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DISCUSSION

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The contribution of Komar (2010) advancing the understanding of coastal processes for southern Hawke Bay is welcome because it could encourage an open international discussion and assist management of this unusual dynamic coastal environment. By opening this discussion, I hope to clarify some points, and more importantly initiate greater long-term, focused investigations into the Hawke Bay coast. I apologise for some statements that are not completely referenced because the material is in storage in Hawkes Bay and memory is lapsed. In this discussion, the vertical heights are relative to modern mean sea level (MSL) (Napier Port datum), and locality names follow Komar (2010) with some modification, specifically Bluff Hill in Napier is termed Marine Parade. Bluff Hill is also known as Scinde Island. A bit of nomenclature: the regional terrestrial part is Hawkes Bay, not Hawke's Bay, and the marine part is Hawke Bay.

The main hypothesis is that the barrier is eroding from the abrasion of the greywacke gravel and that the incident wave climate induces a net littoral drift (Komar, 2010; Reinen-Hamil, Clode, and Daykin, 2009; Tonkin & Taylor, 2005) and establishes a sound base for coastal planning management (Baker, Ide, and Reinen-Hamill, 2009). However, much is based upon a numerical process model, where quantities are altered to make the model fit for the purpose. There are other possibilities: where possible the barrier is migrating landward, the sediment supply is being increasingly limited by human impact, the barrier is stretching, and the barrier appears to be eroding as it attempts to adjust.

Komar (2010) mentions there are many reports on the Hawke Bay, and these "are part of the problem." This problem stems from the types of report, for example, those that repeat previous work and those based upon short visits. Marshall (1929) is indicative of short visits and assumptions made. Some reports are not based upon field investigations, or sound observations; many statements are being made that lack field data to substantiate statements and assumptions, and in this respect, Hawke Bay is not alone.

The Hawke Bay coast does have some data sets, namely the cross-shore topographic profiles. These, however, do not extend into the nearshore; pre- and poststorm profiles are few; and profile benchmarks are selected for ease of access and not necessarily representative of recognisable morphodynamic processes. As an example, the most glaring oversight reflecting a capacity to understand the importance of natural processes is obtained by examining resource consent requirements. Resource consents are required for certain activities within the marine coastal environment, for example, to build, or remove structures. Nevertheless, it is not a requirement of the consent to gather data (topographic and sediment) before and continuing until after the activity; hence data and information are lost. Further to this, it is necessary to have a resource consent for terrestrial activities within the coastal environment, yet it is not a requirement to log or sample sediment exposures in cuttings. Consequently, the present hazard zone assessments (Baker, Ide, and Reinen-Hamill, 2009) produced largely from synthetic data, derived from hindcast winds (Andrews, Reinen-Hamill, and Ayde, 2003), do not relate to what could be observed and measured, specifically washover debris. The main reasons for these omissions are a consequence of a sampling agenda and few staff. Other sampling omissions include the difficulty of obtaining wave and tidal data, synchronous sediment samples, and the lack of research with a long-term purpose. Most investigations are in response to a high seas event and are *ad hoc*.

Komar (2010) has the Tukituki River as the main supply of gravels to the coast, where this is a hypothesis of Marshall (1929). Observations over some 16 years indicate that the Hawke Bay beach, specifically the lower beach face, is gravelly in winter, and sandy in summer (White, 2005; White and Healy, 2003). Marshall (1929) noted a sandy beach with few gravels to the south of the Tukituki inlet, but to the north the beach was gravelly. Marshall (1929) proceeded to sample gravels to the north of the Tukituki inlet and surmised the river was the main supply of gravel to the beach, both to the north and south of the inlet. This notion has persisted in time to become an established fact (for example, Reinen-Hamil, Clode,

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and Daykin, 2009). Observations suggest that river discharge events are relatively fewer than cliff fall events from the Cape Kidnappers, the primary supply of gravel sizes. The volume of cliff fall Pleistocene conglomeratic material supplied directly to the fringing beach is relatively easy to estimate. Estimation of the volume of bed load gravel from the Tukituki remains elusive but is possible.

Detailed observations of the gravels can give clues to their supply origin (White, 1988, 2005). Gravels from the Cape Kidnappers have an iron oxide coating whereas those from the Tukituki River do not. At Marine Parade, the beach gravels can have residual iron oxide on the flat surfaces and in pitting. This observation gives us a clue as to how the gravels transport and abrade. The main abrasion is not via a process of sliding on sand in the swash zone (Dobkins and Folk, 1970; Marshall, 1929); the Hawke Bay clast abrasion is mostly on the edges, that is, the clasts roll in the swash and, if stationary, are edge sand blasted. This was also observed on painted clast tracer experiments (White, unpublished data). Edge abrasion suggests that clasts are trapped in sand. When being transported, clasts are lifted and rotate.

Marshall (1929) found the lower Tukituki River gravels were spherical and those on the adjacent Haumoana beach flatter; the flatness increased northward to near Awatoto. This change of clast form was thought to be from a swash process that slides clasts across abrasive sand. It is important to dwell on the Hawke Bay gravel because much of the sediment volume changes are attributed to abrasion (Komar 2010; Reinen-Hamil, Clode, and Daykin, 2009). Notwithstanding the iron oxide staining, the dominant clast form (Zingg, 1935) in Hawkes Bay and Hawke Bay is flat, ranging discoidal to bladed. The reason for this could be the tectonic signature on the greywacke. The fissile splitting of clasts in fresh falls from the Cape cliffs and alongshore to Te Awanga can be observed. Indeed Bluck (1967) and Bartholoma, Ibbeken, and Schleyer (1998) have noted the importance of clast splitting in gravel supply rivers prior to or upon entering the marine beach process phase. Therefore, most of the abrasion in Hawke Bay can be found near Cape Kidnappers, where relatively large clasts can quickly fragment into smaller sizes. One of the main triggers for this is possibly the release of the overburden pressure when the Cape Kidnappers cliff face breaks away and drops onto the fringing beach below. t-test and F-test results on samples from the lower Tukituki River and the adjacent Haumoana beach show that the samples could be drawn from the same population. Selecting the oblate-prolate index (OPI; Dobkins and Folk, 1970) as a measure of the gravel forms disc, blade, and rod. Samples from the lower Tukituki River (mid bar), and the Haumoana beach (lower beachface cusp horn), have the results 0.90 (t-test) and 0.14 (F-test). The match for gravel sizes is $H_0 = 1$. Similarly, in the alongshore samples from Clifton (sediment supply) and Marine Parade (sediment sink) beaches, the results are $H_0 = 1$ for sizes, and the OPI results are 0.64 (t-test) and 0.19 (F-test). The sampling period for the river is 10 years, and the beach over 4 months (spring equinox). Results show a small increase in negative OPI between Clifton and Marine Parade over a season (winter to summer), but the intersample variation ($n = 9$, synchronous samples at each site) is greater than the season variation (White, 2005). At Clifton and Marine Parade the respective average OPI are -0.131, and -0.354, hence clasts become slightly more discoid and fit the increasing negative OPI model proposed by Dobkins and Folk (1970). Dobkins and Folk (1970) suggest an OPI alongshore gradient could be from abrasion or selective sorting, where disc forms are trapped by sand. Indeed the selective sorting can be observed on the Hawke Bay beach face. The cuspate beach face morphology has size- and form-sorted gravels, similar to Marlin Head (Sherman, Orford, and Carter, 1993).

White and Healy (2003) demonstrated that the Clifton and Marine Parade gravel mean grain size and sorting differ. Over the spring to summer period 1997, gravel samples ($n = 5$) are coarser and better sorted at Clifton than at Marine Parade. White (2005) found over a winter to summer season, with three high seas events (H_b greater than 1.0 m) that the sorting variation was greater at Clifton. This suggests the sediment supply swamps the sorting signal, whereas at Marine Parade the gravels are established, or at equilibrium, with the hydrodynamic forcing. Marshall (1929) suggested that flat forms with sizes smaller than 3.4 mm (-1.5 Phi) become stable, having small abrasion rates. At Marine Parade the frequency peak for discoid forms (Zingg, 1935) is in the size range 8 to 12 mm (-3.0 to -3.5 Phi). In high seas events, within the Marine Parade swash zone, the disc form content changes less than at Clifton, lending support to the idea that the clast forms are sorted and stable at Marine Parade.

Komar (2010) and Reinen-Hamil, Clode, and Daykin (2009) have the gravel at Bluff Hill consumed by abrasion. It could also be expected that the concrete armor units used as port breakwater fragment in high seas. What happens to these fragments? If transported away, where are they? Marshall (1929) found the by-product of greywacke abrasion experiments to be mud; Hemmingsen (2000) found South Island greywacke can abrade to sand and the Hawke Bay greywacke is harder than its low-grade metamorphic South Island counterpart. White (1994) sampled sediments along the 10-m isobath from Tangoio to Clifton. The mud percentage decreases from the Tukituki and Ngaruroro river inlets to Marine Parade. If the greywacke abraded to sand, then it would be noticeable off the main river inlets. If the greywacke was abrading into mud, then it would be expected to increase toward Marine Parade. Indeed, most of the sea bed sediment textural sizes were very fine sand, except for silty muds off the Tukituki and Ngaruroro River inlets.

White (1994) analysed the 75-μm particles (3.75 Phi) and mud sizes for their geochemistry. The sediment had a greywacke signature, but anomalies existed, for example, the port of Napier, and this possibly from a process at the port breakwater. High-energy waves could winnow the less dense components leaving a residual lag of heavy minerals—certainly because of the Fe_2O_3 content with some 35 wt. %. Trace elements were of interest; for example, zirconium is abundant in the Esk River, and off Westshore. We cannot be certain whether the Westshore zirconium is derived by the southward transport of fines in the nearshore, or relict from when the Esk drained into the Ahuriri Lagoon. Certainly, seabed drifter experiments had a net southerly drift from the

Esk (White, 1994). Whilst the sediment has a greywacke signature, and it could be argued this is proof of the fine sand being an abrasion by-product of greywacke, petrological evidence suggests otherwise. Petrological microscope examination shows well-formed mineral grains, namely hypersthene and magnetite, derived from tephra (White, 1988). The geochemistry of greywacke and that of silicic magma are closely related (Reid, 1982). The main tephra source is interbedded with the Pleistocene conglomerates of Cape Kidnappers. Within beach sands, relict yellow quartz grains (Pantin, 1966) can be seen with a petrological microscope. Indeed, much of the sediment in Hawke Bay is terrigenous and is thought not to be derived from erosion (Lewis, 1973).

Komar (2010) quite correctly asserts the important role tectonics have on the state of the coast. To extrapolate the evidence for a coseismic event (1931 Napier earthquake), I consider that the 1-m subsidence along the shore of Haumoana, Te Awanga, and Clifton is tenuous. There is evidence for a shore subparallel syncline (Carter and Lewis, 1976). Hull (1990) found a 0.78-m subsidence at the Tukituki inlet, but to the south, there is only anecdotal evidence. Indeed the chances are that Clifton had a relative uplift because Cape Kidnappers is uplifting (Lewis, 1971, 1973); also, the single barrier ridge at Clifton rests directly upon the Pleistocene. White (2005) observed the difference between a grounded and a suspended barrier. At Bluff Hill, and certainly Clifton, the barrier is grounded and rests directly on bedrock. The suspended lengths are those resting on subsiding unconsolidated sediments. At the Ahuriri (Hull, 1986) basin, there is Westshore. The barrier from Awatoto to Haumoana rests on the large mud-infilled subsiding Heretaunaga Plain basin (Ota *et al.*, 1988) that passes beneath the barrier to seaward. At Awatoto, a previous barrier dated at some 6000 YBP is now 30 m below MSL (Brown and Gibbs 1996). The inference here is that where coastal erosion or barrier migration to landward is significant also happens to coincide with a subsiding basin, and to invoke a Silvester and Ho (1972) crenulate plan shoreline driven by wave refraction, we could be missing the main driver, namely gradual tectonic subsidence.

Komar (2010) and Reinen-Hamil, Clode, and Daykin (2009) uphold a littoral drift model (Tonkin & Taylor, 2005) where sediment volume losses are attributed to abrasion. Yet, no investigations at sea are made to determine if the gravels transport seaward. Gravel losses at Marine Parade may not be a product of abrasion but are lost when transported into the nearshore. White (1994) found nearshore gravels off Clifton–Te Awanga and Marine Parade.

Recently, Reinen-Hamil (personal communication, 2009) recalculated the supply volume from the Tukituki River (Tonkin & Taylor, 2005) by reducing the volume in Komar (2010) to produce a better fit for the littoral drift sum and perhaps better explain the abrasion. Surely, some years have greater or lesser high seas events, and the Marine Parade sediment volume could be observed to correlate, especially if the beach is a closed system held against the port breakwater? The proposed model has a budget, with sediment supply, littoral drift sediment driven by a synthetic wave, and with sediment losses accommodated, *vis.*, the Awatoto gravel extraction (Tonkin & Taylor, 2005). However, there are other possibilities that could explain sediment losses other than abrasion. For example, unknown, unrecorded quantities of sand (an abrasion by-product) are trucked out of Hawkes Bay every week and have been for years. Overtop and washover losses are not accommodated. There is historical photographic evidence of sediment overwash passing into storage at Marine Parade *ca.* 1864 (Hawkes Bay Cultural Trust, 1864). On one occasion, a washover of some 700 m^3 was topographically surveyed at Haumoana (White, unpublished data). Does the model only use swell waves and not local wind waves? There are days when a nearshore swell wave is observed with a northern incident wave crest as are wind waves with south traveling crests. Komar (2010) suggests the high seas swell events are from the southeast, but ex-tropical cyclones from the northeast are devastating and are thought to be at the east coast, South Island (Stephenson and Schulmeister, 1999). The last cyclonic storm to arrive in the Hawke Bay was cyclone Bola in March 1988, and more recently, on the 9 March 2010, the high seas were generated by a low pressure to the east. The synthetic wave data (Andrews, Reinen-Hamill, and Ayde, 2003) did not replicate the long wave swell, with a typical period of greater than 14 seconds. It is these long wave swells that are often a precursor to storm high seas and flood events, as may have occurred on 9 March 2010.

Komar (2010) has the first beach profiles dating from 1916; whereas the first is 1914 at Clive, a moot point; what is important is that a fire following the 1931 Napier earthquake destroyed surveyor log books, making the location of benchmarks difficult. Excursion lines (Kirk, 1992) are useful, but why chose one at 1.5-m above MSL, with a mean high water spring at 0.72 m? Perhaps at Westshore this is more a measure of beach renourishment monitoring. Following a Westshore renourishment, there was an apparent sediment volume loss. White (personal communication, 1999) noted this was from compaction of the recharge sediment at the barrier crest. Sediment from the Ahuriri Lagoon was used as Westshore beach renourishment until the late 1980s. White (personal communication, 1988) found a proportion of the gravel sizes were pumice, which floated off on the next high tide after renourishment. White (2005) investigated the change of sediment volume and beach profile index (Fuccela and Dolan, 1996; Orford, 1986) for $n = 33$ samples from June 1998 to May 2001. The beach topography was sampled to -1.0 m (MSL). Clifton had a near flat intersample beach volume change (as a time series linear regression), ranging from -6 to $+8$ m^3, whereas Marine Parade had a greater intersample change, ranging from -28 to $+20$ m^3. However, the great sediment volume change at Marine Parade is because the swash width is greater than at Clifton. Across the beach face, the vertical height changes between surveys are greater at Clifton than at Marine Parade. For example, at Clifton the maximum vertical bed changes can be slightly greater than 0.4 m, whereas at Marine Parade vertical changes are less than 0.4 m. Hence, in a high energy event, the profile will change less at Marine Parade than at Clifton. This suggests the beach face at Marine Parade is more stable in high seas per unit of cross-shore width. Beach changes, sediment volume losses, in the Hawke Bay may not solely be a product of abrasion; there is evidence that the barrier is a sediment sorting feature. With limited sediment supply, coupled with landward migration and the extension of the barrier, there is apparent erosion. Certainly the barrier does not behave uniformly along its entire length. Along certain lengths the barrier is accreting, whilst along other lengths it is cannibalistic, and other lengths are in roll over with human rubbish exhumed in the beach face (White, 2005). Indeed there are two main barrier components, an antecedent multiple ridge barrier and a recent single crest barrier (White, 2005).

The management of the coastal environment in the Hawkes Bay could be improved. The message for Hawkes Bay should be the more the coast is played with, the worse the long term effects turn out to be. It is difficult to instill sound practice into the public domain when the public witness counteractivities, for example, gravel extraction on a commercial scale for aggregate, and locally for stop bank construction and inserting structures. One of the reasons given for continuing to extract gravel from Awatoto was that it could prevent gravels from entering the port fairway (Tarkis Koutsos, personal communication, 1988); there was also a financial interest, with the central government receiving $80,000 per year royalty. The public actively lobbies for coastal protection from flooding and erosion especially after each event. The ideal is a seawall with a promenade like those in England, but groynes are also called for. Indeed Ide (Gavin Ide, personal communication, 2009) claimed seawalls may be required. It is not widely appreciated that Hawkes Bay is fortunate and already has the best protection nature can offer, a gravel barrier with natural supplies. Hawke Bay has a near natural beach system that is able to adjust to forcing and has done so for several thousand years. As a principle, the barrier should be left alone, but there is no money to be made from this option. Indeed the barrier was fine until people started to build on it, especially on the seaward crest, and expected no physical change. Resource consents were granted for the buildings, and within the time frame of the Resource Management Act and the New Zealand Coastal Policy Statement. It should be noted that the coastal population demographic has changed. The once social dropouts were replaced by those with aspirations. Rented single story holiday baches have been replaced by two-story villas. Funding for research may remain difficult. Requests were met with "we know all we need to know," and as an example of recent thinking, "We do not need to keep getting science *ad in finitum*" (Gavin Ide, personal communication, 2009). Suggestions that it is possible to construct hydrodynamic models about Bluff Hill with and without the port in place were refused, as were requests to install video cameras, side scan, and multibeam surveys. Napier City did supply funding, and this resulted in a thesis. Other management oversights include the accurate measurements of overtop and washover deposits. Immediately after the event, the local population and then the district councils clear up the debris before the topographic survey people arrive. The public can also express anger at the survey people, delaying their progress. Hence, precise data on run-up and subsequent overwash remain scarce. Subsurface washover deposits are not noted because there is no legal requirement. Consequently, the present hazard lines, based upon synthetic data, do not reflect the ground evidence.

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e. Total Free or Nominal Rate Distribution *(Sum of 15d (1), (2), (3) and (4))*			23	25
f. Total Distribution *(Sum of 15c and 15e)*			606	598
g. Copies not Distributed *(See Instructions to Publishers #4 (page #3))*			65	27
h. Total *(Sum of 15f and g)*			671	625
i. Percent Paid *(15c divided by 15f times 100)*			96.3	95.8

16. Publication of Statement of Ownership
☐ If the publication is a general publication, publication of this statement is required. Will be printed in the ____________ issue of this publication.
☑ Publication not required.

17. Signature and Title of Editor, Publisher, Business Manager, or Owner

Date: 8.17.10

I certify that all information furnished on this form is true and complete. I understand that anyone who furnishes false or misleading information on this form or who omits material or information requested on the form may be subject to criminal sanctions (including fines and imprisonment) and/or civil sanctions (including civil penalties).

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