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Data management and mapping technologies

7.1 This chapter reviews the evidence received on the management of data, and mapping technologies. The chapter develops issues addressed in chapters two and six.

7.2 This chapter first addresses issues relating to data collection, management and retrieval, as follows:

- an outline of submitters' concerns about the current data management arrangements (paragraphs 7.6-7.8);
- options for improving the coordination and retrieval of data (paragraphs 7.9-7.32); and
- the Australian Government initiatives aimed at reducing the problems associated with data management (paragraphs 7.33-7.46).

7.3 The second half of this chapter reviews the evidence received on salinity mapping technologies, in particular:

- a discussion on the place of mapping technologies, particularly airborne electromagnetics (AEM), in *A National Action Plan for Salinity and Water Quality* (NAP) (paragraphs 7.47-7.60); and
- an outline of submitters cautions and concerns about AEM (paragraphs 7.61-7.75).

The collection and management of data

> *The science to combat salinity is only as rigorous as the data that underpins it.*[1]

7.4 By modelling and interpreting spatial and temporal data, scientists are able to refine their knowledge of salinity and its management, which in turn enables them to provide information for targeted policy making.[2] The emphasis in this section is on the management of fundamental datasets, not the extension of 'interpreted' data (which is discussed in chapter eight of this report).[3]

7.5 During the inquiry a range of issues relating to salinity data and its management were raised, including the adequacy of access, storage and maintenance of data, data standards and the availability of useable data.[4] In this section, the issues raised by submitters with regard to data management are explored. The Committee acknowledges that there were limitations in the evidence received on the governance structures for data management and salinity data specifically.[5]

Data and the concerns of submitters

7.6 At the time of writing *A Full Repairing Lease*, the Industry Commission heralded the proposed National Land and Water Resources Audit (NLWRA) and the Australian Spatial Data Infrastructure (ASDI)[6] as offering solutions to the problems associated with environmental datasets, such as poor access, the duplication of information, and incompatibility across jurisdictions.[7] Six years on, despite the commencement and successes of both the NLWRA and the ASDI initiatives, the Committee

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1 Australian Society of Soil Science Inc. (ASSSI), *Submission no. 68*, p. 3.

2 Dr Richard Price (National Dryland Salinity Program), *Transcript of Evidence*, 3 November 2003, p. 18. Also see: Australian Government Departments of Agriculture, Fisheries and Forestry and the Environment and Heritage (DAFF and DEH), *Submission no. 72*, p. 5.

3 For a discussion on the differences between 'raw' and 'interpreted' data see Mr Greg Hoxley (Australian Spatial Information Business Association), *Transcript of Evidence*, 24 November 2003, p. 6.

4 Dr Martin Blumenthal (Grains Research and Development Corporation), *Transcript of Evidence*, 7 November 2003, p. 79.

5 The Committee did not receive direct evidence from the National Land and Water Resources Audit, the Australia New Zealand Land Information Council and Geoscience Australia (or the Office of Spatial Data Management).

6 The Australian Spatial Data Infrastructure is a network of fundamental spatial databases maintained by custodians and linked through the adoption of consistent standards, policies and administrative arrangements.

7 Industry Commission, *A Full Repairing Lease*, Report no. 60, 27 January 1998, pp. 185-186.

noted similar issues to those found by the Industry Commission during its inquiry.[8]

7.7 The concerns of submitters included:

- difficulties associated with accessing data held by individual researchers, research organisations and government agencies, and the need to increase access to datasets—related issues raised were:[9]
  - ⇒ the relatively high costs for consultants and other non-government users to purchase data;[10]
  - ⇒ data not being made publicly available because of the competitive nature of research, and issues relating to intellectual property rights;[11]
  - ⇒ the need for distribution guidelines, so that publicly accessible data does not negatively affect landholders (for example by decreasing property values) or breach intellectual property rights;[12]
  - ⇒ options for improving access, which included the development of a national database containing datasets, a meta-database describing the location and attributes of available datasets or interactive, flexible, web-based networks of information;[13]
- the need for nationally consistent data measurement and collection standards to ensure that datasets are fit for their purpose, and that there is commensurability and interoperability between datasets, across regions, states and other jurisdictional boundaries;[14]

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8 *ibid.,* pp.111-112, 181.

9 Centre for Salinity Assessment and Management (CSAM), University of Sydney, *Submission no. 19*, p. 3. Also see: Dr Inakwu Odeh (CSAM), *Transcript of Evidence*, 29 October 2003, p. 56; Mr Philip Dyson (Phil Dyson and Associates Pty Ltd), *Transcript of Evidence*, 31 October 2003, p. 9; Cooperative Research Centre for Landscape Environments and Mineral Exploration (CRC LEME), *Submission no. 64*, p. 5; Australian Nuclear Science and Technology Organisation (ANSTO), *Submission no. 22*, p. 5.

10 Mr Anthony Dawson (Murray Catchment Management Board), *Transcript of Evidence,* 30 October 2003, pp. 16-17.

11 Dr John Triantafilis (CSAM), *Transcript of Evidence*, 29 October 2003, p. 65. Also see: Sinclair Knight Merz, *Submission no. 28,* p. 3; Professor Les Copeland (CSAM), *Transcript of Evidence*, 29 October 2003, p. 64.

12 The Hon. Dr Sharman Stone MP, *Transcript of Evidence,* 31 October 2003, p. 42.

13 Dr Jerzy Jankowski, *Transcript of Evidence*, 29 October 2003, p. 33. Also see: Professor Les Copeland, *Transcript of Evidence*, 29 October 2003, pp. 56, 62; Mr David Hocking (Australian Spatial Information Business Association Ltd), *Transcript of Evidence*, 24 November 2003, p. 2; ANSO, *op. cit.*, p. 4.

14 The Pelham Group, *Submission no. 11*, pp. 1-4. Also see: Dr John Bradd (Australian Salinity Action Network), *Transcript of Evidence*, 29 October 2003, p. 3; Mr Andrew Huckle (NSW Farmers' Association), *Transcript of Evidence*, 29 October 2004, p. 47; Dr Martin Blumenthal (GRDC), *Transcript of Evidence*, 7 November 2003, p. 79; NSW Farmers' Association, *Submission no. 45*, p. 4; Australian Spatial Information Business Association, *Submission no. 58,* p. 1.

- the need to ensure data is maintained appropriately;[15]
- the lack of data upon which to make informed decisions, in particular:[16]
  - ⇒ data at catchment, sub-catchment and farm scale, combined with the need to increase support for catchment management organisations (CMOs), local governments and landholders, to use and access datasets;[17]
  - ⇒ to monitor project outcomes in the short, medium and long-term;[18] and
- long-term funding for the collection of salinity data.[19]

7.8 These concerns are discussed below, together with examples of the Australian Government initiatives aimed at addressing them.

Improving the coordination of data exchange

7.9 The weight of evidence indicated that the poor exchange of data and difficulties accessing datasets, between individual researchers, research organisations, industry groups and government agencies, was inhibiting the salinity research effort.[20] Despite improvements in data coordination resulting from the NLWRA, Mr Phil Dyson noted difficulties accessing data held by different states and government departments:

> We have multiple jurisdictions and multiple agencies that manage data and information … There are many projects that I have worked on where it does not matter whether it is Victoria, New South Wales, Queensland or wherever, data is something that is still very institutionalised. An awful lot of time is spent trying to secure access to information, particularly when you work on national projects or Murray-Darling Basin projects where you are

15 ASIBA, *ibid.*, p. 2; ASSSI, *loc. cit.*

16 Murray Catchment Management Board, *Submission no. 10*, p. 1; CSIRO, *Submission no. 42*, p. 14.

17 Mr Paul Wilkes (CRC LEME), *Transcript of Evidence*, 12 November 2003, p. 18. Also see: Mr Colin Kandan-Smith (Western Sydney Regional Organisation of Councils), *Transcript of Evidence*, 29 October 2003, p. 17; Orbtek Pty Ltd, *Submission no. 3*, p. 11; Mr Ian Thompson (DAFF and DEH), *Transcript of Evidence*, 7 November 2003, p. 53; Dr Philip Price (GRDC), *Transcript of Evidence*, 7 November 2003, p. 76; Mr Paul Farrell (ASIBA), *Transcript of Evidence*, 24 November 2003, p. 12; Western Australian Salinity Research and Development Technical Committee (WA SRDTC), *Submission no. 54*, p.4; Webbnet Land Resource Services Pty Ltd, *Submission no. 40*, p. 4.

18 Agrilink, *Submission no. 25*, p. 6.

19 Murray Catchment Management Board, *loc. cit.*

20 See for example Mr Warwick McDonald (MDBC), *Transcript of Evidence*, 7 November 2003, p. 37.

> trying to get information out of either a region or a state. It is as though you are dealing with a different country sometimes.[21]

7.10 While acknowledging the constraints imposed by intellectual property rights, the Centre for Salinity Assessment and Management (CSAM) submitted that increased access to databases held by different research organisations was needed.[22] CSAM suggested that:

> Some of the basic landscape data … should be made available to researchers free of charge, as occurs in the USA. The high cost of access to some of these data is a constraint on research, especially in earth sciences. At the very least, public good research programs should have free access to these data.[23]

A national repository of salinity data

7.11 A number of submitters recommended a national repository of data be established.[24] It was generally accepted that the Australian Government would be best placed to coordinate such an initiative.[25] In this regard the Australian Cotton Cooperative Research Centre recommended:

> Building and managing national and state databases containing publicly funded research data, rather than outcomes. The data should be recorded and reported in consistent (international standard) SI units. These databases should be accessible by other publicly funded research projects (possibly for a small fee to manage access).[26]

7.12 The Forest Products Commission of Western Australia (FPCWA) supported the establishment of a meta-database, which identifies the location of available data, rather than a database containing the actual datasets.[27] The Commission argued this arrangement could potentially assist in overcoming intellectual property right issues associated with data sharing.[28]

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21 Mr Philip Dyson (Phil Dyson and Associates Pty Ltd), *Transcript of Evidence*, 31 October 2003, p. 9.

22 CSAM, *op. cit.*, p. 2.

23 *ibid.*

24 See for example Sinclair Knight Merz (SKM), *op. cit.*, p. 5; Murray Catchment Management Board, *op. cit.*, p. 2.

25 *ibid.*

26 Australian Cotton Cooperative Research Centre, *Submission no. 67*, p. 1.

27 Dr John McGrath (FPCWA), *Transcript of Evidence*, 12 November 2003, p. 5.

28 *ibid.*

7.13 While noting weaknesses in the coordination of data, the Murray-Darling Basin Commission (MDBC) did not support the establishment of a repository and preferred 'networks' of information:

> I am not proposing to you that we should have a gigantic repository. What I am suggesting is that, over and above all, we need networks that share information—distributed networks. Yes, there is a technology component to that which can help, but it is a change of behaviour and a change in attitude in terms of information sharing, pricing policies and access to information. It is about coming to some agreed standards by which we can exchange and compare apples with apples, rather than having a mishmash of approaches when we are asking national scale questions.[29]

7.14 Land and Water Australia (LWA) endorsed the views of the MDBC, and suggested that a salinity data portal might be jointly managed by the Bureau of Rural Sciences (BRS), NLWRA and LWA.[30]

7.15 ASIBA submitted that the Australian Government's role in data management involves 'ensuring that data that is collected by disparate groups is not duplicated; and building on that knowledge base through an effective salinity data atlas':[31]

> No mechanism exists for aggregating salinity data and distributing it through an open system to stakeholders. Results of work carried out by the public and private sector are held in data silos without a single repository or metadata reference source. Failure to maintain a single salinity data infrastructure means duplication and conflicting results.[32]

7.16 ASIBA also noted the 'tendency' to consider a 'central repository' as the best way to coordinate data.[33] However, it argued that as long as there are clear standards and frameworks for data exchange a repository may not be necessary. ASIBA drew the Committee's attention to the arrangement developed by the Australian Greenhouse Office for managing data relating to the clearing of vegetation.[34]

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29 Mr Warwick McDonald (MDBC), *Transcript of Evidence,* 7 November 2003, p. 37.

30 Mr Andrew Campbell (LWA), *Transcript of Evidence,* 7 November 2003, p. 31.

31 Mr David Hocking (ASIBA), *Transcript of Evidence,* 24 November 2003, p. 2.

32 ASIBA, *loc. cit.*

33 Mr Greg Hoxley (ASIBA), *Transcript of Evidence,* 24 November 2003, p. 3.

34 Mr Paul Farrell (ASIBA), *Transcript of Evidence,* 24 November 2003, p. 4.

7.17 The Cooperative Research Centre for Plant-Based Management of Dryland Salinity (CRC PBMDS) stated that it was developing networks to successfully distribute data:

> Within the CRC, of course, we are setting up systems so that can happen, because our projects generally speaking extend across institutions and state boundaries. We have systems where our scientists can enter their data into databases that are managed by the Internet. What I think is needed is something like this managed by an organisation something like the National Dryland Salinity Program, which is a body constituted by the states, the Commonwealth, and other interested people.[35]

7.18 Caveats on making salinity data publicly available were raised with the Committee. Despite supporting in principle the need to increase access to datasets, Sinclair Knight Merz (SKM) raised concerns about providing commercial information freely over the internet, and urged that consideration be given to the licensing control of topographic material.[36] The Hon. Dr Sharman Stone MP cautioned against putting salinity information into the public domain without adequately consulting the landholders on whose properties the data was gathered.[37] Dr Stone cited instances where farmers had been financially penalised, and felt stigmatised, by the publication of maps indicating that their properties exhibited signs of salinity.[38]

Data standards

7.19 In addition to supporting a single site for the storage of salinity data, the Grains Research and Development Cooperation (GRDC) submitted that the lack of data standards, and the resulting incommensurability of datasets, is an added hindrance to researchers working with multiple datasets:

> There are different state databases, information sources and ways of collecting information. There is very little standardisation. It is very difficult to compare across boundaries.[39]

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35 Professor Philip Cocks (CRC PBMDS), *Transcript of Evidence*, 13 November 2003, p. 23. Also see: Dr John McGrath (FPCWA), *Transcript of Evidence*, 12 November 2003, p. 9.

36 SKM, *Transcript of Evidence*, 31 October 2003, p. 38.

37 The Hon. Dr Sharman Stone MP (Parliamentary Secretary to the Minister for the Environment and Heritage), *Transcript of Evidence*, 31 October 2003, p. 42.

38 *ibid.*

39 Dr Martin Blumenthal (GRDC), *Transcript of Evidence*, 7 November 2003, p. 79.

7.20 ASIBA also noted that varying standards made it difficult to compare information, and a lack of standards could result in collected data being useless for its intended purpose.[40]

7.21 To address the concern that salinity data relating to geophysical surveys is not being consistently or efficiently collected, the Pelham Group presented clear recommendations:

> 1. The development and definition of standards for data collection and interpretation that will be applied for all NAP (and other) geophysical surveys for salinity; and
>
> 2. The development of a Quality Assurance process that ensures that the standards are attained.[41]

7.22 While acknowledging that 'minimal' collection standards are of value, Dr Brian Tunstall, from Natural Resource Intelligence (NRI), told the Committee: 'I hate standards. They are a bit like records: they are made to be broken. As soon as you set a standard, it is obsolete. They are too constraining.'[42]

7.23 While it is beyond the scope of the inquiry to provide a prescriptive recommendation regarding what standards should be applied nationally to salinity data, the Committee acknowledges that the adherence to clear standards reduces the risk of creating scientific and technical barriers to the exchange and use of data.

Maintaining data

7.24 ASIBA drew the Committee's attention to the need to ensure data is properly maintained:

> there is little recognition of the need to ensure that the data is properly maintained. Spatial information and its technologies are important tools in the management of the environment and its natural resources. It is also an infrastructure, just like a bridge or a road, and must be maintained. Without maintenance, the information with which organisations make important decisions, such as in salinity mitigation, will be corrupted, inferior and wasted.[43]

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40 Mr Greg Hoxley (ASIBA), *Transcript of Evidence*, 24 November 2003, p. 3.

41 The Pelham Group, *op. cit.*, p. 4.

42 Dr Brian Tunstall (Natural Resource Intelligence), *Transcript of Evidence*, 7 November 2003, p. 16.

43 Mr David Hocking (ASIBA), *Transcript of Evidence*, 24 November 2003, p. 2.

7.25 The Australian Society of Soil Science Incorporated (ASSSI) lamented the loss of historic databases, and argued that it had 'severely constrained' the NLWRA's ability to asses the current 'condition of our natural resources'.[44]

Scales of data for differing needs

7.26 To solve natural resource management (NRM) problems, data and information is required at a variety of levels. The amount of detail in the data should correlate with the scale of the issue it is aimed to address. As the MDBC stated:

> there are farm level decisions, catchment level decisions and, in our case, basin level decisions. The knowledge is best in the hands of the people who are closer to the decision front, because that is where you adapt it and refresh it and so on.[45]

7.27 The Committee heard that there is not sufficient data available at the farm, sub-catchment and catchment levels, which presents a problem for on-ground land managers implementing NRM programs.[46] In this regard Webbnet Land Resource Services submitted:

> The common constraint faced by regional groups and government agencies is the lack of appropriately scaled data on soil and landscape attributes, and DEM's. In many of the catchments where dryland salinity is an issue, more detailed datasets than the current ones are required for evaluating land use changes at the sub-catchment or property scale.[47]

Utilising pre-competitive and legacy datasets

7.28 The Committee received evidence that there is a need to improve access to datasets not collected specifically for salinity or NRM related projects, held by Geoscience Australia (GA) and the State Geological Surveys, including pre-competitive and legacy data.[48] On this issue, the Cooperative Research Centre for Landscape Environments and Mineral Exploration (CRC

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44 ASSSI, *loc. cit*.

45 Mr Kevin Goss (MDBC), *Transcript of Evidence*, 7 November 2003, p. 39.

46 Dr Brian Tunstall (NRI), *Transcript of Evidence*, 7 November 2003, p. 9. Also see: Webbnet Land Resource Services Pty Ltd, *op. cit.*, p. 3.

47 Webbnet Land Resource Services Pty Ltd, *ibid.*

48 CRC LEME, *op. cit.*, p. 3. Pre-competitive data refers to geoscientific data collected and managed by government agencies, essentially Geoscience Australia and the states' geological surveys. Legacy data refers to technical data collected during exploration works by private companies. As a licensing requirement companies must periodically lodge this data with relevant state agencies, thereby making it public information.

LEME) was concerned that 'local NRM projects are not getting the benefit of datasets that already exist, often in the state geological surveys'.[49]

7.29 CRC LEME recommended the arrangements instituted under the National Geoscience Agreement (NGA), for the sharing of pre-competitive data, could be replicated to manage NRM data:

> The national Geoscience [Mapping] Accord [now the NGA], between GA and the State Surveys, has been very positive in providing basic geoscientific information to help mineral exploration. Similar knowledge sharing could greatly assist in applications to Natural Resource Management.[50]

7.30 In addition to encouraging data sharing, it was submitted that NGA avoids duplication in data collection, and promotes national data standards and objectives.[51]

7.31 The MDBC agreed that Geoscience Australia's experience, managing pre-competitive data, makes them well placed to assist with the management of NRM data:

> Geoscience Australia is a key custodian for some of the fundamental datasets in Australia. It has the capacity, linkages and discipline in the information sciences to provide a support role.[52]

7.32 Furthermore, the Western Australian Salinity Research and Development Technical Committee (WA SRDTC) recommended Geoscience Australia's standing orders be amended to encourage them to work in groundwater and natural resource management related areas.[53]

The Australian Government's role in the management of salinity data

7.33 According to the Departments of Agriculture, Fisheries and Forestry (DAFF) and the Environment and Heritage (DEH), the Australian Government has taken significant steps to standardise, collate and distribute salinity data.[54] In this regard, it was submitted that the departments were undertaking projects on:

> data standards and data management systems, mapping and mapping science, models and tools, communication and

49 Mr Paul Wilkes (CRC LEME), *Transcript of Evidence*, 12 November 2003, p. 18.

50 CRC LEME, *loc. cit.*

51 *ibid.*, p. 5.

52 Mr Warwick McDonald (MDBC), *Transcript of Evidence*, 7 November 2003, p. 41.

53 WA SRDTC, *loc. cit.*

54 DAFF and DEH, *op. cit.*, p. 4. Also see: Dr Rhondda Dickson (DEH), *Transcript of Evidence*, 7 November 2003, p. 54.

> knowledge networks, and systems to access and disseminate salinity data and information.[55]

The National Land and Water Resources Audit

7.34 According to the National Dryland Salinity Program (NDSP), the NLWRA represents the first attempt to bring all the variable datasets on salinity together to produce salinity information at a national scale: 'It is the bible at the moment on the extent and cost of salinity'.[56] DAFF and DEH explained:

> At the national level, the National Land and Water Resources Audit (the Audit) works with DAFF and DEH to maintain a digital data library and an atlas of Australian natural resources. A key role of the Audit is to coordinate the science and data collected through investments of the NAP and NHT. The Audit also works with ANZLIC – the spatial information council, to ensure data standards are established and implemented consistently throughout the nation.[57]

7.35 In support of the efforts by NLWRA, LWA stated that:

> … the National Land and Water Resources Audit showed, when you can get the data out of the map drawers of the state agencies, get it into a consistent format and make it publicly available through a user-friendly system, then the community can start to access some often very useful information.[58]

7.36 According to the MDBC, the NLWRA highlighted that:

- there is not consistent data coverage of the Australian landscape;
- the wealth of information that does exist in institutions needs to be better linked;
- data standards need to be established to ensure datasets are commensurable.[59]

7.37 The NLWRA has been criticised for not providing data with sufficient detail to assist farmers,[60] however it is worth noting that the information generated out of the NLWRA was developed to promote broad scale

55 DAFF and DEH, *ibid.*

56 Dr Richard Price (NDSP), *Transcript of Evidence*, 3 November 2003, p. 13.

57 DAFF and DEH, *op. cit.*, p. 5.

58 Mr Andrew Campbell (LWA), *Transcript of Evidence*, 7 November 2003, p. 2.

59 Mr Warwick McDonald (MDBC), *Transcript of Evidence*, 7 November 2003, p. 37. Also see: Dr Richard Price (LWA), *Transcript of Evidence*, 3 November 2003, p. 13.

60 Government of New South Wales, *Transcript of Evidence*, 29 October 2003, p. 80.

information on salinity and water issues, and to facilitate national policy decisions.[61]

7.38 ASSSI submitted: '[t]he Audit in relation to salinity was based upon incomplete, disjointed and partial sets of data, and so in many respects is not very useful'.[62] The NLWRA acknowledges limitations in the audit process resulting from variability in the 'methods, scale and reliability of data underpinning the state assessments', which made comparisons between states invalid.[63] The second phase of the audit aims to address these issues.[64]

7.39 To ensure data is collected in a consistent manner, DAFF and DEH submitted that the Bureau of Rural Sciences (BRS) will conduct a Salinity Data Infrastructure Project:

> The project will provide a specification for salinity data and information quality, which includes a set format (architecture) for salinity spatial data and data fields (attributes), including metadata (descriptions of datasets). The project will have input from all jurisdictions.[65]

Other national and state initiatives

7.40 DAFF and DEH submitted that BRS is the Australian Government's lead agency in the management of salinity related data and mapping technologies:

> As the lead agency in the development of nationally consistent catchment scale land use datasets, BRS is working with other Australian Government and State/Territory government agencies to establish agreed national land use mapping standards and specifications. This work includes ensuring land use information is available to support natural resource management and policy needs, including the NAP and NHT.[66]

7.41 The Australian Government, often in collaboration with state and territory governments, has taken steps to manage salinity related data through the

61 Mr Warwick McDonald (MDBC), *Transcript of Evidence*, 7 November 2003, pp. 40-41.

62 ASSSI, *loc. cit.*, p. 3.

63 National Land and Water Resources Audit, *Australian Dryland Salinity Assessment 2000 – Technical Overview*, viewed 22 March 2004, <audit.ea.gov.au/ANRA/land/docs/national/Salinity_Technical_Overview.html>

64 Dr Richard Price (LWA), *Transcript of Evidence*, 3 November 2003, p. 13.

65 DAFF and DEH, *op. cit.*, p. 9.

66 DAFF and DEH, *ibid.*, p. 15.

development of measurement and lodgement standards, the creation of retrieval systems and data sharing agreements. Initiatives include:

- improving accesses to data for decision makers at all levels, through:
  - ⇒ the Australian Natural Resources Data Library managed by the NLWRA in conjunction with DAFF and DEH;
  - ⇒ the Australian Spatial Data Directory[67] (an essential component of Australian Spatial Data Infrastructure) maintained by Geoscience Australia on behalf of ANZLIC;[68]
  - ⇒ Discovering Data on the Natural Resource Management website, which provides information on NAP and *Natural Heritage Trust* (NHT) initiatives;
  - ⇒ the proposed Australian Water Data Infrastructure Project, to be developed between 2003-06, with DAFF as the lead agency;
- policies on data costs and access:
  - ⇒ of note is the Australian Government Spatial Data Access and Pricing Policy developed by the Office of Spatial Data Management (hosted by Geoscience Australia);
  - ⇒ through the endorsement of the Spatial Information Industry Action Agenda (2001) which recommended that spatial data should be priced at 'a maximum of the cost of distribution, with minimal copying and royalty restrictions';[69]
- increasing data sharing through collaborative arrangements, such as exists between Geoscience Australia and CRC LEME;
- consistent data standards, for example:
  - ⇒ ANZLIC's Policy Statement on Spatial Data Management, DAFF's Australian Land Use and Management Classification, and other agreed procedures for producing land use maps, maintained and promoted under the ASDI;
- standards for the collection of salinity related data:

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67 The Australian Spatial Data Directory provides information about the availability, characteristics and quality of spatial data held by governments and the private sector and how that information may be obtained.

68 ANZLIC is the peak council for the coordination of spatial data management in Australia and New Zealand.

69 Department of Industry, Tourism and Resources, Spatial Information Industry Action Agenda, viewed 4 May 2004, <www.industry.gov.au/content/itrinternet/cmscontent.cfm?ObjectID=5BDDEA05-13C1-480C-BB4BB289E3976439>.

- ⇒ through collaborative policies developed between the NLWRA and ANZLIC and promoted by the ASDI;
- ⇒ via the Salinity Data Infrastructure Project being conducted by BRS;
- ⇒ by providing Guidelines for Best Practice in the Public Presentation of Salinity Data and Mapping Products, developed by the Science and Information Working Group of the Natural Resource Management Standing Committee (among other objectives these aim to ensure that researchers gain appropriate approval for data collection, identify data ownership, access rights and establish intellectual property);

- increasing support for CMOs:
  - ⇒ to access, visualise and manage their data through the development of the Natural Information Management Toolkit, prepared by NLWRA and ANZLIC;
  - ⇒ by the Monitoring and Evaluation Working Group, establishing the National Natural Resource Management Monitoring Framework and the National Framework for Natural Resource Management Standards and Targets.[70]

7.42 The Australian Government performs a vital role in the management of NRM data. The Committee is concerned that despite the Australian Government's substantial efforts to improve access to spatial and temporal datasets, and standardise measurement and lodgement procedures, problems persist.

Recommendation 13

7.43 **The Committee recommends that the Australian and state government agencies holding natural resource management datasets, accelerate the development of data collection, management and retrieval systems that are standardised, integrated and accessible.**

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70 DAFF and DEH, *op. cit*., pp. 2, 4, 5, 9, 36; Mr Ian Thompson (DAFF and DEH), *Transcript of Evidence*, 7 November 2003, p. 53; Australian Government, Geoscience Australia, *Australian Spatial Data Infrastructure [ASDI]*, Canberra, viewed 4 April 2004, <www.ga.gov.au/nmd/asdi/>; National Land and Water Resources Audit Australia, *Audit data projects*, viewed 10 March 2004, <www.nlwra.gov.au/minimal/35_data/data.html>; Australian Spatial Data Infrastructure, Australian Spatial Data Directory (ASDD), viewed 4 April 2004, www.ga.gov.au/asdd/; ANZLIC, Policy Statement on Spatial Data Management, April 1999, viewed 6 April 2004, <www.anzlic.org.au/pubinfo/2358011750>; National Resource Management website, Discovering Data, viewed 19 April 2004, <www.nrm.gov.au/data/index.html>.

7.44 With the increased involvement of CMOs in data collection, the Committee is concerned that best practice standards for data management are developed and adopted by regional project managers. The Committee notes that in addition to supporting CMOs gain access and use salinity related information, there is an onus on the Australian Government to ensure that the spatial data collected becomes part of the national data resource base—available for multiple uses, across-jurisdictional boundaries—both now and in the future. The Committee notes the efforts of the NLWRA and other Australian Government initiatives in this regard. The Committee urges that these be adequately resourced to undertake the task of assisting CMOs into the future.

Recommendation 14

7.45 **The Committee recommends that ANZLIC – the Spatial Information Council, in collaboration with the National Land and Water Resources Audit, be resourced to support managers of regional projects to develop and implement best practice data management policies. Emphasis should be placed on developing:**

(a) consistent data collection, management and retrieval systems;

(b) mechanisms to encourage data sharing between catchment management organisations, research institutions, industry bodies and government agencies; and

(c) quality assurance processes to ensure standards are attained.

7.46 The Committee supports in principle the development, by the Australian Government, of an easily accessible web-based network to manage and disseminate salinity data. This proposal will be further developed in chapter eight. The Committee notes that any system to coordinate data should have the capacity to evolve as technological advances occur and understandings of salinity management and NRM develop.[71]

71 SKM, *op. cit.*, p. 4.

Mapping technologies

7.47 The range of techniques used to model the salinity processes and delineate surface expressions of salinity include ground-based and airborne electromagnetics (EM and AEM), air photo interpretation (API), satellite imagery, radar, soil surveys, borehole and stream monitoring and digital elevation models. The Committee received evidence on both airborne and ground-based mapping methods.[72]

7.48 In January 2004, a review of salinity mapping technologies was published on behalf of the Natural Resource Management Ministerial Council. The Salinity Mapping Methods User Guide and Technical Report were produced from this process.[73] The User Guide stressed that the appropriateness and efficacy of mapping and modelling techniques depends on a range of factors:

> The choice of mapping methods depends on scale, ground conditions, the problem at hand and the expertise of the user. To map the extent of areas affected by dryland salinity the most straightforward methods are API and satellite imaging combined with visual inspection, and ground EM38. To map the presence of salt at depth we recommend AEM constrained by borehole logging and point EC [electrical conductivity] sampling. To investigate hydrological factors affecting the transportation of salt by groundwater, aeromagnetics and AEM are the key techniques.[74]

7.49 Mapping is a central component of the NAP.[75] The NAP states the '[a]pplication of new scientific, technical and engineering knowledge requires … "ultrasound" salinity mapping and related technologies in priority catchments/regions'.[76]

7.50 The Committee notes that researchers have found geophysical mapping beneficial in assisting them to understand the processes of salinisation,

72 See for example: DAFF and DEH, *op. cit.*, pp. 20-21; *Exhibit no. 69, Technical aspects of salt mapping*; GecOz Pty Ltd, *Exhibit no. 131, GecOz Submission to the Review of Salinity Mapping Methods in the Australian Context.*

73 The Technical Report and User Friendly Guide for *The Review of Salinity Mapping Methods in the Australian Context*, viewed 19 April 2004, <www.ndsp.gov.au/80_airborne/airborne.htm>. Transcripts of the public forum convened by the Australian Academy of Science and the Academy of Technological Sciences and Engineering on 17 October 2003, to receive and critique the draft review products, are available online, viewed 5 February 2004, <www.science.org.au/proceedings/salinity/index.htm>.

74 The User Guide for *The Review of Salinity Mapping Methods in the Australian Context*, viewed 19 April 2004, p. 18, <www.ndsp.gov.au/80_airborne/airborne.htm>.

75 Council of Australian Governments (COAG), *A National Action Plan for Salinity and Water Quality*, DAFF and DEH, Canberra, 2000, p. 5.

76 *ibid.*

and the development of management options. CRC LEME argued that mapping is one means of facilitating targeted salinity interventions:

> Airborne electromagnetics are an important tool—not everywhere, but in many of the environments we work in—to help us map salinity and work out solutions.[77]

7.51 Similarly, Professor Les Copeland of CSAM stated:

> I think the key to understanding the problem and addressing it is to map the salinity and to get good data or risk assessment on where the salinity problems are greatest and where the opportunities for management are greatest … What we lack is the mapping of the risk of salinity and where we can best invest to reverse it.[78]

7.52 As outlined in chapter six of this report, the Australian Government through the NAP has placed considerable emphasis on airborne geophysical mapping techniques.[79] The tension between the usage of AEM to aid targeted interventions (at least in eastern Australia) versus the calls for broadacre solutions was noted. Also, as Murray Irrigation highlighted, the emphasis on mapping technologies by researchers may be at variance to the needs of land managers:

> we are after new and improved methods on how to deal with salinity; and, to a large degree, our salinity researchers are more focused on mapping and where to find salinity.[80]

7.53 The Committee concluded in chapter six, that AEM has the potential to contribute to targeted salinity management, when used in combination with other techniques and adequately calibrated. However, it was posited that the Australian Government's support for this technology should not be at the expense of R&D investments in new land and water use systems.

77 Mr Paul Wilkes (CRC LEME), *Transcript of Evidence*, 12 November 2003, p. 16.

78 Professor Les Copeland (CSAM), *Transcript of Evidence*, 29 October 2003, p. 59.

79 See DAFF and DEH, *op. cit.*, p. 20.

80 Mr Alex Marshall (Murray Irrigation Ltd), *Transcript of Evidence*, 31 October 2003, p. 16.

The Australian Government's involvement in salinity mapping

> *Investments made by the Australian Government have enabled innovative technologies such as airborne geophysics to be developed and applied. This technology provides a hitherto unattainable level of understanding of Australian landscapes in three and four dimensions (ie through space and time).*[81]

7.54 BRS and the Australian Bureau of Agricultural Resource Economics have developed the application of airborne geophysics, integrated with hydrogeological assessments, field measurements and land use information, to map and predict salinity.[82] A technical description of the geophysical mapping technologies employed by the BRS, which incorporates airborne electromagnetic, magnetic, radiometric and digital elevation techniques, is provided in Appendix F to this report.

7.55 DAFF and DEH outlined some of BRS achievements in the area of regional salinity mapping, these included:

- the *South Australian Salinity Mapping and Management Support Program*, which utilises airborne electromagnetic, radiometric and magnetic techniques to map five catchment regions within two of the NAP priority areas;[83]
- a guide for regional planners, *Five Steps to Tackling Salinity*, in its 'Science for Decision-makers' series, which explains where mapping fits in the planning process for salinity management;[84]
- establishing agreed national land use mapping standards and specifications, as previously mentioned;[85]
- synthesising the results of salinity mapping conducted in ten catchments in eastern Australia and in the process revealing that:
  - ⇒ salt is more localised in the landscape than previously thought and only represents a salinity risk if it is likely to be mobilised;

81 DAFF and DEH, *op. cit.*, p. 3.

82 DAFF and DEH, *ibid.*

83 Australian Government Department of Agriculture, Fisheries and Forestry, Bureau of Rural Sciences website, viewed 21 April 2003, <www.affa.gov.au/content/output.cfm?ObjectID=BB7F7EE7-38A9-4DD8-805FCFC19E763449>.

84 DAFF and DEH, *Exhibit no. 65, Five Steps to Tackling Salinity*, p. 1. In summary, the five steps are: consult with the community to specify salinity management objectives; map salt stores and identify areas likely to be at risk from salinity; consult with land users and professional agencies to identify feasible management options; work with the community to develop and implement an action plan; and monitor and review effectiveness, see *ibid* p. 3.

85 DAFF and DEH, *Submission no. 72*, p. 15.

- ⇒ AEM can be used in conjunction with other information to define the location and quantity of salt in the landscape and how it moves;
- ⇒ specific management interventions (which may include land use change or engineering solutions) can be tailored to individual situations, substantially reducing the cost of managing salinity and minimising potential disruption to agriculture; and
- ⇒ priority areas for AEM can be effectively established by compiling existing data and undertaking rapid community based stream surveys to identify sub-catchments contributing major salt loads.[86]

7.56 BRS has noted that, through the judicious use of mapping technologies, smaller land use change than previously thought is necessary to manage salinity in catchments:

> In the Billabung, land use change over 17 per cent of the catchment (tree planting over 6000 hectares in the highlands, and conversion of 10 000 hectares of crops and annual pastures to perennial pastures) is expected to achieve a 50 per cent reduction in salt export to the Murrumbidgee, with limited impact on agricultural productivity.[87]

7.57 In addition, BRS has concluded that it can substantially reduce the cost of the information needed to develop salinity management options. For example, the Bureau found that conducting airborne surveys in 10 per cent of the Billabung Catchment and 'combining this with previously collected landform, soils, regolith and groundwater data provided farm scale (1:25 000) management options … at 60 cents per hectare'.[88]

7.58 While noting that AEM is expensive,[89] CRC LEME argued that its studies demonstrate that the cost of conducting AEM surveys can be lowered, without necessarily reducing their effectiveness. This is achieved by increasing the distance between flight transects and identifying important landscape elements prior to surveying.[90] As a result of mapping undertaken at Honeysuckle Creek (Victoria) and the Lower Balonne (Queensland), DAFF concurred that there is the potential to double or

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86 DAFF and DEH, *Submission 72.1*, p. 1. It is worth noting that BRS has produced catchment scale land use maps for 80 per cent of Australia, with a further 15 per cent to be completed by 2005.

87 *ibid.*, p. 4.

88 *ibid.* p. 3. 1:25 000 means that 1cm on a map equals 250m on the ground.

89 According to CRC LEME AEM survey costs $60 to $80 per line kilometre.

90 CRC LEME, *Exhibit no. 116, Reducing the Acquisition Costs of Airborne Electromagnetics Surveys for Salinity and Groundwater Mapping*, p. 1.

triple the distance between line spaces, and thus reduce costs to less than $1 per hectare.[91]

7.59 The Committee received favourable feed-back from the Integrated Natural Resource Management Group for the South Australia Murray Darling Basin on the potential benefits of airborne mapping for regional planning:

> Although the airborne geophysics mapping in the region has not been completed, initial results indicate that the knowledge gained will be valuable in supporting prioritisation of on-ground works. This will ensure that future investment is well targeted and achieves the maximum return. The results are also expected to direct further research through the identification of knowledge gaps.[92]

7.60 Despite the Australian Government's enthusiasm for airborne geophysical surveying, particularly AEM, some submitters cautioned the Committee about the realities of its application. These concerns are outlined below.

Cautions against viewing Airborne Electromagnetics as the 'silver bullet' of salinity management

The appropriate usage of AEM technology

7.61 In his considered submission, Dr Andy Green provided a history of AEM and its present capabilities.[93] Dr Green acknowledged the 'over-enthusiastic endorsement of the technology in the National Action Plan'.[94] However, providing that the limits of the technology are understood and it is used appropriately within the broader NRM framework, he argued:

> we can now distinguish the situations were AEM … should be considered in salinity management.
>
> There must be:
>
> - Realistic, cost effective options for action
> - Genuine commitment to, and mechanisms for action
> - A need for hard geo-scientific information to enable successful action

91 DAFF and DEH, *Exhibit no. 69,* p. 3. The current cost per hectare is between $2 and $10. These costs are based on flight-line costs of $50-$100 per line kilometre at a line spacing of 100-400 metres. Note mobilisation is expensive at $70 000 which limits practical survey areas to greater than 50 000 ha.

92 Integrated Natural Resource Management Group for the South Australia Murray Darling Basin, *Submission no. 23,* p. 1.

93 See Dr Andy Green, *Submission no. 38,* pp. 1-3.

94 *ibid.,* pp. 1, 4.

- Recognition that AEM is the most cost effective way of getting the information[95]

7.62 It is argued by Dr Green that current AEM technology has an important role in ameliorating the symptoms of salinity and protecting high value assets.[96] However, to date, AEM has not been successfully adopted to assist with treating the causes of salinity, and its role in broadacre recharge reduction strategies has been limited:

> My experience would suggest that current AEM technology is highly applicable for the protection and management of assets but application at the other end of the spectrum [that is, recharge reduction] awaits great clarity…[97]

7.63 Despite its limitations, Dr Green argued: 'AEM technology should not be ignored while clarity is achieved'.[98] In conclusion it was noted that: '[u]nless clear, attractive salinity management strategies are available there is little point in expending resources on activities that are unlikely to result in salinity management action'.[99]

7.64 Mr Phil Dyson explained that AEM provides another layer of information for researchers, which should not be interpreted in isolation from the existing salinity knowledge base.[100] Furthermore, Mr Dyson stated that geophysical surveying should be used more strategically in the future.[101]

7.65 As discussed in chapter six of this report, in Western Australia the benefits of AEM are limited due to the relative homogeneity in geology and the vast scale of the salinity problem.

7.66 WA SRDTC told the Committee that in Western Australia:

> They [AEM technologies] are quite good at predicting where discharges will occur [which] … can help you to fence out those areas before they become completely affected [by salinity]. We have used geophysics to do that, but it is not solving the problem … I have yet to see a highly effective geophysics technique that can identify small areas of landscape which you can treat and have a significant impact on salinity.[102]

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95 *ibid.*, p. 3.

96 *ibid.*, p. 4.

97 *ibid.*

98 *ibid.*

99 *ibid.*

100 Mr Philip Dyson (Phil Dyson and Associates Pty Ltd), *Transcript of Evidence*, 31 October 2003, pp. 8-9.

101 *ibid.*

102 Dr Donald McFarlane (WA SRDTC), *Transcript of Evidence*, 12 November 2003, pp. 44-45.

7.67 Furthermore, WA SRDTC submitted that the politicisation of airborne geophysics by BRS had lead to unrealistic expectations about the technology's abilities. The recommendation was made:

> Prevent a repeat of the "Ultrasound era". Politicised processes that are related to such technologies create unrealistic expectations and cause distortion in the scientific process and integrity of information. Other sensible knowledge-based organisations become driven by political processes and rational science and justified expenditure is the victim (e.g. BRS and airborne geophysics).[103]

7.68 The South Australian Government noted that, as a result of its involvement in the NAP, airborne geophysics has been used to fill knowledge gaps surrounding both the causes and impacts of dryland salinity, and viable management actions.[104] However, it was stressed that: 'South Australia has been careful not to over-emphasise the ability of the technology to provide answers to all salinity issues'.[105]

7.69 In this regard the South Australian Government:

> Continue to use airborne geophysics in a highly targeted manner to fill critical knowledge gaps in our understanding of salinity processes and to assist in the development of management plans for high value assets, noting that the application and interpretation of the technology requires expert knowledge and the use of multi-disciplinary teams.[106]

AEM: one technology among many

7.70 The Committee was presented with evidence on a range of alternative salinity mapping and monitoring technologies.[107] For example GecOz's airborne imaging radar application and in particular SaltSAR—a surface soil salinity mapping technology.[108] Similarly, NRI has patented a process whereby gamma ray data is modelled to produce soil property maps.[109]

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103 WA SRDTC, *op. cit.*, p. 5.

104 Government of South Australian, *Submission no. 81*, p. 6.

105 *ibid.*

106 *ibid.*, p. 7.

107 See for example: Agrilink, *Submission no. 25*, pp. 1-4.

108 SaltSAR was the recipient of the 2001 iAward for Innovation in IT Services, awarded the 2002 Asia Pacific ICT Award (APICTA) for Research and Development and represented Australia at the International 2003 APICTA. GecOz, *Exhibit no. 131, Submission Brief: Review of Salinity Mapping Methods in the Australian Context*, p. 1.

109 Orbek Pty Ltd, *Submission no. 3*, pp. 1-10.

Additional technologies used in salinity hazard mapping and risk assessments, include:

- at the surface (0-10 cm depth)—visual inspection, aerial photo interpretation, airborne multi-spectral imagery, gamma ray spectrometry, satellite multispectral and hyperspectral;
- at the shallow subsurface (<2m)—on-ground electro-magnetic conductivity mapping and ground probing radar;
- at the subsurface (>2m)—deep-probing electro-magnetic, nuclear magnetic resonance, gravity and airborne magnetics.[110]

7.71 GecOz submitted that the Australian Government has supported AEM technology at the expense of other equally useful mapping techniques.[111] It was argued that this has inhibited technological advances and unfairly disadvantaged small to medium sized enterprises.

7.72 Similarly, Natural Resource Intelligence submitted that the Australian Government's approach, in all areas of salinity management, is too prescriptive. This in turn has limited industry involvement in the provision of salinity services:

> One reason for the suppression industry providing technical services is the strong "top down" approach with the existing structure. We are told what causes dryland salinity, how it should be mapped, and how it should be remediated. There is limited scope for industry to deliver effective technical services when the problems and methods have been so rigidly defined.[112]

Appropriately scaled maps

7.73 As discussed in the previous section, farmers and CMOs have requested data and information that will help them make decisions at the paddock and sub-catchment scale.[113] It has been posited that airborne technologies may not provide as useful information at the local scale, as other mapping methods.[114]

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110 For a more complete list, and explanations of, the available technologies see: The Technical Report and User Guide for The Review of Salinity Mapping Methods in the Australian Context, viewed 19 April 2004, <www.ndsp.gov.au/80_airborne/airborne.htm>.

111 GecOz, *Submission no. 80*, p. 1.

112 Natural Resource Intelligence Ltd Pty, *Submission no. 32*, p. 9.

113 See for example: New South Wales Farmers' Association, *op. cit.*, p. 5.

114 See for example: Dr Baden Williams, *Submission no. 1*, p. 3; Dr Donald McFarlane (WA SRDTC), *Transcript of Evidence*, 12 November 2003, p. 45.

7.74 The Salinity Mapping Methods User Guide compared the efficacy of airborne and ground EM techniques over three areas of differing size. It was concluded that the correlation between AEM and EM31 was high over large areas but that EM31 provided more detailed data of small areas:

> At broader scales represented by the 5 and 50 km profiles, the AEM predictions correlate moderately well with the trends in the raw EM31 measurements. However, over profile lengths that are little more than the horizontal resolution of the AEM system (eg 1 km) … the broad averaging involved in the AEM measurements is unable to capture the local variability detected using an EM31 instrument. The AEM conductivity predictions and the raw EM31 apparent conductivity values would show very low correlation at this local scale.[115]

7.75 Dr Baden Williams submitted that airborne EM is 'a very useful product in describing the presence / absence of deep (>15-20m) stores of soluble salt but they have yet to provide any real information that a landholder could rationally devise land management options'.[116] WA SRDTC concurred with this view.[117]

Conclusions

Data management

7.76 The Committee acknowledges that a range of Australian and state government initiatives are in place to facilitate best practice data collection, management and retrieval. However, the Committee is concerned that problems in this area persist. With the increased involvement of CMOs in data collection, the Committee recommends that the Australian Government increase efforts to equip managers of regional projects with the requisite skills for data management. In chapter eight, the proposal for a national salinity database is further explored.

Mapping technologies

7.77 The Committee notes the importance accorded to mapping technologies, particularly airborne geophysical techniques, in the NAP. The Committee

115 The User Guide for *The Review of Salinity Mapping Methods in the Australian Context*, viewed 19 April 2004, p. 26, <www.ndsp.gov.au / 80_airborne / airborne.htm>.

116 Dr Baden Williams, *loc. cit.*

117 See Dr Donald McFarlane (WA SRDTC), *Transcript of Evidence*, 12 November 2003, p. 45.

contends that mapping technologies may perform an important role in salinity management, for example: surveying large areas of land (greater than 50 000 hectares); the prioritisation of on-ground works; and in protecting high value assets (such as towns).

7.78 The Committee notes the range of concerns about the use of airborne geophysical techniques and specifically the observation that AEM may have been 'over sold' by relevant Australian Government agencies. The Committee believes that the Government should take note of the concerns raised by submitters. Above all, the Committee concludes that while AEM is a useful enabling technology, the utilisation of the technology should not detract from efforts to develop new land and water use systems that can be adopted by land managers on-ground, particularly in Western Australia.

7.79 The Committee was disappointed to hear that some companies felt they were being discouraged from participating in salinity surveys. The Committee believes that the private sector has an important role in developing innovative technologies, and providing on-ground services to land managers. These issues are explored further in chapter eight.