Coastal News

Te Hunga Takutai o Aotearoa

Issue 45 • November 2010

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www.coastalsociety.org.nz

ISSN 1172-6938

New Approaches in Sea Level Research

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Background

The current sea level rise prediction estimates contained in the 2008 Ministry for the Environment guidelines, were based largely on the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report released in 2007. There is now a range of intriguing new research giving higher estimates. This article reviews this new research and considers its implication for coastal management and decision-making. The first area of research involves detailed analyses of palaeoclimatic records which contain information on ice sheet instability and sea level change during past interglacial periods when temperatures became somewhat warmer than at present. The second is from a new generation of (semi-empirical) models that relate sea level change to temperature change using century- to millennial-scale calibration records.

The IPCC (2007) assessment produced estimates of sea level rise that were strongly dominated by geophysical models focusing on the thermal expansion of sea water, and it was not possible at that stage to provide upper bounds for the rise this century due to uncertainty in the contribution from melting ice sheets. The IPCC (2007) estimate gave an additional ice sheet contribution (0.1 to 0.2 m) assuming that the difference between explained and observed 1993 to 2003 melt rates would increase linearly with global average temperature change over this century. New analysis of current causes of sea level rise (Domingues et al., 2009), however, show a greater contribution comes from glaciers and major ice sheets (about 50%) than was previously thought. Furthermore, satellite and airborne-based data indicate that ice mass loss from Greenland and West Antarctic, the major contributors, is accelerating (Cazenave and Llovel, 2010). Such situations provide the basis for the new approaches to future estimation of sea level rise.

Interglacial proxy evidence

It was noted in the IPCC (2007) report that there had been increases in sea level of up to 6 m due to reduction in ice sheets during the last warm period between ice ages (interglacial). Average temperatures were then more than 2˚C warmer and that is comparable with what is now predicted for later this century. At the time of the IPCC (2007) assessment there was little published information on the rate at which sea level had previously responded to global warming on century time scales, so the longer-term estimate of 6 m could not be directly related to century-scale sea level rise.

Significant palaeo evidence from the previous warm period has come from high-resolution oxygen isotopes from Red Sea cores (Rohling et al., 2008). This investigation produced a record of sea level for the period 124 000 to 119 000 years ago with sampling at about 300-year intervals. These data show century-scale rates of change in sea level between 0.6 m and 2.5 m with an average value of 1.6 m (see Figure 1 upper right panel). A recent study of kinematic constraints on glacial contributions to sea level rise (Pfeffer et al., 2008), however, concluded that increases above 2 m/century are untenable.

In spite of these palaeo researchers taking due care, there are the inevitable issues surrounding proxy precision, i.e. the temperature indicator used to reconstruct past climates, and the issue of wider representation of their particular samples. Furthermore, these findings are not a straight analogy for the future as temperature increase is expected to be driven by greenhouse gases rather than variation in insolation due to changes in the Earth's orbit around the sun. Nonetheless, the results do quantify a potential range of sea level change above the present level should major ice sheet collapse occur.

Other palaeo studies provide some support for sea level rise exceeding 1 m/century. An overview of past sea level rise in response to global warming over the last six interglacial periods (see lower panel in Figure 1) by Berger (2008) concluded that there were several occasions when sea level rise may have exceeded 1 m per century. Another study (Carlson et al., 2008) covers decay of the North American Ice Sheet during the present interglacial period (the Holocene) and suggests that a sea level rise in excess of 1 m per century occurred during the onset of the present warm period when temperatures were generally higher than the present.

The upper left panel in Figure 1 depicts an east Australia example of a Holocene sea level curve, in which the amplitude of the medium-term fluctuations (10^3 years) are dramatically less than those from the previous interglacial example (NB upper right panel in Figure 1). We stress that while sea level curves tend to be geographically specific, these data are at least suggestive that higher atmospheric temperatures may be associated with larger sea level fluctuations and hence the increased likelihood of larger century-scaled sea level rises.

The palaeo-interglacial results are summarised in

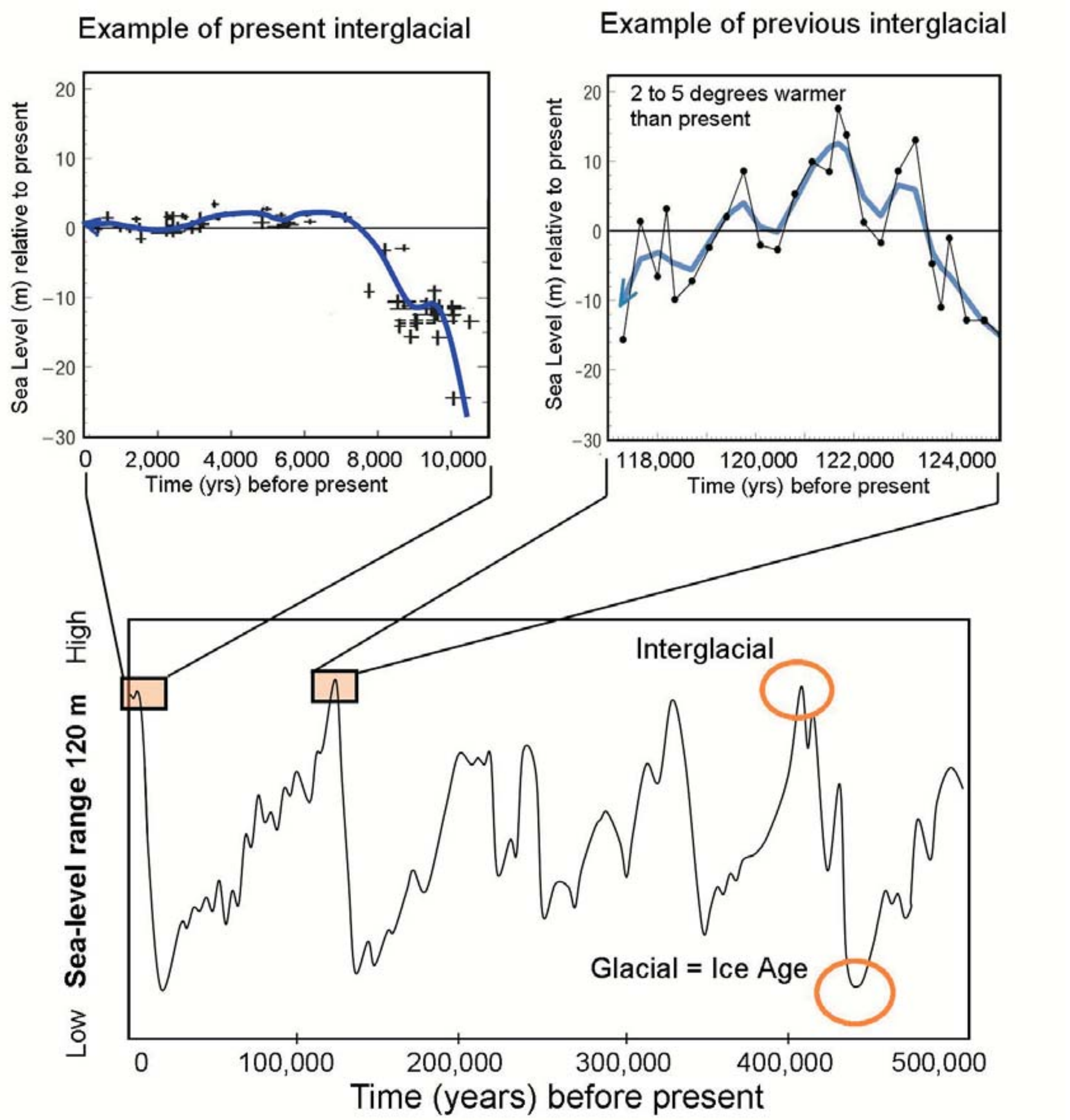

Figure 1: Palaeo sea level curves. Lower graph shows an oxygen isotope-based sea level record for the previous 500 kyr depicting 100 kyr glacial-interglacial fluctuations (adapted from Berger, 2008). Upper graphs illustrate contrasting "medium-term" sea level fluctuations with graph on left depicting a higher resolution sea level Holocene record from the Australian east coast (adapted from Milne et al., 2009), while graph on right shows a higher resolution record from the Red Sea for the previous interglacial (adapted from Rohling, 2008).

Table 1 and indicate century-scale sea level rise in excess of 1 m and perhaps as high as 1.5 m appear to be plausible. The present rate of sea level rise is ~3 mm/year, so a linear increase up to 15 mm/year (1.5 m/century) over the next 100 years would result in a total sea level rise of 0.89 m. However, the higher rate (1.5 m/100 years) could continue over subsequent centuries.

Semi-empirical models

This approach uses statistical models based on observational data to establish the link between temperature and sea level, and this relationship is extrapolated into the future to match the IPCC temperature predictions. These models are referred to as semi-empirical models and an example of such output is depicted in Figure 2.

Two subgroups of semi-empirical models exist. The first by Rahmstorf (2007), Horton (2008) and Vermeer and Rahmstorf (2009), use about 120 years of overlapping temperature and sea level data and a two or three parameter model calibrated by using a least squares fitting routine. The latter study incorporates a second term that accounts for large and highly nonlinear ice discharges. The second group (Grinsted et al., 2010 and Jevrejeva et al., 2010) use more extensive observational data (1800 years) including palaeo reconstruction plus more detailed mathematics with four parameters calibrated using an inverse Monte Carlo method. In addition, the latter study relates sea level changes to change in natural and anthropogenic forcing. The resulting sea level prediction ranges for the semi-empirical models out to 2010 are shown in Table 1, and it can be seen that they are about twice as high as the IPCC (2007) estimates shown at the base of the table.

Unlike the geophysical models used to predict sea level rise in the IPCC (2007) report, the semi-empirical models combine and then extrapolate the effects of all sea level rise contributors including dynamical ice sheet processes. As noted earlier, the linear assumption underlying the IPCC (2007) ice sheet contribution now appears to have been exceeded. In this regard, the semi-empirical models may provide more realistic sea level projections. They are also more applicable than the century-scaled palaeo predictions, because they can be more closely aligned with estimates for temperature rise over the present century.

There is a potentially serious limitation with the semi-empirical approaches in that they assume the historical relationship between temperature and sea level will continue under future regimes which go beyond the model's calibration range. One potential problem relates to treating future temperatures as scenarios as this effectively decouples temperature from the sea level model so that possible feedbacks that sea level may have on temperature are not taken into account. For example, higher sea level is likely to be associated with greater ice loss which may well influence global climate through albedo changes. While defining and quantifying such limitations is not presently possible, Grindsted (2010) shows that present day sea level rise is dominated by a 200- to 300-year response time to temperature, indicating that the historical relationship these models are based upon will likely prevail through the present century.

Dealing with higher sea level rise

How to implement an increasing range of sea level rise estimates that include significant scientific uncertainty within decision-making is becoming increasingly important. The Ministry for the Environment (2008) recommends a risk-based

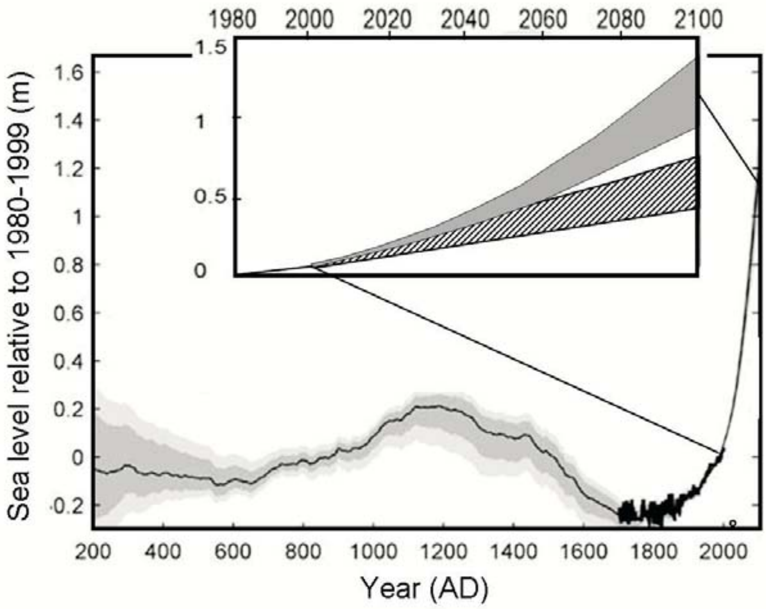

Figure 2: An example of semi-empirical modelling using 1800 years of palaeo-historical temperature sea level data with dark grey band defining one standard deviation about the median sea level (bold line), and light grey band depicting 5-95 percentiles. Thick black line depicts 300 years of historical calibration data. Inset details the model projection with grey band depicting 5-95 percentiles. For comparison, diagonal infill band depicts a comparable range for the IPCC (2007) prediction. Adapted from Grinsted et al., 2010.

MODELS	Projected sea-level rise (m) (0 – 0.5 – 1.0 – 1.5 – 2.0)
Century rates	
Berger (2008)	←1.0----2.0
Rohling (2008)	0.6----→2.5
Carlson (2009)	0.7----1.3
Semi-empirical	
Rahmstorf (2007)	0.5----1.4
Horton (2008)	0.47----1.0
Vermeer (2009)	0.75----1.90
Grinsted (2010)	0.7----1.6
Jerejeva (2010)	0.59----1.80
Present guidelines	
IPCC (2007)	0.4----0.8
MfE (2008)	0.5----0.8+

Table 1: Ranges of sea level rise estimates from the studies described in the text

approach which considers the acceptability of potential risk; this approach was described by Bell and Ramsay in an earlier issue (42) of *Coastal News*. Briefly, for each activity, the likelihood and magnitude of hazard consequences are assessed for different sea level rise scenarios, together with potential adaptation costs including those if sea level rise or other hazard driver effects are underestimated.

The upper extreme would thus relate to major coastal infrastructure such as new highways, where economic losses and other consequences could be severe in the longer term, where there is minimal opportunity for subsequent adaptation, and where existing policy emphasises hazard avoidance. In such cases there is virtually no allowance for failure and prudent planning is required with upper range sea level rise estimates being appropriate, along with application of potential sea level rise over a longer time span.

At the other end of the coastal activity spectrum is an addition to an existing dwelling. In this case the worst consequence is destruction of that dwelling with only minimal chance of personal risk. The lower sea level rise estimates would thus be appropriate for interim use (decades) or if hazard avoidance (relocation or removal) is viable.

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Point of View: Sea Level Rise – Predictions, Projections and Guesses

by Willem de Lange, Department of Earth and Ocean Sciences, School of Science and Engineering, University of Waikato

Sea level is of particular interest to coastal management, as most hazard analyses incorporate some component to account for future sea level rise. There are several different approaches to determining sea level in the future, which vary in rigour and reliability.

The most rigorous approach is a statistical analysis of the underlying structure of historical sea level trends, which forms the basis of a prediction of future sea level. This method allows the uncertainties of be quantified, but is limited by the amount by which sea level can be extrapolated.

The simplest approach is to fit a linear trend through the data, and extend this into the future. One difficulty is that sea level shows considerable variation at different time scales, so that the trend obtained varies with the choice of data. For example, different rates of sea level rise have been published for Auckland New Zealand based on the same start date, but increasing amounts of data: 1.34±0.11 $mm.y^{-1}$ in 1991; and 1.30±0.09 $mm.y^{-1}$ in 2003. Selecting just the 20th Century data gives 1.39±0.12 $mm.y^{-1}$. Although these differences are small, they are important at century time scales.

Another difficulty is that sea level data are serially correlated, so that the data are not independent. For example, sea levels at Auckland are dependent on the previous decade of sea level anomalies. This does allow the use of an autoregressive model to predict the sea level up to a decade ahead, which predicts sea level at Auckland to be 145±5 mm in 2017 relative to the 20th Century base level (cf. 188 mm in 2000).

Previous work, however, has suggested that the rise of Auckland sea level follows a step-like pattern, with sharp rises occurring around 1907, 1947 and 1998. Therefore, a simple linear trend is probably not appropriate. Empirical Mode Decomposition allows flexible curves to be fitted to the data, without making assumptions about the underlying data structure. This approach predicts up to 25 years ahead for Auckland, giving 168±80 mm in 2017 and 95±190 mm in 2031. There is more uncertainty in these predictions, but both indicate that a decrease in sea level, which started in 2002, is likely to continue for a while.

A decade ago, I was expecting the rate of sea level rise to decrease for the first quarter of this century, followed by a sharp rise of about 50 mm, consistent with the pattern since 1898. Now, I do not really know what to expect, as it seems possible that sea level could step downwards. In order to speculate about sea level beyond about 2025, it is necessary to consider projections. These are less rigorous and do not always identify the uncertainties, which is a concern. Normally they are based on an analysis of the factors contributing to past sea level rise, and modelling of a range of scenarios representing estimates of future forcing conditions.

The Intergovernmental Panel on Climate Change (IPCC) has reviewed the published sea level projections in four main assessment reports. Assuming that the review followed the IPCC procedure, these represent an excellent summary of the range of projections available at the time. Accordingly, the published values are a useful guide to possible long-term sea level rise. Remember, however, that the values are scenario based, and the scenarios may not correspond to the actual changes in sea level drivers in the future.

Subsequent IPCC reviews have projected lower sea level rise over the 21st Century, consistent with the published literature. My preference is to use the most likely projections, rather than the extremes, as they tend to reflect extreme scenarios, which suggests a sea level rise of 380-400 mm by 2090 relative to the IPCC datum. This is approximately double the 20th Century rise.

After the first three IPCC reports, there were a number of publications claiming that the projections were either too high or too low, and this has been the case for the most recent report. The claims of too high are based on a comparison between the projected sea level rise and available measured sea level rise, and in comparison to tide gauge data, the IPCC projections do tend to be too high.

The claims of too low are usually based on either an empirical projection based on a statistical model linking temperature and sea level, or geological data of higher sea levels during previous interglacials. The geological data are difficult to extrapolate to the present, primarily because the relationships between a specific site and global sea level, and sea level drivers are difficult to quantify.

The empirical models make a range of assumptions about the relationship between sea level and temperature. The most recent models have assumed that a lag occurs between temperature and sea level changes. This is not supported for thermosteric (density) sea level changes, but may be valid for glacio-eustatic (ice melting) changes.

For coastal management, my suggested approach is to determine a "Most Credible Rise" in the same way as Most Credible Earthquakes (MCE) were used for New Zealand lifelines studies. Note that the MCE for Christchurch is magnitude 7.2, which formed the basis of the first lifelines study. The method used depends on the time frame being considered. For most coastal development, prediction using existing data with a requirement for periodic review seems appropriate. For infrastructure with long design lifetimes, it is necessary to use projections.

For New Zealand, it is important to recognise that at the century scale tectonic and neo-tectonic influences on relative sea level are also important. At present they are largely ignored. The Canterbury earthquake should serve as a reminder that they should not be.

To encourage dialogue on important issues the New Zealand Coastal Society has introduced the Point of View column to our newsletter. If you would like to contribute a Point of View, or have topic suggestions, please contact our editor Shelly Biswell at shelly@biswell.net.

Coastal News

Word from the Chair

by David Phizacklea, david.phizacklea@envbop.govt.nz

This is my last word from the Chair as I will be stepping down from the role at our annual general meeting in November. I have been Chair for the past four years and have thoroughly enjoyed the challenges presented during that time, be they the effect of IPENZ rule changes, the design of our new website, or ensuring conferences are successful and well run.

The New Zealand Coastal Society is unique as a multi-disciplinary entity. Our membership is comprised of professionals in coastal engineering, science and planning disciplines who have a healthy respect for each other and the issues that face New Zealand's coast. We operate on a largely volunteer basis and have a sound financial position.

A key challenge remains in maintaining and growing our membership to make NZCS attractive to new members with interest in New Zealand's coast. Our membership numbers have remained static for some time. Next year will be 19 years since NZCS was initiated and it may be timely to look at whether the structure of the society is right, do we need to become bigger through amalgamation with a related body for example, or are we doing just fine in the niche market we operate in?

A question that is often raised is whether NZCS should become involved in making submissions or advocating a position on matters such as coastal development, climate change, or natural hazards. Apart from needing to financially resource people to make submissions, attend hearings and send out media releases on behalf of NZCS, our diverse membership brings into question the appropriateness of taking such a role.

This edition of *Coastal News* pays tribute to Professor Terry Healy. In May, NZCS held an awards dinner to celebrate Terry's achievement in his long career in coastal management in New Zealand. Sadly Terry passed away following illness in July this year. Terry made an enormous contribution to our understanding of New Zealand's coast and formed successful commercial and international partnerships. Terry will be missed by those who have had the good fortune of knowing him.

NZCS's 2010 annual conference is being held in Whitianga from 17 to 19 November. One of the great things about NZCS is our annual conferences allow an opportunity to visit parts of the country that our members may not otherwise get to and hear about not only new research but also local coastal issues. The 2010 conference promises to be another cracker and thanks go to the conference organising committee for all their hard work.

The 2009 Coasts & Ports conference in Wellington made a small profit in difficult economic times. The 2011 conference will be held in Perth, Australia and we should aim to get as many NZCS members over there as possible. Our relationship with our Australian counterparts through Engineers Australia and the fledgling Australian Coastal Society is important. We also get a share of the conference profits based on the number of New Zealanders who attend.

I would again encourage members to assist with the organising and hosting of regional events for your area. If you have any ideas for a regional event in your area, particularly with the end of year approaching, get in touch with your local regional coordinator. Their contact details are listed in *Coastal News*. Regional events may involve a guest speaker, presentation from your local council or consultancy on a local coastal project, or a site visit and discussion on a topical issue in your area.

In closing I want to acknowledge the significant commitment that the NZCS Executive Committee and other members of the NZCS give voluntarily to ensuring the success and continued existence of the NZCS. The New Zealand Coastal Society is your society. Please make the most of it by putting into it. This could be by contributing articles to *Coastal News*, looking to assist with regional events, or encouraging your organisation to become a corporate member.

Past, Present and Future: Morphology and Dynamics of River Mouth Lagoons in Westland, New Zealand

by Claire Kain, Department of Geography, University of Canterbury, Christchurch

Coastal lagoon and wetland systems are complex and dynamic environments, responding rapidly to a complex network of climatic, tectonic, anthropogenic and other synergistic drivers. The purpose of this research was to investigate two systems in the Westland Region; Totara Lagoon and the Shearer Swamp-Waikoriri Lagoon Complex, using a multidisciplinary methodological framework to investigate active processes and document changes in these systems over historical time. Future developmental changes were then predicted under differing climate and management pressures.

The current topography and hydrodynamics of these systems were investigated using a combination of Global Navigation Satellite System (GNSS) surveys, hydrological records, and field observations. Changes regarding outlet migration and lagoon structure were investigated by analysis of aerial photographs taken between 1948 and 2006. Snapshots of dynamics occurring at specific locations over a longer-time scale were investigated with several sediment cores, using stratigraphy, sediment texture and organic percent analyses to document changes in depositional environment.

Existing morphology and hydrology

Totara Lagoon shows significant differences in structure and morphology along its 10-km length, exhibiting a gradient of decreasing energy and increasing dune height (e.g., steepness and degree of vegetative cover with increasing distance from the river mouth). Hydrological records show a significant direct tidal influence extending several kilometres up the lagoon.

Waikoriri Lagoon is much smaller and more dynamic than Totara Lagoon, and the hydrology of the lagoon and creek behind is a function of the outlet position. Long-term hydrological measurements in Waikoriri Creek showed that at times of substantial outlet offset, no tidal influence occurred in terms of either water level or conductivity changes, but when a breach occurred at the river mouth the water level began responding to the tidal cycle with regular oscillations. Conductivity records indicate no regular tidal influx was occurring, thus water level response was due to a tidal backwater effect. Isolated conductivity spikes, however, suggest saltwater incursions occurred sporadically in response to occasional wave overtopping at high tide.

Decadal-scale dynamics

Strong net northward direction of littoral drift caused both systems to experience outlet offset in solely a northerly direction. Aerial photograph measurements show Totara and Waikoriri lagoons reached maximum offsets of 5800 m and 2500 m respectively. The rate of migration in Totara Lagoon was between zero and 575 m $year^{-1}$, but was not calculated for Waikoriri Lagoon as the outlet migrates on very short time scales.

Channel structure did not vary largely over time in Totara Lagoon, except for notable changes through the central reaches. Lagoon surface area appeared to correlate negatively with outlet offset, thus the surface area of water in the central channels was greatest during periods of least offset outlet position. Core analysis indicates lagoon configuration has been essentially stable over recent centuries and supports the morphologically derived conclusion that the system becomes more stable with increasing distance from the river mouth.

Waikoriri Lagoon was much more variable in size and structure, tending to drain completely northward of the outlet. When the outlet was situated at the river mouth, no lagoon was present.

Figure 1: Taking a sediment core

Figure 2: Empty channel of Waikoriri Lagoon, March 2009

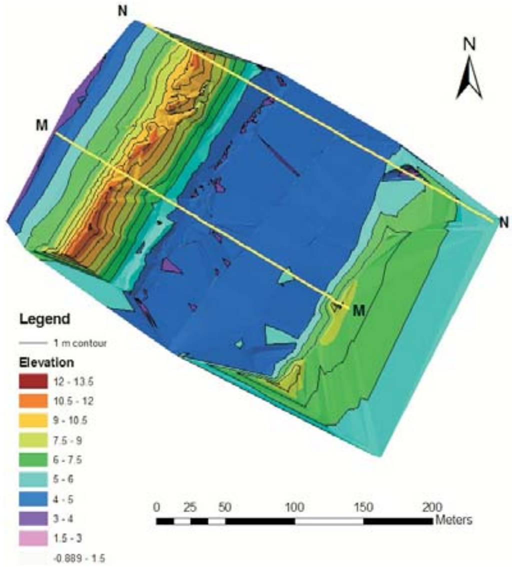

Figure 3: Results of a surveyed portion of Totara Lagoon

These differences in outlet dynamics between Totara Lagoon and Waikoriri Lagoon are likely a consequence of vast differences in spatial scale, barrier development and stability (for example, vegetative cover). Totara Lagoon is inherently much more stable than Waikoriri Lagoon.

Discussion and conclusions

Findings challenge the existing classification of Totara Lagoon as a hapua-type lagoon, as the definition of a hapua excludes systems showing any degree of tidal influence. This research supports the idea of a continuum between the definitions of 'hapua' and 'estuary' within an overarching category of 'river mouth lagoon'. This recognises that the pattern of tidal influence observed here may not be permanent, suggesting this system is merely experiencing an 'estuarine phase'.

The longer-term record of outlet migration supports the classification of these two systems as hapua-type lagoons, as they display long-term patterns of behaviour and dynamics consistent with models of east coast hapua (for example, Kirk, 1991; Hart, 2007). It is very unlikely that Totara Lagoon experienced tidal inflows during periods of large outlet offset, further supporting the argument that this system exists in the middle of the hapua-estuary continuum; shifting between these two hydrological states at different times.

This research highlights the importance of barrier permeability in controlling hapua formation. The seaward barrier of these systems is sandy, in contrast to the typically mixed sand and gravel nature of east coast barriers. Consequently, these hapua are able to form at the mouths of rivers that have much smaller flow volumes than their east coast counterparts. Thus, there is an approximately linear, positive relationship between river flow and barrier permeability (assuming a wave-dominated environment and suitable sediment supply and littoral drift conditions) in terms of providing conditions conducive to hapua formation.

Figure 4: GNSS survey of Totara Lagoon

Figure 5: The more stable, northern end of Totara Lagoon

Over the next century, these systems may experience pressure from a variety of factors, interacting in a complex network of feedback loops.

Climate change could result in a sea level increase and barrier rollback, but artificial outlet management will likely remain the biggest management challenge. Findings suggest that should it be necessary, a breach should be performed upstream from the river mouth and orientated on a slight diagonal in the direction of littoral drift to minimise hydrological and ecological disturbance. Smaller, regular interventions are preferable to larger-scale emergency measures.

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Claire was a NZCS scholarship recipient. As an advocate for coastal environments, NZCS aims to promote coastal research in New Zealand. Towards this aim, the NZCS offers annual scholarships to support the postgraduate research of a student enrolled in a New Zealand academic institution.

MNZ's Commercial Fishing Vessel Garbage Survey – Results Focused

by Alison Lane, Maritime New Zealand

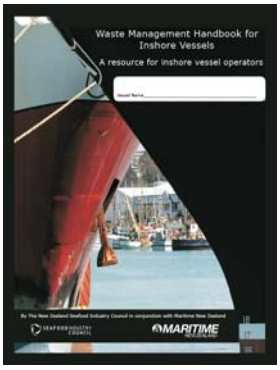
In 2009 Maritime New Zealand engaged in an extensive process of consultation with New Zealand fishing operators to learn more about the challenges to effective management of garbage waste on board boats.

The results of this study (summarised in *Coastal News* No. 43 in March 2010) identified that nearly all fishing operators produce plastic waste and that this forms the greatest volume of the garbage on the vessel. The main plastic items that are included in the garbage of most vessels are plastic bags and wrapping, bottles, strapping, and damaged or waste fishing gear. Garbage is generally stored in plastic bags on the deck of the vessel, increasing the risk of material getting washed overboard.

A number of barriers to effective management of garbage on board vessels were identified, with one of the most commonly cited concerns being a lack of suitable reception facilities available where vessels are berthed or at boat ramps. This issue, combined with a lack of space and time to deal with waste during fishing operations and concerns about hygiene, increase the likelihood that waste will be deliberately discarded at sea.

As a result of these findings Maritime New Zealand, in conjunction with the New Zealand Seafood Industry Council, has put into action a number of initiatives. Based on the problems identified we have developed waste management advice for the fishing industry. This is designed to reduce waste discharged into the sea through effective planning and procurement of ship's stores, improved storage and handling of waste on board, and cultivation of greater stewardship for the marine environment. This advice has been promoted through articles in industry publications and presentations to fishing operators. Stickers have been developed that very clearly articulate the rules regarding waste disposal at sea and are packaged with a sorbent refuelling pad to reduce fuel spills. Both are being widely distributed to fishing operators through the FishSAFE network.

One of the key products from the project has been publication of the *Waste Management Handbook for Inshore Vessels* (http://seafoodindustry.co.nz/f464,84718/84718_Waste_Management_Handbook.pdf). This handbook is presented in a very user-friendly form designed to engage fishers, from skippers to deckhands. All types of commonly produced waste – garbage, oil, sewage and chemicals – are included. The handbook is illustrated with cartoons and includes straightforward descriptions of the problems, the rules and best practice. The content is written from the perspective of fishermen and has been published by the New Zealand Seafood Industry Council.



In addition, Maritime New Zealand has contacted regional and district councils to highlight the importance of shore-side reception facilities that are accessible and suitable for the needs of boaties. Training material is also being made available through the Seafood Industry Training Organisation to improve the standard of environmental education given to fishing operators through formal qualifications.

The next step is to move the project into the recreational and inshore commercial sectors. It is planned to work together with regional and district councils to produce a small formal handbook with advice on rules and best practice. The base text would be provided by Maritime New Zealand but each region would customise the publication with information regarding their own bylaws, location of local marine and mataitai reserves and the availability of reception facilities, before branding and producing the document as a council publication. This project will be developed over the next year.

For more information please call Simon Coubrough at Maritime New Zealand on 04 473 0111.

NZCS Mission Statement

The New Zealand Coastal Society was inaugurated in 1992 "to promote and advance sustainable management of the coastal environment".

The Society provides a forum for those with a genuine interest in the coastal zone to communicate amongst themselves and with the public. The Society currently has over 300 members.

Members include representatives from a wide range of coastal science, engineering and planning disciplines, and are employed in the engineering industry, local, regional and central government, research centres and universities.

Applications for membership should be sent to NZCS Administrator Hannah Hopkins (email: hannah.hopkins@ew.govt.nz).

Professor Terry Healy's Lifetime Achievements Honoured (1944 – 2010)

by David Phizacklea, Chair, New Zealand Coastal Society

Professor Terry Healy died on 20 July 2010 after a long battle with cancer. Prior to his death his outstanding contributions to science were acknowledged with a Queen's Birthday honour, a University of Waikato Medal and a life membership of the New Zealand Coastal Society.

Terry Healy was honoured by the cream of the coastal management industry in May with a life membership of the New Zealand Coastal Society. Widely regarded as New Zealand's pre-eminent coastal scientist, Professor Healy is only the third person – and the first scientist – to be awarded life membership of NZCS.

The honour was conferred at a special awards dinner on Sunday 30 May 2010 in Hamilton attended by 85 colleagues, Society members, ex-students and family of Terry.

The life membership award acknowledged Terry's substantial contribution to our understanding of New Zealand's coast over the last 40 years. He was Waikato University's Research Professor of Coastal Environmental Science.

Terry spent a lifetime researching coastal erosion, sedimentation and hazard management, including tsunamis, and applying his environmental expertise to port and marina developments around New Zealand, from planning and development to management and monitoring of issues such as dredging and spoil disposal.

Professor Healy was one of the first members of NZCS and assisted the professional careers of many of our members.

Since his elevation to professorship in 1990, Terry had built the Coastal Marine Group at Waikato University into the leading research group of its kind in a New Zealand university. In the 1990s the group was recognised as a Centre of Excellence for its research by NIWA. Terry also led coastal marine science research projects in New Zealand – particularly in the Bay of Plenty – in the Baltic Sea, the North Sea, Japan, and the United States.

His professorial Chair, sponsored by the Port of Tauranga Ltd since 1990, was the first Chair in Science to be sponsored by industry in New Zealand. Terry was also Adjunct Professor at Nanjing University, China, serving in that role since 1995.

Terry was the major driver behind the New Zealand and Germany INTERCOAST (Integrated Coastal Zone and Shelf-Sea Research) initiative – a collaboration between Waikato University's Coastal Management Group and Bremen University's Marine Environmental Research Centre. INTERCOAST receives funding from the German Research Foundation DFG to train up to 39 PhD and post-doctoral scientists to tackle the challenges associated with coastal and shelf-sea areas subject to significant global changes.

His research assisted port and regional authorities across New Zealand in managing their operations efficiently and in maintaining the environmental health of harbour and coastal environments. In the 1980s he advocated for using knowledge of tides and currents to build beaches with sand dredged from navigation channels – a strategy that is now commonplace.

International recognition for his work includes acknowledgement as a 'Top 100 Scientist' by the International Biographical Centre, Cambridge, UK. He was the first New Zealander to receive the Alexander von Humboldt (AvH) Foundation Preistrager Award in 1997 after winning three Humboldt Fellowships in 1978, 1985 and 1989. Other Fellowships included a Fulbright, and research and invitation Fellowships from the Japan Society for Promotion of Science Research.

Terry was the director of the US-based International Coastal Educational Research Foundation from 1989 until his death. The foundation publishes the leading international journal for coastal science and engineering, the *Journal of Coastal Research*. He also served as vice-president of the Scientific Committee for Oceanic Research of the International Council of Science, UNESCO.

In New Zealand he was a leading member of the Royal Society, and served as New Zealand's primary advisor to Civil Defence on tsunamis. In 2003 he was elected a Fellow of the Institution of Professional

Terry receiving his life membership of the New Zealand Coastal Society from David Phizacklea, Chair, New Zealand Coastal Society.

Engineers of NZ (IPENZ) – only the second non-engineering graduate to be accorded the honour.

As an educator, Terry developed a range of courses in coastal and marine science. During the 1990s when coastal issues became very important under the Resource Management Act, his third-year paper on coastal processes and management became the largest in the School of Science. Terry said his main forte was supervising student research, and that he encouraged his students to treat him like "a sports coach". During his academic career he supervised 119 postgraduate students.

Terry had a prodigious publication record of 584 scholarly items, including 256 peer-reviewed book chapters and journal articles, 52 reviewed research reports, 16 conference abstracts, 140 international conference presentations and 52 consulting reports.

He also presented 38 statements of expert evidence in planning hearings, resource consent applications and Environment Court appeals.

During his career he won 150 research contracts totalling more than $10 million, and led 21 major projects and expeditions, including two to the Antarctic.

On behalf of the New Zealand Coastal Society I would like to extend my condolences to Terry Healy's family and many friends.

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For any enquiries regarding *Coastal News* articles, please contact NZCS Editor **Shelly Biswell (shelly@biswell.net)**.

NZCS Regional Coordinators

Every region has a NZCS Regional Coordinator who is available to help you with any queries about NZCS activities or coastal issues in your local area.

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Coastal News

Tsunami Mapping

by Martin Butler, Regional Planner, Bay of Plenty Regional Council

Newly developed maps showing tsunami inundation zones for the Bay of Plenty coastline have been released by the Bay of Plenty Civil Defence Emergency Management Group (CDEMG). The maps are to help coastal residents and emergency management staff improve their tsunami preparedness planning.

The maps are indicative only with further modelling expected to refine the inundation zones. Currently, the maps show the inundation zone for surge heights at shore of 6.75 m and 8.25 m in the eastern Bay of Plenty, and 4 m and 6.75 m in the western Bay of Plenty. The two heights were identified as being the 'worst case' scenario, and the extreme scenario based on historical and palaeotsunami records. The maps show the distance a tsunami surge would travel inland.

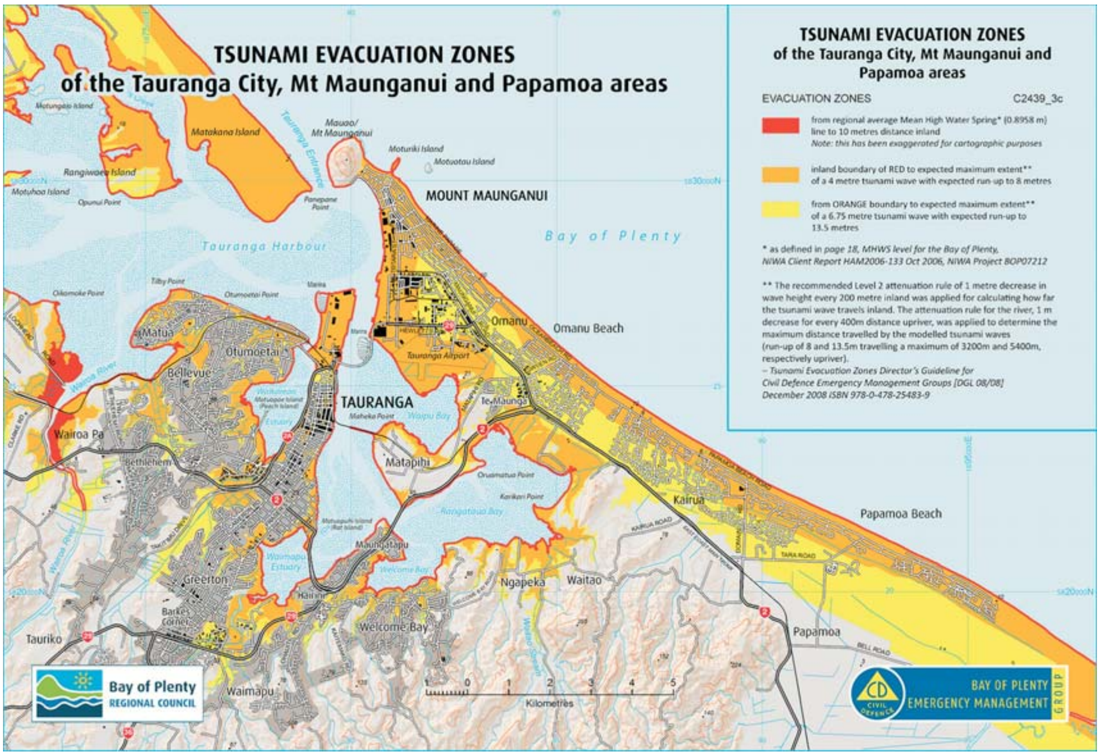
Since 1840, tsunamis with height at shore of between 1 m and 3 m are known to have affected places along the Bay of Plenty and Eastern Coromandel coastline at least 11 times. Recent tsunami events have been small (<0.8 m in height at shore) and are usually only detected by sea level gauges. Over the past 4000 years, at least two major regional tsunami events have been recorded in sediment cores (one of these may represent two separate events). Sediment cores also reveal that up to four localised tsunami events have occurred in the Bay of Plenty during this time. New Zealand local source tsunamis have less than one-hour travel time to the nearest New Zealand coastline, many travel times are less than 30 minutes, and some travel times are as short as a few minutes.

The maps have been prepared in accordance with Tsunami evacuation zones: Director's guideline for Civil Defence Emergency Management Groups, from the Ministry of Civil Defence Emergency Management. The maps are to the Level 2 standard of those guidelines. The level standards are as follows:

- Level 1 – 'Bathtub', where inundation is based on a maximum wave height projected inland from coast to a cut-off elevation. Not adequate for civil defence and emergency management (CDEM) or land-use planning.
- Level 2 – Rule-based wave height attenuation inland from coast (calibrated against real and modelled tsunami). Uses probabilistic wave height at coast.
- Level 3 – Computer derived simulation model to attenuate inland. Uses probabilistic wave height at coast.
- Level 4 – Computer modelling based on envelopes around all inundations from multiple, well-tested models.

GNS Science has been engaged to conduct further tsunami modelling to allow the inundation zones to be refined to Level 3. This will also allow modelling of tsunami consequences and enable pre-event recovery planning to occur. It will also assist risk assessment and consideration of possible land-use planning responses.

The maps can be downloaded from the Bay of Plenty Civil Defence Emergency Management Group website www.bopcivildefence.govt.nz. The website has further information about tsunamis and advice on how to prepare for them.



News from the Regions

Northland Regional News

Michael Day, Northland Regional Member

Plan changes

In July two plan changes to the Regional Coastal Plan for Northland became operative. Plan Change 2 reviewed the zoning of the Whangarei Harbour, with the most significant change being the addition of multiple (12) Marine Management 1 (Protection) Areas (the highest value zoning under the Regional Coastal Plan) within the Whangarei Harbour. Plan Change 3 relaxed the policies and rules for managing mangroves.

Ocean Survey 20/20

The two-year Bay of Islands Ocean Survey 20/20 was completed in July. Land Information New Zealand (LINZ) is the government agency responsible for coordinating Ocean Survey 20/20 which is a cross-government initiative. LINZ contracted NIWA to conduct the Bay of Islands survey project for Ocean Survey 20/20. The survey, which was conducted by NIWA from 2008 until 2010, was completed in two phases. The first phase involved a comprehensive seafloor mapping exercise, and the second involved biodiversity sampling. For more information: www.linz.govt.nz/hydro/projects-programmes/ocean-survey-2020/work-programme/bay-of-islands/index.aspx.

Mangrove Steering Group

On 10 September 2010 the Northland Regional Council hosted the Mangrove Steering Group. It was the first meeting of the group in nearly three years. The Mangrove Steering Group includes representatives from central and local government agencies, tangata whenua, conservation organisations, community groups and research providers. The intent of the group is to enable the efficient use of resources (for example, by jointly commissioning priority scientific research) and to support agencies in carrying out their functions with respect to the management of the coastal marine area, including mangroves.

Aids to Navigation

A substantial upgrade to the Aids to Navigation (buoys and beacons) in Rangaunu Harbour was completed earlier this year by the Northland Regional Council maritime operations team. Twenty-four aids were upgraded providing a substantial improvement to navigation in New Zealand's fifth largest harbour. The six-yearly rolling maintenance is now being completed for Whangarei's Aids to Navigation.

Pest Strategies

Northland Regional Council approved three new pest strategies for Northland on 20 July 2010, including a strategy to specifically deal with marine pests. The strategies can be viewed on the Northland Regional Council website: www.nrc.govt.nz.

Bay of Plenty Regional News

Reuben Fraser, Bay of Plenty Regional Coordinator

Coast Care

Volunteers with Coast Care Bay of Plenty have so far planted 80% of the 102 000 native dune plants for this season. It has been a great planting season with regular rain and hardly any of the frosts which affected some of last year's back dune projects.

This year we have continued our push to restore a native foredune along the Matata straights. We've worked with the local Coast Care volunteers, the surfcasting club members, Forest & Bird, KiwiRail and other stakeholders to reduce the impact of vehicles on the beach and dunes.

Whakatane District Council passed a bylaw 12 years ago banning vehicles from its beaches but there has been little enforcement to date. This spring they will be restricting one of the vehicle access points to quad-bike width. Forest & Bird will do the same thing at another access point through a Bay of Plenty Regional Council Environmental Enhancement Fund grant. These actions should significantly reduce damage to both dune plants and shorebird nests.

Coast Care is assisting Tauranga City Council with its reserve encroachment work. Many residents have mown an extra metre or two into the dune reserve over the years (up to 300 m²), or in some cases built structures such as concrete steps, decks, boat ramps and in one case even the first floor of a house! Council has now listed all of these encroachments on their property land information memorandum (LIM) reports and has started to remove them. Once the weeds and grass are sprayed and die off the decaying plant material is removed by community workers from the Department of Corrections. Native plants are then planted at the sites by Coast Care volunteers.

Recently we also completed a site assessment throughout the Bay of Plenty with Department of Conservation staff checking suitability for the threatened strand plant *Atriplex hollowayi* (Holloway's crystalwort). The annual plant is currently restricted to two sites in the Far North. The plant was recorded in the Bay of Plenty in 1905 and with a bit of luck we may be able to bring it back late in 2011.

Karewa Planting, July 2010

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Consents

Tauranga City Council existing coastal structures

The regional council may have sent its last ever restricted coastal activity recommendation off to the Minister of Conservation. Commissioner Greg Hill recommended granting consent to Tauranga City Council (TCC) for the reconstruction of two seawalls as part of the consents of 260 existing coastal structures around Tauranga Harbour for which TCC is taking responsibility. TCC commissioned Beca Carter Hollings & Ferner Ltd (Beca) to undertake planning and engineering assessments of over 600 coastal structures around Tauranga Harbour. Structures looked at included public access structures such as jetties, ramps and steps, as well as erosion protection structures such as seawalls and groynes. Beca then made recommendations to TCC whether to maintain, upgrade or remove each structure and whether TCC should accept responsibility for specific structures. These recommendations were based on whether the structure provided a public benefit (such as protecting public land and/or assets or providing public access to the coastal marine area), the condition of the structure, and the relative potential environmental effects of maintaining versus removing the structure. A publicly notified consent process was undertaken for each structure.

Port of Tauranga dredging

A hearing was held relating to the proposed dredging of the shipping channels of Tauranga Harbour by the Port of Tauranga Limited from 8 to 11 March. The hearings committee then granted, and recommended to grant, consents authorising the Port of Tauranga to deepen the channels from 12.9 to 16.0 m below chart datum inside the harbour entrance, and from 14.1 to 17.4 m in the entrance channel. The objective of the proposal is to enable Port of Tauranga Limited to accept larger vessels of up to 7000 TEU (twenty-foot equivalent unit) with a draught of 14.5 m and length of 347 m, requiring channel depth of up to 17.4 m. The total volume of material estimated to be dredged is up to 15 million cubic metres. This decision and recommendation has been appealed by Te Runanga O Ngai Te Rangi, Te Taumata O Nga Potiki and Ngati Ruahine and an Environment Court hearing date has been set for April 2011.

Eastern Sea Farms

Eastern Sea Farms Limited is the holder of a suite of consents which authorise activities associated with the construction and operation of a 3800-ha marine farm situated approximately 9.3 km offshore from Opotiki. The consent holder has now applied to have consent conditions changed under Section 127(1) of the Resource Management Act to extend the range of species that can be farmed. In addition to the already authorised mussels, it is proposed to:

- farm scallops, Pacific oysters and flat oysters anywhere within the consented area at a density not exceeding that authorised for the mussels
- to grow, on a pilot basis, a range of other shellfish, algae species and sea cucumbers including, but not necessarily limited to, cockles; surf clams; geoduck; kina; blue mussels; and red, brown and green seaweeds.

These proposed changes will also require the installation of structures alternate to the currently authorised longlines. Proposed additional structures are baskets, trays, and a limited number of rotoshells.

Ohope wastewater

Whakatane District Council has applied for replacement consent to authorise the continued discharge to treated human effluent via a subsurface pipeline and diffuser approximately 550 m off Ohope Beach. The application is currently awaiting information prior to public notification.

Hawke's Bay Regional News

Neil Daykin, Hawke's Bay Regional Coordinator

Waimarama seawalls

Who would pay for ongoing maintenance of Waimarama's two seawalls attracted more submissions than any other issue during the Hastings District Council's Annual Plan process. Hastings District Council (HDC) established that the seawalls have a district-wide benefit of 10% with Waimarama area residents deriving 90% of the benefits. Maintenance of the two seawalls was based on identified benefit – meaning the HDC will pay 10% and area residents will split the other 90%. For the Waimarama residents' split, HDC decided that the maintenance of the two seawalls will be funded using the same financial split as was used when the seawalls were built – a decision that was also the consensus of the submitters. Under this payment scheme, properties fall under three categories depending on their distance from the beach: beachfront properties (responsible for 67% of the residents' maintenance costs), the next line back (responsible for 23%) and to the rear (responsible for 10%).

Protecting the Coastline

Hastings District Council (HDC) has conditionally dedicated $200,000 to the consent process for groyne protection at Te Awanga, Haumoana and Clifton. Coastal community group Walking on Water (WoW) has been working with HDC and Hawke's Bay Regional Council (HBRC) for a number of months, exploring hard-engineering options to stop erosion along the coast. HDC's $200,000 contribution is based on the assumption that it is one-third of the total cost of the project with HBRC and the community providing the other two-thirds of the funding. The project is conditional on a peer review of WoW's proposal and consultation with the wider community. The review will include an evaluation of the likelihood of success through the consent process.

ICCE 2010

by Tom Shand, Coastal Engineer, Water Research Laboratory, Sydney, AU

The 32nd International Conference on Coastal Engineering (ICCE) was held 1–5 July 2010 at the impressive International Convention Centre in downtown Shanghai, China. The conference brought together 650 delegates from over 40 countries with over 440 papers presented covering applied, experimental and theoretical aspects of coastal engineering.

While the majority of attendees were of university background lending the usual academic flavour to the conference proceedings, industry and government were well represented with many practical and useful papers presented detailing new design and construction techniques and case studies.

Advancements in numerical models and modelling techniques was, again, a hot topic, as were tsunami and storm surge themes owing to the recent devastating occurrences of both. An encouraging theme carried throughout the conference was a reiteration of the importance of field data collection, particularly during and immediately after extreme events. While such programmes are comparatively expensive to undertake with limited immediate benefit obvious, their value in later model development, vulnerability assessment and planning is immense.

Having the conference in mainland China was in itself an eye-opener for most attendees. China does not do things by halves or even by wholes but rather by orders of magnitude greater than the rest of the world. This was evident on the conference technical tours to the massive Yangtze Estuary Deepwater Channel, the Yangshan International Deep Water Port projects, and even more so during the post-conference tour to the immense Three Gorges Hydropower Project on the Yangtze River. The scale of China's growth planning is evident with the creation of a 660-km long reservoir to service the world's largest hydropower dam requiring flooding of over 600 km² of land and relocation of over 1.3 million people. It is perhaps ironic that Shanghai is built entirely on sediments deposited by a pre-dammed Yangtze River.

Overall, the Chinese Ocean Engineering Society and the local organising committee did a commendable job organising the first such conference on mainland China in the midst of World Expo fever in Shanghai with an estimated 400 000 to 600 000 visitors moving through the city per day. The world expo itself was a vast 3.2 km² expanse of pavilions and stadiums showcasing the history, culture and achievements of over 200 countries. The customary philosophy of 'if there's a line get in it, if it's long, get in quick as it's probably for something really good' was evident with queues of over five hours for some exhibitions. This wouldn't have been quite as excruciating except for the 40°+C temperatures and tendency for people to assume the space you'd left in front of yourself would be best utilised by inserting themselves there!

The next ICCE takes a U-turn, with the historic Spanish city of Santander hosting the conference in 2012 – a must for coastal engineers and tapas lovers alike.

Tom presented a paper at ICCE looking at engineering design in the presence of wave groups.

Shanghai night scene

Yangshan deepwater port

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