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INQUIRY INTO CATCHMENT MANAGEMENT, WESTERN AUSTRALIA

Executive Summary

The current approach to Catchment Management and the development of 'best practice' is WA has been flawed due to the difficulty of obtaining several factors:

1. Size of the salinity issue
2. Its effect/s upon the rural/urban communities
3. The time frame in which to operate with some degree of success
4. The potential cost of remediation and the immediate availability of funding.

Catchment management (WA) has bee primarily developed by agencies upon the premise that the development and extension of catchment management plans will be sufficient to coerce the landholder into action and also sufficient to obtain vital NHT funding to assist with implementation.

The harsh reality has revealed that this approach has not worked and indeed is creating a mentality of 'haves and have nots'. A recent survey conducted within the BBG by Agknowledge has revealed that of the 23% of farmers who participated in the survey, 38% of them were undertaking no or minimum landcare activities in the 97/98 financial year. Landcare activities were defined as including no-till, liming, pasture regeneration etc.

The reasons why this is happening is for several reasons:

1. Low commodity prices
2. Low level of confidence in success of remedial action and the level of advice.
3. Inadequate knowledge of the landscape to provide information at the necessary scale.
4. Availability of funding from external sources approved not to be a critical factor for the rate/level of implementation undertaken by farmers.

Factors Influencing Development of Catchment Management

The principle inhibiting factor governing the development of catchment management plans and the extension of these plans are:

1. Level of expertise available – landscape and hydrology technical skills; and agricultural liaison skills
2. Source and availability of data and interpretation products suitable for catchment management planning and for extension into farm planning.

The level of expertise available is not the subject of discussion in this paper as the authors believe that the private sector already has the necessary skills, personell and knowledge available to provide landholders with the consultancy necessary.

The source and availability of data and interpretation products is the area of concern. To effectivley halt dryland salinity in WA, six basic actions are needed:

1. **Measure**
2. **Plan**
3. **Budget**
4. **Fund**
5. **Fix**
6. **Monitor**

The response of catchment managers has been to address 2 and 5 without obtaining the information and data relevant to a catchment.

Budgeting inadequacies are becoming documented and the community in WA is calling for immediate changes to budget and funding levels from State, Federal and community sources.

Methods of 'fixing' or implementating strategies is based upon regional strategies that provide blanket remediation over many catchments and are not targeted at on-ground solutions. Monitoring of implementation is grossly inadequate.

The basic actions mentioned above are:

1. Measure

Aim: To capture and distribute data suitable for the development of knowledge which will be adequate for the planning of remedial actions.

The Western Australian Salinity Action Plan (SAP1996) identifies the need to evaluate water management plans (Section 4.2.1) and the need to plan salinity control strategies based on good biophysical information (Section 4.2.2). The plan defines *fourteen data sets* which need to be collected and understood. The National Dryland Salinity Program has endorsed (December 1998) this approach.
These data when interpreted we will redefine (below) as a list of *Knowledge items*.

The distinction we are trying to draw is between *information itself* and *information understood* in terms of using it in a *meaningful way*. To become *Knowledge*, as we are defining it, expert integration and interpretation is necessary.

Data Requirements

Fundamental to the planning process is access to appropriate data detailing the biophysical characteristics of the catchment. Economic and social data constitute another strata required for implementation of the biophysical plan.

The Fourteen Required Information Types Defined by the SAP (4.2.1) are:
1. Cadastre (land ownership)
2. Infrastructure (roads, rail and towns etc)
3. Climate
4. Topography
5. Geology
6. Soils and/or land management units
7. Land use
8. Flora and fauna
9. Drainage systems including depth, flow volume and water quality

10. Groundwater (water levels, salinity, trends)
11. Multi-spectral data from satellite or airborne systems (eg LANDSAT)
12. Magnetics (ground or airborne systems)
13. Radiometrics (ground and airborne systems)
14. Electromagnetics (ground or airborne systems)

These data are accessible, in the main from the agencies, but they are not in a condition where they can, as the *Statement* puts it, "…form the basis of process models of landscape behaviour or treatment." In other words each data set needs to be put into a **data base** where it can be accessed and integrated and interpreted with other data sets.

This integration and interpretation multiplies the power of understanding of landform processes, particularly for the trained scientist, but also for conscientious farmers, foresters, viticulturists, environmental bodies, shire officers, main roads and railways officers etc (impediments such as roads and railways cause salinity).

<u>Uniform Data Sets</u>
Some of these data sets are yet to be collected particularly geophysics and satellite data. The cost is not inconsiderable, but stern resistance must be presented to the proposition of compromising the *necessity for a uniform, comprehensive data set* over *all* the various landforms. To second guess *What you really don't need to know* is invariably disastrous.

<u>Data Delivery</u>
The size of the **data base** required is approximately 36 terabytes. These data must be made available in an understandable form. This entails Internet accessibility.

Construction and management of the **data base** should be under the control of a private, non-government organisation selected by tender. This is essential because experience has shown that subjugating such a process to any discipline other than commercial performance criteria cannot deliver timely outcomes.

<u>Benefits</u>

- The immediate benefit of this phase will be to enable the expert farm planner to design a sustainable catchment and farm plan set for progressive farmers and catchment groups.

- Subsequent benefits will include the inevitable expansion of a farm planning consultant industry devoted to sustainable agriculture spanning the generations.

- The ability to search the local and state wide data base will give farmers and others a perspective of their own and other distant initiatives all in the same information context. For example inter-catchment and intra-catchment water flow and its impact on drainage remediations will be displayed for all to see as will the relative effectiveness of different measures across soil types, rainfall and cropping practices.

- Confidence generated by better knowledge will result in greater application of farm plans.

2. Plan

Aim: To Interpret data gathered in 1 and to produce farm, catchment and district plans for recharge management and to design pumps and drains for discharge management.

To plan discharge and recharge

For both discharge management and recharge management_a comprehensive knowledge of basement geology, salt stores, soil types, elevations, catchment boundaries, cadastre, water table depth and quality and crops and remnant vegetation is essential.

For *discharge management* using drains, piping and canals our planning relies on regional and sub-regional data sets.
For *recharge management* a farm plan at paddock scale for every farm must encapsulate our knowledge.

Nine Knowledge Types

There are nine essential landform criteria that must be well understood before embarking either upon farm planning for salinity control or upon canal and drainage design to remove excess water. *Knowledge* will develop from use of the data base.

1. Basement geology:
Underlying the soil are the rocks from which the soil derives. Some of these rocks, such as dolerite dykes, are not heavily weathered. Dykes form when lava flows quickly and cools quickly into large cracks in the earth called faults. In our farmlands this happened over two thousand million years ago, when volcanic events were frequent. Some of these dykes behave like dam walls, impeding water flow and causing salty water to build up behind them. It is essential to know *where* these dykes are. It is also essential to know where the basement rocks are near the surface because they restrict water flow in the same way.

2. Salt stores:
Although salt is carried in small quantities from the sea by rain, this process has been going on for a hundred million years and the amount of salt accumulated has become huge where the rainfall is not high enough to carry it away again in rivers. This problem is called *dryland salinity.* This means that near the coast where the rainfall is high (say higher than 1100 mm per year) salinity is not generally a big problem, but in the relatively dry wheatbelt about thirty million years have gone by since the salt was flushed out by rivers.

Salt storage in soil profiles (the regolith) have been measured at sites across southern Australia in the range of 50 to 5000 tonne/ha for an annual rainfall range, respectively, of 1400 to 320 mm.

A lot of landscape changes occur in thirty million years and a lot of the salt is now to be found in old fossil river beds, called *palaeochannels*. An in –situ weathering of the fresh rock has also been occurring. This is called *lateritisation* and results in complex layers of gravels and clays. The clays are frequently very salty. Some uplift and weathering down of the land has occurred, often leaving lateritic layers and sections of old palaeochannels high in the drainage system.
It is important that all salt stores in the landscape be thoroughly mapped.

3. Soil types:
Soil types determine the range of land-use options available when remedial methods are being considered. Also the soil texture (sand, gravel, clay etc) often determines whether water is absorbed .

Localities where water enters the landscape are called *recharge zones.* The areas where pressure causes water (and often salt) to surface are called *discharge zones.*

4. Elevation:
In determining how the salt and fresh water moves through the landscape we obviously need to map the high and low points. When this is done we have what is called a *Digital Elevation Model* (DEM).

We need to know not only the elevation of the present landscape, but also the elevation in the subsoil landscape. This is called *basement elevation*.

5. Catchment boundaries-surface and sub-surface:
Catchments mostly form closed systems as far as water flow is concerned; thus if we know the catchment thoroughly we can predict the effect of intervention at the head of the catchment on farms lower down. It is true however that major faults can carry water across topographic catchment divides. Sub-surface catchment divides, if they are not identical to surface landforms, can lead to misdirected work.

6. Cadastral information:
We need to map all the human-made structures, fences, railway lines, roads, dams, drains etc, as many of these structures affect water flow.

7. Water table depth and water quality:
Water table depth and water quality data are important to enable inferences to be made regarding recharge, flow and discharge processes and to monitor improvements brought about by our interventions.

8. Crop types and vegetation:
Deep rooted perennial crops and native vegetation have a significant impact on groundwater levels and water flow and it is essential that they are mapped

9. Climate
Data on climate requires to be linked to water management, cropping results and soil condition.

Regional district and farm scale planning for drains and canals to control discharge.

1. Surface water management
Management of surface run off water (primarily run off water at one area becoming run-on water at another area) requires proper management to avoid the development of inundation and waterlogging.
We must legislate to enable natural drainage to be used to carry water.

Degradation of present day rivers and streams has already happened. Apart from a very few areas where canals are feasible, water must be allowed to escape quickly down natural waterways.

Denying this approach is completely counter-productive as the water must, in a "do nothing" scenario seep slowly into these same watercourses; the speed of the waters' exit from the landscape obviously determines the amount of scalding which will occur.

2. Keyline drains
Drains that slope very gradually from high in the landscape into dams and then into natural drainage channels, creeks etc are called *Keyline drains*. *Keyline drains* are designed to catch fresh water and either use it or store it before it soaks into the water table.

3. Deep drains
Deep drains used properly can 'de-water' a farm in the long term quite often allowing fresh rain water to de-salinise the soil by allowing the fresh water to leach the salts to the drain.

4. Integrated drainage systems
Integrated drainage systems involving surface drains, deep drains, bores pumping from permeable aquifers (particularly in palaeo-drainage systems and saprolite aquifers) and management of effluent disposal involving evaporation ponds with salt harvesting, canals/pipeline to ocean outfall, and use of the water for industrial purposes.

5. Stream diversion
Stream Diversion is an engineering approach suited to diverting saline flows around a reservoir with the aim of maintaining or improving water quality in storage.

Farm, catchment and district recharge management

Each farm plan will conform to a holistic plan for catchment for the district and farming area in total, thus ensuring that there is uniformity between local and regional understanding. The farm plan must be a product of the regional planner using data collected in which the farmer signs on as a co-author.

Development of a thorough understanding of the knowledge assembled by both parties will require continuous communication, training and feed back.

The technology exists to develop soundly based catchment and farm plans and to assess the probable impacts of the proposed works.

The technology is based on:
- Deriving relevant information from a large number of data sets
- Designing proposed works
- Testing the biophysical impacts of these works with a mathematical model of the catchment and farm

Catchment and farm planning is the first step in a long term commitment to change the way in which the land is used and managed to minimise the adverse impacts of salinity.

Works implemented under a catchment or farm plan generally have a long life expectancy:
- Perennial pastures (3 to 5 years)
- Blue gums (10 to 20 years)

- Pine plantations or pine agroforestry (20 to 30 years)
- Trees for environmental benefits (50 to 100 years)
- Re-fencing (20 to 50 years)
- Earthworks for water control (20 to 30 years)

Investing in works, which are more or less permanent, and for which there is an expectation of some permanent production benefit and on-site and off-site environmental benefits, requires soundly based planning and an assessment, before implementation, of the anticipated biophysical benefits.

Data Interpretation and Integration

No data set can singly deliver a technically sound farm or catchment biophysical management plan. Each data set makes a unique and significant contribution to the understanding of landscape and *regolith* (*regolith* is the weathered rocks and the soils) processes. Combined, they can detail what is causing the problem, and where treatments should be sited to achieve maximum effectiveness and efficiency for both containing and preventing the problem.

In the salt prone environments which predominate WA agriculture, an estimate of the catchment water balance should be a basic requirement before developing a works plan.

The water balance should estimate the contribution from each major land unit and identify hydrologically significant features (dykes, faults, paleo-channels etc). The water balance will indicate the degree to which land use in various parts of the catchment must change and guide the selection of land uses.

3. Budget

Aim: To determine the appropriate level and timing of expenditure.

This item should be referred to the State Salinity Council to determine appropriate funding levels to ensure efficacy of extension programs.

4. Fund

Aim: To ensure that funding is made available.

Opinions expressed in the BBG survey and around the state are the frustrations of farmers at the beaurocratic red tape that they need to go through to get funding. 68% of participants believed that regional groups such as the BBG and LCDCs were most appropriate to administer landcare funding.

5. Fix

Aim: To develop remedial measures by informing and encouraging the farmer to ensure that intensive farm and catchment application of these measures are implemented.

A Suite of Remedial Measures

In order to establish suitable remedial measures it is necessary to recognise that there are three basic requirements for salinisation:
1. A store of salt
2. A supply of water to mobilise the salt
3. A mechanism by which the salt is re-distributed to locations in the landscape, including rivers

Remediation necessitates only one of these three requirements to be eliminated, though where management is able to only partially control one requirement, then achievement of the remaining control must be found within either or both of the other two requirements.

Cutting off the supply of water (preventing excess groundwater recharge) requires manipulation of vegetation type and its distribution. Since the hydrogeology of a catchment identifies the mechanism for water to move in the groundwater system, techniques to intercept the process of salt redistribution requires working with the characteristics of the hydrogeological structures in which groundwater flow occurs.

Remediation requires a holistic total catchment management approach which could be expected to include an assessment of the applicability of a variety of both biological and engineering options within a social and economic framework.

There is no single universal remedy for salinisation of agricultural landscapes. Combinations of the range of diverse types of remedial options will provide the particular suite of suitable measures in any one catchment.

<u>Agroforestry</u>
The use of trees and other woody vegetation to provide a range of benefits (and some dis-benefits) in landscape water use by both the trees and associated agricultural vegetation. Trees of all types.
These can be blue gums, which do well in a high rainfall area, or maritime pines and oil mallees, which are better suited to the drier areas.

<u>Corridor Farming</u>
Corridor Farming divides paddocks into tree belts 50 to two hundred metres apart, with farming carried out in the corridors.

<u>Deep-rooted Perennial Pastures</u>
Deep-rooted perennial pastures are far more useful as water table controllers than annual crops. Economics of grazing animals (wool prices, mutton and beef prices) however dictate their take up by farmers. Examination of the cost effectiveness of new types of grazing animals, such as Damara sheep
may lead to a greater focus on deep rooted perennials. There are many hundreds of potentially useful
grasses that need to be seriously assessed in this regard.

<u>Saline Pastures</u>
Saline pastures in a system where it is accepted that a proportion of land in a catchment will be salinised, management of the land as a saline pastured area is required. Plants growing on saltland must cope with problems of salinity, water logging and inundation. Useful species occur within the genera *Atriplex, Maireana, Puccinellia, Elitrigia, Melaleuca and Casuarina.*

Potentially there are about 1500 highly tolerant salt plants that could be of value in our saline environments. Programs of screening and development of management methods are urgently required.

Plant partnerships with for instance, saltbush and the more salt sensitive balansa planted together (the Saltbush to draw down the water table and protect the high-fodder quality clover).

Maintenance and Re-establishment of Areas of Remnant Vegetation
These areas will include existing natural vegetation, but could include assigning re-vegetation of land which is recognised as poor quality for agriculture and significant locations for excess recharge under agriculture, for example, rocky outcrops.

6. Monitor

Aim: To ensure that the progress of the SAP is transparent and to evaluate progress.

A system for monitoring the biophysical changes in the catchment as a result of implementing the plan must be an integral component of the plan.

The monitoring requirements will be dictated by the objectives of the plan. However, a minimal monitoring system should include watertable depths, change in percent cover and health of perennial vegetation and change in farming practice.

A commitment to on-going monitoring and reporting should be a condition of acceptance of any public monies to assist planning and/or implementation. Monitoring is essentially the process of accountability.

Shire Salinity Committees

Shire councils must be enlisted to report on all works undertaken on a Quarterly basis in their areas.

Testing the Plan

Implementing a works plan will be a long term commitment involving considerable expenditure in cash and kind. There is a need to provide some evidence that the works will have the desired effect. As this
cannot be tested in the field the only option is to use an appropriate computer model of the catchment.

Computer based hydrological models are available which predict the head changes in the groundwater that result from changing the land use in different parts of the catchment. The models can also assess the impact of the 'do nothing' option and thus indicate the potential extent of salinity under current management.

The input parameters required to run the models are either available in, or derived from, the biophysical data sets.

The biophysical models can be linked to economic models and the combination can indicate the preferred approach to implementation and also the requirements for funding arrangements to address the private and public good outcomes of the plan.

The Land Management Society has developed a Farm Monitoring Program concentrating on trend analysis which should be considered as a useful tool.

Summary

This outlines a strategic approach to dealing with dryland salinity. This problem can only be tackled by a coordinated approach to giving landholders the best information possible for them to make sound decisions that they are confident in implementing. It is the implementation of catchment and farm plans that is the ultimate goal and we must work towards this in a deliberate way.

Acknowledgements

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