Water, technology and policy interactions

2 April 2003

Introduction

The DNRE were invited to attend a demonstration of the Micro Flood system in operation. After numerous requests for a response they declined to attend. The following is my response

Preamble environmental lessons

I received you response immediately on my return from Ethiopia where I have been working on the chronic water issues facing that country while my partner, Nance, who has medical expertise, was worked on health issues.

On my previous visit some six months ago I Introduced the Micro flood technology to Ethiopia as a way of providing sustenance food to the starving. At that time the season's crops had failed however the people were, on the whole, adequately nourished without the normal visible signs of starvation.

This last trip showed the situation had deteriorated dramatically; the effects of large scale famine were striking us in the face. Nance was working in the hospital organising nasogastric feeding for children on the verge of death from malnutrition. These children were too weak too even suck and their lives were only saved by the nasogastric feeding.

My skills and interest are in the long term sustainability of food production. I had the opportunity to visit a water harvesting scheme supported by both the Ethiopian Government and World Vision. Desertification is a critical problem, with the slow but steady advance of the Sahara desert into once fertile land. The reason is so starkly obvious.

Local people, living in extremes of poverty, and their livestock, have been steadily consuming the vegetation in an attempt to survive. In the dry season the bare earth is reflecting increased radiation back into the sky, which now dissipates any rain clouds. Local people tell me that day time rainfall used to be common but that now rain clouds just fade away and it only rains at night. Any rain that does fall tends to come as major downpours which, with the reduction in vegetation, leads to massive soil erosion.

This is man made destruction of a once fertile natural environment, sacrificing the long term for the needs of the short term. I saw for myself the resulting poverty with children dying from the failure to protect the sustainability of the environment and the capacity to grow food. The enclosed picture of mothers and their children waiting for famine relief to dramatically show the result of environmental degradation.

These experiences are traumatic, yet I see exactly the same process happening here in Australia due to the dominance of short term greed over the need to protect our natural resources.

Salt

The key environmental issue facing Australia is salinity or more correctly sodification of our prime irrigated agricultural soils. Soil sodification in Australia has much in common with the environmental degradation in Ethiopia, it is unspectacular, insidious and totally destructive. This is not to be confused with the expanding areas of salt pans which are the subject of much publicity but in comparison with the insidious sodification of our premium irrigated soils are a minor problem.

Every time we irrigate we apply a certain amount of salt to our prime agricultural land. This is easily calculated, for example if the salt content is say 500 ppm we apply 500 Kg of salt for each mega litre of water applied. Over 20 years, which is the time scale we need to look at for sodification, this amounts to 100 tonnes of salt per hectare.

The salt is in solution with no visual signs of damage; however the salt forms ionic bonds with the soil which inhibits the capacity of the soil to absorb nutrients, as well as destroying the structure of the soil. It is the chemical equivalent of wrapping every grain of soil in a polythene bag. The soil just becomes progressively less productive until it is no longer worth farming.

The danger is that it is unspectacular, just as there is no obvious connection between one individual peasant cutting off a few small branches and a climate change leading to mass starvation there is no obvious connection between one individual farmer irrigating with water containing trace elements of salt and the mass collapse of an agricultural system.

Greed is not good

The Malthasian theory, which still dominates much of economic policy, states that the optimum economic performance of a society is achieved when each individual acts to maximise his own returns. Whether there is any truth in this theory in the context of the complex economics of modern society is debatable. It is totally false when applied to the environment.

When an African peasant sees his neighbours removing firewood he will ensure that he collects his own stockpile before it disappears, so he is not left out. When an Australian farmer finds his land becoming saline from the action of upstream farmers he will attempt to flush that salt from his land even though this will increase salinity of farmers downstream. They act in their own short term self interest which is in direct opposition to the long term needs of the environment.

Greed is not good, at least for the environment.

To protect our environment Governments must ensure that proper controls are in place and not rely on simplistic economic theory from the late 1700's.

Learning from environmental disasters

Typically with insidious degradation, no action is taken until a critical level of catastrophe is reached. This applies to Australia now, but we should learn from Ethiopia. The core problem was ignored for years but now the damage has been done the level of activity has becomes frenetic. Throughout sub-Saharan Africa resources from Governments, NGO's and the World Bank are resulting in a whirl of activity trying to resolve the environmental problems.

In Ethiopia I am treated like some travelling hero, I have the resources of qualified hydraulic engineers and agronomists and labour made available to me to install micro flood irrigation systems to help feed the people. I am doing my best, but the tragedy is that is a case of too little too late. It takes generations to destroy an environment. With the best will in the world and all the resources it cannot be rectified overnight.

Sodification of our soils in Australia is at an earlier stage but despite its' potential for destruction is not receiving the priority it deserves. The CSIRO has clearly identified sodification as the number one environmental hazard in numerous reports going back to the 80's.

Perhaps an even more alarming source of information is described in Sandra Postel's book Pillars of Sand which revues the history of all irrigation societies throughout the world starting from the Sumerians over 6,000 years ago. This book should be compulsory reading for anyone involved with water management.

Virtually every irrigation society has collapsed after a period of some 200 years largely from salinity. Some, like the Incas escaped the curse of salinity because their civilisation was destroyed by the Spaniards before salinity had time to strike. Egypt is the only irrigation civilisation which has managed to avoid salinisation, which they have done for over 4,000 years by using a unique method of irrigation based on adapting the natural flood and drain of the Nile River.

In my study tours of irrigation around the world I have visited ghost towns in the Middle East. All the infra structure of the houses and abandoned farms still remain, but not a soul in site. For many generations they have been irrigating with water extracted from wells using donkeys to lift the water, which has been collecting since biblical times. The advent of the modern diesel pump enabled farmers to expand their operation by drilling deeper and faster. The water turned saline as the water table dropped and entire towns simply faded away.

Even advanced countries like the US have many environmental lessons. Look at the Imperial Valley, the irrigation area opened up by George Chaffey after he returned to the US from Mildura. Farmers have been taking huge quantities of water from the Colorado River. The mid west states have been ineffectively fighting over the water and are under pressure from the Federal Government to cut water but with minimal result. This year for the first time the Federal Government (who have control of the supply of water) simply turned off the pumps feeding the irrigators schemes. Dramatic but attention getting.

Just look at the drainage channel which in the 80's was partially constructed in the San Joaquin valley and now remains as a monument to environmental action. The near riots in San Francisco stopped construction when it became know that the channel would be dumping irrigation drainage water containing selenium, a highly toxic salt known to be responsible for birth abnormalities in birds and under suspicion for similar effects on humans.

I am far from a pervayer of gloom and doom. Soil sodification is readily resolvable by a two stage process. First irrigation must be managed to ensure that there is adequate flushing flow to remove the salt from the irrigated area, this salt will inevitably end up back in the river system. The second stage is to ensure that there is adequate flow in the river system to flush the salt to the sea.

This can be done, I spent some time studying the Snake Valley in Idaho, US, a major centre for agricultural production analogous to our Murray Valley. Salinity used to be a major problem but by correctly managing the water used in both irrigation and the river, salt is no longer an issue.

Our problems are more severe than in the Snake Valley, we have a larger area, less rainfall and a history of greater exploitative use of water, but at least the Snake gives us an example and optimism for what can be done. It is a question of having the right technology and determination to resolve the problem before it becomes too severe.

What can I do?

This has been clearly defined as our number one environmental problem and is of great concern to me. The challenge I faced almost a decade ago was what I personally could do about it. The various Governments and departments have huge resources devoted to environment protection. What could one man possibly hope to achieve? I had to do something very different.

I had built up one of the most successful high technology software companies in Australia, (Moldflow) specialising in computational fluid flow which leads the world in its field. Through this company I was responsible for bringing hundred of millions of dollars of export earnings into this country and was universally recognised as the leader in my field. The formula for success was continuous investment in long term strategic research and I am proud to say the company is still introducing technology to the market which I initiated while managing the company.

When I reviewed what contributions I could make to our environmental problems I identified three components.

First, I had demonstrated skill in computational fluid flow and computer simulation.

Secondly, I had experienced the benefits of long term strategic research, managing the process of high risk speculative research and the creation of an innovative environment.

Thirdly, when I sold Moldflow I was in a position to undertake long term speculative research knowing full well that if it failed I had no one to answer to but me. It was my money and if it was wasted, that was my risk, one I was willing to run.

The study phase

My initial efforts were to study and understand what research was being undertaken both in Australia and overseas, in irrigation countries such as the US, the Middle East, India, China etc.

The bulk of irrigation research is financed from the public sector, scientist are confined to work on what will be financed and this generally means carefully planned tactical research with clearly defined milestones and outcomes. Governments quite reasonably have a duty of financial responsibility and in general are not willing to finance research with high risks and with long times to maturity.

Running risks

I was willing to adopt the highly speculative approach to research I had proved worked at Moldflow. I set up a team of some twelve qualified people to develop appropriate solutions for managing irrigation water. We were prepared to look at any idea, however crazy it seemed at first.

For example, we experimented with a special combined plough and seeding machine which would lay the seed in a funnel shaped channel so any rain was directed to the seeds. We used a giant fan to blow air and water mist through the soil from subsurface pipe to try and wet the soil without saturating it. We knew most ideas were possibly crazy ideas but the only way of finding out it they were actually crazy was to try them.

Most failed for technical reasons, others did not meet market requirements.

One such device was a simple way of measuring irrigation depth so farmers could control the amount of water they were flushing past the root zone. Technically this worked fine but we learned that individual farmers will not spend money to resolve a national problem. Like seat belts and speed limits, Government action is required.

We accepted that failure would be common and we just had to grin and bear it and move onto the next project hoping that this just might be the breakthrough. This is the nature of speculative research.

While we had a share of failures, (if I had been working for the Government I would probably have been sacked), we did develop totally innovative but solid technology.

Simulation of irrigation with saline water

The problem of flushing of salt from irrigated land is amenable to mathematical analysis. I appointed a Ph. D mathematician, Peter Grossman, and together we worked on the mathematical simulation of the irrigation process with saline water.

We developed a method of using soil moisture data to calculate the effective water usage of the plant. We solved the partial differential equations for the problem of irrigation water (which is marginally saline) replacing the water in the soil in which salt has been concentrated by evapo-transpiration from the plant.

This simulation enables irrigators to precisely predict the optimum irrigation schedule to ensure the plant has the water needed for growth while ensuring just adequate flushing of salt from the soil with minimal further salt mobilisation.

Our ability to mathematically model the irrigation process and the transport of salt in irrigation soils is a powerful tool. It shows the amount of water that must be allocated for flushing flows, both in the land and in the rivers.

Myths of irrigation efficiency

Working on this problem showed us that simply providing financial assistance to farmers to improve irrigation efficiency does not automatically lead to a sustainable environment, in fact the very opposite, as I will now show.

The physics is that we apply a certain volume of irrigation water, which contains salt. The plants transpire the bulk of the water which concentrates the salt in the soil. Some water is lost by leakage beyond the root zone which will remove some salt. The balance of salt in the soil will depend on the mass of salt in this flushing water. Salt in the soil will either accumulate or be dispersed. This is what the simulation shows.

Improved efficiency is obtained by reducing the flushing flow, not by reducing the amount of water supplied to the plant.

Farmers will either sell or use the water saved for further irrigation. Irrigators do not race out and spend money on improved irrigation technology just so they can 'donate' water back to the river system. They use the extra water to make more money.

This means that despite the improved efficiency the same amount of water is still taken out of the river, however less water is returned to the river by the reduced flushing flows.

Improved efficiency, by itself, actually reduces the flow in the river.

Integrated strategies

To have any beneficial environmental effect, a strategy of improved irrigation must be part of a broader strategy in which the Government controls the water allocated for salt flushing, both from the land and in the river.

The work we have done on simulation and monitoring together with the Micro flood technology provides the Government with tools to manage and control these flushing flows.

Relying on economic incentives by themselves will not preserve the environment. The Government has to think through these deceptively simple traps and take

advantage of available technologies to ensure that the environmental benefits are achieved.

Frustrations

You suggested that I contact the Department in Mildura and Tatura. What has stunned me is the woeful lack of understanding of salinity within the Department. I am a frequent visitor to Mildura and make regular contact with the Department there. Let me tell you of the reaction from a tertiary qualified member in your Department in Mildura. Quote, '**we do not have a salinity problem in Mildura as the area is all tiled drained**'.

The Department in Tatura has been very cooperative, and would like to undertake a trial of the system, but there is no funding available for speculative research. As you know Mark Wood is carrying our some very sound research aimed at improving the efficiency of flood irrigation.

The philosophy is clear, 95% of the irrigation water used in Victoria is for flood irrigation, used to feed animals, predominantly dairy cattle, but fodder crops and general grazing are still major users. This responsible research involves carefully evaluating all technologies which may make flood irrigation efficient and then evaluating alternative irrigation technologies. It is good solid science.

If we think in terms of say a five year project then research focussing on trying to improve the efficiency of flood irrigation is appropriate. It is quite unrealistic to think that flood irrigation is going to be replaced by any technology in the short term. There is simply too much investment in infra structure both physical and social.

A speculative approach would start from the same diagnostics but would think in terms of say 100 years. Can we conceive that we would still be flood irrigating then? The answer is clearly no. Flood irrigation saturates the soil which inhibits plant growth until the water has either evaporated or soaked away. Clearly flood is going to be replaced by some other technology. It is also clear that the current alternatives to flood such as travelling irrigators or subsurface drip all have major limitations and are far from an ideal replacement for flood.

Speculative research would recognise a need for some new form of irrigation system, and try and develop one. Initially there would be no nicely formulated R & D program with classic milestones and objectives. It is very difficult to get serious funding for this type of research, within the traditional structures.

Last year I suggested to the Department that we could cooperate on providing training on irrigation scheduling so that growers could manage their irrigation and salinity correctly based on the simulation of irrigation we had developed.

This offer was rejected, as far as I could see without any real thought or understanding of the environmental issues.

The justification was that the Government could not be seen to be acting preferentially to any one organisation.

This I find totally unacceptable. Every month for the last eight years I have drawn out $50,000 from my personal account to pay the salaries and costs associated with this speculative research, receiving not one cent for all my commitments. I would be amazed if there is any other individual who has made such a contribution or who is likely to object to the Government cooperating with me to prevent salinity destroying our land.

The Department was clearly confident in its ability to handle these environmental issues and my efforts appeared redundant. I therefore laid off the staff and decided to focus all my energies on Ethiopia where I really felt I was actually contributing. This was a sad day for me. I felt particularly sorry about loosing Peter Grossman, the mathematician who had done all the slog work on the irrigation simulation. It seemed regrettable that his skills and knowledge would no longer be available to the people of Australia to make a further contribution to the environmental problems, at least here in Australia.

I have tried to keep the Department fully informed of my researches, publishing numerous reports, Intelligent Irrigation, The Murray Darling Basin, a technological solution, Soil Moisture Interpretation made easy, Vision for the Bush, Waterright the new thinking on Irrigation Scheduling and the last report Reaping the benefits of Water Saving Technology.

I prepared a report for John Anderson suggesting that water policy needed to take into consideration the need for flushing flow for salt removal, which fundamentally challenges the way we allocate irrigation water.

John Anderson asked me to obtain the Victorian Governments view and a copy of the report (John Anderson 29 Nov) was submitted to your Department for comment. Receipt of this report was acknowledged but no response was ever received.

Writing and submitting these reports has had absolutely no result. I understand that reading reports is dull and often the relevance or meaning is lost, so I decided to try a different approach by setting up a demonstration block on the basis that seeing a working site may at least generate a curiosity visit. **Eight years of development, 5 million dollars in hard cash and your Department could not warrant the 40 minute drive from the City to see the demonstration site.**

I appreciate your suggestions to contact your offices in Mildura and Tatura. We have been down this track and it does not work.

The way forward

No one would doubt that I have made commitments, well beyond what many would call reasonable. It was hoped that this would make a serious contribution to the protection of our environment. This hope has been totally dashed because the Department fails to put any serious resources into understanding the technology we have been developing, and considering how this could be incorporated into strategies to protect our environment.

Obviously this is a great disappointment to me but it would not be productive for me to comment further on the workings of the Department, but rather take one step back and try and understand what the core issues are, test for agreement, and see what can be done to achieve a positive outcome.

Salt and science

I have put forward an argument that we are facing a serious long term crisis with salt destroying our soils, by sodification.

My information is largely based on published papers by the CSIRO and other recognised research centres. These clearly show that salt is a major environmental problem, that salt is being mobilised at an ever increasing rate, much of this salt is not being removed from the system but is being absorbed by our soils which is acting as a salt buffer.

Figures for salt balances have been widely published by the CSIRO with predictions of the amount of salt which will be absorbed by our soils over the next 20 years. I find these figures dramatic and disturbing.

I summarised the key elements of these figures in my report to John Anderson which has been submitted to you.

Independent analysis of these figures can be readily obtained by contacting such well respected scientist and John Williams of the CSIRO and Greg Jones of the ANU.

Based on these figures it is straight forward to calculate out the amount of water require to flush this salt from the system both on farm and in the river. My report shows that there is not sufficient flow in the river system to remove this salt and calculates the required flow.

If I wanted to be dramatic I would point out that the Murray flow has not reached the mouth for some eighteen months. That means every drop of salt that has entered the river water, difficult to estimate because of the effect of the drought on salt mobilisation, but probably in excess of 2 million tonnes, has been re-applied to our agricultural land.

Do we have basic agreement on these facts on salinity?

Timing

I argue that we need to take action now.

In my preamble I went to some lengths to show examples from around the world of the almost universal characteristics of homo-myopic (the species known falsely as homo-sapiens) is to ignore clear signs of impending environmental catastrophe until the damage has largely occurred.

Are you satisfied that we should wait until salt has destroyed our land before we take significant action?

Technology

I argue that salt on our irrigated land can be managed by a twin strategy.
;-Irrigators must manage their application of water such that sufficient water is applied to flush salt from their land but without further mobilisation of salt.
;-There must be adequate flow in the river system to control reapplication of salt to downstream irrigators.

My contributions are
;-the development of a computer simulation of irrigation with saline water which enables irrigators to apply the correct amount of water.
;-the development of the micro flood system which enables flood irrigators to maintain current production levels with reduced water allocations.

Do you consider these may be relevant?

Implementation

Current Government policy appears to be based on the Malthusian philosophy, basically that greed is good. My view is that this is not facing up to the harsh realities. Experience around the world shows that the *greed is good* philosophy is in direct conflict with the preservation of the environment. Individual farmers will act in their best interest. They will use water which maximises short term profits at the expense of the longer term protection of the environment.

To protect our environment the Government has to take positive action to control water. Water rights entitle irrigators to the of use water for growing crops. Farmers do not own the water to do just as they like

with after it magically passes the water wheel or meter. They own a right to use that water for productive agriculture. The Government has the right and the responsibility to control how that water is used.

The population accepts controls in every aspect of their lives. Reasonable people accept that they are not allowed to drive at 140 kph in a drunken stupor because that gives them some protection from a drunken lout wiping them out.

In the short term individuals may lose out on Government action, but gain overall from being part of a better society. This is the exact opposite of the greed is good approach.

Irrigators will more willingly accept controls on how they use water if they see that this is protecting their land from salinity and the controls apply to all irrigators. The initiative has to come from the Governments; it cannot be left to the voluntary action of individual irrigators.

The benefit to an irrigator of controls on how he uses his water is that it protects him from having his land destroyed by the action of other irrigators.

The Government has to take the responsibility of both formulating and selling policies which control how water is used.

If the Governments fail to take action then we will not have an irrigated agricultural industry in a few decades hence. It is as simple as that.

Are we in agreement?

Politics

The Bracks Government was elected with a clear mandate from the people of Victoria. Environmental protection and water policy were key policy platforms. The appointments of John Thwaites and his speech at the SaveWater awards clearly demonstrate that the Government is committed.

Long ago, I decided that I could contribute to a sustainable environment by using my skills and resources. My skill is in technical innovation;- that is what I do.

I now wish to pass this technology onto the Government to make use of in an appropriate way. I am not a manufacturer or marketeer; I cannot go out and mass produce and promote water saving technology. What I do have is intellectual property, and I am most anxious that the people of Australia benefit form this intellectual property.

The only way I can do this is to offer this intellectual property to the Government and assist them in any way I can to make use of the I.P. This may mean

licensing other companies to manufacture product or to develop training schemes to help the Government transfer the technology to the irrigators, or simply presenting my views on how these technologies can best be incorporated into Government strategies as I have tried to do here. Whatever the preferred route I welcome these opportunities.

The only way for this Intellectual property to benefit the people of Australia is for the Government to participate in its spread.

I would therefore be grateful if you would communicate this message to John Thwaites in the hope that he will take the decision on wether he wishes the Government to take advantage of these technologies. If so the next step is clearly for the Department to devote appropriate resources to gaining a better understanding of the technologies and how this may be incorporated into Government strategy to benefit the people of Australia.

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