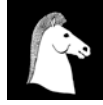




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The Spectre at the Feast: The Emergence of Salt in Victoria's Irrigated Districts

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ABSTRACT

Salinity in Victoria's irrigated districts can be understood as the result not only of environmental predisposition and technological inadequacies, but of a prevailing political philosophy which considered irrigation as a social and economic good *per se*. Victorian authorities (governments and water institutions), anxious to secure the state's economic prosperity and to encourage the establishment of independent family smallholdings, tended to underestimate the actual and potential severity of salinity problems, and to blame their development on the farming practices of individual landholders rather than on systemic failure. Their dismissal of farmers' concerns as 'ignorance' and their tardiness in implementing remedial measures in salt-affected areas were indicative not only of the restrictions imposed by insufficient knowledge, primitive technologies, and limited finances, but also of official resistance to the challenging of 'progress-through-irrigation' narratives. The salinity problems experienced today in many of Victoria's irrigated districts therefore reflect the long-term consequences of a broadly progress-oriented philosophy of natural resource management.

KEYWORDS

Irrigation, salinity, progress, natural resource management, Victoria Australia

INTRODUCTION

Though much has been written about the physical causes of Australia's salinity problems – principally climatic and geological conditions, and the effects of particular land-use practices – salinity in Australia is as much the result of social and political conditions as of environmental predisposition and technological inadequacies. Yet this web of what we might call social, political, economic and ideological propellants has until recently received little scholarly attention. Two notable exceptions are Quentin Beresford et al., *The Salinity Crisis*, and Edwyna Harris, 'Development and Damage: Water and Landscape Evolution in Victoria, Australia', which examine the political and economic stimuli underlying the development, respectively, of salinity in the West Australian wheatbelt and of water-related environmental degradation in Victoria.¹ In this paper I focus their approach to landscape analysis on Victoria's irrigated districts, to explain the failure of Victorian governments, institutions and local communities to manage salinity effectively in these areas prior to the 1970s. I argue that responses to salinity in Victoria's irrigated heartland from the 1890s to the 1970s, though tardy and ineffective by today's standards, made sense within the context of a progress-oriented philosophy of natural resource management, particularly given the limitations of state finances, inchoate knowledge of environmental conditions, and underdeveloped technologies.

Two documents bookend this discussion. One, the Victorian Irrigation Act of 1886, launched the state's official irrigation development; the other, the 1970 *Murray Valley Salinity Investigation* (the 'Gutteridge Report'), represented the first official recognition of salinity in the Murray-Darling Basin as a serious *regional* problem requiring urgent and concerted management action.² Between these two dates, the expansion of irrigated agriculture in Victoria, the rising incidence of associated waterlogging and salinity problems, and the responses of landowners, politicians, water institutions, and agricultural experts to such problems, are the focus of the paper.

Biogeographer Stephen Trudgill has identified four broad barriers to effective environmental action: agreement barriers, knowledge barriers, technological barriers, and economic/social/political barriers.³ All four kinds are recognisable in the history of Victoria's irrigated districts. First, though salinity and waterlogging were acknowledged as problems wherever they were observed, their actual and potential severity was consistently underestimated. Landowners and scientists tended to demonstrate more concern than politicians and water managers, but there was no real agreement either within or between these groups about the extent to which salinity constituted an environmental problem. These difficulties were compounded by an imperfect knowledge of the environmental conditions (soils, climate, and hydrology) of the irrigated districts, and by technological limitations, notably the relatively primitive condition of irrigation technology during the late nineteenth and early twentieth centuries, and the prohibitive

expense of installing the more effective irrigation and drainage systems then available. Ideological and political forces also drove irrigation forward: the desire for wealth creation and agricultural expansion, the perceived benefits of the rural life to individuals and to society as a whole, the progressivist views which understood land and water as natural resources to be developed and not 'wasted', and the economic pressures which necessitated rapid implementation and expansion of irrigated agriculture to keep the agricultural industry competitive in export terms. Social dilemmas, such as the pressure to provide for returned soldiers following the First and Second World Wars, also contributed; and a prevailing faith in the capabilities of science and technology led to overoptimistic assessments of the suitability of certain areas for irrigation, and a tendency, at an official level, to dismiss criticisms of irrigation and concerns regarding developing waterlogging and salinity problems.

WHAT IS SALINITY?

Irrigation salinity and dryland salinity, though closely linked, are distinct phenomena. Dryland salinity is essentially a product of land clearing, and the subsequent replacement of trees and other deep-rooted native perennials with shallow-rooted annuals (introduced grasses and crops). As the replacement vegetation is less effective at absorbing natural rainfall, increased volumes of water penetrate below the root zone to underground aquifers, causing the watertable to rise. High watertables cause waterlogging and result in decreased plant vigour and damage to soil structure. In much of Australia's groundwater, dissolved mineral salts are present in high quantities; these cause affected plants to become dehydrated, wilt and eventually die. Under irrigation, water is applied to the soil in greater quantities and with greater frequency than would be the case under natural rainfall conditions; the consequent increase in the amount of water passing through the soil accelerates the development of waterlogging and salting symptoms, and further exacerbates the difficulty of their management. In many irrigated areas, seepage of irrigation water from unlined distribution channels adds to the problem.⁴

Salinity is not a new phenomenon, nor is it confined to Australia. Donald Worster, who has described it as 'the oldest and most endemic form of water decline associated with all hydraulic societies', supplied a grim catalogue of salt-affected lands worldwide in the mid-1980s: 60,000 acres of fertile cropland per year in Pakistan, 10 per cent of Peru's agricultural land, along with substantial areas of Afghanistan, India, northern Mexico, Syria and Iraq. Recent estimates for Australia suggest 5.7 million hectares of land at risk or affected by dryland salinity alone, increasing to 17 million hectares at high risk within 50 years; in the Murray-Darling Basin, over 100,000 hectares of irrigated land are currently salt-affected.⁵

During the late nineteenth and early twentieth centuries, salinisation world-wide was less extensive, and scientific understanding of salinisation processes was relatively limited. Irrigation salinity, importantly, was better understood and better documented than dryland salinity. The latter was not described until the 1920s, and did not become widely accepted for several decades more; the former, if not fully understood, was certainly recognised even before the introduction of irrigated agriculture to Victoria, from observations of irrigated areas in North America, India and Europe.⁶ Though Victorian authorities generally agreed that drainage was necessary to prevent waterlogging and salinity in irrigated areas, drainage systems were rarely installed in such areas, even after salt problems had become apparent.⁷ More importantly, the need to recoup expenses incurred through the construction of water storages, distribution channels and other large-scale irrigation works led to the introduction of compulsory water rates, which simultaneously encouraged excessive and indiscriminate use of irrigation water, and discouraged innovation in irrigation-related technologies.⁸ The considerable awareness of salinity demonstrated by Victoria's irrigationists⁹ was not sufficient to change patterns of behaviour that increasingly revealed themselves to be dysfunctional. However, there is little benefit in assigning blame for what may, with the benefit of hindsight, be perceived as the mistakes of the past; rather, it is important to examine the ideals and cultural values, the social, ideological, and economic motives, which informed Victoria's irrigation-based settlement projects and underlay the onset and development of salinity in irrigated areas.

VICTORIA'S IRRIGATION BEGINNINGS: ALFRED DEAKIN

Although irrigation had been attempted locally by various enterprising individuals in Victoria from the 1850s, the question of irrigation on a large scale was not seriously considered before the 1880s.¹⁰ In response to a series of severe droughts in southern Australia, which lasted from 1877 to 1881 and 'brought hardship and privation' to settlers, the Victorian Government in 1880 appointed a Water Conservancy Board to report on water supply and irrigation in Victoria's northern plains. The reports of this Board led in 1881 to an Act providing for the establishment of waterworks trusts closely linked to local councils and aided by State loans, and concerned primarily with the supply of water for domestic and stock purposes. To provide for irrigation, a further Act, the Waterworks (Water Conservation Amendment) Act, was passed in 1883. Concerns regarding the scale of expenditure required for irrigation schemes led in 1884 to the appointment of a Royal Commission on Water Supply, to 'inquire into the question of Water Supply, and into other matters relating thereto'.¹¹ In the multiple progress reports subsequently submitted by the Commission to Parliament, its President, the Hon. Alfred Deakin (later second Prime Minister of Australia), found the

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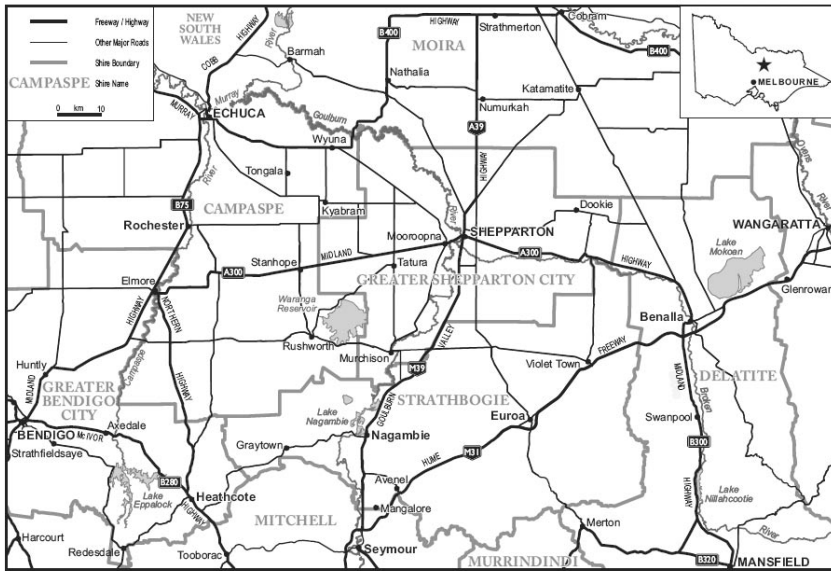


FIGURE 1. Map of the Goulburn Valley, Victoria, Australia.
Courtesy Peter Smith, Spatial Vision

opportunity to express his passionate personal belief in the material and moral prosperity which irrigation would bring to its practitioners.

Deakin, who became Minister of Public Works and Water Supply in 1883, saw in irrigation not simply drought-proofing and stock and domestic supplies, but the opportunity ‘to secure permanence and prosperity to our agriculture, and a wealth and populousness to our country districts, which without irrigation they could never hope to attain’. He confidently predicted the glowing future of an irrigated Victoria:

When the whole of this continent becomes well settled, or even settled in all its parts, it may be possible for the valleys of the Murray and the Goulburn to hold something like the position which that of the Po does in Northern Italy, and by the careful utilization of their waters to become densely peopled, splendidly productive, and enormously wealthy.

Economic pressures intensified the pull of prospective wealth. Competition from primary producers in India and South America, and drastic price fluctuations

in wheat and wool, convinced Deakin that 'the safety of the farmer lies in the variety of his products ... the days of profitable wheat exportation are drawing to a close ... in dry districts the first and essential, if not the sole, remedy is irrigation'.¹²

The economic benefits of irrigation constituted only half the vision. Irrigationists such as Deakin saw it also as an agent of moral and intellectual improvement, a means by which the widely-held 'yeoman ideal' could be realised.¹³ Irrigated agriculture, which was seen to '[tend] to the subdivision of great estates and the increase of small holdings', would 'unlock the land', breaking the power of the squatters and allowing the establishment of independent family smallholdings, and would also compel landowners 'to co-operate for common purposes', encouraging the development of community spirit and self-determination. The ultimate result would be 'a superior class of small farmers' leading 'a semi-communal life, favorable to education, individuality, and mental activity ... thus according admirably with the pursuits of citizens capable of controlling democratic institutions and undertaking local self-government'.¹⁴

These claims were strengthened by a general belief in the superiority of the rural life. Biblical and historical precedent identified cultivation of the soil as the cornerstone of human society, and farming as 'the one original and fundamental occupation; all other businesses and professions are either its offshoots or its parasites'.¹⁵ Urban life was considered to represent a deterioration from humankind's natural state; cities were compared to 'huge cancers', sapping the health and strength of their inhabitants, and destroying the 'national fibre' of Australia.¹⁶ The vitality and character of the people, as well as the stability of the nation, depended upon maintaining a strong rural population. It was therefore a matter of national importance to encourage ongoing agricultural occupation of Victoria's open spaces; and irrigation, which promised high financial returns from small areas of land and security from the vagaries of climate, came to form an indispensable part of this aim. Even cautious individuals accepted it as essential for the complete utilisation of Victoria's inland regions;¹⁷ those of more buoyant temperament employed quasi-soteriological language. Francis Myers, travelling correspondent of the *Argus*, introduced his 1891 pamphlet *Irrigation; or, the New Australia* with these words:

I believe in practical, scientific irrigation with all my heart and soul and strength. I know too well what, in its absence, life in the bush of Australia has become ... old men have become debauched and degraded to the state of absolute brutes ... young men and boys have fled from it to the city as to a haven of refuge ... in those cities the curse of pauperdom, of vagrancy, of lowest vices and crime increase terribly ... sedition, anarchy, and all blackest forms of socialism are bred, and while the rich and beautiful country is untilled and unutilised, the cities are thronged with wolf-eyed multitudes, eager only each for the other's substance.

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For the existence of such conditions I blame chiefly ... the unnecessary harshness and brutality of our bush life. For its removal I look chiefly to the gentler order which shall follow a general introduction of irrigation.¹⁸

Religious imagery and irrigation frequently went hand-in-hand, an issue to which scholarly attention has already been directed. Donald Worster and Ian Tyrrell, for example, have examined the Judeo-Christian expression of America's irrigation dream;¹⁹ Melissa Bellanta has discussed the religiosity of Victoria's irrigation imagery and language, especially in relation to Deakin (famously portrayed as Moses striking the rock by *Punch* in June 1886) and journalist William E. Smythe.²⁰ Similar language was adopted by early irrigation historians, Ernestine Hill describing the Renmark irrigation settlement as 'a paradise of living green', Deakin as 'a youthful St Paul', and Chaffey as a 'redeemer of deserts',²¹ while J.A. Alexander's Chaffey became a Christ-like figure who 'won the wilderness' and 'conquered the desert', whose arrival was an 'advent' and whose opponents were 'jackals'.²² These forms of discourse were symptomatic of a wider climate of opinion in which 'irrigation [was] not about drains, pumps, pipes, and dams, but about dreams'.²³

Despite their high expectations, however, Victoria's irrigationists were not blind to potential problems. Deakin, during his travels in Egypt and Italy, had noted the development of waterlogging and salting through insufficient drainage, 'aggravated by extravagance in the use of water'. His comparisons of irrigation in the Old and New Worlds had convinced him that though it was 'often possible in a new country to omit drainage works, at all events for some time ... where considerable volumes of water are employed, they soon become an essential part of every scheme, and it is clear that it is always cheaper and easier to make this provision at the outset'. His recommendation was for preventive management; it was 'highly desirable' that drainage be installed 'when it can be done most cheaply, efficiently, and comprehensively, that is, at the initiation of a scheme'. He also emphasised the need for education, warning that although the problem of drainage might not manifest itself in familiar forms in a new country, 'it will present itself in some shape ... [and] we should provide against it in advance, and be prepared with knowledge of foreign remedies for it'.²⁴

The first priority, however, was to get this brave millenarian project off the ground. Victoria's Irrigation Act of 1886 bifurcated irrigation development into colonial socialism (via locally controlled irrigation trusts) and free enterprise (the Canadian Chaffey brothers' irrigation colonies in Renmark and Mildura). Within twenty years, however, it became evident that both strategies had failed to develop efficient systems of irrigation. The Mildura colony had encountered a variety of obstacles, most notably the lack of a railway link with the Melbourne market; seepage and salt troubles, though acknowledged by the Mildura Royal Commission as having contributed to the colony's failure, were largely overshadowed by the greater scandal of the Chaffey brothers' dramatic financial

collapse.²⁵ The irrigation trusts collapsed for different reasons. Victorian farmers of the late nineteenth century, it transpired, 'were at best lukewarm supporters of irrigated agriculture'; those who did make use of irrigation water generally considered it only as a supplement to the existing farming system. As a rule, they were disinclined towards intensive cultivation and small-scale irrigation farms, and preferred to stick with what they knew: wheat, sheep, and dairy cattle. The 'sparing and irregular use' made of irrigation water under the original trust system, though far friendlier to Victorian soils than later intensive methods, meant that farmers were simply not using (and therefore not paying for) enough water to offset the debt burdens of the trusts. 'Costly engineering difficulties' hampered the construction of larger facilities for water conservation.²⁶

ELWOOD MEAD AND THE STATE RIVERS AND WATER SUPPLY COMMISSION

The 1905 Water Act abolished Victoria's irrigation trusts, replacing them with the State Rivers and Water Supply Commission (hereafter the SRWSC) as a central administrative body. The painful memory of the trusts ensured that the primary concern of the SRWSC was to remain solvent. Firmly determined to avoid financial collapse, and faced with the very real necessity of recouping expenses incurred by the State through construction of water storages, distribution channels and other large-scale irrigation works, the SRWSC introduced a compulsory charge which 'required farmers to pay for a minimum amount of water ... whether they used it or not'.²⁷ These charges, though they were later found insufficient to cover the entire costs of water supply, management and maintenance,²⁸ effectively resulted in 'inefficiencies [dominating] the Victorian irrigation industry over the bulk of the twentieth century', encouraging excessive water use and stifling innovation in irrigation technology for the next seventy years.²⁹ The financial pressures resulting from the failure of the trusts also made the SRWSC particularly unwilling to incur 'the delay and ... extra expense' attending installation of drainage schemes.³⁰

The compulsory charges were introduced on the advice of Elwood Mead, professor of irrigation institutions and practice at the University of California and Chairman of the SRWSC from 1907 until 1915. Mead saw the expenses involved in Victoria's irrigation development as a necessary precursor to its success; he admitted after the construction of the Goulburn Irrigation Scheme (1887-91) that it had 'cost the State an immense sum of money', but was confident that 'the returns from this expenditure will be all that can be desired'.³¹ Arguably the state's most influential irrigationist after Deakin, he published countless articles on the practice and benefits of irrigation, and toured the country to spread its gospel. As a foreign academic and expert, his advice was revered and his recommendations assiduously followed, sometimes with unfortunate consequences.

Nevertheless, even Mead's critics acknowledged his good intentions, and his departure for America in 1915 'was genuinely regretted by most of the people with whom he worked in Australia', including many settlers whom Mead knew personally and in whose welfare he 'had always shown an interest'.³²

Economic considerations were undoubtedly of principal importance to Mead and his fellow Commissioners. Under the strength of their conviction that irrigation was central to Victoria's social progress, however, their insistence that farmers use the water provided for them was frequently expressed in moral terms. Mead, for example, described opposition to irrigation as 'a situation in which the inclination of the individual runs counter to the welfare of the state'; he spoke of 'the responsibility of the State to develop its latent resources', and claimed that 'Northern Victoria has now reached a stage in its development when agricultural methods must change if there is to be further growth ... if we are to have success we must work for it'.³³ He then asserted that in many instances:

The ardent convert to irrigation during a drought becomes a backslider when it rains. For a time, at least, there is a reluctance to submit to the order and system which irrigated agriculture requires, and a continual balancing of the merits and drawbacks of watering from canals or from the clouds.³⁴

Mead further suggested that it was the irrigator's duty to provide for his less fortunate neighbour when the seasons proved unfavourable:

the most useful functions of irrigation canals in Victoria is [sic] to lessen the hazards and losses of dry years, to save money and relieve the misery of helpless starving dumb animals. *This purpose will never be fulfilled so long as the land under canals is used as pastoral areas. When dry years come the irrigator is protected, but he is in no condition to extend aid to the pastoralist on non-irrigated land.*³⁵

Irrigationists such as Mead, who considered their promotion of irrigation a social and economic good, showed little patience with settlers who hung back from embracing it wholeheartedly. Though they frequently joined with Deakin in protesting the importance of practical experience, such irrigators would not countenance experience that questioned the viability of irrigation itself.³⁶ The initial reluctance of many settlers – whether for financial reasons, doubt of irrigation's efficacy, or simply a disinclination to alter their accustomed farming styles – encouraged irrigationists to dismiss their concerns as ignorance.

Convinced of the achievability of Victoria's irrigation dream, and determined to realise it, Mead took hesitant irrigationists to task in no uncertain terms. He declared 'the attitude towards irrigation of the land-owners' to be the 'one serious obstacle' to the development of irrigated agriculture in northern Victoria: 'as a class, [the landowners] do not believe in irrigated agriculture, and they are not willing to do the things which success in irrigation requires'. When a landowner from the Rodney district sent a letter to the *Argus* in 1909 protest-

ing that ‘the bulk of our land is not suited for irrigation ... the water is cheap enough ... but the results obtained from its use ... is [sic] not such as to induce us to use it freely’, Mead retorted: ‘If this statement is true, then the State has wasted a quarter of a million pounds on distributaries in the district.’ He added that ‘the only obstacle to irrigation is that its methods are not understood and its advantages not realized’. Though Mead’s confidence in the potential of the district – ‘I have never known a new irrigated area where the prosperity of farmers under irrigation is more assured’³⁷ – was more reflective of his own wishes than of actual environmental conditions,³⁸ the circumstances of the trusts’ failure made it more plausible to construe such farmers as obstructive than to accept that their land might indeed be unsuited to irrigation.

To some extent, certainly, this promotion of irrigation’s benefits was justified. The dry seasons immediately following the 1886 Irrigation Act had supplied ample evidence of the misery experienced by settlers unprepared against the vagaries of climate and rainfall. Irrigation, in addition to private water storage, was the farmer’s best insurance against drought in a country where climate and soil conditions did not favour European crops or sedentary agriculture. In his concern to maximise the benefits obtainable from irrigation, however, Mead tended to underemphasise the need for caution, and to downplay the risks associated with irrigation – although, as the former state engineer of Wyoming and member of the American Society of Irrigation Engineers, and ‘one of the most widely travelled and knowledgeable authorities on [irrigation] in the entire arid world’,³⁹ he must have been aware of the damage caused by salinisation in irrigation districts elsewhere.⁴⁰

Under Mead’s watch, development of the state’s irrigation settlements proceeded apace. By 1910, J.E. Jenkins, Secretary of the Lands Purchase Board, was able to report to Parliament that ‘over 34,800 acres in Irrigation Districts have been purchased and are being subdivided as Irrigation Settlements’.⁴¹ The SRWSC’s Annual Report for 1910-11 recorded 142,857 acres of land under irrigated culture, proudly noting this as ‘an increase of 13,086 acres over the area irrigated in the previous year’. During the same year £13,300 was expended on new works (principally distributary channels and outlets) within the Rodney District, and £72,720 on Goulburn Main Channels and Distributary Works, including 117 miles of distributary channels in the parishes of Bamawm, Rochester West, Nanneella, Koyuga, and Tongala, and a system of distributary channels throughout the Shepparton Irrigation and Water Supply District, an area of 3,500 acres.⁴² At a time when Victoria’s finances were still recovering from the devastating effects of the 1890s depression, these substantial sums attest to the importance of rapid irrigation development to the State, and the anxiety of its authorities to ‘press on with getting people settled on the land’.⁴³

Bigger was better in the irrigation creed; water not used was water gone to waste.⁴⁴ Though the Commissioners noted that ‘new activity is being manifested, land is being graded, lucerne and other fodder crops seeded, orchards

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and vineyards planted ... over 700 acres of new orchards have been planted in Rodney this season', they added with regret:

Last season irrigators in Victoria only diverted 4 per cent. of the total flow of the Murray, and only used 2 per cent. of the total flow of the Goulburn. The extension of irrigated agriculture to the extent which this unused water supply makes possible means so much to Victoria that no precaution should be neglected which will insure its complete success.

Experts in intensive agriculture from 'noted irrigation districts', added the authors, who had visited the Victorian irrigation areas, had 'united in admiration for their resources and surprise at the neglect to use the great opportunities they present'.⁴⁵

Knowledge of Australian soils, climate and hydrology during the early years of irrigation was limited, and opinion on best practice in watering was consequently divided.⁴⁶ Some of the state's experts, basing their recommendations on the irrigation regimes of other countries, promoted practices which by current standards would appear imprudent. The government viticulturist F. de Castella, for example, reported in 1908 from his travels in Spain:

the extent to which winter irrigation is practised. Though it was approaching midwinter, olives, vines, and even wheat were everywhere being watered, usually by flooding ... The great aim of the farmer in the drier parts of Spain is to well soak the subsoil in winter, by irrigation, wherever this is possible.

De Castella declared his observations 'a lesson for Victoria'; he had 'no doubt that we could with advantage utilize much of our surplus water in the same way'.⁴⁷

Others advised restraint. E.E. Pescott, Principal of the Burnley School of Horticulture, recommended that orchardists give their trees 'a good watering ... after each picking, so as to improve the quality of any fruit remaining on the tree', but added that 'unless the soil is well drained, a heavy flooding should not be resorted to'.⁴⁸ A.S. Kenyon, Engineer for Agriculture, was ambivalent regarding winter irrigation, suggesting that 'in many parts of the State, winter crops get sufficient moisture from the heavens for all their requirements, at any rate with proper cultivation', but acknowledging that 'in other localities – over the greater part of our Northern districts – winter crops require additional moisture in many, nay, most years'.⁴⁹ He declared '*cultivation without irrigation* ... to be preferable to *irrigation without cultivation*',⁵⁰ and later stated that summer crops 'may be successfully grown, without artificial aid in watering, over large areas where they are at present either whole or partial failures, by the adoption of improved methods [of cultivation]'.⁵¹ Nevertheless, compulsory water rates, combined with glowing reports of the benefits of irrigation, an imperfect communication of its risks, and a prevailing view that water not used for human purposes was 'wasted', tended to encourage widespread over-watering.

The primitive nature of early twentieth-century irrigation technology did nothing to alleviate this tendency. Flooding and furrow irrigation delivered large volumes of water more or less indiscriminately, and were only marginally assisted by techniques such as grading and subsoil ploughing, which in any case were prohibitive in terms of both labour and expense.⁵² Those who did recognise the ‘ills attendant upon irrigation’ could recommend little beyond ‘careful and economical use of water’, and, for severe cases, the installation of tile or agricultural pipe drains. These, too, were expensive; Kenyon acknowledged a cost for installing tile or pipe drainage of ‘as much as £6 or £7 per acre’, and confined his recommendation of it principally to ‘orchard lands, and ... like crops where the capital value of the producing land is high’. Though he described a complete system of drainage for trees and vines as ‘a matter of life and death’, adding hopefully that ‘general adoption [of the tile or pipe system] should lead to the establishment of tile-making works in the locality, and consequent cheapening of the tiles’,⁵³ the costs of implementing such a system were sufficient to discourage most irrigators.

Irrigationists, meanwhile, were convinced that science would provide technical solutions to irrigation’s problems.⁵⁴ Deakin’s predictions of ‘future triumphs ... rapid, signal, and fruitful’ from ‘modern science ... in connexion with irrigation’⁵⁵ were supported by reports of vast and profitable crops printed in local newspapers, and by bulletins and pamphlets promoting irrigable closer settlement which were ‘lavishly circulated in Britain and America’.⁵⁶ Experimental ventures which demonstrated the potential of technology to adapt seemingly unfavourable land for agricultural purposes added weight to such arguments. At an experimental farm on the Barwon River, several hundred acres of low-lying swamp land were converted between 1905 and 1908, via irrigation channels, underground piping, and levee banks, from ‘waste ground that in its unimproved state was useless’ to land ‘of high agricultural value’. Soil samples had yielded salt ‘to such an extent that doubts were expressed as to the land proving suitable for general cultivation’, yet dairy supervisor J.S. McFadzean reported triumphantly:

from a 65-acre paddock of salty ground ... there has been harvested something like 550 tons of green maize without any manuring; and on appearance that land now can be classed as equal to anything in the district.

He concluded that ‘the ultimate success of the whole undertaking [demonstrated] the economic potentiality of many thousands of acres of apparently useless land’.⁵⁷ Such apparently incontrovertible evidence of scientific omnipotence offered further support to irrigationists inclined to underestimate the severity of salinity and waterlogging problems.

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The emergence of salinity in Victoria's irrigation regions, however, was not long delayed. A mere decade after Deakin's Irrigation Act, the Mildura Royal Commission found numerous farmers experiencing salinity problems. Ten years later, Kenyon drew attention to problems of over-irrigation and insufficient drainage in Victoria: seepage and deaths of fruit trees in Mildura and Bendigo, loss of soil structure, and damage to cereal crops. He also alluded to the experiences of irrigationists in other countries, including a Commission on the effects and causes of alkali [salt] in the Aligarh district of Northern India, which had 'reported in effect that the introduction of irrigation increased the alkali areas, both by seepage from the channels, and by excessive use of water in irrigating', and a statement by the editor of the *Chicago Irrigation Age* that 'the constant pouring of water upon the soil in many of the older irrigated districts has resulted in creating a water table near the surface ... formerly fertile tracts of land have become converted into swamps'.⁵⁸ Such evidence, however, was insufficient to mobilise any fundamental change in irrigation practices.

A further decade produced more dramatic proof of salinity's growing menace. The final report of the 1916 Royal Commission on Closer Settlement discussed the emergence of salinity at the Mead settlement in Cohuna on the Murray River in northern Victoria, declaring that 'due to an immensely greater volume of water being put upon the land than it was accustomed to ... the water table rose, and the alkali being a deadly poison to plant life, desolated the areas it affected ... at Mead already about 1,200 acres out of 11,000 have been affected, rendering the land temporarily unfit for production of any kind.' The development of this 'alkaline trouble' was attributed to a combination of flooding of local creeks, channel seepage, irrigation, and a clay subsoil that hindered subterranean drainage. Commissioner John Dethridge, under scrutiny for the SRWSC's tardiness in implementing 'remedial efforts', asserted first that 'no anxiety was felt by the Water Commission until about the end of 1910, although it was aware of patches of alkali-affected land in the Cohuna district since the days of the administration of the old trusts'; when it was pointed out that this still left three years of inaction unaccounted for before commencement of a main drainage channel to remove saline water, Dethridge attributed the delay to debates regarding the exact cause of the trouble, 'and in the last contingency ... whether the cost of [a drainage] system would be warranted as against the abandonment of affected portions'. Elwood Mead, added Dethridge, had 'expressed the view that there would be certain patches which would become so bad that it would be the best policy to determine them ... to attempt to put into effect any scheme before you knew just what was going to be bad and what was going to be fairly good would be to incur the risk of a very heavy expenditure, which might, after all, not be required'.⁵⁹

Dethridge's comments reveal the pragmatic difficulties underlying management of a complex environmental problem. It was not merely that irrigationists were unwilling to recognise that salinity challenged their narratives of social and moral improvement, though this was certainly a factor; they simply were not able to command sufficient funds, knowledge, or technology to deal with it effectively. In the case of Cohuna, financial difficulties were at the forefront, with the SRWSC doubting whether a successful drainage scheme was 'practicable at a reasonable cost', and debating as to 'whether the proper course might not be to transfer or abandon the settlement on the badly-affected blocks'. The Royal Commission, though, retorted that 'the raising of the water table would in any case have waterlogged the land, which would have had the same effect on vegetation as the alkali. Everything points to the necessity for this land to have been drained before settlement occurred.' By their judgement the SRWSC's delay was negligent, as was their failure to have installed a drainage system initially.⁶⁰

Much of the Royal Commission's criticism was directed specifically at Elwood Mead. Commissioners found 'no doubt at all that his colleagues allowed Mr. Mead's opinions to sway them in this matter of dealing with the salt trouble'. Dethridge testified that 'we certainly attached the utmost importance to his views ... we naturally regarded it as a thing coming peculiarly within his scope ... I would say it was undoubted that he had the experience.' Mead 'had come from the position of Director of Irrigation and Drainage Operations in the United States of America, a country with an immensely greater area than we have under irrigation, and with very many difficulties of that sort; we knew from actual publications in print that he was familiar with those problems'. Mead's publications in Victoria, however, were largely aimed at promoting the *benefits* of irrigation. The Commissioners, while they acknowledged Mead's reputation as 'an eminent irrigation engineer', added that:

the exigencies of the position forced him to devote himself to the purchase of land which he considered to be suitable for intensive culture and the direction of cultural methods for the development of the settlements. When he, perforce, had to step into these spheres he made mistakes, which account to a large extent for the unsatisfactory condition of a large part of the movement as it now stands.⁶¹

Mead's overseas experience was here construed as a hindrance. Hugh McKenzie, Minister of Water Supply, asserted in Mead's defence that 'it was very difficult for a man to come from America to a country with different conditions and say what was suitable land here'. During the early stages of irrigation development and expansion in Victoria, when knowledge was scant and experts few, individuals recognised as having superior experience or qualifications in the field were, perforce, too much relied on, and 'in the absence of any other person' were expected to supply advice on matters outside their area of expertise. With political, ideological and economic imperatives urging extensive settlement

and rapid expansion of irrigated agriculture, decisions were made in haste and without sufficient preparation or preliminary research; the result, unsurprisingly, was, in the Commission's diplomatic understatement, 'mistakes'.⁶²

Mead's fellow Commissioners, along with other agricultural 'experts' who had failed to take seriously the concerns of settlers in irrigated areas, were also culpable. While the financial constraints on the SRWSC cannot be overlooked, their dealings with landowners on the affected Cohuna settlement appeared at times to reflect a certain amount of callousness. The Royal Commission, assessing the situation, waxed indignant: these settlers, 'in addition to the prospect of having to bear the comparatively heavy cost of the main channels to carry away the salt-charged waters ... [had] to face the cost of making lateral drains on their properties', expenses which were 'never contemplated when they took up the land.' Others who had 'planted lucerne and fruit trees on areas which ... proved to be salt basins' had received no warning 'as to the danger of so doing.'⁶³ Dethridge, criticised both for the SRWSC's lack of foresight in establishing the Cohuna settlement and its failure to act promptly when problems first began to appear, replied that:

he honestly believed the danger was not so great, and that the thing [salinity] should be allowed to develop so that he would know what he was doing, and, in those circumstances, the settlers might just as well cultivate the doubtful places. It was more an expenditure of labour than capital on their part, and when matters developed he would know what advice to give.⁶⁴

Though reluctant to act at first, the SRWSC did eventually attempt to mitigate the difficulties of those settlers who had been most severely disadvantaged by the salt. The affected portions of their allotments were excised, and they were given an additional area to work 'while their land [was] unproductive'; settlers were also given the choice of 'being bought out and paid for their improvements'. To settlers prepared to stay on, the SRWSC allowed 'free water to wash out the salt', and financial advances for the reclamation of their land. The Royal Commission added its own recommendations to these management strategies: greater care in the use of water, greater attention to surface tillage, and better preparation and grading of land before irrigation. They also recommended 'a systematic inquiry ... to find the best means of supplying drainage'.⁶⁵

Such measures, however well-intentioned, had no noticeable effect on the upward trajectory of salinisation. The 1925 Royal Commission on Soldier Settlement, examining the manifold difficulties experienced by soldier settlers, noted that 'on irrigation areas, blocks, which when taken up appeared suitable, have proved to be unsuitable owing to salt trouble after watering'.⁶⁶ Once again, the principal recommendation was that 'to prevent further development of the salt trouble ... necessary drainage works be put in hand as expeditiously as possible'. A minority report by Commissioner H.J. Wiltshire took up these issues in greater detail; Wiltshire declared that some areas utilised for soldier settle-

ment had *never* been suitable, even at the time of their acquirement, including the districts of Cohuna, Tresco, Woorinen, Nyah, Merbein, and Mildura, all of which were suffering from 'salt and seepage troubles'.⁶⁷ He suggested that the SRWSC had been negligent in allowing settlement in these areas:

As this salt and seepage trouble has ruined many fine areas of land *prior* to the inauguration of [the] soldier settlement scheme, the Water Commission should have been cognisant of the risk which the settlers took in irrigating this land. It seems to be fairly well established that there is considerable risk of salt trouble arising in almost all of the dried fruit areas.⁶⁸

In the Mead settlement, in particular, the area of salt-affected land had increased from 1,200 of 11,000 acres to 5,000 acres out of 34,000; and, as a further affront, the drainage system then proposed was 'still uncompleted, although we are told that a very complete scheme is now under construction'. Wiltshire observed that 'without a proper system of drainage, it seems inevitable that all soils with an alkaline sub-strata must finally reach the stage when no vegetable growth can survive ... seepage will cause serious damage if unchecked, even if there is no salt in the subsoils, by drowning out fruit trees, lucerne, &c.' He concluded that 'drainage must be proceeded with wherever salt is present in subsoils, at the same time as the digging of the irrigation ditches ... [it] should be inaugurated in all irrigation schemes in such saline areas at the initial stage'. His final recommendation, 'to install a drainage system on all irrigation areas at the inception as a safeguard against salt and seepage troubles', recalled Deakin's, but was equally impotent in the face of cold, hard economic reality.⁶⁹

Subsequent decades saw little alteration in the ways of thinking which had characterised irrigation's early years. While incidences of salinisation continued to spread throughout the state's irrigated districts, scientists who investigated them were reluctant to conceptualise these appearances as more than localised and anomalous problems. Analyses of Victoria's soils increasingly demonstrated the unsuitability of many soil types for irrigation: Goulburn Valley soils were 'relatively impervious to moisture' and thus subject to waterlogging, Cohuna soils 'present[ed] difficulties in watering' and were often high in salt, Mallee soils showed 'an increase of salt with depth' which 'frequently cause[ed] subsequent trouble', and Echuca confronted irrigators with 'the very flat nature of the country and the great risk of waterlogging'.⁷⁰ However, experts demonstrated a persistent tendency to regard such soils as 'abnormal', with de Castella, for example, noting that the difficulties caused by 'shallow soils with impenetrable subsoils' (this description including the predominant soils of the Goulburn Valley, as well as those in Cohuna and parts of Echuca) were 'exceptional' and 'seldom to be feared on normal soils'.⁷¹ A 1936 investigation of soils in the Bamawm and Ballendella regions of the Rochester Irrigation District found them to be 'particularly susceptible to seepage effects' and described them as presenting

irrigators with 'conditions of unusual difficulty', despite the publication of earlier articles noting similar conditions in other major irrigated districts.⁷²

Practical difficulties also continued to limit irrigators' opportunities to refine their irrigation practices. Experts eager to optimise the benefits of irrigation developed increasingly sophisticated schedules for watering, but these seem to have been infrequently adopted. The complexity and additional effort they required may have discouraged some irrigators, but in many cases irrigation water simply was not available on a sufficiently regular basis to allow for minutely calculated applications. Such irregularities of water availability also contributed to overwatering; many irrigators felt 'compelled to give heavy waterings, as we never knew when we would get it again'.⁷³

Some experts recognised these problems. De Castella, for example, noted in 1935 that his recommendations regarding winter irrigation would in some cases be frustrated by 'the exigencies of community irrigation', adding that 'many an unnecessary watering is given owing to fears that the vines may not hold out until the next irrigation'.⁷⁴ L.C. Bartels, aware that in some districts 'water may not always be available when required', advised that farmers in such circumstances should select those pasture species best adapted to survive infrequent irrigation.⁷⁵ Others, however, frustrated to find that their recommendations for improvement were seldom acted upon, reacted by attributing salinity problems primarily to farmers' poor management. The judges of the 1929 Cohuna Irrigated Farm Competition (two of whom were SRWSC Commissioners) blasted 'Cohuna settlers generally' for lack of judgment and 'misuse of water', which had 'blighted' the 'bright prospects with which closer settlement was first established'.⁷⁶ The findings of the 1916 Royal Commission were conveniently ignored. Frank Read, Horticultural Research Officer in charge of investigations of 'soil alkali' in the Tresco settlement near Swan Hill, bypassed his own findings that Tresco's salt problems were largely the result of the settlers' financial limitations⁷⁷ to accuse them of mismanagement:

If our irrigationists, from the beginning, had realized the necessity, and taken the trouble to find out what happened to the irrigation water when it percolated away out of sight, it is inconceivable that their errors would have persisted – as they most assuredly have done – unto the second and third generations.⁷⁸

Such attitudes were at odds with the SRWSC's earlier admission that settlers in the irrigated districts were 'earnest and industrious men ... but, as a rule, they lack experience, and have limited capital'.⁷⁹ While many irrigators did continue to employ inefficient practices, the SRWSC and other experts, accustomed to consider such farmers as merely old-fashioned or obstreperous, showed little interest in investigating underlying financial and other constraints, and seldom took full account of external factors such as unsuitable soils and irregular availability of irrigation water. The notion that salinity was primarily linked to poor farming

practice had the additional effect of discouraging irrigators from acknowledging salinity problems; even in the 1980s, irrigators were suggesting that ‘you don’t talk about it’,⁸⁰ and describing salinity as ‘pretty much a dirty word’.⁸¹

Despite mounting evidence of its problems, Victoria’s irrigation dream persisted well into the 1950s and 1960s. Suggestions of physical and economic limits to irrigation drew indignant responses from irrigation communities.⁸² The *Shepparton News*, which in 1966 described irrigation as the key to Shepparton’s ‘surging progress’ and claimed that Australia was ‘a water economy ... as solid as any Rock of Gibraltar’, dismissed the failure of some to ‘appreciate the importance of irrigation’ as merely ‘the old story of familiarity breeding contempt’.⁸³ At this time irrigators were also receiving mixed messages on water use; while many experts continued to stress the importance of judicious watering, the SRWSC tended to encourage greater use of water where it was available. Additions to the Goulburn irrigation system’s storage capacity, particularly the 1955 enlargement of the Eildon Weir, allowed Goulburn Valley irrigators to access greatly increased quantities of water.⁸⁴ Tatura dairy farmer Brian Williams recalled:

The Eildon Weir was enlarged and completed in the mid-1950s, and before that we all had much smaller water rights ... there wasn’t a great deal of water about to use. Then in the 50s we had this terrible lot of rain, Eildon filled up in the one season after it was finished ... after that they increased our water rights ... irrigating really sort of took off, ... [they were encouraging us to irrigate more, for better production] and, well, selling more water, I think! Anyway, people took up the offers, and almost everybody increased their water rights considerably ... [water was] dirt cheap ... [my father was paying] the likes of ten pounds a year ... now you pay tens of thousands!⁸⁵

Norm Mitchelmore, former secretary of the Goulburn Irrigation Region Drainage Action Committee (GIRDAC), added that ‘people connected with the old State Rivers and Water Supply Commission used to say, “We’ve got unlimited water in the Goulburn system ... we’ve got the water, use it”’. He described this as ‘almost a blasphemous comment these days’⁸⁶ – a perceptive remark that brings the story of Victoria’s irrigation religion to its logical conclusion.

CONCLUSION

Salinity in Victoria’s irrigation districts was as much the product of ideological forces as of physical (environmental, technological, and economic) limitations. The visionary aspirations and science-fuelled optimism of the state’s irrigationists allowed them to overlook both the environmental problems caused by their ‘religion’, and the concerns of individuals and communities experiencing those problems. Even when the impacts of salinity became at last too serious to ignore,

this institutionalised disregard for community concerns did not immediately dissolve, but remained evident in the initial efforts of Victoria's water institutions to manage the menace they had helped create. The Gutteridge Report, published in 1970, painted an alarming picture of the future for the Riverine Plains in the absence of major remedial measures – 1.9 million acres out of 3.9 million salt-affected by the year 2020, with annual losses in gross value of production estimated at over \$15 million;⁸⁷ yet despite this indictment of their past performance, Victoria's water institutions were so firmly entrenched in a 'bureaucracy knows best' approach that the active community input into salinity management for which Victoria is now renowned was achieved only through a series of dramatic and often bitter conflicts.

NOTES

¹ Quentin Beresford et al., *The Salinity Crisis: Landscapes, Communities and Politics* (Crawley, WA: University of Western Australia Press, 1995). Edwyna Harris, 'Development and Damage: Water and Landscape Evolution in Victoria, Australia', *Landscape Research* 31 (2006): 169–81, doi: 10.1080/01426390600638687.

² Gutteridge Haskins and Davey, in association with Hunting Technical Services Limited, *Murray Valley Salinity Investigation Volume 1: The Report* (Canberra: River Murray Commission, 1970).

³ Steven Trudgill, *Barriers to a Better Environment: What Stops Us Solving Environmental Problems?* (London: Belhaven, 1990).

⁴ Further detail may be found in Ann Young, *Environmental Change in Australia since 1788* (Melbourne: Oxford University Press, 1996), 51–63, and Peter Cullen, 'Salinity', in *Ecology: An Australian Perspective*, ed. Peter Attiwill and Barbara Wilson (Oxford and New York: Oxford University Press, 2003), 474–87.

⁵ Donald Worster, *Rivers of Empire: Water, Aridity, and the Growth of the American West* (New York: Pantheon, 1985), 319–20. 'Australian Dryland Salinity Assessment 2000', *National Land and Water Resources Audit*, available from http://www.anra.gov.au/topics/salinity/pubs/national/salinity_austr.html, accessed 10 Mar 2008. 'Extent of Irrigation in the Murray Darling Basin', *National Land and Water Resources Audit*, available from http://www.anra.gov.au/topics/irrigation/images/mdb_case/mdb_ag_stats.html, accessed 10 Mar 2008.

⁶ W.E. Wood, 'Increase of Salt in Soil and Streams following the Destruction of the Native Vegetation', *Journal of the Royal Society of Western Australia* 10 (1924): 35–47.

⁷ Note that the extensive systems of deep drainage recommended by these authorities would not be appropriate by today's standards. Current management practice emphasises a combination of shallow drainage, targeted irrigation and water recycling to minimise rather than facilitate mobilisation of subsoil salt. Deep drainage systems, if extensively implemented, might in fact have added to the salinisation of Victoria's waterways. I do not wish to suggest that Victoria's current salinity problems would have been eliminated by deep drainage; my intention is to explain why colonial water authorities who recog-

nised salinity as a problem did not implement those remediation measures that at the time were understood to be best practice.

⁸ See Harris, 'Development and Damage', 177.

⁹ In this paper 'irrigationist' refers to any prominent individual who promoted irrigation, 'irrigator' to a farmer who practised irrigated farming. Frank Read's statement (endnote 78), however, should be understood from its context to refer to irrigators rather than irrigationists.

¹⁰ A.S. Kenyon, 'Irrigation in the Early Days', *Journal of Agriculture Victoria* (hereafter JAV), 10 (1912): 658–61; Peter J. Hallows and Donald G. Thompson, *The History of Irrigation in Australia* (Mildura, Vic.: ANCID, 1995), 16–17.

¹¹ Hallows and Thompson, *History of Irrigation*, 18.

¹² Alfred Deakin, 'Royal Commission on Water Supply. Fourth Progress Report. Irrigation in Egypt and Italy. A Memorandum for the Members of the Royal Commission on Water Supply', *Victorian Parliamentary Papers* no. 111 (1887): 21, 44–6.

¹³ For a detailed discussion of the 'yeoman ideal' and its effects on settlement policy, see Marilyn Lake, *The Limits of Hope: Soldier Settlement in Victoria 1915–38* (Melbourne: Oxford University Press, 1987), 11–24.

¹⁴ Deakin, 'Irrigation in Egypt and Italy', 41.

¹⁵ J.S. McFadzean, 'A Farm in the Making. The Geelong Harbor Trust's Farm, Sparrowvale, Geelong', *JAV* 6 (1908): 490.

¹⁶ Lake, *The Limits of Hope*, 18–19.

¹⁷ A.S. Kenyon, Engineer for Agriculture and certainly no uncritical advocate of irrigation, nevertheless stated that 'in the Northern areas and to some extent in the South, the full use of the land can only be made by means of irrigation' (A.S. Kenyon, 'Experimental Farms. The Work at Wyuna', *JAV* 5 (1907): 449–62).

¹⁸ Francis Myers, *Irrigation; or, The New Australia* (Melbourne: Spectator, 1891), 3–4.

¹⁹ Worster, *Rivers of Empire*; Ian Tyrrell, *True Gardens of the Gods: Californian-Australian Environmental Reform, 1860–1930* (Berkeley, Los Angeles, London: University of California Press, 1999).

²⁰ Melissa Bellanta, 'Irrigation Millennium: Science, Religion and the New Garden of Eden', *Eras* 3 (2002), available from http://www.arts.monash.edu.au/cgi-bin/inc/print?page=/eras/edition_3/bellanta.htm.

²¹ Ernestine Hill, *Water into Gold* (Melbourne: Robertson & Mullens, 1951), 247, 256.

²² J.A. Alexander, *The Life of George Chaffey: A Story of Irrigation Beginnings in California and Australia* (Melbourne: Macmillan, 1928).

²³ Tyrrell, *True Gardens of the Gods*, 103.

²⁴ Deakin, 'Irrigation in Egypt and Italy', 11, 31, 44.

²⁵ 'Mildura Settlement. Report of the Mildura Royal Commission', *Victorian Parliamentary Papers* no. 19 (1896).

²⁶ Lionel Frost, 'Government and Economic Development: The Case of Irrigation in Victoria', *Australian Economic History Review* 32 (1992): 56–8; see also C.G. McCoy, 'Victorian Irrigation and Drainage Practice Paper 1: Historical Development of Irrigation in Victoria' (Melbourne: State Rivers and Water Supply Commission, 1981), 18.

²⁷ Harris, 'Development and Damage', 177.

²⁸ SRWSC Chairman Ronald East complained in a 1939 address that inadequate funds for maintenance 'since the commencement of water supply development' had resulted in 'a constant deterioration of the works ... at the present time many costly structures essential to the State water supply systems are in a most unsatisfactory state' (L.R. East, 'Water Supply Problems in Victoria' (Melbourne: State Rivers and Water Supply Commission, 1939)). By 1969, Davidson could still argue that irrigation was not a profitable investment, since 'farmers on all Australia's major irrigation schemes are supplied with water at a price which is only sufficient to pay the operating expenses of the schemes and not the interest on the capital invested in them' (B.R. Davidson, *Australia Wet or Dry? The Physical and Economic Limits to the Expansion of Irrigation* (Carlton, Vic.: Melbourne University Press, 1969), 3).

²⁹ See Harris, 'Development and Damage', 177.

³⁰ Samuel Wadham, *Australian Farming 1788–1965* (Melbourne, Canberra and Sydney: F.W. Cheshire, 1967), 141–2.

³¹ Elwood Mead, 'Problems in Irrigation Development', *JAV* 7 (1909): 491.

³² James R. Kluger, *Turning on Water with a Shovel: The Career of Elwood Mead* (Albuquerque: University of New Mexico Press, 1992), 72.

³³ Mead, 'Problems in Irrigation Development', 494.

³⁴ Elwood Mead, 'Irrigated Agriculture in the Goulburn Valley', *JAV* 6 (1908): 257.

³⁵ *Ibid.*, 262.

³⁶ Deakin stated that 'there is no teaching so pregnant as that of practice in the field ... without it no theoretical knowledge can be thoroughly assimilated. What we must aim at is the training, by experience, of a body of waterers ... whose practical knowledge, accumulated by season after season of watchful experiment, will enable us to work out a system of our own' (Deakin, 'Irrigation in Egypt and Italy', 1065).

³⁷ Mead, 'Problems in Irrigation Development', 490-1.

³⁸ Evidence to this effect was given during the 1916 Royal Commission on Closer Settlement in the Irrigable Districts. See John Glass Johnstone et al., 'Final Report from the Royal Commission on Closer Settlement as to the Working of the Closer Settlement Acts in the Irrigable Districts and a General Review of the Finances of Closer Settlement; together with Appendices', *Victorian Parliamentary Papers* no. 29 (1916).

³⁹ Worster, *Rivers of Empire*, 154.

⁴⁰ Worster notes that by 1891 four to five thousand square miles in the North-West Provinces of India were reported to have been damaged by salinisation, while salt problems in California had been studied and written about, at an academic level, from the early 1880s (*Ibid.*, 153).

⁴¹ J.E. Jenkins, 'Report of the Lands Purchase and Management Board for the Year Ended 30th June, 1910', *Victorian Parliamentary Papers* no. 39 (1910): 5.

⁴² Elwood Mead, William Cattanach, J.S. Dethridge, 'State Rivers and Water Supply Commission. Sixth Annual Report. 1910–11', *Victorian Parliamentary Papers* no. 6 (1911), 15, 18.

⁴³ Wadham, *Australian Farming*, 142.

⁴⁴ For one example of many, see L.C. Bartels: 'Irrigation farming is of ever-increasing importance in Victoria, and in the future most of the water now running to waste in our rivers will be impounded to serve large areas of land which need only moisture to make

them productive' (L.C. Bartels, 'Irrigation Experiments at Werribee', *JAV* 22 (1924): 37).

⁴⁵ Mead et al., 'SRWSC Sixth Annual Report', 20, 23.

⁴⁶ George Chaffey, pressed by the Mildura Royal Commission to admit that he and his brother 'had no knowledge of the Victorian soils', argued that when the settlement had been established 'there was no seepage question', but admitted that the Mallee lands '[seemed] to be a country of contradictions. There are places ... precisely alike – you cannot tell the difference, and yet one has salt and the other has not' ('Mildura Settlement. Report of the Mildura Royal Commission', 191).

⁴⁷ F. de Castella, 'Fifth Progress Report on Viticulture in Europe. From Almeria to Madrid', *JAV* 6 (1908): 579.

⁴⁸ E.E. Pescott, 'Orchard and Garden Notes', *JAV* 9 (1911): 63.

⁴⁹ A.S. Kenyon, 'Irrigation Methods', *JAV* 6 (1908): 31.

⁵⁰ A.S. Kenyon, 'Drainage and Irrigation', *JAV* 5 (1907): 206 (original emphasis).

⁵¹ Kenyon, 'Irrigation Methods', 31.

⁵² In many cases even this minimal level of intervention was lacking; Kenyon emphasised that 'the letting of water on to a paddock to find its way as best it can over the surface forming islands and leaving pools is not a [distributing] system, though unfortunately only too common in practice' (*Ibid.*, 34).

⁵³ Kenyon, 'Drainage and Irrigation', 207.

⁵⁴ James C. Scott's description of 'high-modernist ideology' as 'a strong, one might even say muscle-bound, version of the self-confidence about scientific and technical progress, the expansion of production, the growing satisfaction of human needs, the mastery of nature ... and, above all, the rational design of social order' is pertinent here (James C. Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed* (New Haven and London: Yale University Press, 1998), 4).

⁵⁵ Deakin, 'Irrigation in Egypt and Italy', 1027.

⁵⁶ These bulletins were later found by Johnstone's 1916 Royal Commission to have contained 'not only grossly extravagant and incorrect but obviously wrong statements' and 'most immoderate assertions' (Johnstone et al., 'Royal Commission – Closer Settlement in Irrigable Districts', 38).

⁵⁷ McFadzean, 'A Farm in the Making', 492, 497–8, 500–502.

⁵⁸ Kenyon, 'Drainage and Irrigation', 206–9.

⁵⁹ Johnstone et al., 'Royal Commission – Closer Settlement in Irrigable Districts', 28–9.

⁶⁰ *Ibid.*, 32.

⁶¹ *Ibid.*, 23, 29.

⁶² *Ibid.*, 24.

⁶³ *Ibid.*, 31–3.

⁶⁴ *Ibid.*

⁶⁵ *Ibid.*

⁶⁶ James Turnbull et al., 'Report of the Royal Commission on Soldier Settlement, together with Appendices', *Victorian Parliamentary Papers* no. 32 (1925): 17.

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- ⁶⁷ H.J. Wiltshire, 'Minority Report', in Turnbull et al., 'Royal Commission – Soldier Settlement', 49–50.
- ⁶⁸ *Ibid.*, 50.
- ⁶⁹ *Ibid.*, 51.
- ⁷⁰ W.R. Jewell, 'Some Soil Types of Victorian Irrigation Areas', *JAV* 29 (1931): 598–607; E.T. Beruldsen and A. Morgan, 'Echuca Irrigated Pasture Competition', *JAV* 34 (1936): 200.
- ⁷¹ F. de Castella, 'Vineyard Irrigation', *JAV* 33 (1935): 140.
- ⁷² F. Penman, 'Soil Conditions at Bamawm and Ballendella in Relation to Citrus Growth', *JAV* 34 (1936): 399–432.
- ⁷³ Comment made by James Henshilwood, settler, in a statement dated 5 May 1892, included as Appendix A2 to 'Mildura Settlement: Report of the Mildura Royal Commission', 278.
- ⁷⁴ F. de Castella, 'Winter Irrigation of Vineyards', *JAV* 30 (1932): 342.
- ⁷⁵ L.C. Bartels, 'Irrigation Practices', *JAV* 30 (1932): 566. See also Bartels, 'Irrigated Pastures: Hints on Management', *JAV* 31 (1933): 591.
- ⁷⁶ J. Roy, E.A. Ryland, L.C. Bartels, 'Report on the Cohuna Irrigated Farm Competition', *JAV* 27 (1929): 465.
- ⁷⁷ Frank M. Read, "'Soil Alkali'" Investigations at Tresco', *JAV* 28 (1930): 65–90. Additional papers on the topic may be found in *JAV* 29 (1931): 551–72, and 31 (1933): 140–5.
- ⁷⁸ F.M. Read, 'Orchard Irrigation: The Need for Careful Watering', *JAV* 28 (1930): 653.
- ⁷⁹ Mead et al., 'SRWSC Sixth Annual Report', 22.
- ⁸⁰ John Sawtell and John Bottomley, *The Social Impact of Salinity in the Shire of Deakin & Waranga. A report for the Goulburn Regional Advisory Council* (St. Kilda, Vic.: Urban Ministry Network, 1989), 4.
- ⁸¹ Interview, Goulburn Valley dairy farmer (anonymous), 14 December 2005.
- ⁸² These are best expressed in Davidson, *Australia Wet or Dry?*, though this was not published until 1969.
- ⁸³ 'Water at Work: Souvenir Issue of Shepparton Show', *Shepparton News*, 10 Oct. 1966.
- ⁸⁴ McCoy, 'Historical Development of Irrigation in Victoria', 41.
- ⁸⁵ Interview, Brian Williams, 11 August 2006.
- ⁸⁶ Interview, Norm Mitchelmore, 10 August 2006.
- ⁸⁷ Gutteridge Haskins and Davey, *Murray Valley Salinity Investigation*, 155.

