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**What We Have Learned:
A Summary**

John Radcliffe

Paper prepared for presentation at the “Water For Irrigated Agriculture and the Environment: Finding a Flow for All” conference conducted by the Crawford Fund for International Agricultural Research, Parliament House, Canberra, Australia, August 16, 2006

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FINAL SESSION

What We Have Learned: A Summary

JOHN RADCLIFFE

Email: john.radcliffe@csiro.au

This morning the Chairman, Neil Andrew, introduced the *raison d'être* of the Crawford Fund, as well as the conference sponsors. I would reinforce that the Crawford Fund is here primarily to promote the value of applied agricultural research in developing countries. We've certainly seen some contrasting research opportunities and outcomes to the issues of water in and beyond developing countries in the foregoing contributions.

Opening address

The Minister for Foreign Affairs, the Hon. Alexander Downer, after establishing his technical, electoral and family credibility for speaking on water including especially issues involving the River Murray, observed that the policy issues of water are complex and highly intertwined. We have seen that throughout the conference. In introducing the topic, the Minister showed that we have made significant advances in research and technology. We are able to use water better, and we are now intending to integrate water for the environment with water for economic production, use wa-

DR JOHN RADCLIFFE is a Commissioner of Australia's National Water Commission and an Honorary Research Fellow in CSIRO. He is currently Chairman of the SA State Committee of The Crawford Fund. Until retirement in 1999, Dr Radcliffe was a Deputy Chief Executive of CSIRO. Previously he was Director-General of Agriculture in South Australia. Other appointments have included Murray Darling Basin Commissioner for SA and Chairman of the Executive Council of CAB International. Dr Radcliffe authored the ATSE study *Water Recycling in Australia* published in 2004. He has an agricultural science degree from the University of Adelaide and a PhD from Oregon State University.

ter efficiently and better manage our landscapes. These developments are providing the opportunity to share our expertise with those Asian countries who may want to draw on our experiences, not all of which, I must say, have been universally successful. But we have, I hope, learnt a few things.

The Minister outlined how the Murray–Darling Basin Commission, through AusAID, has been providing support in the development of the Mekong with a basin-wide approach — a useful introduction to the Mekong Basin case study which was presented subsequently. He highlighted the issues of rice, fresh water, fish and eco-systems being brought together, and the importance of efficiency of water use as a fundamental to increasing growth. The Australian Centre for International Agricultural Research has been undertaking a number of experimental projects to improve water management in India, the Philippines, Sri Lanka and other places. But the Minister did point out 'flow for all' isn't a matter of 'free for all'. Nevertheless, it must be recognised that in many cases, water access has been a matter of 'first in — best dressed', as anybody that now has an entitlement in Australia probably knows advantageously. The pricing of water and a market for water are increasingly being used to encourage efficiency. The whole issue of institutional reform has been an important development in this country over the last 10–12 years. Australian agencies have been exploring, with others such as the Chinese Academy of Sciences, scope for advances elsewhere using similar policy frameworks.

Keynote address

Dr Frank Rijsberman, taking a much more global view, commented that Australians were now being recognised as being knowledgeable about water, and indeed Malcolm Turnbull subsequently reinforced that perception. Dr Rijsberman highlighted that there has been a very big increase in world water use — six-fold in one hundred years. This has been important in terms of famine prevention, but the ultimate issue is ‘where is the water and who gets it?’ The amount used for drinking, 2.5 litres per head per day, isn’t that much. Households use between 20 litres and 400 litres per head per day. The amount of water used for human consumption is important, but it is quite small compared to the amount that is used in agricultural production. But water consumption estimates must also be related to the local food culture and the water embodied in that diet. For example 2600 litres a day is required for people consuming vegetable diets if that is their cultural background, but maybe 5400 litres a day is used by people in a society that is fond of grain-fed meat as in North America.

There are great contrasts in water storage capacity around the world. The developed countries have very considerable amounts of storage capacity, but the undeveloped countries have relatively little. Overall we have to recognise that 280 million ha, give or take 50 million odd, including much with double cropping, does represent the salvation of the global population, even though 20% of that land is at risk of salinity, sodicity and other problems. Dr Rijsberman suggested that the approach of splitting water use between rainfall and irrigation, and as a result between rain-fed agriculture and irrigated agriculture, was an outdated notion. We really need to manage the total available water for agriculture as a single entity. The notion of splitting water resources didn’t really arise in the conversations again during the day until we got much further down in the discussions, when the split between surface water and ground water started to be considered. This followed a question reinforcing the critical necessity of conjunctively managing surface water and ground water. That point was reinforced by a number of subsequent speakers.

Many water basins are over-allocated. We need to review the allocation of their water resources. Recognising the increased competition for water, we are now seeing basins around the world where wa-

ter is being transferred to higher-value uses. Australia is a major ‘virtual water’ exporter, as several speakers pointed out. Our economy depends on it. We are also exporting minerals as well, and that industry will tell you how important their exports are. While recognising that, we should also recognise that the mineral industries have installed very efficient water facilities in some of the remote areas where they operate.

Various priorities were suggested — increased water productivity in rain-fed areas; multiple use of water; reinvention of how we go about irrigation with new systems; making an asset out of waste water and improving the governance of water resources at the base level. We saw this after lunch when we moved on to discussions of case studies, where the bottom line was governance over the water resource and its use.

Food flows, water flows

Dr Mark Rosegrant from the International Food Policy Research Institute reinforced the perspective that Dr Rijsberman had given us, drawing attention to the potential loss of grain production induced by water scarcity by 2025, resulting in the need for increasing grain imports into the developing countries as populations expand. Limited progress is being made in reducing the numbers of malnourished children in many parts of the world, despite our best intentions. We cannot expect a big increase in the actual area of irrigation. By 2025, water consumption will be increasing proportionately much more quickly in the areas of domestic and industrial usage than through increased use for agricultural irrigation. But Dr Rosegrant did highlight the issues arising from moving much fish production from ocean catch to aquaculture (two-thirds, by 2020): these include the potential problems of eutrophication, oxygen deficiency and algae blooms, and the substantially increased water consumption.

He also suggested that there are great opportunities in bio-technology, particularly oriented to rain-fed agriculture, but only so long as the community is happy about the bio-safety and is willing to accept the technology. In particular, there should be much more significant drought tolerance in crop varieties within ten years.

Climate change is another issue that has had considerable attention. It could lead to more emphasis on economic incentives and water resource development in the developing world, and to the clarifi-

cation of water rights, direct costing and pricing in industries and removal of production subsidies.

A perceptive question was asked at the end of that session, enquiring what fraction of the world's irrigation water is not being replenished. We received a somewhat vague answer which said something like 7–12% of our resources are in depletion. We didn't pursue that subject very much, but it is an important one that must have more consideration for the long term.

Future water availability and improved agriculture

Dr Bryson Bates then came to us with healthy scepticism and uncertainty, which I feel is how some people think about climate change. He highlighted the great differences between assessments by global climate models, and the variation in how they simulate various processes within their models. He pointed out that whilst modellers certainly have some 'runs on the board' in terms of the future vision of global climate, their models have limitations at the regional level. They become even more uncertain in terms of providing advice about the specifics of local precipitation. He said that climate systems tend to be non-linear, noisy and chaotic. In giving a little list of 'frighteners', he said that we can expect increased floods, increased drought risk, changes in secondary flows, changed seasonality of flows of various rivers, more soil erosion, and the need to consider the issue of sea level rise. There is not only the inconvenience of finding your feet in the water, but also the need to determine how sea level rise might impact on coastal estuaries. Dr Bates then gave several examples, some of which we followed up in subsequent discussions. But he highlighted the knowledge gap in issues relating to climate change, for example the responsiveness of vegetation to increased carbon dioxide and the consequent impact on ground water, water quality, aquatic ecosystems, algae blooms and related topics. He concluded that 'climate change will impact on fresh water resources'. But he did say clearly that there had been very limited assessments of the performance of global climate change models at the regional scale, so there is a long way to go.

A participant then asked 'is the Greenland ice cap melting?' to which we received a reply which basically said 'there is evidence we do have a problem'.

Professor Wayne Meyer went on to discuss the more specific and driving aspects of irrigation. He advised that the world has an average of 22 people

per irrigated hectare. Australia has only nine, so we must be feeding thirteen others by shipping foodstuffs off-shore. That raised the question 'is Australia exporting half the water we use?' He then discussed a few opportunities for improvements across the plant industries — how we can conserve water, for example by using partial root-zone drying and by decreasing the seasonal duration of crops. We aim to decrease evaporation in relation to transpiration by such techniques as using sub-surface drip irrigation, but we need good management and access to capital to undertake those changes. Productivity increases can be expected deriving from increased yield, but we are not likely to reduce our total water use very greatly. We do need to look at the whole water cycle system — the storage facilities, delivery to the farm gate, use on farm, and management of water in the soil and how it is consumed by the plant. In the total system, there would be some scope for savings, even though the specifics for savings in the individual crops themselves might be quite limited. But there is a dilemma between improving system efficiency while recognising that increasing yield may then drain more water. So he asked whether, and why, in reality farmers will actually bother to improve the efficiency with which they use water? He observed that it is not a primary motivator and we had better understand that. Agriculture is a business. Most people identify with a need for change, but the community also needs to identify what the needs and benefits are for inducing change. We will have to ensure simple institutional arrangements, and that is going to involve compromises. Professor Meyer followed up with a discussion about how we might double the yield, which might be difficult, but at the same time, we may be able to halve the demand for water providing we are willing to expend a great deal of capital in improving the infrastructure.

As to the earlier question about the scope for managing water as an interconnected resource in river flows and ground water, the answer was agreed to be absolutely critical. We do have to consider how we manage that conjoint use. We will also have to consider how we manage leaching — a necessity arising from continual applications of somewhat saline irrigation water. Innovative ways must be identified to address these issues.

Balancing demands: four case studies

After lunch we went into a number of interesting case studies. In each case, it transpired that water resource use primarily revolved around governance as the principal issue. There were several parameters within the systems described, such as varying population pressures, access to the water resource and how people dealt with their perceptions of economics, the environment and the social issues.

The study outlined by **Professor Li Rui** described seven provinces that have 35% of the total population of China and provide a similar proportion of the GDP. The study revealed that some frightening changes were occurring. For the Huaihe River area, for example, annual average precipitation has reduced by 10–15%, run-off has reduced by 47% per cent, but over nearly 50 years, annual water consumption has increased by 4.5 times, and industrial and domestic consumption by 48 times. The water table has been declining by 1.8–2.4 m per year in the deeper layer and 0.7–1.4 m per year in the shallow layer. Ground subsidence has become a problem as a result of removal of groundwater. I can't say we've seen a lot of ground subsidence as a result of Australian groundwater use, but certainly our attention was drawn to an additional problem that could arise.

Dr Philip Hirsch then told us about the Mekong Basin. What we saw was a management example potentially involving six countries. In effect, there are currently four participating 'shareholder countries' and two non-participating countries managing a water resource that is not constrained and is largely under-developed. It provides a model for development within a set of communities of great diversity. There will be a challenge to find out how the Mekong population — 60 million people in 100 ethnic groups joined into the six communities — can achieve equability, sustainability and efficiency. The obvious governance challenge is that of moving beyond national interest, through pathways of expanded knowledge, leading to better development decisions and including the ultimate engagement of China which is apparently building eight dams upstream. It seemed rather like trying to get Queensland into the Murray–Darling Basin Commission, which took a little bit of time. The focus must be on the triple bottom line, working at multiple levels to achieve an integrated and equitable management system.

Dr Tushaar Shah then gave us a wonderful history lesson on the colonial diversity of the irrigation systems introduced in different countries from the 1850s. Governance again became an important issue. Some of the forms of governance, such as the command and control in the Gezira System, are not how we seek to do things these days, but it appears to be still operating, at least in technical terms, reasonably effectively. The whole issue of civil and social engineering and their integration is something that we are considering more thoroughly in irrigation and the community use of water. We saw some proposals for integrated civil and social engineering recently in the referendum on the addition of purified recycled water into Toowoomba's water supply, but they didn't engineer quite as their proponents had proposed. We may see some more examples of that shortly. The particularly interesting thing to observe about the Gangetic Plain is the apparent ungovernability of its water resource. It seems that governance there is all 'too hard'. It seems to be impracticable to give out water entitlements to many thousands of people that have each got a quarter of hectare of land. The transaction costs appear too high. It sounds like one of the Australian state governments which says it doesn't want to prescribe a water resource because the transaction costs of issuing water entitlements are too high, so it will allow that water resource to continue to be used unregulated until it is shown to be stressed. Then it may be too late. The other important issue to recognise about the Gangetic Plain is that this is the only region in a humid area in the world where significant ground water use is occurring, and it is a very high level of ground water use. All the other areas of high ground water use are in drier parts of the globe. The impact of surface flow irrigation being replaced by pumped groundwater irrigation in a very short period, really since 1995, was highlighted. That point was brought to bear indirectly in one of the later questions at the end of that session by a commentator who observed 'this is all very well and good, but there is the whole issue of the cost of energy'. We hadn't previously heard anything about energy costs. Subsequently we began to consider energy when Malcolm Turnbull said that use of recycled water depended on where it was and where you had to send it to, observing that energy costs are a big issue in moving water about.

Dr Wendy Craik told us about the Murray–Darling Basin Commission, a long-standing national institution. It is now the result of an agreement encompassing six jurisdictions, though formerly only four. But it is quite a contrast to some of the subsistence-based water systems because the Australian irrigation systems had been based on economic development incentives established in the 1800s on an aspiration of developing an agricultural yeomanry that was perceived to be an upstanding and successful community. We were introduced to the variability of the Murray–Darling system and the much greater variability of the flow within and between the River Murray and the River Darling, compared to some of the other well-known international rivers. The gradual development, over the last 50–60 years, of techniques to manage the river was outlined. My perception is that the Murray–Darling Basin Commission actually does a very good job of managing the river from many perspectives, but of course it is playing in an environment where the ‘goal posts’ are being continually moved, not the least by droughts. The Commission does have a clearly defined governance system despite its many limitations. It has constraints because of the differing budgetary conditions of the represented state governments, but nevertheless it does work. Dr Craik outlined the conflicts that led to the creation of the original Murray Commission, the River Murray Waters Agreement, the subsequent development of the river basins, the introduction of the catchment approach, the recognition of the need for river health and increasingly the identification of risks that we may have to face in the future. This has been achieved through a maturing of management within an evolving governance system. However, I think we need to be careful not to blow our trumpets too much, even though Malcolm Turnbull suggested we tend to be a little bit coy about recognising the significance of what we have achieved. The ‘proof of the pudding’ may not yet be fully established, but we have put our faith in the operation of the Commission.

Australian water policy: options for the future

Finally, in the concluding session, the chairman National Water Commission Chairman Ken Matthews advised that Australia has no option but to press on with implementing the National Water Initiative — we can’t stop now.

Parliamentary Secretary for Water, the **Hon. Malcolm Turnbull**, then began his presentation by saying that water is a complex, fascinating subject, which is exactly what we know it to be. The problems are national, the solutions are local. Water is heavy and it costs a lot to move around. One might observe that it can be a bit heavy in political terms too. Mr Turnbull pointed out that most hydrological means are pretty meaningless in the reality. He also identified how much change there has been in water use, even in the last 20 years, with extraction from the Murray–Darling Basin doubled and New South Wales use of ground water increasing three-fold. However, he also observed that the state of New South Wales has now entered a difficult adjustment process to bring groundwater use in some areas back into a sustainable balance. He highlighted that the National Water Initiative is a shared vision that revolves around the management of consumptive use while recognising the environment’s need for a share of the water, and that we need to develop the best ways of keeping them in balance. I’m not sure that we really know how to do that effectively yet, but we’re certainly approaching it with a degree of commitment. Beyond that, we have to take account of climate change and the extent to which that may potentially reduce the total water yield. But equally well, we have to manage climate variability, whose breadth, as we saw in some of Dr Craik’s charts, has been quite substantial between the Federation drought, the droughts of the 1940s, the 1956 flood and the drought we are currently having. That means we have two sets of ‘noise’ that we must accommodate, one being a short-term periodic one (natural variability) and the other being one with what we assume to be a longer evolutionary time-frame (climate change).

Malcolm Turnbull did highlight the importance of a number of other issues. One in particular was the relationship between ground water and stream flow. It is all the same water. We need to understand it and manage it appropriately. He also talked about the impact of forestry and how that uses water. He alluded to the removal of an exotic pine forest from the Gnangara groundwater mound in Perth. Though an unimpressive forest, it does represent water consumption that Perth could do without. Mr Turnbull was rather more defensive when the possible implication of logging the Barmah-Millewa Forest was raised, reflecting a sensitive awareness for the environmental and political reality surrounding this issue.

Irrigation efficiency is another important matter to which he alluded. The Australian Government Wa-

ter Fund will be supporting some innovative demonstration projects in that regard, and you'll have to watch for those. He also highlighted that water lost upstream is potential water for people to use downstream. He also pointed out that the evaporative loss is a genuine loss, but interpreting that is a question about which there can be debate depending on your personal perspective. Several years ago when reviewing water recycling, I sought to find out how much recycling was occurring at various wastewater treatment plants. One of the water authorities in Victoria claimed 100% recycling. So I enquired how that was managed and was advised that it was by evaporation. In the terms of the water cycle, that conclusion is perfectly correct. It is an example of water recycling, but that isn't quite how we normally define it. Mr Turnbull went on to discuss the importance of trading, the potential interest of the private sector in providing water services and participating in water

management, and some of the subjects which are causing angst in the urban water area. There will be more debate in a lot of those areas. Finally Mr Turnbull fairly obliquely invited members of the audience to send material to him, by e-mail. I can guarantee that if you do, you will get a reply because he seems to have a great capacity to promptly and personally respond to his e-mail.

We had a very successful range of presentations and discussions during the day. They highlighted the importance of differing technical, environmental and social drivers, whether for the need for survival and to minimise starvation, or whether to maximise profit in an enterprise, or even to ensuring the continuity of a government. There are many different drivers. We need to understand how they can be best integrated to ensure that we do manage our water resources successfully for the benefit of future generations.

Other Crawford Fund Publications since 1997

- Lawrence, Janet (ed.) 1997. *Partners in the Harvest*. Record of a seminar, 'NGOs, scientists and the poor: competitors, combatants or collaborators?', conducted by the Crawford Fund for International Agricultural Research and World Vision Australia, Parliament House, Canberra, 8 April 1997. ACIAR Monograph No. 47. iv + 98 pp. ISBN 1 86320 206 4
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- The ATSE Crawford Fund 2005. *Healing Wounds: An Australian Perspective*. Research that rebuilds agriculture after conflicts and natural disasters. The Fund, Parkville, Vic. 14 pp.
- The ATSE Crawford Fund 2005. *Report 1 January 2004 to 30 June 2005*. The Fund, Parkville, Vic. 25 pp.
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- The Crawford Fund newsletter, *Highlights*, is available from the Fund's website (<http://www.crawfordfund.org/index.htm>) or in printed form. In 2006, two issues were published.
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- The publications below discuss the global setting for international agricultural research. The website of the Cooperative Group for International Agricultural Research (CGIAR) (<http://www.cgiar.org/>) provides other information.
- Alston, J.M., Pardey, P.G. and Taylor, M.J. (eds) 2001. *Agricultural Science Policy: Changing Global Agendas*. John Hopkins University Press, Baltimore, 285 pp. ISBN 0 8018 6603 0
- Pardey, P.G., Alston, J.M. and Piggott, R.R. (eds) 2006. *Agricultural R&D in the Developing World: Too Little, Too Late?* International Food Policy Research Institute, Washington DC. Available for download from <http://www.ifpri.org/pubs/books/oc51.asp>