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MONITORING SEA LEVEL AND COASTAL CHANGE

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ABSTRACT

It is well established that New Zealand has a large highly varied and already much modified coastal zone for which we have not always done a good job of balancing private rights and market forces against the inherent character of the zone, sustainability of use of and wider community interests. For many years it has been argued that better management of the coast should flow from sound knowledge of its physical and ecological systems. Monitoring of sea-levels and shoreline changes are basic to informed decision making.

Yet no comprehensive, co-ordinated programmes exist for these purposes and no agency exists with a clear mandate to inform us about our coasts. Research to date has been piecemeal, reflecting the interests and field areas of the few available scientists and the dictates of crisis or project-oriented studies. More recently there has been a growing regional level of activity by MOWD (pre-demise), by some Catchment Authorities and some Harbour Boards. The places and futures of these initiatives in government restructuring and devolution are far from clear. The advent of Department of Conservation with a limited mandate for the coastal zone has seen a strong initiative to take inventory of shores as a prime establishment activity and as an ongoing management tool. At the same time the planning legislation is in flux, and there is strong interest in market forces as determinants in resource allocation; and there is growing concern at all levels of the community with the problems of "Greenhouse" gasses and the prospects for accelerated sea-level rise.

The needs for monitoring sea-level and coastal change are thus greater than ever but the means by which the measurements and research are to be done in the national, regional and local interests are less clear than ever.

INTRODUCTION

Were it to be advocated, as an example, that water resources are of such little value or at most of local significance to us that monitoring and research can be left to whomever shall need or choose to do these activities, for whatever purposes to whatever standards; then at least a few eyebrows might be raised. Yet, such has long been the case with monitoring of the coast and with the research necessary to give measurements meaning. This is not to denigrate the efforts being made by disparate individuals and agencies, merely to point out that they are isolated, non-coherent efforts that are poorly underpinned by connections to basic research on one side and to clear coastal management on the other. Such monitoring and research as are done more often reactive than anticipatory and are usually project or crisis-led.

On the coast the present ferment about "Greenhouse" is remarkable for the extent to which it throws up old problems in new relief rather than raising new ones. It is a fact that we have never moved to be well organised to comprehend our coast and have been slow to integrate what we do learn into planning, management, policy and legislation. The latest in a time-honoured line of reviews of this situation by many authors is to be found in Kirk (1987).

If the gravity of the "Greenhouse" hypotheses cannot prompt a more adequate structure for coastal monitoring and research in the national, regional, and local interests, it beggars analysis as to what can.

Monitoring of coastal change and its causes is thus a fragmented, thinly populated activity that evidences large disparities in data quantity, quality and applied expertise from place to place. It reflects exactly the institutionalised ad-hoc-ism of coastal management in New Zealand.

Monitoring of sea-levels is an activity that no-one has undertaken, though data collected for other purposes from tide gauges in enclosed harbours have limited use in the embryonic field of New Zealand sea-level studies.

It should thus be no surprise that there is no agreed or "standardised" equipment, or techniques for measuring coastal change; no codes of practice no uniform methodologies for precision, frequency or reliability of data. Similarly, there are only the crudest common threads in the analysis, presentation and uses of such data.

Ocean waves, the prime agents of coastal change are not recorded systematically anywhere on the New Zealand coast except as an outcome of the Maui operations off Taranaki. The recent formation of a New Zealand Ocean Wave Society(Inc.) is an attempt to improve this situation.

Few other developed nations find it acceptable or economic to try to determine wise-use of coastal resources in sustained ignorance of primary energetic factors and first order response. To this, as noted, we now add our concerns about "Greenhouse" and the spectre of accelerated sea-level rises, again begging questions of our knowledge of local relative sea-level change, its significance as an agent of change on our very varied coast, and of our technical and institutional capabilities to deliver the answers the community will need. Lack of our own monitoring information makes it increasingly difficult to relate to models and research procedures developed in other parts of the world. Again this situation contrasts markedly to those in other areas of environmental research where well established agencies and structures are adapting quickly to new perspectives.

Uncertainties about the physical future of a coast we seem unprepared to know the basic energetics of are matched by a state of legislative and institutional flux. By 1977 the Town and Country Planning Act incorporated a well-intentioned, if ill-defined statement of "national concern" for coasts. The advent of the Department of Conservation has seen a new coastal initiative seaward of mean high water mark, and the launch of an inventory exercise as an established activity to provide the base for a management resource. Monitoring of coastal changes, waves and/or sea levels and the ongoing research to support and apply the work presently form little part of DOC's functions.

More generally, the principal planning legislation for land and water (are coasts land or water?) is under review in a climate of 'user pays', 'market forces' and devolution of functions. Here it is cautionary that most of our numerous hazard sites on the coast represent failures of the market and the decision making process to adequately identify the physical character of coastal land and its responses to commonly applied development practices. It is difficult to discern the place of "Greenhouse" with all its technical and managerial coastal connotations in the review process. The "state of the art" in coastal monitoring is as uncertain as ever; but it seems it is still in the kitchen where the heat has just been turned up even as the cooks continue to debate among themselves about the menu and the places to serve it on.

MONITORING SEA LEVELS

In strong contrast to predictions of future sea-levels held to be probable by given times, we are in virtual ignorance of the historical behaviour of sea-levels in our region. No organisation monitors sea-levels per se, yet we are data rich. Most port authorities operate tide gauges for navigational purposes and the Navy stores the data for checking tidal predictions. Until now, there has been little other work on this mass of raw data. Sea-level studies are thus in their infancy for New Zealand.

Analysing tide gauge records for secular sea-surface change is costly and technically complex, not least because the changes sought are small signals among higher frequency variations that are orders of magnitude larger. Technical procedures for datums, data reduction, detrending (eg. removing tidal frequencies of up to 18.6 years), air pressure correction etc. are all matters vital to the results obtained for secular change.

While tide gauge records provides a starting point they come from enclosed harbours, sometimes remote from the open sea, so that they differ significantly from conditions on the open coast.

It is also pertinent that sea-level varies at many different time-scales. Some of these have frequencies measured in years and amplitudes that are large (many cm) with respect to secular rates of change. There are, for example, important weather (and sea-state) coupled variations of sea-level related to ENSO(El Nino/Southern Oscillation) phenomena that have been shown elsewhere (e.g.Australia, West Coast, U.S.A.) to be as significant, if not more so than the secular changes targetted by "Greenhouse" as major determinants of shoreline change.

In short, it is an assumption that secular sea-surface change is a prime, if not the dominant influence in coastal stability. Similarly, it is important to be clear that assumptions are also involved in ascribing secular sea-level change to global warming.

Resolving these questions can most readily be attempted through simultaneous monitoring of sea-levels, waves and coastal change. Such experiments would also allow better modelling of the relationships between water-level and shoreline position. Presently available procedures are poor in that they involve very restrictive assumptions that are seldom satisfied for even the simplest beach geometries.

"Greenhouse" also implies changes in the distributions of extreme events. Here it is pertinent that waves erode the coast and transport the bulk of inshore sediments, not varying water levels. Extreme waves are thought of readily in height, frequency and power terms. Perhaps less obvious are changes that might occur to wave approach direction. Coasts and their sediment transport systems would respond at least as dramatically to changes in the vectors of storm energy application as to changes of event magnitude.

Recent research in Australia has demonstrated important teleconnections among elements of weather, ocean water levels, wave action and beach change. Monitoring of sea-level change alone is therefore unlikely to prove adequate for predicting coastal change (Bryant 1987).

Finally, it is a well known feature of all coastal work in New Zealand that the shore is so physically variable (for example, in structure, tectonics, sedimentation and ocean processes) and so culturally modified that research findings have poor portability from place to place. No single figure for sea-level change (either past or future) is likely to suffice for more than local or regional purposes. There has also been a tendency for predicted sea-level rises to be steadily reduced in magnitude.

MONITORING COASTAL CHANGES

This activity is more advanced than studies of sea-level change but is spatially, temporally, and technically highly non-uniform. Monitoring of coastal change is also written into consent conditions for activities such as coastal sand mining with increasing frequency. Quite what is to be measured, to what temporal and spatial standards and for what purposes are usually unspecified.

Coastal change is usually determined by two interrelated methodologies. Historical changes are usually determined for the coast in plan by correlating old surveys, maps, deposited plans and air photographs made at a variety of dates since 1930. Contemporary changes are more often determined for the coast in profile by repeated survey of transverse profiles.

Catchment Authorities, some local authorities, the former Ministry of Works and Development, and university coastal research groups have been responsible for most monitoring of coastal change. Viewed from national and regional perspectives the effort has been piecemeal. The longest profile survey records span about one decade with remeasurement either at about annual frequency or after significant storms. Spatial coverage is highly variable and few surveys extend offshore to include the important form and volume changes that occur beneath the surf and the nearshore. Analysis and presentation of the data is usually in crude forms such as intersurvey erosion and/or accretion (rates, distances and sand volumes) or as cumulative changes, or as averages. Application of the data to modelling of shoreline changes has yet to be attempted and only one attempt has been made at a national survey of historical coastal change (Gibb 1978).

The Geography Department coastal group at Canterbury University has been active in developing improved analytical methods for monitored data on coastal change, initially through the necessity to predict performance standards for beach nourishment (Kirk and Weaver 1985). Neale(1987) has extended these techniques to enable important insights into rates and patterns of longshore sediment transport, so that there are good prospects for a high quality management yield from profile survey data; provided fieldwork and technical standards are adequate to ensure spatial and temporal coverage. In the present climate of reform and reconstruction it is far from clear how such coverage will be obtained and where the specialist expertise will be based to render the information meaningful, not least in "Greenhouse" contexts.

CONCLUSIONS

The advent of "Greenhouse" concerns, especially as to the prospects for accelerated sea-level rise, has rapidly heightened a steadily growing demand for high quality and more comprehensive information on the behaviour of our coast. In turn, this dramatically underscores long standing and often aired deficiencies in coastal management, most particularly in measuring and specialist research on coastal controls (waves, water levels) and responses.

Important new initiatives in coastal management presuppose a monitoring system and appropriate research structure that do not yet exist. "Greenhouse" concerns invite an immediate and perhaps engrossing fixation with secular sea-level change without corresponding attention to the full spectrum of associated coastal landform changes.

The ongoing review and reform of legislation and agencies presently offers few insights into how these problems might be resolved; or even that such matters form any part of the process.

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