

### 5.6.1 Environmental research

Research should be broad in scope and include examination of social science questions, particularly those associated with the raising of awareness and attitudinal change in relation to natural variation in the environment of the ARR. Natural systems research is needed to document the processes of change and their effects on the biophysical environment. Both areas of research endeavour will require a high level of innovation in order to integrate the cultural implications of change for Binninj and Balanda. *eriss* has approached this task and has based its wetland research direction on key local issues (see Finlayson 1995) under an umbrella of national interest in ecologically sustainable development.

### 5.6.2 Monitoring

Management of coastal wetlands requires that effective monitoring programs are implemented and that the results are effectively utilised. Monitoring of ecological change in wetlands can be undertaken at several levels and with vastly different techniques. Satellite imagery, often linked to a GIS, aerial photography, flora and fauna surveys at the species and community levels, physico-chemical analyses, ecotoxicological testing, and biomonitoring in stream and bankside all have particular advantages and disadvantages. These have been reviewed by Finlayson et al (1994). The choice of technique is dependent on the objectives of the monitoring program and the nature of the site.

Monitoring also encompasses social, economic and cultural dimensions of change in the coastal zone of the ARR. Social science survey techniques are needed to monitor levels of awareness and community attitudes to the effects of environmental change. Such work should be undertaken in a cross cultural context to ensure that Balanda biases do not overwhelm all community interests., as well as to ensure that there is a high level of community involvement in ongoing assessment of environmental change.

Apart from monitoring to assist with maintenance of the intrinsic values of the region, there is a need to provide national and international benchmarks from which to measure changes in wet-dry tropical environments. The ARR, and especially Kakadu National Park, provides an excellent opportunity for the establishment of a National Environmental Reference Station for the wet-dry tropics. The circumstances that make this region special are that it has a sound history of research, and that there is considerable body of material that could be collated and synthesised to provide baseline descriptions of the essential characteristics and attributes of change in this type of environment. *eriss* has a considerable infrastructure already in place to facilitate continuous measurement of climatological and hydrological parameters, and a number of permanent sampling stations have already been established. Additionally, there is a substantial aerial photographic record.

## 6.0 Management responses

In the Northern Territory context, for example, I believe that one metre rise of sea level in 100 years or so would turn the South Alligator plains and wetlands to mangrove, samphire, and salt flat from the coast through to a zone about 20 km south of the Arnhem Highway, and that other parts of Kakadu National Park would be similarly affected. We should understand this matter now so that appropriate monitoring can begin and the costs or remedial action can be considered, before any such change is upon us. (Chappell 1988)

## 6.1 Assessment of the significance of changes

There is a very substantial body of information describing geologic and, particularly, recent historical changes to the coast and wetlands of the ARR. The changes are consistent with similar changes reported to have occurred elsewhere on the coast of Van Diemen Gulf. Oceanographic processes contribute to many of the changes and are manifested by very high rates of shoreline erosion, changing tidal regimes within the river systems, and contribution to saltwater intrusion into freshwater ecosystems. Changes resulting from these processes are seen in reduction of the fringing mangroves along the shores of the Gulf, expansion of the samphire and saltflat areas, colonisation of mangroves along estuarine levee banks, and the headward erosion of tidal creeks. The processes of change are interactive with those of the river systems and with human interference, particularly the introduction of feral animals and infestation of introduced plants. While the terrestrial and riverine processes of change are reasonably well researched remarkably little is known of the hydrodynamic processes in Van Diemen Gulf and their immediate impacts on the shoreline of the ARR.

### 6.1.1 Natural

Ecological process affected by environmental change include the expansion and contraction of plant communities with consequent effects on animal habitats. Again, knowledge of the interaction between wetland plant communities and changes in hydrological and depositional conditions makes prediction of the long-term effects difficult. Plant communities are viewed as being widespread in the region and highly dynamic in terms of variability in species composition, structure of the community and geographic spatial extent. The plant species are widespread at pan-regional and regional scales and no communities or individual species of rare or endangered species have been recorded. Similarly, animal species are widespread and no rare and endangered species are known from areas that could be affected by environmental change.

#### *Freshwater floodplains*

Stratigraphic records show that as recent as 1500 years before present virtually all of the subcoastal alluvial plains supporting today's freshwater wetlands were saline and covered by estuarine mangroves. At that time the freshwater floodplain flora and fauna in the region would only have been conserved in the set of isolated refugia provided by billabongs and swamps associated with more upland reaches of the rivers and creeks. How effective these refuges were, how many species were driven to extinction or how many others teetered on the brink of extinction will never be known. What can be said though is that the diversity of freshwater wetland biota on the present-day subcoastal floodplains is a direct measure of the collective conservation capacity of those refuges.

Faced today with global climate change, particularly sea level rise, and the possibility that much of the freshwater floodplain habitat in the region will be lost to a 'second coming' of mangroves, the upland swamp and billabong system may again act as the primary refuge for regional freshwater floodplain biota. Will the collective conservation capacity of the upland swamp and billabong system be as effective in the future as it was in the past? An assessment of this as a measure of vulnerability of floodplain biodiversity to climate change is probably ecologically more astute than one based simply on the loss of coastal floodplain habitat per se, which in the natural scheme of things is an unstable, temporally transient environment.

The recent history of upstream swamp and billabong systems in the ARR has been dominated by intensive disturbance from feral buffalo, cattle, horses and pigs. The problem wetland weeds, *Salvinia molesta* and *Brachiaria mutica* have been very successful at establishing in these systems, and *Mimosa pigra* is a constant threat. Many upstream billabongs may now

have been released from such intensive pressure through recent removal of wild populations of buffalo and cattle. Clearly though having been exposed to such impact, for a long period of time, the current status of upstream billabongs and swamps needs to be evaluated in terms of how well they continue to conserve the biodiversity of the floodplain habitats. It has already been demonstrated that very few animal species would appear be threatened by a total loss of floodplain refuge area. However, the same may not be assumed of the flora ; there is simply insufficient basic distribution data from upstream wetland areas to be able to make an assessment although from a survey of 3 upstream and 2 floodplain billabongs associated with Magela Creek (Finlayson et al 1994) almost 30% of the plants occurring on the floodplain were absent from the upstream billabongs.

The above discussion probably represents a worst case situation that won't eventuate during the current period of climate change. However, in the event that only modest losses of present-day freshwater floodplains occur there is still no guarantee that the biodiversity of its flora will be maintained. This is because extinctions in downstream floodplain environments could still occur; driven primarily by competitive exclusion of native plants by aquatic weeds such as *Brachiaria* and *Salvinia*. There is insufficient knowledge about how these weeds are interacting with the native plants to validate this assertion. With low incidence of aquatic weeds however, the case for focussing on protection of upstream billabong and swamp habitats may be further strengthened.

#### *Monsoon forest*

Many aspects of the future climate scenario indicate a potential for coastal and subcoastal monsoon forest to improve their current status; ie improved soil moisture relations through wetter Wet seasons and a more persistent ground water supply during the Dry season; greater productivity from elevated CO<sub>2</sub> levels and warmer Wet seasons. Critically though, the climate change scenario does not suggest any change to current seasonality. If anything, the definition of seasons in the future may be more pronounced with the Dry season being drier and warmer. It may be this, and the potential it has to produce a more intensive fire regime that could eventually determine the future status of coastal and subcoastal monsoon forest. An overall increase in exposure to 'hot' fires may initiate a long-term trend of decline (Russell-Smith & Bowman 1992). However, this potential need not be realised. Unlike many of the other more insidious elements associated with climate change, cost-effective practical management strategies to reduce undesirable potential impacts of fire are possible. If long-term conservation of coastal and subcoastal monsoon forest is a priority for the future of the National Park management environment of the ARR then current fire management strategies to reduce the incidence of 'hot', late-Dry season fires will need to continue for the foreseeable future.

#### *Mangroves*

Mangrove settings include some of the most spatially and temporally unstable environments in the ARR; a consequence of having young, unconsolidated substrates continuously exposed to the cut and thrust of daily macro-tidal oscillation and annual floods. Mangrove communities are thus an expression of success in a contemporary environment dominated by change. However, from an historical perspective, their survival to the present is also an expression of their resilience to the various sea level fluctuations that have occurred throughout recent geological time. Present-day survival though, will not necessarily confer future survival, especially if anticipated future global climates are more extreme than those of the past.. It would appear that anticipated sea level rises in the ARR, particularly the rate of rise, while high, will probably fall within the range of historical experience. While this may appear to offer some measure of confidence for a future for mangrove communities

characterised not only by mere survival, but with possible proliferation, it hinges on the critical assumption that future sediment accretion rates will match the rate of sea level rise; they have done in the past.

#### **6.1.2 Cultural**

Reduction in freshwater habitats as a possible consequence of sea level rise would undoubtedly have an effect on most of the floodplain flora traditionally used by Binninj as part of their staple diet. The effect on fauna would be dependent on such characteristics as species mobility, range of habitat and food, as well as nesting requirements.

In a regional context, presence of effective refugia for plant and animal species displaced by local habitat loss may ensure survival of threatened biota and thus provide opportunities for Binninj to maintain their utilisation of traditional resources.

It may be the case that the effect of climate change/sea level rise needs to be viewed as another element in a complex of influences upon Binninj and hence their culture. Already utilisation of traditional resources in the ARR has become part of a wider strategy which incorporates certain material, social and political elements of Balanda origin. In itself, displacement of certain species from the Binninj diet may be more an issue for those cultural aspects tied to a long relationship with hunting and foraging for a particular species. Indeed, the changes may be encompassed within the natural flexibility and opportunism traditionally displayed by Binninj in their utilisation and management of natural resources. Concern for what might be viewed as an example of depauperation of species or cultural values may be largely an issue of anthropological sensitivities rather than something of concern to the Binninj. With the possible expansion of one habitat over another, the availability of alternative staple species may be an acceptable trade off. This is something Binninj will decide for themselves and we should be careful not to make assumptions.

#### **6.1.3 Social and economic**

Population pressures are expected to increase within the Region irrespective of environmental change. This will have significant effects on the natural resources of the Region through the demand for increased access to the resource base of the coastal wetlands. Strategic planning is required to address this problem at the biophysical regional level, and ensure that population growth and development can proceed in an orderly fashion and not degrade the significant environment values that underpin economic growth in the region.

Infrastructure within the region has been developed to cope with extreme events, although with a necessary component of contingency action and maintenance being required during and after each major event. Future infrastructure planning and provision should take into account the probable need to accommodate more frequent and severe weather conditions, including increased summer rainfall, high temperatures, Dry season droughts and increased fire risk.

#### **6.1.4 Governance**

Governance in the Region is currently not geared to deal with environmental change of the type and magnitude that is currently occurring. Issues are dealt with on a sectorial basis rather than in an integrated, intergovernmental and cross-sectorial manner. Change is manifest across the biophysical region irrespective of jurisdictional boundaries. Governmental structures and community based management mechanisms must be developed that provide a consistent and appropriate response for system management, rather than simply addressing problems at a sectorial level.

## 6.2 Integrated environmental management

Integrated environmental management has been a topic of considerable research by the Centre for Resource and Environmental Studies at the Australian National University (Brown 1994; Brown & Reynolds 1992; Brown & Smith 1992) with particular focus on the coast (Brown 1995). This research was funded by the Commonwealth and sought to enhance the role of local government in the management process. Additionally, the Commonwealth has funded the Australian Centre for Local Government Studies to develop courses in integrated environmental management for officers of government (Waterman 1995). This has worked towards development of capability in the areas of coastal and catchment management. The Commonwealth has recognised that all three spheres of government must be involved in the management process for it to function effectively.

The Commonwealth Coastal Policy is the basis for *putting the Commonwealth's house in order* (DEST 1995). A lack of integration across sectorial interests within government has repeatedly been identified as a cause for great concern about the effectiveness of coastal management. The number of agencies with sectorial management responsibilities that affect the coast and the unclear boundaries of responsibilities contributes to this lack of integration (RAC 1993). The Commonwealth view is that the best way to achieve integration of Commonwealth programs affecting the coastal zone is for agencies and authorities to retain existing responsibilities while increasing coordination between them. This ensures that programs and policies share a common goal and meet government objectives for use of the coastal zone (DEST 1995).

Integrated environmental management is essential for the ARR because of the range of Commonwealth Government sectorial interests. These include Parks Australia, EPA-*eriss*, the Australian Heritage Commission, Bureau of Meteorology and CSIRO. If the various departments and agencies, several from the same portfolio, can't coordinate their activities in the coastal zone of the region there is very little hope that integrated coastal management can be achieved at an intergovernmental level elsewhere. The need to bring the Northern Territory Government, the Northern Land Council, Binninj Associations and the Jabiru Town Council together with other organisations and communities of interest adds another dimension to integrating the management process.

Management is a process that integrates the control mechanisms, organisation and administrative arrangement, planning, implementation, monitoring and auditing. This process can be applied within a sphere of government, or can bring spheres of government and communities together to work strategically toward common goals and agreed objectives.

### 6.2.1 Control and organisational arrangements

Control of the management process for Kakadu National Park is derived from the Commonwealth *National Parks and Wildlife Act 1975*. Elsewhere in the ARR it is more difficult to specifically prescribe a statutory basis for control. That is, there is a range of statutes covering the sectorial responsibilities for management of specific resources in land under Northern Territory jurisdiction and administration by the Northern Land Council. For management to be integrated at a regional level there will need to be specific control mechanisms established through intergovernmental agreement.

Organisational and administrative arrangements for Kakadu National Park are specified under the *National Parks and Wildlife Conservation Act 1975*. The arrangements are detailed in *Kakadu National Park Plan of Management* (ANPWS 1991). These arrangements encompass the mechanisms for controlling activities in the mine lease areas and the town of Jabiru. There are no

administrative or organisational arrangements that are specific to coastal wetland areas within the Park.

Integrated catchment management has been implemented for the Mary River. A catchment management committee has been established that brings together government, conservation, pastoral, fishing and community interests. There is no similar organisational means of dealing with management of those parts of the East Alligator River. A Landcare group operates in the catchment of the Mary. No similar group operates on the eastern flank of the Park, although the multi-agency Mimosa Strategy Committee has provided a mechanism for integrated control of the weed.

There is scope to develop an innovative approach for the control and organisational arrangements of integrated coastal management for the ARR. This can be done through the use of a Task Force representing Commonwealth, Northern Territory Government, Northern Land Council, Binningj associations and local government.

### **6.2.2 Coastal and catchment management plans**

In its policy statement the Commonwealth Government identified a number of areas on which attention should be focused to improve coastal management (DEST 1995). These include:

- community participation in coastal management;
- provision of integrated solutions to particular management issues;
- increased capacity and knowledge of those with coastal management responsibilities to enable them to be discharged effectively;
- development of appropriate links with regional neighbours.

All of these matters have been canvassed above and the most appropriate mechanism for their application is through the preparation and implementation of coastal and catchment management plans. For Kakadu National Park, these plans could be prepared as an integral part of or addendum to the Plan of Management. A coast and catchment plan could be prepared for each of the rivers within the Park. The plans should be developed cooperatively with the jurisdictions responsible for those parts of the East Alligator and Wildman Rivers outside the Park as a function of the Task Force (Section 6.2.1).

The plans for each catchment and its coastal component of the wider ARR should be drawn together in a Regional Strategy for management of coastal lands bordering Van Diemen Gulf. Such a strategic planning framework is essential to ensure that coastal management for the biophysical region is integrated and that parties responsible for the implementation of specific coast and catchment plans are working to shared goals and commonly agreed objectives. The Task Force should serve as a technical steering committee for preparation of the Regional Strategy.

### **6.2.3 Governmental and community involvement in implementing management**

Government and community involvement in the implementation of coastal and catchment management plans should be as broad as practicable. Resources provided for implementation should be allocated with full awareness of the multi-faceted nature of the management processes needed to deal with the maintenance of the conservation and economic values of the area as well as for the long-term sustainability of the greater region within the context of environmental change.

Mechanisms will be required within the regional strategic planning, and coast and catchment planning, processes that will accommodate the consultative processes used by Binningj. Consultation mechanisms should be used that can cater for the small and dispersed regional

population. The use of electronic communication systems should be fostered. Existing technical committees run by *eriss* and Parks Australia could provide part of the mechanisms. However, these are generally directed towards technical planning and advice and may not be appropriate for the broader community. Yet, it is the involvement of the entire local community that is essential if local community responsibility and empowerment are to succeed.

#### **6.2.4 Monitoring**

Monitoring and baseline research has been undertaken in Kakadu National Park and on the floodplain of Magela Creek since mining commenced at ERA-Ranger uranium mine. Results of the wide ranging studies and investigations have been documented in published and unpublished sources (Bibliography and Appendix 1). As a first step in upgrading monitoring programs to provide information on climate and associated changes the location of sites previously used for environmental monitoring should be accurately determined. Additionally, all future field work should be georeferenced by using a differential Global Positioning System. There will need to be a meta-database developed to locate and indicate accessibility of all material, and a full audit undertaken of all spatial data to incorporate it in the ARRGIS. This will require determination of data integrity, including its reliability, scale of capture and area of coverage.

*eriss* is ideally located and resourced to provide the expertise to establish and operate a National Environmental Reference Station. Such a service would provide information which will have utility for wider application for park management and monitoring effects of mining and other activities within the region.

Tasks that could be undertaken by the National Environmental Reference Station include:

- baseline and Reference Station Research to provide input to the National Coastal Monitoring Program to be initiated under the Commonwealth Coastal Policy, and as input to international climate change monitoring programs such as the Global Ocean Observation System;
- administration and operation of long-term monitoring programs which focus specifically on climate change implication for the management of the tailings dam and mine tailings and overburden stockpiles in the catchment of the Magela Creek;
- information management, including custodianship of spatial information for Kakadu National Park and the Van Diemen Gulf Region;
- co-ordination and documentation of change in the Van Diemen Gulf Region, including the coastal wetlands, shores and nearshore waters;
- provision of information and advice to assist strategic planning, preparation of coast and catchment plans, and implementation of specific management programs and prescriptive tasks;
- auditing of the effectiveness of planning and management activities in Kakadu National Park and the Van Diemen Gulf Region.

Specific monitoring requirements have been identified for the coastal wetlands of the Region. These are outlined in Appendix 4.

#### **6.2.5 Auditing**

Auditing is an integral component of the monitoring process and is essential for providing feedback on the effectiveness of the implementation of management plans, research

programs, and day to day tasks. The key auditing activities required to support Regional Strategic Plans and the Coast and Catchment Plans should include:

- management reviews;
- compliance auditing; and
- review of plans and monitoring programs.

Even when effective monitoring is undertaken the audit process can lag behind. Efforts to effectively audit environmental management at the ERA-Ranger Uranium Mine may provide the basis for even further environmental auditing in Kakadu National Park and the ARR as a whole.