Contents and forewords

From
Future Dilemmas: Options to 2050 for Australia's population, technology, resources and environment

Report to the Department of Immigration and Multicultural and Indigenous Affairs

By CSIRO Sustainable Ecosystems

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October 2002

Working paper series 02/01

CSIRO Resource Futures Working Paper 02/01
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Published by
CSIRO Sustainable Ecosystems
GPO Box 284
CANBERRA ACT 2601
Phone: +61-2-6242-1600
Fax: +61-2-6242-1555
This report is available online at
http://www.cse.csiro.au/futuredilemmas

ISBN 0 95808453 X

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Foreword by Authors

When in 2050, a dusty copy of this report is located in the storage room of a library, the reader may wonder what led the authors to their conclusions.

However many things won't have changed. A joule of energy will still be a joule of energy, a kilogram of coal will still be a kilogram of coal and a litre of pure water will still be a litre of pure water. Humans will still require food, habitation, water and warmth. Australia has a wide range of options explored in this report, to ensure that the physical foundations of its quality of life will endure.

If accepted into policy design, many of the graphs, tables and commentary in this report will not eventuate. The study will have contributed to changing national function and how the nation thinks about itself. If by 2050 we are still following the paths described in many chapters of this report, then our cities, the air around them, our farmlands, our rivers and export industries could be struggling. This research explores many options for change, but tries to remain dispassionate about which are better or worse directions. These decisions must be made by the Australian people and their leaders.

During the process of the scenario development and testing, some analytical errors will have occurred. Inevitably, the size and complexity of this undertaking sometimes produces interactions not fully understood nor fully revealed. However the model development and grounding procedure have been designed to limit the flow-on effect of errors, which do not multiply throughout the system. Generally some system wide indicators may be underestimated since effects such as inter-sectoral rebound, and increasing diversity of personal consumption, are not automatically enabled in the simulation. As information becomes more comprehensive, then the robustness of the modelling outcomes will improve markedly.

By 2050 many current global issues will have been played out and there may be a new set of seemingly protracted issues which seem insoluble. By 2050 the globe will have decided whether global warming and climate change are major issues, whether supplies of oil and natural gas are unlimited, whether globalised trade helps or hinders environmental quality in each of its participating nations, and whether technological progress and the 'factor 10' economy can allow virtually unlimited growth in consumption without declining environmental consequences.

Many readers may find some of these issues challenging. In particular, the concepts from the theory of physics that, notwithstanding the many opportunities for substitution, many of the transactions that underpin modern day economies and lifestyles have physical and thermodynamic limits. Some may interpret these concepts as being antagonistic to contemporary societal values and political views. No challenge or antagonism is intended! Rather the analysis seeks to complement contemporary ideas with concepts of physical realism. This blending should help, rather than hinder, political decisions and business planning.

Lastly, there are many thanks due. First thanks go to the Department of Immigration and Multicultural and Indigenous Affairs who collaborated with us and helped fund this study, and in particular Neil Mullenger, Monica Millhouse, John Ryan, Chris Smith, and Abul Rizvi. For CSIRO, Joshua Conroy, Tory Quinnell, Michael Dunlop, Don Lowe, Doug Cocks, Ray Bemelman, Mark Howden, Graham Turner, Allen Kearns, Andrew Johnson, Shona Miller and Hugh Tindale Biscoe were important contributors to the processes of organising, workshopping, writing and editing. In the final phase of completion, our editors Robin Taylor of *Page One* and David Salt of *Ywords* added polish and completeness. More than 500 experts from a wide variety of fields contributed to the

workshop process and subsequent reporting that preceded the writing of this report. The depth of their insights show partly in this report, but they will become more apparent as the national modelling capability invested in the *Australian Stocks and Flows Framework* becomes more developed during the next decade. The external reference group chaired by Roger Bradbury made many fair challenges to the analyses and provided sound advice on structure, content and style.

In an earlier era, there were many colleagues who laid the foundation for bringing Australia's policy world and its physical world into potential confluence. Our colleague Doug Cocks, and the then Chief of CSIRO Wildlife and Ecology, Brian Walker, decided as early as 1990 that CSIRO should do something *scientific* to provide numerate and analytical contributions to the national population debate. Over the ensuing decade, Brian Walker, Dave Spratt and Steve Morton continued with intellectual and funding support, through many difficult periods of scientific development when the project was frequently under scrutiny from corporate managers who thought it too dangerous, or beyond the safe margin of contemporary policy inquisition. Former chief executive officers of CSIRO, John Stocker and Roy Green supported the early days of the project with funding and credibility.

The warmest thanks should go to our friends and colleagues at Robbert Associates in Ottawa Canada, Rob Hoffman, Bert McInnis and Michael Hoffman. They, and other colleagues formerly in Statistics Canada in the early 1980s, developed the philosophies and concepts behind the *WhatIf* analytical platform which we use today. Research and development sometimes take 20 years or more to bloom, and produce edible fruit. We hope this research offering from Australia helps Robbert Associates further expand their intellectual and analytical capability.

The biggest and most heartfelt thanks must go to the families of Franzi Poldy and Barney Foran who ceded many family night times and family weekends to this analytical task, as well as the occasional lapse in good humour from their spouses and fathers.

Foreword by External Reference Group

In the world of modelling and simulation, practitioners talk of the *Cassandra problem*. Cassandra, was a daughter of Priam, the king of Troy, and had the gift of prophecy. She, alone of all the Trojans, was alarmed at the Greek's wooden horse, and begged her father not to allow it into the besieged city. She had foreseen the fall of Troy. No one believed her, and the rest, as they say, is history. Cassandra lacked street-cred in a big way, and so gave her name to the problem of how one can describe the future accurately and still be believed.

The future need not be catastrophic, or even a Greek tragedy, for the problem to rear its head. All it really needs is to be complex enough that our common sense and our past experience are not adequate guides. Of course, each of these is a good guide for the local neighbourhood – for the short term and the immediate environment. Indeed, we — or any other species — would not have survived if this were not so.

Alone among living things, human beings, in a sense, have moved beyond their local neighbourhood. Our problems are no longer local or short-term. They are, instead, global, long-term and complex. Their futures are sure to contain a Cassandra or two. Common sense and past experience might have helped us handle the small problems of the past, but they just are not up to dealing with the complexity of issues such as ecologically sustainable development.

This is where modelling and simulation come in, and where the Cassandras lurk. We can see this clearly in the present report. It tries to come to grips with a big complex problem — the future of Australia's human population and its interactions with the natural resource base.

The future, for something as complex as this, of course is not predetermined. It is not as if the authors set out to discover some already-written future chapters of the history of Australia. Those chapters do not exist, today's chapter is being written only today. The real world works in real time. Thus, instead of prediction (which only works for the future of relatively simple systems), the CSIRO team had to do something quite different.

What they did was this. They first built a model of Australia as a bio-physical system; that is, they took all the major components of the physical environment of Australia — the water, the soils, the air and so on — and created a framework which incorporated the history, the trends and, importantly, the interactions among all the components. They then did the same for the living fabric of the continent — the animals and plants. And finally, and in great detail, they added human beings to the mix — where people are in Australia and what they do in terms of how they interact with each other and the world.

The authors have called this description of the stocks and flows of all the things that make up Australia 'a model of the *physical* economy'.

This is a powerful and novel construction. It has never been attempted in such depth (that is, with so many different components) or breadth (at the scale of a whole continent) anywhere else in the world. The Department of Immigration and Multicultural and Indigenous Affairs, as the sponsor of the research, and the CSIRO Division of Sustainable Ecosystems, as the research agency, are to be congratulated for having the vision to undertake this project.

The work is novel because it offers a new and different way to look at the problems associated with the future of Australia's human population. Traditionally, demographic projections of the human

population have been used as inputs to economic models to examine issues such as the future structure of the labour force or problems associated with, say, national infrastructure development. The success of these traditional studies has depended on two things: the extent to which they have been able to focus on these important single issues; and the extent to which they have been able to squeeze 'non-economic' components, such as environmental factors, into an economic framework.

The present study is quite different from this. It offers an opportunity to examine 'simultaneously' all the major components bearing on the human population. It does not require us to focus on some and ignore others. It also offers the opportunity for all the components to be dealt with in a 'natural' form. All models need a common 'currency' with which their components interact with one another. Broadly speaking, economic models use dollars, and so need to dollarise all their components, even though this may be rather forced for some of them. In the present study, the components are represented as physical objects, and measured using the units of physics — kilograms of this and joules of that. Science thus provides an objective external constraint on the model, ensuring that its physical budget of our bit of the universe observes the laws of physics, and in particular that matter and energy are properly accounted for.

This physicality gives the model its power. It does not depend on one's beliefs in this or that socio-political system or on the economic theories that spring from them. Instead it is an objective, neutral scientific description of the problem, even though it is, of course, like all science subject to revision and improvement.

The model's physicality is also its greatest weakness, in terms of making it useful and accessible to policy makers and the general public. It stands quite separately from the more usual (economic) modelling efforts with which most policy makers are familiar. Neither its structure, nor dynamics, nor results are directly comparable with those of economic models. Although, of course, the insights and understandings may be argued across the different domains.

The second thing the CSIRO team did was, having built the model, to then use it to attack the Cassandra problem obliquely. Instead of purporting to predict, which is neither feasible in practice nor really possible in principle, they have used it to explore possible futures through scenarios. By taking major trends in society, such as the growth of population or the growth in the standard of living, they were able to examine the likely future effects of such trends continuing in a very subtle way. The model, obeying as it does, the laws of physics, cannot, for example, resolve an exponential growth in the use of water (as required, say, by an assumed steady increase in the standard of living), with the physical reality of the continent's finite stock of water, regardless of any political, social or economic requirements to the contrary. There are only so many water molecules to go around. Thus, unlike many economic models, which make assumptions about the system striving for equilibrium, the CSIRO model simply will not bend the scientific laws of reality. Instead, it reports such problems as tensions or dilemmas.

This unique ability to identify dilemmas in scenarios gives the model its power and utility. The development of scenarios allows us to examine the future in terms of an envelope of possibilities, and the identification of the dilemmas allows us to zoom in on potential problems that will need our attention, our careful consideration and our action, if they are to be resolved.

So, the CSIRO modellers acknowledge Cassandra, she of the foreknowledge, but in a very modern way. They describe an envelope of possible futures, and then, within that, warn, as she would have done, of likely problems. But, unlike Cassandra, they offer with that foreknowledge the chance to examine and resolve the dilemmas before they come to be, by providing a solid scientific framework for the public debate.

Dr. Roger Bradbury, **Chair, External Reference Group**