Environmental Research &
Information Consortium Pty Ltd
(ABN) ACN (61) 055 194 771
PO Box 132 Braidwood 2622
02 4842 8182
info@eric.com.au
www.eric.com.au

COMMON ASSUMPTIONS ON THE PROCESS OF DRYLAND SALINITY

Introduction

A number of assertions were made during interviews for the Channel 9 Sunday Program, *Salt Solutions* that promote an establishment position on dryland salinity but lack substance. These assertions require further consideration as contrary evidence for some points has been available since the 1950s and more recent observations negate others. For dryland salinity the establishment represents public scientists and administrators that control the research funds, conduct the research, and/or develop and implement regulations relating to salinity.

The need to address such issues largely arises because of the development of *instant expertise* by scientists within the establishment. The sudden availability of a large pool of public funds and the limited availability of relevant expertise in salinity research resulted in scientists changing research directions to gain access to funds. The scientists often had no prior expertise in salinity and limited relevant knowledge. This direction was promoted by public organisations as institutional status has been used to accredit scientists. Public organisations certify their *instant experts* to increase access to funds.

No contrary views to established positions can be presented as acceptance of *instant experts* by the establishment depends on conformance to the established paradigms. *Instant experts* promote the establishment line by researching variations on a theme. The stagnation in science is usually terminal.

Context

ERIC was established in 1992 to provide improved services and comprehensive information to support natural resource management. The benefits are improved matching between the land use and the resource where this promotes profitability and reduces adverse impacts. The ERIC services include ongoing support and the conduct of research and development so that solutions can be tailored to client needs. The benefits are economic, social and environmental.

The ERIC capability addresses all facets of natural resources including climate, vegetation and soils and results from the SoilSelect[1] methodology for mapping soils commercialised by ERIC were unique and provided information on soils not previously available. While consistent with research on dryland salinity in the 1970s the results from SoilSelect identified the inapplicability of the rising groundwater model in a diversity of regions. The ERIC mapping and field results identified that, while salinity was linked with geology, it arose through

[1] Initially commercialised as SoilMap

surficial water flows. The primary source of the salt was identified as being the soil hence the soil structure was of prime importance.

The rising groundwater model originated in the early 1900s but its current status derives from the promotion of groundwater models in the mid 1970s. At this time Geoscience Australia effectively ceased geological mapping on the mainland due to the Australian Government identifying land survey as being the responsibility of the States. The displaced geologists took advantage of the Government then also identifying dryland salinity as a priority. The suggested link between dryland salinity and underground aquifers was used to justify their involvement to the extent that dryland salinity was identified as being a groundwater issue that had to be addressed by hydro-geologists.

The focus on groundwater arose despite dryland salinity arising through land use impacts that do not directly impact on groundwater systems. Due to the dominance of geologists the research ignored soils and climate while vegetation function and land use impacts were simplistically addressed. Research results from around the world summarised by Peck (1978) appear to have been disregarded.

The response by the establishment to the ERIC salinity results was reactionary. They denigrated the SoilSelect methodology without having emulated the ERIC mapping procedures or checking the field results. The issue was not just dryland salinity as ERIC used geophysical data to produced new results that the geologists had not achieved. The geologists considered they were the experts in the analysis of such data and would not concede that others could do better.

ERIC responded with a series of papers to identify how the SoilSelect results were applicable to dryland salinity. The scientific deficiencies related to the groundwater theory and not the results from the SoilSelect soil mapping which derive from field observations as well as the numerical analysis of airborne gamma radiation data (radiometrics).

The intrinsic difference between the ERIC considerations and the groundwater models relates to the postulated mechanism for dryland salinity. The rising groundwater model has the cause as tree clearing on hills and slopes and, as presented in the 1980s, the salt derives from stores beneath the soil on plains. The ERIC considerations have dryland salinity being caused by soil degradation due mainly to a loss of organic matter with the salt mainly deriving from the soil.

The sequence of papers available on the ERIC web site reflects the continuing need to address reactionary comments by the establishment and involves the development of basic science within a commercial company. ERIC initially produced two papers that identified salinity as a natural process and provided a scenario for the cause of dryland salinity. The third paper addresses models for the development of dryland salinity while the fourth examines the dryland salinity implications of interactions between clay, organic matter, salts and water in soils. The most recent papers illustrate ecological implications of the considerations in addressing competition between trees and grasses, and plant and site characteristics of importance with saline soils. Additional relevant reports include notes identifying the ERIC capability, and papers that specifically address reactionary comments by the establishment (e.g. Tunstall 2004a).

The suggestion that dryland salinity is caused by soil degradation has been long been espoused by others, as with Whittington in the 1950's (Paulin 2002). Recent expositions have provided greater detail, as with Jones (2000a, 2000b, 2001). The new aspects of the papers on the ERIC web site are the provision of greater detail on the salinity mechanisms (process) within the context of the functioning of natural vegetative systems across Australia.

This paper further addresses assumptions employed by the establishment to justify their position and actions.

Issues addressed

The assumptions addressed are:

- Whatever has not been proven
- Alternatives to the establishment viewpoint have not been suppressed
  - Scientists are not encouraged to present an establishment viewpoint
  - Predictions from alternatives have to be monitored
- No proof exists that the salt derives from the soil
- Addressing dryland salinity through soil structure only addresses symptoms
- Stream salinity provides a valid measure of performance with dryland salinity
- Trees use more water than grasses
- The adverse impacts arise from the imposition of European agriculture
  - Soil compaction arises through the impact of cloven hoofed livestock
- Actions on dryland salinity have been developed using the best possible science
- The rising groundwater model has been proven and is generally applicable
- Existing arrangements ensure the effective application of research results

These assumptions are sometimes inferred rather than being explicit. For example, while the rising groundwater model has been presented as the official and general model for dryland salinity there are no known statements declaring that its applicability has been proven. However, there have been many assertions that it is correct, and it is even promoted on the web site of the Australian Academy of Sciences. The issues addressed here go beyond those raised in the Channel Nine Sunday Program, *Salt Solutions*.

Whatever has not been proven

Some suggest that the proposition that dryland salinity arises through soil degradation has not been proven where this form of argument is used by those that lack a philosophical basis to their science. Procedures developed by other scientists are followed with little understanding of what they are doing or why. The issue relates to scientific training and is more fundamental than the development of *instant expertise*.

While now not prominent Popper provided the philosophical foundation for Australian science. The basics are that a hypothesis is tested with failure resulting in rejection. An inability to disprove does not prove. That is, science operates on disproof and not proof. There can be no proof positive.

Further issues arise in addressing complex systems and Popper considered that only parts of a complex system could be tested. This produces a dilemma as with ecology the whole is not the sum of the component parts. Tests on individual components cannot be reliably extrapolated to complex systems. The whole system can't be tested and tests on individual components cannot be used to evaluate the overall system.

Einstein had a similar view. Relevant quotes are:

- 'When the number of factors coming into play in a phenomenological complex is too large the scientific method in most cases fails.'

- ‘Occurrences in this domain are beyond the reach of exact prediction because of the variety of factors in operation, not because of any lack of order in nature.’

These constraints are ignored by predictive modelers in particular.

The best test in complex situations is the ability to reverse the changes. While cardio-vascular disease is associated with smoking it also arises for other reasons. The association between smoking and cardio-vascular disease is not definitive as to cause. However, the ability to reverse the cardio-vascular disease by ceasing smoking is definitive in establishing a causal link between smoking and the disease.

The best example of the reversal of dryland salinity through land management is given by the Whittington Interceptor Banks (Paulin 2002). Dryland salinity was remediated by retaining water on the hills and slopes by increasing the percolation of water into the soil. When the soil on the hills and slopes was degraded salt accumulated on the flats without there being a groundwater system, and the stream dried up. The stream line eroded due to the increased surface runoff of water. When the soil on the hills and slopes was improved the salt stayed on the hills, soil salinity on the flats declined and the stream again contained good quality water. Remediating the soil increased the percolation of water through the soil and the water had low salinity. According to Whittington the dryland salinity arose through soil degradation and he remediated it by improving the soil. This result is as proof positive as can be achieved.

While the Whittington example establishes the link with soil degradation it is also important in disproving the rising groundwater model, and hence the application of groundwater flow systems in addressing dryland salinity. A network of piezometers demonstrated the lack of a groundwater system to produce the observed salinity on the flats. The adverse salinity was remediated by increasing the percolation of water into soils on the hills and slopes when all versions of the groundwater models have dryland salinity arising because tree clearing on hills and slopes has increased the percolation of water into groundwater systems.

The Whittington result was rejected in official investigations because it did not conform to the rising groundwater model[2] but it is the clearest and best documented example of the cause of dryland salinity. It is also the best example of the inapplicability of the rising groundwater model as, according to the rising groundwater theory, the interceptor banks installed by Whittington should have exacerbated the dryland salinity.

It only takes one exception to negate a model as being general.

Alternatives to the establishment viewpoint have not been suppressed

The establishment position is that all options and alternatives have been considered and have been equally treated. This is either claiming blissful ignorance or is intentional deceit (a lie). Given the numerous occurrences of suppression over a long time it is an example of the charlatanry identified as existing by Passioura (2005) as no scientist can claim innocence.

No research has been funded that is discordant with the establishment position. This alone is suppression that is exacerbated by the exclusion of industry. All ERIC research proposals have been rejected through ‘peer’ review where some involved joint submissions with institutions such as the University of Sydney. The salinity research that has been funded accords with the establishment viewpoint and has been conducted by public organisations.

[2] In science observations are used to test hypotheses and hypotheses are used to develop theories. Observations can negate hypotheses and theories but, while theories can be used to explain observations, they can never be used to negate them. Rejection of observations because they do not accord with theory is irrational.

The review of salinity mapping methods (Spies and Woodgate, 2005) funded through the Department of Agriculture, Fisheries and Forestry (DAFF) effectively identifies methods acceptable in proposals for funding under the National Heritage Trust (NHT) and National Action Plan (NAP). A Deputy Secretary of DAFF identified that the process used to develop the report was administratively sound and that the report results would not be reconsidered. The recommendations in the Spies and Woodgate report are set in stone for the foreseeable future despite the administrative need to implement a process of continuous improvement in performance.

The Spies Woodgate report specifically denigrates industry capability and promotes methods and activities of the public scientists from departments, authorities and agencies that helped develop it. Papers and reports by ERIC were specifically excluded from consideration in the report as all were falsely identified as not having been peer reviewed or published. However, the authors used unpublished and non-peer reports to denigrate the ERIC capability and also used personal communications to justify their conclusions. This undoubtedly involves scientific deceit directed at suppressing alternatives to the establishment view and capabilities.

ERIC has been denied any right of reply despite the publicly released 2004 version of the Spies Woodgate report presenting the comment on the ERIC capability that *claims by some vendors have no basis in science*. Avenues explored by ERIC include communication with the authors and exploration of opportunities under the Trade Practices Act (ASIC), the NSW Ombudsman, and a Deputy Secretary of DAFF. The scientific imperative for open communication has been disregarded so the establishment can maintain status and position by suppressing alternatives.

There are many in NSW Soil Conservation / DLWC / DIPNR / DNR that have presented observations contrary to the rising groundwater model but they continue to be disregarded. CSIRO now restricts public comment to nominated scientists so as to promote an official position. The censorship has effectively become absolute. Even where a particularly applicable capability has been developed, as with the ERIC soil and salinity mapping, there is no market in government funded applications because the methods specified and endorsed by the establishment exclude the ERIC technology. That situation always informally existed but was formalised in the review of salinity mapping methods by Spies and Woodgate.

While the Spies Woodgate report said radiometrics could not be used to map salinity the Cooperative Research Centre (CRC) for Plant-Based Salinity Management is now advertising their use of soil mapping from radiometrics to address salinity (Munday 2006). Moreover, in a ministerial press release Land and Water Australia identified intent to fund research to develop a capability in public institutions to deliver services that ERIC has been delivering commercially for 14 years.

A capability is deemed not to exist unless it can be seen to have been developed by the establishment and can be delivered by them. Passive suppression by way of disregard is initially used but active suppression is invoked when that fails, as occurred with the review of salinity mapping methods.

Passive suppression is effected through control deriving from statutory position. The establishment uses statutory position to claim exemption from the Trade Practices Act hence there is no competition. Exclusive territories are established through statutory responsibilities where these are used to control the delivery of services as well as research. Some organisations additionally specify, implement and enforce regulations and so have absolute power.

Scientists are not encouraged to present an establishment view

This proposition suggests that what scientists present is not constrained by those providing the funds. However, the suggestion that no control is exercised over what scientists present is irrelevant as the control is exercised by determining what research is conducted. Research is only funded where it conforms to the establishment view. The system is self perpetuating and reinforcing as the research results identify what is accepted for future funding.

Reasons given by funding agencies for rejecting proposals that present new or alternate views include:

- The proponents don't have the requisite knowledge / skills.
- The proposal does not accord with the R&D plan of the funding organisation.
- The proposal is not commercially viable.
- The scientific basis for the proposal is not sufficiently established.

The first two responses are routinely applied in rejecting proposals that don't derive from the establishment. The third has been applied to an research proposal by industry by those without business knowledge or experience and where commerciality was not a selection criterion. The reasons for rejecting proposals have been subjective and unsubstantiated and serve only to reinforce the establishment position. There is no need to encourage scientists to present a particular view if research is only funded where it accords with the establishment view.

From a scientific perspective that last dot point is of most consequence as it indicates that research will only be funded where it accords with establishment perceptions. In a rejected proposal a plausible hypothesis was presented that was supported by observations and could not be negated without new observations. It identified the possibility of a new process significant for land management and global warming but anything with the potential to create change is rejected. An apposite quote by Einstein is that '*if the answer was known it would not be called research*'.

With current arrangements funds are directed at promoting the position of those supplying them, and this situation is strongly supported by those that directly benefit. The public scientists are of particular consequence as their work determines what is acceptable for future funding. There is no need to invoke conspiracy theories where the system has evolved to the mutual benefit of those that control the funds and implement the research, particularly when they can use their statutory positions to exclude competition.

Predictions from alternatives have to be monitored

This raises scientific and practical issues. The practical issues relate to the lack of funding to develop alternatives or monitor predictions that might arise from them. While the establishment is funded to keep producing results that justify their position the alternatives have to be addressed without financial support other than can be provided by affected individuals. In consequence, the main alternatives derive from farmers and are almost invariably dismissed by public scientists using glib and gratuitous comments, such as it is not scientific or it is unproven. Comments sometimes get personal with public scientists describing those they don't agree with as being mad or crackpots.

Scientific issues relate to the value of monitoring overall outcomes and the monitoring of predictions. As identified above, in complex systems the total system cannot be tested hence an overall assessment has little if any scientific value. This is compounded by addressing predictions as the predictions will invariably be incorrect. Realised outcomes will differ from predictions and the monitoring will not identify why. The monitoring therefore cannot be used to provide improvements. Effort spent in monitoring predictions serves no scientific purpose. There can be benefit in monitoring outcomes but this addresses administrative rather than scientific needs.

The scientific method revolves around making observations to test hypotheses. While monitoring can sometimes be useful most gains derive through conceptual developments. Doing more of the same seldom results in scientific progress but that it is what is currently being done in addressing dryland salinity.

No proof exists that the salt derives from the soil

Some suggest that dryland salinity cannot arise from soil degradation as there is no proof that the salt associated with dryland salinity arises from the soil. However, situations exist where the salt associated with dryland salinity can only derive from the soil. These are obvious and clearly visible with water flowing on top of the B horizon. This situation is common and arises with salt accumulations at the break of slope in the landscape. There are situations where the salt undisputedly derives from the soil but one has to go into the field to see them.

The results of Whittington (Paulin 2002) identify a situation where the salt did not derive from salt stores beneath the soil as there was no water table and hence no mechanism for any salt beneath the soil to be transported to the soil surface. The water was identified by Whittington as moving laterally on compacted subsoil (B horizon) hence the salt accumulating on the plain derived from soil higher in the landscape. As salts provide nutrients to plants Whittington expressed one of the truisms with dryland salinity: *the adverse accessions of salts on the flats represent a loss of nutrients from the hills and slopes*. The salts are detrimental where concentrated on the flats but can be beneficial when dispersed throughout the landscape. This loss of nutrients identifies that the adverse impacts are usually not restricted to areas of salt accumulation.

Many situations arise where the source of salt has to be inferred. However, there are some that suggest the salt is primarily aeolian in origin. Some go further and identify that it primarily arises through historic rainfall (House of Representatives, 2004) and the source of this suggestion is the CRC for Landscape Environments and Mineral Exploration (CRC LEME). Dryfall is excluded when some of the major depositions of salt in SE Australia have occurred through dryfall that has contained clay as well as salts. However, if the salt is aeolian in origin then all salt associated with dryland salinity has to derive through the soil[3].

There is no possibility that all salt associated with occurrences of salinity is aeolian in origin but the situation varies depending on constraints. In the Hunter Valley the salt that affects rivers mainly derives from old marine sediments and so is not aeolian. Salt accessions to rivers mainly arise from groundwater flows through saline sediments, and the accessions now include salt that is pumped from coal mines[4]. However, soils derived from these marine sediments can develop dryland salinity through changes to soil structure where the salt derives from the geology rather than aeolian accessions. The occurrence of one mechanism does not preclude the occurrence of others.

[3] Most of the salt in oceans has derived through weathering of rock as occurs in the development of soils. Aeolian accessions of salt mainly derive from salt in oceans which mainly derives from soil. As salt mainly derives from the weathering of rock the issue for dryland salinity relates to the significance of aeolian recycling.

[4] The saline sediments can contain high quality coal.

Regardless of the source, the distribution of salt in the landscape is usually related to the geology. The parent material is either a source of salt and/or it alters the way aeolian accessions of salt move in the soil and landscape, as with salt sieving by clays (Blackmore, 1976). Moreover, geological structures can alter flow pathways for water in the landscape and thereby affect expressions of salinity.

Denials that salt associated with dryland salinity can derive from the soil are commonly promulgated by *instant experts* that rely on comments by others for their expertise. *Instant experts* characteristically address issues by presenting the establishment line as that is their source of knowledge. Moreover, the chances of their being questioned are slight when they present the establishment view. Comments are kept general and consideration of specific circumstances is avoided as they lack the knowledge needed to address detail.

Instant experts lack the knowledge and skills that are expected and necessary in science, and are negligent in failing to adequately check whether the information they use and promulgate is correct. Preparedness to provide expert opinion when not expert is part of the charlatanry identified by Passioura (2005).

Addressing dryland salinity through soil structure only addresses symptoms

It is suggested that soil degradation is a symptom of dryland salinity and therefore cannot be the cause. However, this comment has been made by some that acknowledge an inability to understand the mechanisms whereby dryland salinity can arise through degradation in soil structure. An inability to understand the postulated cause means they cannot rationally comment on whether remediating soil structure addresses the cause or symptoms of dryland salinity.

Suggestions that addressing soil structure only addresses symptoms usually arise from acceptance of the rising groundwater model. If the cause is increased groundwater accessions from hills and slopes it cannot be remediated through local treatments on salt affected areas. This spatial dissociation between the cause and effect is used by public administrators to justify their tight control as it is suggested that remedial actions must be regionally planned and extend beyond individual landholdings. However, farmers across Australia have remediated dryland salinity through management of the salt affected area. The suggestion that addressing soil structure only addresses symptoms derives from acceptance of a thoroughly negated premise that, in attempts to maintain the status of the establishment, has been presented as unquestionable doctrine.

The perception that treating soil degradation addresses symptoms can also arise because the accumulation of sodium (Na) can degrade the soil structure by dispersing clay. As dryland salinity is a symptom of land degradation any soil degradation arising from it is also a symptom. However, the degradation causing the adverse salinity primarily arises through loss of soil organic matter and this is general and not restricted to where salt accumulates. The degradation associated with sodium only provides a positive feedback in areas where salt accumulates. Moreover, extreme levels of salts aggregate clays and hence improve the soil structure regardless of their composition, and this situation naturally arises in the Mallee region of Victoria.

Suggestions of circularity in the postulate that dryland salinity arises from soil degradation evidence a lack of understanding of soils and the identified mechanism. While general observations can be used to identify the link between soil degradation and dryland salinity, making a well informed judgment as to whether soil degradation can be the cause of dryland salinity requires detailed knowledge of the composition and structure of soils, the impacts of land use and the physics of soil water (Tunstall 2005). Suggestions of circularity evidence *instant expertise* as a general and unsubstantiated comment is being used in an attempt to negate a proposition.

The above identifies an issue having legal as well as scientific implications. If an alternate hypothesis is presented then scientists have a responsibility to take it into account. There is a duty of care.

Scientifically an alternate hypothesis stands until it can be rejected where rejection cannot be based on glib statements that the arguments are circular and that it has not been proven. There must be clearly identified and valid reasons for rejection. The negligence of scientists in considering alternatives has been extreme given the number of exceptions to the model that they tenaciously cling to and the need for continuous change in its representation.

The above follows the normal scientific process of negating explanations as to why soil degradation is a symptom rather than a cause of dryland salinity. The arguments do not prove that soil degradation is the cause and there is no proof positive. However, the mechanisms proposed are sound and accord with observations. Nothing has been presented that negates the proposition that dryland salinity is primarily a consequence of soil degradation arising largely from loss of soil organic matter. Tree clearing can and usually does exacerbate the adverse outcomes but, as it is not the cause, it need not.

The papers addressing the cause and mechanism for dryland salinity by Tunstall (2001, 2004b) were developed by linking observations with theory. An ecological (whole system) approach was used but with detailed consideration of physical processes. While the considerations are sound they do not prove that dryland salinity is caused by soil degradation, but this situation is normal. The scientific requirement is to demonstrate where the considerations are wrong.

The best evidence that soil degradation causes dryland salinity comes from the many remediations achieved by farmers where all are associated with improvements in soil structure. They operate within landscapes as well as locally and the situations examined encompass a much greater range of circumstances than can be tested by scientists. Approaches include Whittington Interceptor Banks, Natural Sequence Farming and the Ecoplow[5]. The Ecoplow is a derivative of the Wallace plough which is integral to the Yeomans Keyline system (Yeomans 1958, 2002). All gains are associated with increases in soil organic matter but ploughing is sometimes used to expedite the removal of hardpans while retaining the soil profile. All methods increase the infiltration of water into soils.

The consequences to water flows of improving the soil structure are illustrated by Bell et al. (2001) with a 20% water loss by surface runoff with the degraded soil changing to a 20% loss through percolation through the improved soil. However, in applying the rising groundwater model the authors raise concern about a potential for the development of dryland salinity through the increased percolation. The inapplicability of the concern is evidenced by the improvements in soil structure returning the degraded system into something resembling the natural hydrology.

---

[5] www.ecofarming.com.au

Stream salinity provides a valid measure of performance with dryland salinity

Regulatory controls on land use designed to address salinity are based on achieving prescribed levels of salt transport in rivers. The effectiveness of land management is being evaluated by reference to levels of stream salinity despite the lack of knowledge of their levels prior to the introduction of European agriculture. The objective is to achieve low stream salinity despite streams representing natural drainage channels that have historically drained salt from the land.

If the primary source of salt associated with dryland salinity is historic rainfall, as suggested in the House of Representatives (2004) and Senate (2006) committee reports on salinity, then attempts to manage dryland salinity by having low levels of stream salinity can only be damaging to the land. Salt accessions through rainfall evidence a natural cycle where salt from the oceans deposited on the land is returned to the ocean through stream flows. Blocking this cycle through attempts to retain salt on the land will inevitably result in land degradation. Draining salt from the land through rivers is normal and essential.

The use of stream salinity as a measure of the effectiveness of land management reflects the use of rivers to transport irrigation and drinking water. Target stream salinity levels have been set to what some desire them to be without regard to what salinity levels naturally were[6] or how the system naturally functions. It represents the greatest attempt yet to impose our view on how the system should be rather than developing an understanding of the natural functions so as to promote sustainable and viable land use.

Attempts to retain salt on land to lower stream salinity serve to promote land degradation, as is currently occurring with major irrigation areas being sinks for salt from rivers. Such accumulation of salt has historically been the reason for the eventual demise of irrigation areas throughout the world. Current measures used to regulate salinity are perfectly designed to destroy the commercial enterprises they are meant to protect, and they will damage the environment.

Trees use more water than grasses

Descriptions of the rising groundwater model always refer to the clearing of trees and there is no reference to grasses where many of the areas subject to dryland salinity were naturally grasslands or grassy woodlands. Moreover, remedial treatments always involved planting trees and never grasses. The premise is that trees use more water than perennial grasses simply because they have deeper roots. This is despite grasses having a much greater proportion of their biomass in roots than trees, and the grass roots being much finer. Grasses can have a much greater potential to exploit soil water than trees.

There is no simple answer to the question as to whether trees use more water than grasses as the answer depends on the characteristics of the soils, plant species, climate and the land use impacts. Within grazed woodlands the trees usually use most water as the grasses are suppressed by grazing, but grasslands are capable of using as much water as forests.

Some scientists working on salinity have rediscovered that high water use by young tree plantations reduces stream flows. Tree planting is no longer seen as a panacea for dryland salinity as the measure used to assess benefit is stream salinity: stream salinity can increase

[6] Useful data on stream salinity have only recently been obtained. Knowledge of natural levels of stream salinity derives from comments by explorers and early farmers where these identify that major rivers stopped flowing and the salinity of some streams was too high for its use by livestock.

due to the reduced water inputs. However, if the scientists were to examine the literature, as with water use of *Eucalyptus regnans* following devastating bushfires, they would be aware that the high rate of water use does not continue as the community matures. This has also been documented in studies on global warming where mature forests become sources rather than sinks for atmospheric carbon.

Understanding how dryland salinity has arisen depends on understanding how the natural systems function as a reference is needed to determine the changes induced by land use. The failure to consider the functioning of the native vegetation is endemic in most considerations of dryland salinity. At best the estimates of change are based on ill-informed guesses as to how things naturally were, as illustrated by the lack of consideration of understory plants in natural vegetation. At worst the natural situation is disregarded, as with the proscription of stream salinity levels.

While the temporal patterns of change in water use with age of the community identified for *Eucalyptus regnans* and northern hemisphere forests are general there is considerable variation in the effects of plantations. An examination of the literature in the mid 1980s had tree planting equally split between increasing and decreasing stream flows. The specific outcomes depend on the circumstances but, as the temporal pattern identified above derives from the life cycles of the plants, it is common to all regenerating woody plant communities.

The adverse impacts arise from the imposition of European agriculture

It is commonly asserted that the problems with Australian agriculture in general, and dryland salinity in particular, have arisen because of the implementation of European agricultural practices. This assumes that European agricultural practices are uniform and have remained unchanged. A key development in England involved crop rotation with a manure crop being used to improve the soil. In broad scale farming in Australia, which accounts for by far the largest area of faming, the rotation mainly involves fallow (bare earth) to conserve water where this degrades the soil.

Australia developed distinct agricultural practices that over much of the land were very different from Europe. The low unit area yields resulted in early implementation of extensive agriculture with low management inputs. It was a mining operation that was highly constrained by the degradation of the resource arising from the interaction between the land use and the large climatic fluctuations. The degradation of the resource promoted the development of weeds and vermin such as prickly pear and rabbits which further reduced the agricultural yields.

Agriculture now seeks to replace extracted resource to increase yields but this replacement is restricted to the more productive areas. Moreover, the replacement involves a hydroponic approach to growing plants. The soil is seen simply as a medium for storing applied water and nutrients with the nutrients mainly being applied through chemical fertilisers. This approach to land management has caused widespread damage to soils so they no longer function as in natural systems. Agricultural soils have effectively lost their biological function and have largely become a lifeless physical system.

Australian agriculture has produced adverse impacts but we cannot blame European agriculture. The approach is home grown and is largely a result of recommendations and controls by public scientists and administrators.

Soil compaction arises through the impact of cloven hoofed livestock

Loss of soil organic matter degrades the soil structure producing compaction and reducing the retention of water and nutrients. Widespread soil compaction and erosion has occurred with European settlement throughout most of Australia, where much of the erosion was a consequence of compaction increasing the amount and velocity of surface water runoff. The compaction was primarily due to loss of organic matter as, while the feet of all animals can cause compaction, it is usually localised.

The soil compaction that occurred with grazing is general, and the most extreme compaction arises through practices such as ploughing. While normal ploughing breaks up the soil it can produce greater compaction more rapidly than grazing as the increased aeration increases the rate of loss of organic matter. In one example involving the cropping of recently cleared country the depth of penetration of the plough decreased from 30 to 5cm over five seasons. In some areas historic ploughs that were previously effective cannot now be used because of the lack of penetration. Soil compaction can also be produced by annual burning without any livestock or ploughing.

The structural change primarily comes from within the soil rather than from a compressive force exerted on it.

Actions on dryland salinity have been developed using the best possible science

The typical and almost invariant response of administrators as to why particular actions were taken is that the decisions were based on the best possible science. Given the suppression of research on alternatives to the rising groundwater model this claim is undeniably wrong. Suppression of the examination of alternatives logically means that it cannot be known if the best possible science has been used. However, if the science is considered to be the best possible the question arises as to why the predictions of the future extent of dryland salinity have been so wrong. Comparing predicted with realised outcomes the science has at best been ineffective.

Soil mapping using radiometrics illustrates the reality. A cost effective method for producing soil information essential for addressing land management including salinity was commercially initiated by ERIC 14 years ago. An equivalent approach is now being promoted by the CRC for Plant-Based Dryland Salinity Management and is being applied by a Victorian State agency. Benefits they now espouse were identified from the start by ERIC in 1992 but in coming from industry they were denied by the establishment, as exemplified by the review of salinity mapping methods (Spies and Woodgate, 2005).

Despite the long availability of a commercial capacity to map salinity a Victorian agency told a Catchment Management Authority that no such commercial services exist so that they would be automatically handed work funded through the NAP[7]. ERIC had previously won an open tender for such services in competition with the agency even though the agency had written the specifications. Also, Land and Water Australia has identified intent to fund research to develop a capability that already exists commercially. Better research was and still is available but the capability has been suppressed as it did not derive from the establishment and it threatens their control and access to funds.

[7] The agency helps specify the requirements as well as providing the services.

The most recent development with the publicly funded research has been the focus on practical tools (technology). This is exemplified by dryland salinity where the science was solved by definition (the rising groundwater model) and all efforts are now directed at developing practical tools. The science cannot be the best possible as there is effectively no scientific research, only technological development.

The situation will further degrade with the planned next manifestation of the plant-based salinity CRC as the new CRC is identified as incorporating industry which it now suppresses. The CRC is attempting to become industry when, from the available information, there is no indication of understanding of how industry operates or how to service clients such as farmers.

A slide presented at an establishment presentation in the Shine Dome of the Australian Academy of Sciences in 2005 identified what has and will likely continue to occur. A schematic diagram identified that the organisational arrangements for salinity research started with government policy and finished with the research addressing the needs of government. The diagram accurately identified that public scientists have been directing their efforts at producing results to benefit the government administrators that fund them. Research directed at supporting the administration rather than resolving the problem cannot produce the best possible science but the administrators and scientists involved will inevitability identify it as such.

While irrational constraints have been imposed on farmers to address salinity the most restrictive relate to vegetation clearing. Vegetation clearing is linked to dryland salinity through application of the rising groundwater model, hence the widespread support for the model by conservation groups.

The greatest absurdity in this situation is that compulsory levies on farmers are being used to fund the deficient research that is used to by agencies to justify imposing increasing controls. The funds are controlled by Government R&D Corporations and are being directed to public organisations as they provide the expertise used to vet the research proposals. These and other public organisations use the research results to justify the restrictive controls. With the current administrative arrangements farmers do not have an opportunity to direct their funds to industry research that will address their needs.

The rising groundwater model has been proven and is generally applicable

Proponents of the rising groundwater model usually assume the model has been proven hence their requirement that alternatives must be proven. This assumption has been addressed above logically and through observations. Logically the model cannot be proven and, as observations identify numerous exceptions, it cannot be general. It may apply in some situations but this is highly uncertain if only because predictions based on it have been grossly incorrect.

The Australian Government response to the House of Representatives salinity report (2004) prepared by DAFF (Anon. 200?)[8] identifies that the National Dryland Salinity Program (NDSP) accomplished a significant task in identifying the cause of salinity. The true situation was given by Land and Water Australia (LWA[9]) on behalf of the then disbanded NDSP in their presentation to the House of Representatives salinity inquiry. LWA identified the main finding of the NDSP as being that salinity was much more complex than they had initially thought. Application of the rising groundwater model was expected to provide general solutions and they had no alternative when it didn't.

---

[8] No date is provided on the report.
[9] LWA is a statutory authority funded through DAFF.

With the rising groundwater model dryland salinity is identified as a symptom of land degradation as the cause is attributed to the clearing of trees on hills and slopes. The universal solution initially given was to plant trees on the hills. When this failed to provide significant benefits the call was for more practical tools and this is the focus of the CRC for Plant-Based Management of Dryland Salinity. The science is assumed to have been solved and the tools (technology) being provided include activities that can only address symptoms, such as pumping groundwater and crop adaptation to saline land. The identified need for the continuing development of a plethora of tools is a good indication that the activities have been addressing symptoms rather than the cause.

The rising groundwater model is applied through the identification of groundwater flow systems which are used to map salinity hazard and specify appropriate remedial treatments (Coram et al. 2000, Walker et al. 2003). This approach has groundwater flow systems occurring at different scales from local to regional with the rate of response of the system changing with scale. This is despite the rate of response of confined aquifers effectively being scale independent. Where salt beneath the soil on the plains is bought to the surface by water on hills percolating into a confined groundwater system[10] the response can be very rapid regardless of the size of the catchment. The response is determined by the transmission of a pressure, which can effectively be instantaneous, and does not depend on how long it takes water to flow from the hills to the plains.

Extending the groundwater flow system approach to the Great Artesian Basin would have the salt in inland lakes deriving from groundwater accessions when it derives from rivers that flow into the lakes. Surface expressions of large groundwater systems exist in inland areas, as with mound springs in South Australia, but the water is fresh. This situation has arisen locally on the eastern coast where water from a spring that developed in a remote airfield was fresh while the water seeping through the soil into the airfield drain was highly saline. The surficial systems are often completely independent of underlying groundwater systems.

It has been suggested that a consensus exists as to the applicability of the rising groundwater model but the model means different things to different people. It is seldom clear whether the groundwater rises in the sense of moving vertically upwards or simply fails to drain away. The mechanisms for salt movement in these situations are very different even where all salt is transported by water.

The rising groundwater model has been presented in various forms and not all are physically valid. Moreover, representations have changed over time in attempts to account for observed exceptions. The salt stores said to be mobilised were originally identified as occurring somewhere below the soil and almost invariably only under plains. New variants that allow for lateral movement of water in soils axiomatically have the salt deriving from the soil. This variant was necessary for several reasons, one being that dryland salinity is not restricted to plains.

The variants of the rising groundwater model incorporate the usual failure to discriminate between soil water and groundwater. Groundwater is effectively identified as all water that can flow freely in the ground thus, as virtually all salt is transported in water flows, the pointless situation arises whereby dryland salinity arises through changes to groundwater flows by definition. The need to distinguish between soil water and groundwater systems is critical as groundwater flows are driven by gravitational gradients when these are a very small compared to other forces controlling soil water flows.

[10] This is the only physically sound version of the traditional presentation of the rising groundwater model.

Another technical point that evidences the illogicalities is the reference to primary and secondary dryland salinity. As dryland salinity arises through dryland agriculture by definition it can only be secondary. Moreover, the underlying physical mechanisms for natural and dryland salinity are identical. There is no logical or practical rationale for attempting to discriminate between primary and secondary dryland salinity.

The note on the ERIC web site titled *Examples of the Inapplicability of the Rising Groundwater Model for Dryland Salinity* illustrates some of the exceptions. The most obvious discrepancy is where water flows through the soil down a hill slope and the salt derives from the soil. This discrepancy is 'accommodated' by defining groundwater as any water that flows in the ground but this adjustment does not address the issue of the salt being said to derive from beneath the soil on the plains. A more subtle discrepancy is where the salinity arises in situ. This can be accommodated by postulating a groundwater lens but it can arise where there is no water table and hence no definable groundwater system such as a lens. The most dramatic discrepancy is evidenced by the results of Whittington as his situation was meant to represent the classic occurrence of the rising groundwater model. It is a comprehensive exception as everything with the Whittington result is diametrically opposed to the rising groundwater model. Negation of the assumption that dryland salinity arises through increased percolation through soils on hills and slopes is of most consequence.

With the rising groundwater model the number of observed exceptions raises the issue of where it is applicable, if at all. However, examination of whether the rising groundwater model is applicable depends on an explicit description of what it is. At present the descriptions are becoming more diffuse with the identification of variants to accommodate discrepancies. The prevarication is exemplified by the Senate Committee Report (2006) on the extent and economic impact of salinity in Australia as there is no consideration of cause, only the identification that salinity is associated with a change in vegetation. The statement is '*It usually occurs where deep rooted perennial vegetation is replaced by crops and pastures that use less water because they have shallow root systems and shorter life cycles*.'

Identifying an association does not discriminate between cause and effect and there are many more effects (symptoms) than causes. For example, shallow rooting can arise from the development of hardpans where hardpans decrease the infiltration of water into soils. The identified change in plant rooting characteristics can arise through soil degradation and hence need not be associated with increased percolation through the soil.

The Senate Committee Report (2006) also identifies that '*Saline groundwater may rise to the surface (discharge) in low lying areas or at the break of slope'*, so gravity is still being defied[11]. Dryland salinity is identified as that which occurs in non-irrigation areas when this includes the urban salinity identified by others. Dryland salinity has become a Magic Pudding (Lindsay 2004) in being whatever the establishment wants it to be and effectively being supported by inexhaustible funds.

The only commonality in representations of the establishment position on the mechanism for dryland salinity appears to be that it is caused by tree clearing on hills decreasing the evaporation of water from the soil and thereby increasing the percolation of water into some form of groundwater system. This is negated by the results of Whittington and is at odds with changes to the seasonality of river flows in SE Australia. Winter stream flows should have increased when they have decreased while summer flows have increased. The changes reflect

[11] Drainage of water at the break of slope follows a gravitational gradient hence the water and salt do not rise.

decreased percolation into soils that is almost inevitably due to soil compaction. It is likely that the rising groundwater model is almost invariably inapplicable to dryland salinity.

The inapplicability of the rising groundwater model does not negate the importance of plants as the development of soil structure and vegetation are entwined. However, the focus should be on developing a functional soil rather than simply attempting to insert deep rooted plants. There is much more to it than plant rooting depth, or perennial vs. annual plants. An apposite quote by Einstein is that '*Things should be made as simple as possible, but not any simpler'*.

Existing arrangements ensure the effective application of research results

A key unresolved issue relates to the provision of environmental services. The House of Representatives report (2004) strongly advocated growth in the provision of extension services by the States despite the reverse having occurred in agriculture. This recommendation was not supported in the Government response (Anon. 200?) but the response identifies the existence of many support positions funded by governments. There has been large growth in public employment to address Natural Resource Management (NRM) but little in industry despite industry being best placed to provide services.

The House of Representatives salinity report (2004) and the Government response (Anon. 200?) identify a role for industry in service provision but the focus is on accreditation and standards rather than the cost effective achievement of outcomes. The response gives recommendations from a Rural Industries Research and Development Corporation (RIRDC[12]) report that examined the need and support for a national accreditation scheme for professional consultants and advisers in agriculture, natural resource management and related sectors (Toohey 2002). The RIDIC report suggests such a scheme would need to have strong industry ownership and be coordinated by a national industry council. Setting aside the question as to whether that represents the best approach to improving NRM, it is contrary to the approach promoted by DAFF in the same report (Anon. 200?).

The Government response by DAFF (Anon. 200?) identifies that the CRC for Plant-based Management of Dryland Salinity has developed a nationally accredited salinity training program to develop national competency standards in salinity. In addition, the New South Wales Southern Salinity Action Team, apparently centred on the NSW Department of Primary Industries, is developing competency based salinity training package to be accredited under the Australian Quality Training Framework. The training and accreditation schemes are being developed and controlled by the establishment.

Industry involvement is identified as being achieved through CRCs. However, only two large companies are identified as participants in the CRCs as small companies cannot afford to participate. Moreover, the companies are agricultural and not environmental, and their role lies in implementing results developed by the establishment. The CRCs provide a mechanism for the establishment to retain control by making industry dependent on them.

The control process also involves excluding industry by the specification of approved methods as well as the control of funds spent on research and applications. Agencies usually only approve methods that they can implement. Agencies use the methods to provide services and thereby gain additional funding. The process is designed to maximise the flow of NHT and NAP funds to the establishment by excluding industry in R&D and service delivery.

[12] RIRDC is a statutory government body that disburses farmer research levies. The levy contributions are matched by the Australian Government.

The process is illustrated by the ERIC SoilSelect mapping. This has effectively been excluded from being used in applications addressed using public funds as the establishment could not deliver such services. This is despite the benefits of the method having been demonstrated in many applications at different scales and it receiving six awards and recognitions won in open competition. The method is now being researched by the establishment and the indications are that it will only be accepted when the establishment can implement the method and thereby gain revenue and maintain control by delivering the services.

There is an establishment view that incentives for R&D through R&D Taxation Concessions and grants from AusIndustry encourage private sector investment into NRM R&D (Anon 200?). Consequently, the establishment deems that public environmental research funds should only be available to public organisations where this maintains the monopoly of the establishment in addressing the environment.

When addressing the environment any benefits for companies of obtaining R&D tax concessions or AusIndustry funds are more than offset by the exclusion of industry developments from activities funded under the NHT and NAP. Obtaining AusIndustry funding does not remedy the situation as the establishment deems a capability does not exist unless they can control it. When ERIC was established an agency officer responsible for soil mapping across the state agreed to cooperate with ERIC provided all ERIC products were marketed through the agency. Commercialisation of SoilSelect was supported by an AusIndustry Comet grant but that was negated by the actions of the establishment.

Even with AusIndustry support the development of new capabilities with independent industry R&D cannot break the self serving monopoly arrangement developed by the establishment. The potential conflict of interest that exists where agencies deliver services against regulations they specify and police is realised as agencies use their position to promote their activities and exclude others.

Under the existing monopoly arrangements alternatives to the establishment viewpoint can only be suppressed. As this involves the suppression of industry it is contrary to Australian Government policy to promote industry. The situation is also contrary to the Australian government's procurement principles relating to promoting competition, efficiency and effectiveness, ethical use of resources and accountability and transparency.

References

Anon. (190?) The Australian Government Response to the House of Representatives Standing Committee on Science and Innovation May 2004 Report - "Science Overcoming Salinity: Coordinating and extending the science to address the nation's salinity problem". (http://www.affa.gov.au/content/publications.cfm?ObjectID=0DCAA605-1CC1-400F-B31130631257E2DE or www.daff.gov.au/salinity)

Bell, M. J., Bridge, B. J., Harch, G. R., Want, P. S., Orange, D. N. and Connolly, R.D. (2001) Soil structure affects water balance of Ferrosol cropping systems. Proceedings of a GRDC conference, Kingaroy (www.regional.org.au/au/asa/2001/3/b/bell.htm)

Blackmore, A.V. (1976). Salt sieving within clay soil aggregates. Aust. J. Soil. Res. 14, 149-58

Coram, J.I., Dyson, P.R., Houlder, P.A. and Evans, R. (2000) Australian groundwater flow systems contributing to dryland salinity. Bureau of Rural Sciences report to the National Land and Water Resources Audit.

House of Representatives (2004) Standing Committee on Science and Innovation: Science Overcoming Salinity: Coordinating and Extending the science to address the nations salinity problem (http://www.aph.gov.au/house/committee/scin/salinity/report.htm)

Jones, C. E. (2000a). The great Australian salinity debate Part 1:Controlling the salinisation processes. Holistic Management Aust. Quarterly Newsletter, July 2000.

Jones, C. E. (2000b). The great Australian salinity debate Part 2: why the recharge:discharge model is fundamentally flawed. Stipa Native Grasses Newsletter 14, 6-11

Jones, C. E. (2001). The great Australian salinity debate Part 3: Soil organic matter: past lessons for future learning. Stipa Native Grasses Newsletter 15, 4-9

Lindsay, N. (Series 20, 2004) The Magic Pudding. New York Review of Books, pp.172

Munday, B (2006) Matching plants to soils – remotely. Focus on salt. Issue 36 March 2006. CRC for Plant-Based Management of Dryland Salinity (http://www.crcsalinity.com/publications/publications.php)

Passioura, J. (2005) Epilogue: from propaganda to practicalities – the progressive evolution of the salinity debate. Aust. J. Expt. Agric. 45, 1503-06.

Paulin, S. (2002) Why salt? Harry Whittington, OAM and WISALTS: Community Science in Action. Indian Ocean Books, Perth. 63 pp.

Peck, A. J. (1978). Salinisation of non-irrigated soils and associated streams: A review. Aust. J. Soil. Res. 16: 157,68

Senate Committee Report (2006) Environment, Communications, Information Technology and the Arts Reference Committee: Living with salinity- report on progress: the extent and economic impact of salinity in Australia (http://www.aph.gov.au/senate/committee/ecita_ctte/salinity/index.htm)

Spies, B and Woodgate, P. (2005) Technical Report on Salinity Mapping Methods in the Australian Context. Department of Environment and Heritage, Department of Agriculture Fisheries and Forestry. (http://www.nrm.gov.au/publications/salinity-mapping/index.html or www.daff.gov.au/salinity)

Toohey, D. E. (2002) Towards Professional Accreditation for Advisers and Consultants in Agriculture, Natural Resource Management and Related Sectors. Rural Industries Research and Development Corporation (RIRDC) (www.rirdc.gov.au/reports/HCC/02-104.pdf)

Tunstall, B. R. (2001). Scenario for Dryland Salinity. On www.eric.com.au

Tunstall, B. R. (2004a). Mapping to address dryland salinity. On www.eric.com.au

Tunstall, B. R. (2004b). What Model for Dryland Salinity? On www.eric.com.au

Tunstall, B. R. (2005). Dryland Salinity Implications of Interactions between Clay, Organic Matter, Salt and Water in Soils. On www.eric.com.au

Walker, G., Gilfedder, M., Evans, R., Dyson, P. and Stauffacher, M. (2003) Groundwater flow systems framework: Essential tools for planning salinity management. Murray Darling Basin Commission and CSIRO Land and Water. (http://www.clw.csiro.au/publications/general2003/Groundwater_Flow_Systems_Full_Report.pdf)

Yeomans, P. A. (1958) The challenge of the landscape: The development and practice of Keyline. Keyline, Sydney, NSW.

Yeomans, K. (2002). Water for every farm: Yeomans Keyline plan (2nd ed.) Keyline designs, Southport, Qld.