT RESEARCH

Between 2005 and 2009 researchers investigated the impact of land use practises on salinity in the Berg River (WRC project K5/1503) at three locations:

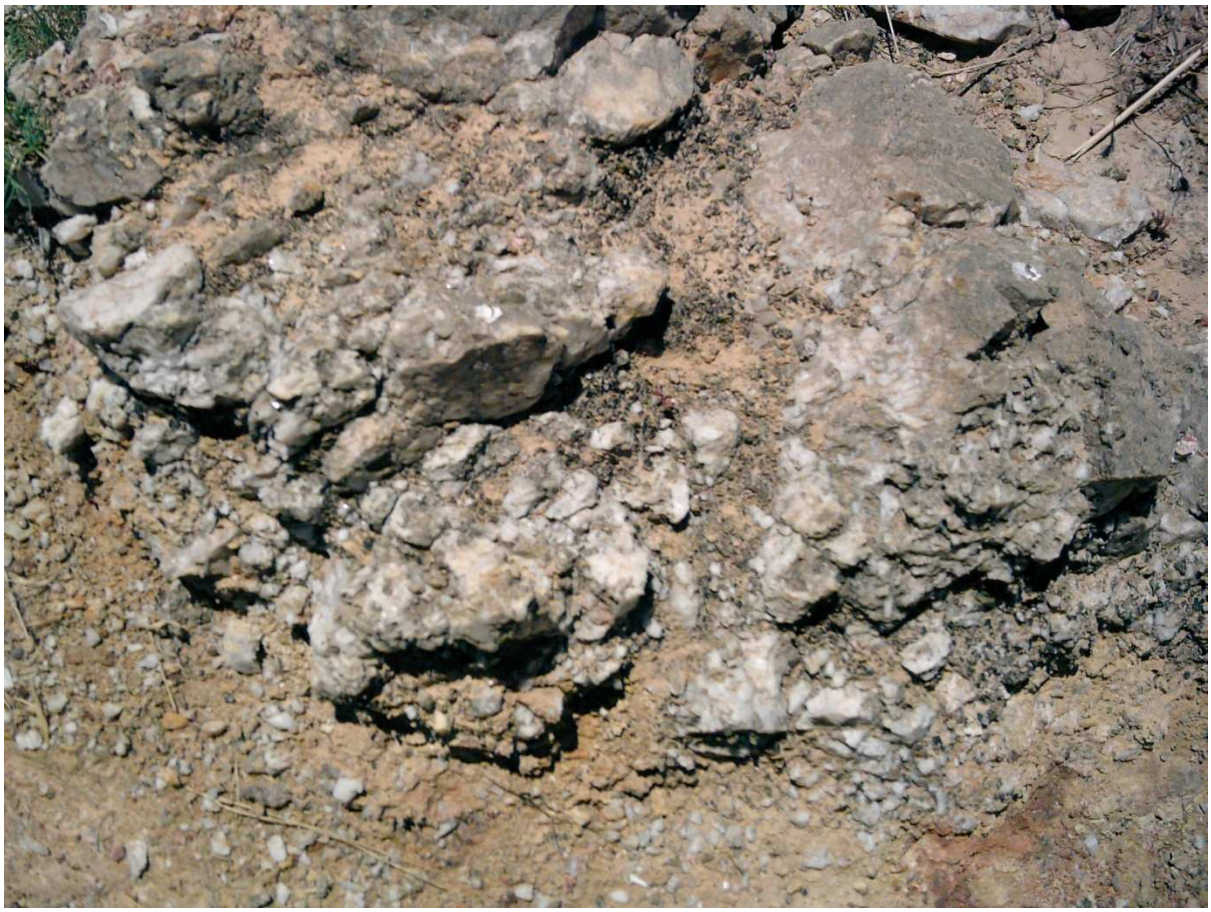
- Goedertrou farm: The water and salt dynamics were investigated in the soil and vadose zone of a 16 hectare small scale catchment, exhibiting evidence of dryland salinity and representative of semi-arid conditions in the Berg River catchment. At this site, salt sources and storage were studied and also groundwater fluxes and catchment runoff with the view of informing future catchment-scale modelling and to guide the development of on-farm management practices.
- Voëlvlei Nature Reserve: An experimental site was established to allow for a comparison of hydrology and salt balances between winter wheat and restored Renosterveld.
- Sandspruit catchment: Salt and water discharge into the Berg River were monitored in this 152 km^2 catchment.

CAPTION: The Goedertrou small-scale catchment: the dominant land use in the mid-to-lower reaches of the Berg River is winter wheat.

Where does the salt come from?

The unconsolidated material overlying the bedrock in this semi-arid coastal region contains an abundance of stored salts of marine origin that have accumulated through atmospheric deposition over a very long period. It is hypothesized that during this period the climate may have been drier than at present and/or a vegetation cover prevailed that allowed less water to be discharged from catchments than currently occurs under the prevailing land use (mainly winter wheat), because of greater water extraction and/or smaller overland flow. Evidence for the deposition of oceanic salts by wind and rainfall is provided by the chemical signature of groundwater and stream flow in these parts of the Berg River catchment.

Analysis of the solutions of a number of fresh, regional Malmesbury shale samples, collected in the mid- to lower-reaches of the Berg catchment, further suggests that salt of such composition and quantity is not present in the rocks. The salts discharging from catchments such as the Sandspruit must therefore have accumulated through atmospheric deposition.



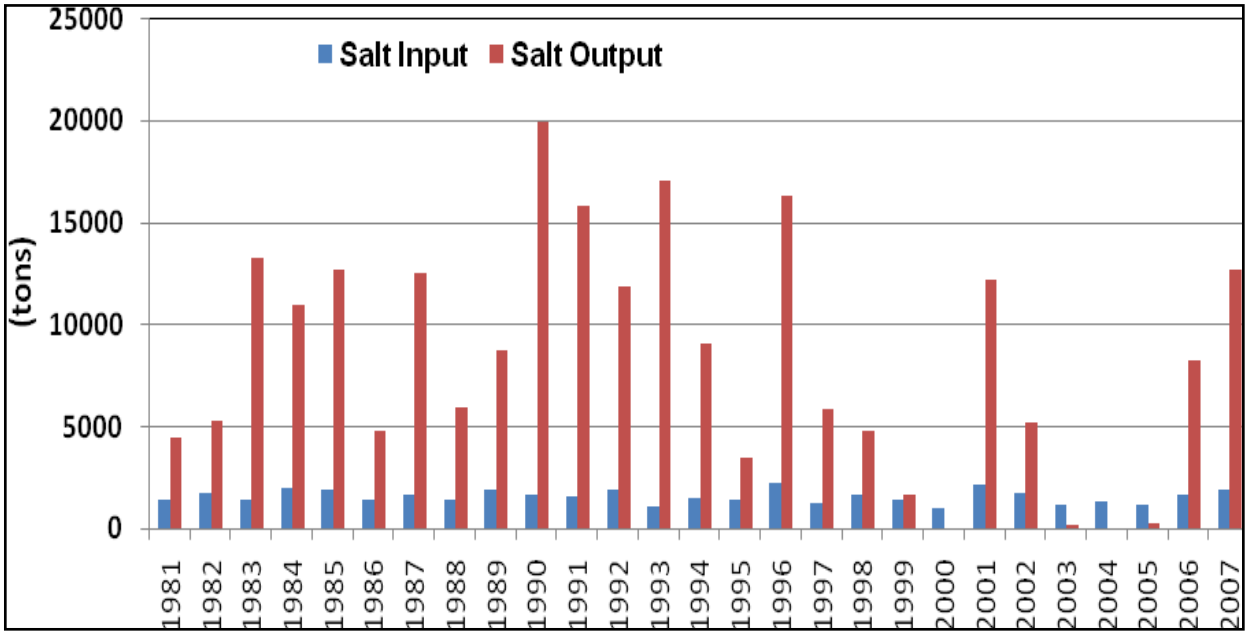
CAPTION: Salt precipitates on the surface. These are commonly associated with patchiness in wheat fields.

Salt discharge

Findings from current research indicate that the severity of the salt discharge is lessened by the fact that most of it is released during periods of high flow so that considerable dilution occurs. The salinity hazard is magnified seasonally, however, by evaporation from the river and storage dams and by more concentrated salt seepage into the lower reaches during periods of low flow and greater water demand. The rate of salt discharge is affected by both the prevailing climate and agricultural practices (land use, soil conservation practices, etc). This study has provided valuable information concerning the water and salt fluxes in overland flow and the unsaturated zone from different land uses.

Text Box 1

Current rates of salt discharge have the potential to remain unchanged, to the detriment of water users. An initial rough estimate suggests that the unconsolidated soil horizon above the bedrock contains approximately 200 tons of salt per hectare, stored mainly as a bulge in the unsaturated zone above the water table and below the soil zone. This salt bulge discharges mainly through lateral leaching by groundwater when water tables rise in winter.



CAPTION: This graph represents the input and output of salts from the significantly saline Sandspruit catchment. The net salt discharge (a maximum of 20 000 tons/annum, however averaging at 6 700 tons/annum) is close to 0.5 ton per hectare per year.

The consequences of dryland salinity

Consequences of dryland salinity in the Berg River catchment are mostly associated with increases in soil, stream flow and groundwater salinities. Soil salinity has the tendency to increase in winter, possibly due to precipitation of salts in summer and subsequent dissolution and mobilisation in winter. The patchiness observed in wheat fields was interpreted to be associated with high soil salinities. Further increases in the electrical conductivity of the soil are likely to cause further loss of productive soils.

The electrical conductivity in a farm dam and groundwater was monitored in the Goedertrou small-scale catchment from April 2005 – October 2007 and during July 2007 respectively. The electrical conductivity of stream flow was also monitored at the Sandspruit gauging weir. The electrical conductivity increases as one moves downstream and also showed strong seasonal influences, i.e., it increased in summer and decreased in winter.

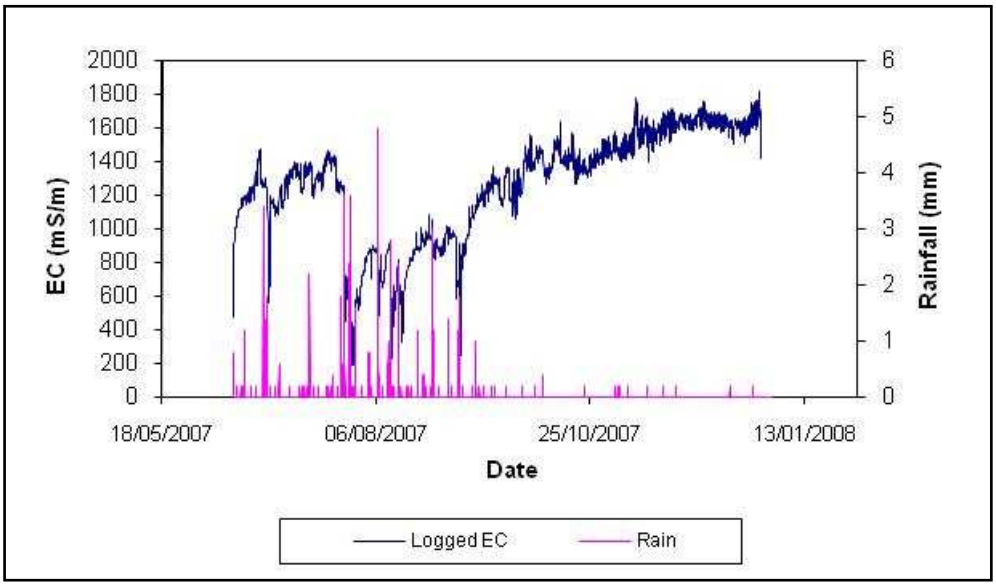
Variable	Min EC (mS/m)	Max EC (mS/m)	Average EC (mS/m)	Comment
Groundwater *	68	375	174	Increases in EC with decreases in water table elevations
Sandspruit River **	400	2000		The minimum was generally recorded in July and the maximum in November

* 7 boreholes drilled in the Goedertrou small-scale catchment

** measured at DWA gauge G1H043

Generally, when referring to the DWA quality guidelines for domestic water supplies, groundwater in this part of the Berg River catchment and the Sandspruit River is predominantly unfit for human consumption, especially when it is shale-derived. Domestic water supplies are mainly reticulated from Voëlvlei dam and the Misverstand weir. Irrigation using this water is also not recommended as it may lead to crop loss and further land degradation. As a result, many farmers in these regions practice dryland and livestock farming.

CAPTION: The Sandspruit River is a significantly saline tributary of the Berg River.



CAPTION: During the rainy winter period, in-stream salinity responded dramatically (within hours) to rainfall events. Rainfall events resulted in the dilution of salts. During dry periods in summer, the salinity tends to increase.

THE WAY FORWARD

The results of the current research provide a clear need to address the issue of dryland salinity and to identify ways of managing it. The next phase of the research is to develop guidelines for regulating land use in an attempt to reduce the mobilisation of salts to the Berg River (WRC project K5/1849). Catchment-scale hydrological models will be used for scenario simulations. The Sandspruit catchment is being used as a pilot catchment due to its significantly saline nature.