

## **KEYNOTE ADDRESS**

### **5<sup>th</sup> International Acid Sulfate Soils Conference**

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## **ENVIRONMENTAL HISTORY & DECISION MAKING**

In any examination of the impact and consequences of human activities on coastal environments over the past 200 years, it is necessary to appreciate how decisions are made which create the changes. The east coast of Australia, especially between Gabo Island and Fraser Island, is one of considerable environmental diversity; however it has experienced several different forms of human occupancy leading to dramatic modification of beach, dune, estuary, river mouth and flood plain environments.

The process of discovering how coastal landscapes have been transformed requires one to understand physical and biological conditions along the coast at the time of the European settlement. Under what circumstances were settlers and later residents encouraged to use these conditions; what actions occurred; what were the consequences; and most importantly how can we learn from past decisions in order to ensure sustainable land and water use in the future?

Very little research has been undertaken on processes, impacts, and consequences of environmental change resulting from human activities in coastal eastern Australia. Yet this is where we most live. An examination of these issues within this region, which today is undergoing enormous pressure for development, and contains large tracts of highly prized natural areas, provides one with an opportunity to seek lessons from the past. These lessons should assist decision-makers today and in the future to address problems of environmental sensitivity and land use compatibility.

## **Contemporary Struggle for “Balance” and ESD**

Recognition by successive governments, especially over the past two decades, of their responsibilities to ensure protection of environmental values, whilst permitting development, has created major policy dilemmas. Land use conflicts have generated numerous inquiries, revisions of policies, and decisions at individual, local and state government levels which reflect tensions between different interests in how land and water resources should be used. The concept of a balance between development invoking property rights and conservation involves competing interests and is reflected in the evolution of planning principles and policies and laws, as well as in management practices and judicial decisions.

Solutions to achieve the balance on the coast have been driven, in recent years, by the application of ESD and ICZM principles. Increasingly an understanding of the so-called “wicked problem” of CZM has forced decision-makers to apply these new principles. This has led to greater roles for both governments and local communities in coastal matters. Yet many problems remain in resolving management difficulties because of conflicts in land and water use arising from population growth, persistence of often fragmented administrative structures, case law, divergent community aspirations, economic greed and environmental ignorance.

Within the structure of our democratic society, and within the confines of an evolving federal-state legal system, resolution of conflict will involve political decisions. These decisions may be taken at any of the three levels of Australian government, but more often than not the power for addressing what we call the “tyranny of small decisions” is vested in elected councillors of local government. In some contentious cases the courts may assume a consent authority role. However, trade-offs and balancing processes remain the same where decision-makers receive advice, which can be critical, supportive, conflicting, or neutral. Key players in providing that advice are:

- bureaucrats
- scientists / engineers / consultants
- community groups and NGOs
- commercial interests.

Contemporary policies (i.e. post 1990) reflect the need to provide for ecological sustainable development as enshrined in legislation. The institutional and policy framework for achieving the goals of ESD involve:

1. inheritance of past legislative and administrative responsibilities;
2. community interests in seeking both protection and rehabilitation of environmental conditions; and
3. State and local demands for economic development and employment growth.

All these interests and demands exist within the context of uncertainty over both how environmental forces will operate in future, and how social and economic factors will impinge on the environment. Politicians will be forced to make “hard” decisions (i.e. no development, or highly conditioned consents), or “soft” decisions based on compromise accepting the imperative of job and wealth creation on the one hand, and for some retention of environmental value on the other.

### **Before 1788: “Pristine Beauty”!**

Coastal landscapes in eastern Australia have evolved over 60 millions years. Reconstruction of past processes and landscapes helps us understand those ecological and geological forces which are responsible for our embayed coast so dominated by headlands, sandy beaches, estuaries and flood plains.

The region has experienced a long-term denudational history arising from the formation and erosion of the continental margin. Subsequent periodic migration of sea levels in and out of river valleys led to drowning and blockage of ancient channels. As sea levels rose, sand reworked first by rivers then by waves and currents, became concentrated into embayments. Muds were trapped behind sand barriers in estuaries rich in chemicals that fascinate you. Models of deposition have been developed to show how natural landscapes came into existence; an excellent example is the estuarine infill model of Peter Roy whose work is well known to you. The role of plants in stabilising and colonising newly formed land is an integral part of this history and in forming its soils. Landscape instabilities can be documented which highlight sensitivities to environmental forces over different time scales. Habitat characteristics relevant to animal life cycles and productivities are related to changing depositional conditions, including changes to water balances and soil moisture conditions.

Aboriginal migration into Australia led to the first wave of human occupation from about 70,000 years ago. Environmental consequences of hunting, collecting and settlement are variously understood. Early explorers and settlers recorded their activities against the backdrop of what they thought to be a natural ecosystem, but which had been continually undergoing change at different space and time scales, especially since the maximum of the last glaciation. We now recognise that indigenous peoples did have some impact especially through use of fire. What was “pristine” to some in 1788 would have been different to what a visitor would have observed 120,000 years at the height of the Last Interglacial, i.e. prior to Aboriginal dispersal across and around the continent.

### **Post 1788: Changing Cultures of Coastal Management**

European occupation of the eastern seaboard was relatively rapid during the 19<sup>th</sup> century. For some of this period, the dominant culture was “struggle with nature”. Natural forces of floods, fires, cyclonic storms and even drought impacted on early coastal settlers. Shipping was a hazardous

occupation. The coast is littered with wrecks resulting from attempts to enter or exit dangerous river mouths. On land there were forests to conquer, to exploit valuable trees such as cedar, and then to clear timber for farming. The floodplains and upland soils, in particular those covered by scrub or brush (rainforest) on volcanic surfaces were particularly attractive for crops and later dairying. Locally, gold found seeping out onto beaches and concentrated in heavy mineral seams was mined and excavated using Chinese labourers such as at the famous Macauleys Lead south of Evans Head. Further digging took place on the floodplains to assist in drainage and extend farming from levee sites into the backswamps. The establishment of drainage unions sees the emergence of collective efforts to modify the wetlands, whilst early attempts to train entrances with rock walls reflects initial demands to use government resources to tame nature.

The “fight against nature” culture using engineering expertise and taxpayer funds progressively emerged in the late 19<sup>th</sup> century and continued as the dominant culture until the late 1960s. Legislation and budgets reinforced the necessity during this period to invest in resource development. Lenore Coltheart’s book detailing the history of ports and coastal waterways of NSW (*Between Wind & Water*, 1997) highlights the difficulties faced by boat users, engineers and the State Government in funding, designing and constructing training walls, the legacy of which is still with us. Similarly the floods of the 1950s stimulated a massive works program of mitigation with little regard for ecological and water quality implications, especially the consequences of exposing those mid-Holocene estuarine deposits lurking quietly below the surface with their rich store of sulfides.

The rise of “environmental awareness” amongst scientists, engineers, community groups and finally politicians in the 1970s generated a new culture. We saw through the 70s, 80s and 90s considerable tension at national, state and local levels between those interests supporting environmental protection and those still advocating resource exploitation and development. It was, and remains, a period of opposing paradigms where conflicting values are played out on various

political stages: in council chambers, in the “bear pit” of parliament, and in numerous boardrooms. Save the Barrier Reef, the battle for Kelly’s Bush in Sydney involving “green bans” against property developers, and the fight to protect Fraser Island from miners and loggers, were just three of the memorable clashes of paradigms which dramatically personify this period.

Legislation and funding now supports conservation and has led through the 90s to the latest culture, which involves “sustaining natural values”. This culture is underpinned by ESD principles in federal and state laws and policies.

Thus we see that the present so-called post-industrial period represents a period of growth of conflicting interests in how coastal landscapes should be used. Economic forces push for expanded use in terms of diversity of product and amount of land to be urbanised. Income and job generation accompanying real estate booms produces waves of settlement intensification at different places along the coast. But conservation interests concerned about uncontrolled development have, since the 70s, taken a more proactive stance in developing a political presence, which constrains the forces of economic growth. In addition, scientific discoveries have raised questions of “best practice”. Communication of uncertainties of impacts as well as new insights on management practices give both developers and conservationists material to assist in fostering respective causes. Governments have been put into difficult positions in making decisions to best suit state and local interests. Added complications of population growth coupled with changing demographics projected for the next 2 decades, plus the consequences of global warming such as sea-level rise, serve to make planning for ecologically sustainable development a most complex and politically hazardous task in the years ahead.

### **Transformation of the Coast – Decisions, Impacts & Consequences**

We have seen that the coast has been afflicted not only by the “tyranny of small decisions” but also by the “tyranny of history”. The combined effect of these two tyrannies is a coast which has been savaged by the human footprint: now we are paying the costs and must pursue a course of rehabilitation as well as protection to ensure treasured environmental services and values will be available for future generations.

Five activities can be shown to have had a significant impact on the coastal landscape. They are:

- River entrance training works
- Sand mining of beaches and dunes
- Urban settlements
- Estuary and catchment use
- Floodplain “management”.

In some areas the impact of these activities has been quite minor although the threat of future impacts remains. However, the scale and severity of change induced by an activity can be such as to have required legislation, new policy and / or funding by governments to address both cause and symptom. This has happened in the past and is happening today in both NSW and Queensland. A few examples of each activity will suffice.

## **1. River Entrance Training Works**

Initial settlements through the colonial period were very dependent on shipping. The difficulty of entering harbours, with few exceptions, was due to sand deposition at river entrances. The history of coastal transport is one of contending with river mouths. Engineering practices evolved as understanding grew of the dynamics of entrances. The role of the NSW Department of Public Works in the design of training walls, and in dredging, highlights the many difficulties over time in maintaining effective programs under different governments and local pressures. Financial

restrictions impeded continued operations, and the battle between ships and bars led to much personal suffering and economic hardship. Novels and songs have been written to highlight the traumas of shipping.

I have already referred to Coltheart's excellent book on entrance works. She "sketches the emergence of a politics of loyalty from the 1860s to 1890s, a period when ready investment funds in London underwrote coastal engineering works in electorates from Twofold Bay to the Tweed River. With the vote no longer the privilege of property owners but gradually the right of all adult [male] citizens, energetic struggles for port development regionalised colonial politics, as most voters lived near or were dependent on a coastal port" (1997, p.XV).

Despite the decline of coastal shipping during the interwar years (with some notable exceptions), the cry for more training walls and more dredging is still with us today. The prevailing rationale is local economic need coupled with improved boat safety for recreational and commercial fishing vessels. On the Manning and Nambucca rivers there remains a demand to complete works left unfinished 80 or more years ago. For the moment, State and Federal governments remain unconvinced. An interesting exception is here at the Tweed where years of wrangling over Queensland's demand for sand trapped updrift of the breakwater at Letitia Spit has resulted in a generous investment by one State (NSW) in the long-term benefit of the beaches of another state (QLD).

But questions remain:

- will future populations of cashed-up baby boomers with their new boats convince governments to spend millions to unplug the river entrances in perpetuity;
- will there be a need for further sand by-passing projects to assist in downdrift nourishment of starved beaches; and

- is there a relationship between plugging of river mouths and reduced tidal flushing of estuaries which facilitates the collection of acid charged waters in tidal channels and wetlands.

## **2. Sand mining of Beaches and Dunes**

A phenomenon of geologic inheritance, which has had considerable impact on coastal land use, is the concentration of economically significant quantities of heavy minerals in beaches and dunes. Over a period of 50 years there has been extensive mining of rutile and zircon along this coast. Progressive improvements in mining technologies have enabled larger and more technically efficient companies to remine old areas and seek minerals in deposits of low concentration (eg high dunes such as Stradbroke Island). With a few exceptions mining ceased as a significant economic activity in the late 1980s. Environmental and other consequences of mining are both positive and negative.

Dune use by early settlers was comparatively limited although cattle grazing and some tree clearance did lead to localised sand drifts. Early mining was not very concerned about the process of vegetation restoration, but through work of the NSW Soil Conservation Service (and the Qld BPA) improved techniques did result in better rehabilitation practices. Mining companies became willing participants in the restoration of native plants on dunes encouraged by security deposits (bonds) and government regulation.

Pressure from environment groups in the late 60s and early 70s on unlimited expansion of mined areas into apparently undisturbed sand dunes led to government inquiries. Acceptance of their reports created decisions to restrict access and the “locking up” of large areas rich in minerals. The result of the inquiries also helped in the establishment of several coastal national parks in which mining is now prohibited.

Three inquiries and court actions should be noted. The first is in Wyong Shire at the North Entrance in the early 70s. Here public interest was aroused with the threat to clear large areas of red gum (Angophora costata) forest. In the Supreme Court, Mr Justice Hope commented that: “The areas proposed to be mined include forests of considerable beauty and great value for educational and scientific purposes” (see Morley, 1981 p.187). The companies appealed to the Privy Council in 1975, the last Australian legal case ever to go to that august body. The companies lost, and the area is now part of the North Wyrabalong National Park.

The second case involved the so-called Bunning Inquiry (1974) described by Morley in his book on sand mining as “a milestone in the history of disputes between black sand miners and environmentalists”. The area to be mined lay between Myall Lake and Smiths Lake, north of Newcastle . This dispute involved a detailed scientifically-based EIS, lengthy submissions in opposition, and a very active media campaign. Mr Bunning’s recommendations were accepted by government and involved a compromise leading to massive high dune mining of one section of the Bridge Hill ridge, to be followed by sophisticated and successful vegetation rehabilitation, and the declaration of a national park (Myall Lakes National Park) covering protected unmined as well as mined areas.

The third case has made history in different ways. The Fraser Island Environmental Inquiry was set up in 1975 by the Whitlam Federal Government and decisions were reached by the Fraser coalition government in 1976. It was a classic federal-state-environmental-company-community entanglement. Jobs, economic welfare, multinational interests, strong personalities and some science, were all debated with lawyers and commissioners. The courts also had a role. The end results – mines were stopped (and later so was logging) and Fraser Island now has a World Heritage Listing.

But what of the legacy of sand mining:

- mining “opened up” many poorly accessed tracts of coastal land;
- mining provided land which could easily be converted into housing estates as seen south of here at Casuarina;
- mining of black sand created its own hazardous waste as one mineral, monazite, has a level of radioactivity which has to be handled carefully;
- mining disturbed soil profiles and ecosystems and to some extent permanently degraded national parks in which mining paths are located;
- mining allowed and even encouraged the planting of bitou bush (*Chrysanthemoides monilifera*), now a weed of national significance, costing the taxpayers \$1-\$2 million per year to try to manage;
- and more arguably, mining may have facilitated shoreline erosion in certain localities during the stormy years of the 70s.

### **3. The Impact of Human Settlements**

Human settlements have many environmental impacts in coastal settings. Changes to biodiversity, water and air quality and the consequences of protecting property from natural hazards, should all be mentioned. In this section, I will concentrate on threats to foreshore property, both private and public, and how we in eastern Australia have struggled to protect the beach environment and beach amenity.

The increasing desire to visit or retire to coastal towns has heightened the threat of erosion of property. There is a compulsion to build hotels, motels, homes and other infrastructure on sites at risk to shoreline erosion. Early 20<sup>th</sup> century resort developments were largely confined to rocky headlands. However, the boom of the Gold Coast from the 1950s onwards has given impetus to use coastal sand dunes for locating dwellings on episodically eroding foredunes.

Severe and recurrent storm events in the late 60s and 70s created local shoreline erosion problems of varying severity. Major investigations and beach improvement programs were initiated by these events. In particular, legislation was changed to give NSW and Queensland governments greater power on planning and managing the erosion threat.

Without going into details, it is now apparent that legislation and policies in both states have required reinforcement in recent years. The sad thing is that from a manager's perspective, historical decisions based on land titles severely restricted "best practice" beach protection, and allowed judicial decisions to support property protection over any obligations that the state may have to maintain the beach amenity and the public's right of access to the beach. Use of the "land surrender" provision of the Queensland Coastal Protection and Management Act (2001, 61ZU), and new enforcement provisions of the NSW Coastal Protection Act (as amended 2002), combined with the new Coastal Protection SEPP (No.71), should make it that much harder for landowners and councils to dump rocks, car bodies and other objects capable of injuring people and affecting the movement of sand during emergency erosion events.

Back in 1968 the Soil Conservation Service of NSW was issuing guidelines for the location of urban subdivisions behind frontal dunes. One guideline stated:

- (a) The frontal dune should be retained as a natural barrier against disturbance.
- (b) The frontal dune should be reserved as public land because of the need for the public authority to accept responsibility for preventing and controlling damage by wind and wave erosion. *If the frontal dune is owned by several owners in small lots there is very little chance of effective coastal measures being undertaken against either beach or wind erosion* (Condor and Barr, 1968, p.240).

These guidelines were reinforced in the 1997 NSW Coastal Policy and fortunately supported in a Land & Environment Court judgement (Davfast v. Ballina Shire Council, 2001). But they highlight

an ever-present problem in coastal management encapsulated in the phrase the “tyranny of small decisions”.

The erosion threat is ever present. Global warming with its potential for higher sea levels, and the threat increased storm activity along this coast, make the hazard of development on frontal dunes (and on cliff edges) that much higher. We are faced with many questions such as:

- how to best protect existing property at risk;
- is the scale of beach nourishment seen on the Gold Coast (including the Tweed bypass project) capable of being reproduced elsewhere and what are the environmental consequences and recurrent costs;
- can coastal zone management plans effectively provide a basis for a long-term commitment by communities and governments to protecting our beaches given the need to interface those plans with other environmental, economic and social plans and interests; and
- will the legal system be more supportive of beach sand rights or private property rights when governments resist the call to protect every property at risk ?

#### **4. Estuary and Catchment Use and Abuse**

Critical to human and biological health of coastal waterways are factors influencing the discharge of waters, sediments, nutrients and pathogens into rivers and estuaries. Throughout 19<sup>th</sup> and 20<sup>th</sup> centuries land clearance, soil erosion and urbanisation (including canal estates) have all contributed to the cumulative degradation of rivers, estuaries and coastal lakes. Symptoms of the degradation are many including:

- siltation of channels, which in some cases like on the Hunter has resulted in downstream displacement of shipping ports, and in the burial of estuarine sea grasses;

- increased levels of nutrients, especially nitrogen and phosphorous, which are key elements for plankton and plant growth and when they reach excessive levels trigger algal blooms; and
- presence of pathogens which may be digested by humans causing death and ill-health following consumption of seafood and in swimming.

Graham Harris in recent reviews of land use, catchment biochemistry and water quality in Australian rivers, lakes and estuaries (Harris, 2000, 2001) has concluded:

The combination of flow regulation, impoundment of rivers and removal of wetlands has had a major effect on the ecology of Australian rivers. Clearance and land use change, increased erosion and increased sodicity, have flipped many Australian rivers from clear and macrophyte dominated to turbid and plankton dominated. These effects are no longer reversible without massive and unrealistic, landscape rehabilitation. While the rivers have been largely lost, most Australian estuaries are not yet past the “critical-load” point.

Quite clearly urbanisation and deforestation has had some effect along the east coast. The saga of Wallis Lake since the oyster contamination event of 1997 is there to remind us of the sensitivities of waters to pollutants. These sensitivities are not just biophysical and economic, but also lead to complex judicial proceedings on responsibilities under the common law concept of “duty of care” currently being determined in the Wallis Lake case by the High Court.

Harris, using data from various sources, has demonstrated linkages between land use and water quality. In particular, he shows how forested catchments yield lower levels of nutrients than agricultural and urban catchments, a not unexpected conclusion. What is interesting is that nitrogen coming from relative pristine catchments is organic nitrogen, whereas that coming from watersheds with high export rates is nitrate or ammonia, in other words “very good fertilisers”.

Thus when we increase the exports of nitrogen, we change its form, and in the words of Harris “that is critical for impacts on coastal waters” (2000, p.10). From Sydney catchment data, he showed up to 50-60% of exported nitrogen is nitrate or ammonia which is going to cause problems with algal growth. Although many of our estuaries and coastal lakes are, generally speaking, “in pretty good shape” (p. 15), there are grounds for concern. A switch in condition, or a hysteresis effect, may result especially in coastal waterways which are poorly flushed. Experience from the Gippsland Lakes in Victoria, and to a lesser extent from Myall Lake in NSW, indicates how these water bodies can suffer from algal blooms: the ecological changes are significant and there are economic implications as well.

NSW is both blessed and cursed with ICOLLs. They provide that beautiful backdrop of coastal lakes which now constitute prized locations for real estate agents. Yet by definition they are poorly flushed for long periods. As with their big brothers, the open or ventilated estuaries like Sydney Harbour, their mud basins trap pollutants including heavy metals. Cockle Bay in Lake Macquarie has an estimated hundred million dollars of lead within its sediments, but the cost of extraction is horrendous. Sea grasses, and other aquatic indicators of good health, are constantly under threat from pressures of urban growth. Good science coupled with good management and planning can make a difference.

We know that increasing nutrient loads or even the sediment loads from catchments into estuarine and lake systems may not trigger off much change as these systems have considerable resilience to varying biophysical conditions. However, the fear is always that a lake/lagoon or estuary backwater will go beyond the “critical load point”. Turbidity and phytoplankton will then dominate, and again in the words of Harris, “everyone’s telephone would start ringing off the wall because water quality would now be appalling” (2000, p.16). It was such a concern that encouraged Planning Minister, Andrew Refshauge, in 2001, to stop a 2000 lot subdivision at Lake Wollumboola

on the NSW South Coast. This was at a location which years before had been zoned for such intensive urban use.

The lessons for us are manifold:

- we can make a difference to the health of coastal waterways if there is a concerted effort by authorities and communities to regulate and manage water flows as seen in Sydney Harbour;
- urban sprawl and economic use of ICOLLs in particular, and estuaries in general, have to be very carefully planned with aquaculture, sewerage and urban runoff schemes so designed to minimize polluted overflow into receiving waters;
- riparian and wetland revegetation in catchments and around estuarine shores needs to be a priority in any coastal catchment management programme; and
- good science, coupled with assessment of potential land use impacts, must continue in order to ensure sustainability of complex east coast waterways.

## 5. Floodplain management

And now to that coastal environment which is of direct relevance to participants at this conference: deltaic floodplains. Your specialist knowledge of this environment and its geochemical behaviour far exceeds mine so I will not labour its environmental properties and history in this address. However a few points need to be made in context with the other stories I've told today about how we need to both understand and learn from our past.

My own familiarity with deltaic floodplains commenced in the early 60s when I inspected newly dug drains cut through the Eskdale backswamp of the Williams River, a tributary of the Hunter near Newcastle. The engineer-in-charge of the flood mitigation works for PWD proudly showed me the network of drains slicing through the swamp to help facilitate runoff. What excited me, however was a blue-grey clay rich in *Notospisula* bivalves below a floodplain silt. I was after the shells as

their location just below MLWM highlighted the existence of a huge proto-Hunter estuary. They yielded a C14 date of c.5900 years. This was the first date from such an environment in NSW, defining a Holocene sea-level history somewhat different from that being espoused overseas.

Around this time, Pat Walker of CSIRO, was exploring similar estuarine sedimentary sequences in more detail on the Macleay. His study of “cat clays” was a pioneering effort in the study of potential geochemical changes to these sediments on exposure. In the mid 70s, I had the opportunity of drilling some of these deltas, especially the Shoalhaven, and helped contribute to the study of their morphostratigraphic evolution in association with Peter Roy.

As noted earlier, drainage for agriculture and flood mitigation (and more recently aquaculture) has “opened” up the deltaic surfaces. It was not known that as part of our geologic inheritance sea level had been more or less stable from 6500 years or so, and by digging these drains part of that geologic history, the sulphide mud basins and intertidal flats, were going to be exposed and it would hurt!

Sea level may have fallen slightly since the Postglacial Marine Transgression (PMT) terminated at  $6500 \pm 200$  years. This “termination” event has had dramatic consequences for human use of coastal NSW: sand barriers have prograded and vertically aggraded; flood-tide deltas have choked entrances; heavy minerals have been swept ashore and concentrated in seams; and estuarine and tidal flat sediments have had time to accumulate to levels close to (and even above) MHW, and be covered by a layer of fine sediments deposited during river floods. Levees, crevasse deposits, abandoned channels, backswamps and lagoons have all evolved over this “stillstand” period. Anoxic conditions prevailed for thousands of years allowing iron pyrite to remain unaffected by oxygen, but upon drainage and exposure, then alas one reason for our presence here today becomes established.

The questions and problems related to the origin and management of acid sulfate soils are for you to explore at this conference. Since those early studies of Walker much has been learnt in eastern Australia as well as from many other parts of Australia and from other countries. This conference will offer all of you an excellent opportunity to share your experiences and help find ways of avoiding future fish kills, sulfuric acid discharge into coastal waters, wetland destruction and loss of agricultural productivity.

There are many lessons we have learnt from past “mistakes” in land and water use in Australia. I have tried to place our use of coastal environments in eastern Australia in a context of first struggling with nature, then fighting nature, only to be followed by a period of greater environmental awareness. You are all part of a generation which takes us beyond just awareness into the brave new world of sustainability, being built on the need to understand and adapt to changing biophysical systems so that we can more effectively manage and plan for improved environmental, economic and social benefits.

Thank you.