



# NEW ZEALAND SURVEYOR

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Striking a balance:

Balancing cultural and productive uses of Māori freehold land



Aligning the ancestors:

The orientation of meeting houses in New Zealand



The search for acceleration in New Zealand's mean sea level record



Watching the river flow:

The law, rights and ownership of rivers in New Zealand



What impact do higher-education experiences have on the environmental attitudes of surveying students?



Book review

Reminiscences of a pioneer surveyor

By S Percy Smith





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## GUEST EDITORIAL

# CHANGE MUST BE GOOD

HADYN SMITH, CEO, NZIS

In the 1980s I visited Ephesus (near modern Kusadasi in Turkey) and heard of a Greek philosopher called Heraclitus who lived around 500 BC. What caught my attention at the time was that he had initiated the often quoted statement “the only thing that is constant is change”. I had thought it would have been a 20<sup>th</sup> century quote from the likes of John F Kennedy or similar, but regardless of who said the words, it was clear in my mind that although we think our generation is the focus of change (as we are experiencing it), change has been a large part of human philosophy and our DNA for thousands of years. It follows that the New Zealand Institute of Surveyors (NZIS) has evolved since its founding in 1887 and as part of this continuing evolution we are now embarking on perhaps one of the biggest change strategies since our formation 125 years ago. My role is to progress that evolution and put in place the strategies outlined in the NZIS document *The Way Forward 2013* that was made available to all members in 2012.

The focus of that document is the need for the NZIS to: include and connect with our entire profession or sector; modernise our administrative platform; grow the value of our Continued Professional Development (CPD) programme; increase our profession’s community voice and add overall value and support to membership. The plan has been formulated by our sector for our sector. However, evolving each part so that it reflects the wants and needs of our entire profession, and adds value to membership, is slightly more complex. I think it is important therefore for me to isolate the work-in-progress at present and explain, as much as is possible, what our aspirations are and what is being developed. The following are the key areas that should explain our evolution and outline what the NZIS Council and National Office is working towards.

### THE NEW ZEALAND INSTITUTE OF SURVEYING AND SPATIAL SCIENCE CONSTITUTION

To go forward the NZIS must expand and connect with the wider land and spatial sciences sectors to increase our membership catchment. In order to do so, our name needs to better reflect our entire targeted sector. To this end, we are working to become the New Zealand Institute of Surveying and Spatial Science (NZISSS), or similar. It follows that we must get the governance structure right, and that it evolve towards a model that retains sector input through Council, and shortly a Board with smaller numbers, to focus on setting and

achieving our organisational goals and provide an efficient level of management oversight. The new rules, intended to capture all the “good” from the past and the improvement needed, are currently being drafted and along with the name change, will be subject to membership approval or otherwise at the NZIS Special General Meeting later this year.

Changing a constitution is no easy task. However, we are on track, and by our timelines the final draft will be circulated around April for membership scrutiny.

### INFORMATION AND COMMUNICATION TECHNOLOGY PLATFORM (ICT)

The basis for many successful membership associations is a quality database, allowing seamless membership communications and a level of quality support technology to be applied. This aim has been a key driving force behind the Council’s decision to progress the NZIS ICT project. I am pleased to confirm that we have now engaged Cyberglue to assist us with the development of a system called Memberconnex. The key element to this project is the support it will provide for all levels of membership needs, ranging from self-membership management, branch support, CPD and event bookings, such as workshops, conferences and webinars, right through to public enquiries for professional skills.

The evolution to an ICT system that will be rolled out to members will take a few months, and we aim to have the whole system functional for launch by the AGM in August.

### THE NEW ZEALAND INSTITUTE OF SURVEYING AND SPATIAL SCIENCE GOVERNANCE MANUAL

The Council, Board, Committees and Management need to know and understand their new roles, the expectations and various governance processes and policies that will support the constitutional changes. The Council has worked hard to draft a document that encapsulates not only the constitutional requirements but also assists office bearers, staff and members in performing their roles effectively. This document is under construction and is also subject to constitutional approval and should be in place by the end of June.

### THE 2013 TO 2018 STRATEGIC PLAN

The Strategic Plan states the vision, the mission and the key objectives as we commence operating under our new

constitution and move through to 2018. It is a key document and one that the Council are doing a lot of work around to ensure that it reflects what our members wish to achieve. Some of the key focuses are:

- Ensuring the final vision and mission truly reflects the future;
- Identifying and supporting the values that underpin our professional culture;
- Identifying the strategic priority areas that will add value to both our profession and our communities;
- Identifying the key outcomes that will, when achieved, allow us to grow our sector voice and professional standing with the New Zealand public.

A key theme underpinning our vision is that national membership is important to the success of the Institute and our profession. Our reason for being is ultimately the power of one. Few individuals or small groups will achieve outcomes that can connect objectively with the greater community good and where we need to go. A profession is as strong as its values and ethical base and a big part of our culture must be its power to identify issues that need our influence, but most importantly, the belief that together we can deliver a product and service that we are accountable for to our communities. As a professional body we must fight for and retain values that must not be ignored or set aside. We must see value in national membership and our vision for being. The new Strategic Plan will support and articulate that objective.

These three documents and the ICT Project form the foundation for our future, and underpin our connection with and value to members. They also allow operational staff to work on what is needed in order to prove and grow our case for membership.

Change for NZIS is not confined to our structure; the technology and methods we use in our day to day tasks are also developing, as is the wider New Zealand society. The *NZ*

*Surveyor* is the Institute's scientific and professional journal where research that underpins our scientific and professional development may be published, in a form that will not only inform the members of our expanded organisation, but also members of the wider scientific and related professional communities.

Organisations that are key to the success of surveying and spatial sciences in New Zealand are the University Departments that, on the one hand, carry out research pertinent to the development of the profession, and on the other, teach young surveyors and spatial scientists. Some of the research involves topics that were probably unheard of 50 years ago when a major change in the training of surveyors – from the old article system to university training – took place. In this current issue of the *NZ Surveyor*, for example, Theresa Cole-Swami and John Hannah address the issue of sea-level rise in response to global warming. As part of their degree, surveying students can expand their horizons by taking electives, such as Geography, Environmental Science, and Maori; and students who go on to do honours in surveying can undertake their own research as part of their course. James Berghan, a recent graduate, investigated how to balance the cultural and productive uses of Maori freehold land for his honours dissertation. This is a matter that is likely to become very important in the next few years as Iwi attempt to maximise the economic return from land that has considerable cultural values, which must be protected. Part of Berghan's dissertation is published in this issue of the *NZ Surveyor*.

Whilst the adage "the only thing that is constant is change", is true, some things change more slowly than others, and one additional constant is the need to keep people informed. The *NZ Surveyor* is our scientific and professional journal – support from Institute members is vital to its continuance.

Although the Institute will be rebranding and focusing on outcomes that reflect our future needs, our communications will expand and improve. A change that will reflect, lead and support both our profession and communities.

# STRIKING A BALANCE: BALANCING CULTURAL AND PRODUCTIVE USES OF MĀORI FREEHOLD LAND

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**Abstract** This paper describes research into whether co-owners of multiply owned land would be prepared to trade reduced access to productive portions of Māori Freehold Land, for increased access to culturally treasured portions, and to manage the latter using a model that seeks to optimise cultural values rather than profit. In answering this question, the paper describes a cartographic technique aimed at facilitating conceptualisation, and responses to this technique by land owners. Using key interviews and questionnaires for three case studies, the research concludes that certain block-specific factors affect willingness to trade cultural and productive uses, and identifies areas for further research.

## INTRODUCTION AND RESEARCH QUESTION

Māori land is important for economic development but, more than that, remains a cornerstone for Māori identity and a sense of continuity with the past... A challenge for the future will be to repatriate all Māori people so that being Māori makes real sense, not only in cultural terms but also in having a place to call home, *tūrangawaewae*.

(Durie 1998:145).

Te Ture Whenua Māori Act (TTWMA) promotes two principles; the retention of Māori land in Māori hands, and the utilisation of Māori land (TTWMA 1993). However, profitable utilisation may conflict with retention, or at least put it at risk. For example, to those holding the view that the best utilisation of Māori land is to sell it to earn a productive benefit from the land, and also to those who favour using the land as collateral security for borrowing, thereby risking its enforced sale, the two principles are in tension. A divergent view is that Māori Freehold Land (MFL) is a *taonga tuku iho* (treasure) and 'utilisation' is less about maximising profit from the land than about developing it to encourage owners to take part and become involved with it (Yetsenga 1990). This sentiment resonates with the challenge set by Durie; to 'repatriate' Māori with the land and give them a place "to call home, *tūrangawaewae*" (Durie 1998:145).

Between the extremes of, on one hand, sale or lease of blocks of Māori Freehold Land for economic uses such as agriculture or forestry, and on the other hand, thoroughgoing cultural use with little or no weight attached to profit, exists a spectrum of compromises between cultural and economic uses. The particular compromise explored in the research for this article has its starting point in the idea that communal land tenure, elements of which still operate over MFL, has two principal strands, namely land links and interpersonal links. In separating these two strands over the years since the Treaty

of Waitangi, general land in New Zealand has tended to cater for shelter and sustenance for the majority of Māori while MFL has retained a disproportionate value in terms of embedded cultural significance (Goodwin 2011). Notwithstanding this, MFL is frequently assessed using a productive rather than a cultural management model, and is often judged to have failed. The expedient investigated in this research is to categorise land into discrete productive and cultural parts and to manage the former on a scale of profit and loss but the latter against a different scale, namely that of cultural success including perceptions of belonging by co-owners (Goodwin 2011).

What is unclear from the literature, and what this research sets out to investigate, is the level of acceptance by Māori land owners of the idea of separating land into cultural and productive parts, and relinquishing some or all use-rights to productively zoned portions in favour of enhanced rights to culturally zoned portions. This leads to the overarching question for this research: would Māori favour the idea of relinquishing use-rights to portions of productive land if this meant gaining better access to treasured cultural areas, and of managing cultural areas using a model that optimized cultural values rather than maximizing profit? From this overarching question flowed four objectives:

- 1) To identify existing relationships that Māori landowners have with Māori land;
- 2) To identify aspirations that owners have for their land, and any barriers preventing these aspirations from being realised;
- 3) To gauge reactions to a draft plan that separates land into cultural and productive parts;
- 4) To assess mechanisms for achieving such separation in law and in practice.

This paper, which is based on a more in-depth honours

dissertation (Berghan 2012), focuses on objectives one to three while objective four is an area for further research. The following section reviews background and the literature, following which are sections on methods used, findings, discussion and conclusions.

## BACKGROUND AND THE LITERATURE

As of 2009, there were 26,556 Māori Freehold Land titles with a combined area of almost 1.5 million hectares, or 5.5% of New Zealand's land area. The average block of land is 55 hectares, and the average number of owners per title is 88 (Clark et al. 2009). A study conducted by the Ministry of Agriculture and Forestry (MAF 2011) categorised approximately 40 per cent of Māori Freehold Land (or 600,000 hectares) as "under-utilised lands"; lands not developed for productive use.

Two underlying causes of under-utilisation, and hence of Māori frustrations, are the geographical isolation of Māori Freehold Land and the nature of the tenure; fragmented and multiply owned. Geographical isolation stems largely from settler demands for the best productive land, which often left poor quality, marginal land remaining in Māori hands. Being distant from urban centres limits owner access to markets as well as specialist knowledge and advice to utilise such land (Hutchings 2006). Turning to multiply owned land, the classification of Māori landowners as tenants in common, where owners' interests in land succeeds to their heirs, has resulted in the exponential growth in owners of Māori land. Such multiple ownership is a primary cause of administration challenges, including informing owners and gaining consensus among those right-holders whenever a development is proposed. Multiple ownership of the land may not be particularly problematic for owners' living on or near the land, but today's more mobile Māori population means that it is increasingly difficult to inform distant beneficiaries of changes or get their approval for decisions (McCarthy et al. 1980). Māori living away from the land might not even know they are owners, or may not have the desire to succeed to rights, thus leaving the land registered to owners who may long since have been deceased (Luetticke 2011).

The fragmentation of title through multiple ownership is at odds with *tikanga* (Māori tradition or protocol). Traditionally, the concept of *ahi kā* applied, by which Māori lost rights to an area if they did not manifest possession or interest in the land for three successive generations (Sinclair 1975). This tradition has been trumped by a competing tradition of inclusivity, and today disconnected or uninterested owners still succeed and are recorded regardless of the relationship they hold with the land unless they actively remove those rights themselves. This often leads to infinitesimally small shares, posing further unnecessary obstacles.

While some co-owners may be apathetic, others can face frustration when attempting to develop and enhance a block of Māori land at their own personal expense. Once

the land shows improvement and provides returns, other owners may come "out of the woodwork" to share benefits, with no intention of compensating for earlier work (McLean 2002; Dewes et al. 2011). Furthermore, multiple owners have multiple views and priorities, placing still further constraints on attempts to utilise land.

## Solutions

A variety of solutions have been tried to mitigate or solve issues of multiple ownership and fragmentation. One solution is that of subdivision of undivided shares, but this carries inherent dangers. For example, computed or "office" survey plans, where blocks were subdivided without field inspection, can result in impractical lots and unusable land. A case in point is the Taieri Native Reserve, which was subdivided into A, B and C blocks, and then further subdivided into impractical strips (Wanhalla 2004; Strack 2006). Other solutions include amalgamation, incorporations, trusts, compulsory acquisition of uneconomic shares, occupation orders and even conversion to general land (TTWMA 1993). However, more recently the focus has been on improving access to information about the land and the owners of that land, as "the effort of trying to reach distant or even non-existent owners is out of proportion to the wider task" of actually developing or making use of the land (Durie 1998:142).

The majority of these solutions skirt the question of whether at least portions of the land could be managed so as to optimise cultural values, and in particular, how Māori would view such a scheme.

## METHODS

Three blocks of Māori land were examined as case studies to apply and contextualise the concept of a balance of cultural and productive land-uses. Flyvbjerg (2011) describes how the case study can be seen as a powerful tool for "detail, richness, [and] completeness" although the statistical significance of any findings is often not quantifiable. Here, the comparison between multiple cases has the potential to add weight to the research by indicating differences and trends inherent with the range of histories, owner demographics and ownership structures of each case.

Based on an honours project, this research was subject to time and resource limitations. As such, the first block (Ahipara 1B2B) was selected on the basis of existing kinship connections and personal familiarity with the land, thus providing some authority to comment on such issues. For contrast and comparison, two blocks in Otago (Taieri Block B, Section 1N Town of Hawksbury) were also selected, mainly on grounds of proximity, in an attempt to remove any potential researcher bias from personal involvement with the land or landowners.

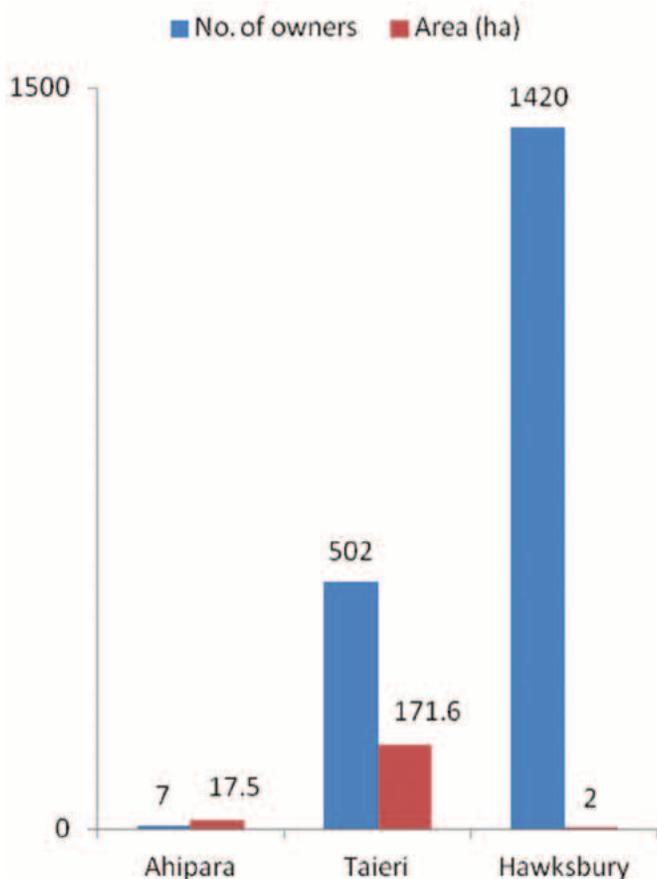
The first and second objectives of the research, namely to identify existing relationships owners have with Māori land and to identify aspirations that owners have for their land and

any barriers preventing these aspirations from being realized, were achieved in two ways: first using guided questions in key-informant interviews; and second using questionnaires.

In-depth, semi-structured interviews with key right-holders in the blocks of land were carried out to gather a history and account of owners' relationships with the land. This information was used to create a draft plan for the land, which was then sent to owners with a questionnaire to gauge their reactions to a land-use compromise concept.

Research participants were recruited from lists of registered owners of the land blocks readily and publicly accessible from Māori Land Online. Participants included both men and women, ranging in age from 41 to 83 years old. The intention was to draw on views of owners from different backgrounds, different professions and differing levels of involvement with the land.

Of the three blocks studied, the first has no management structure in place while the remaining two both have *ahu whenua* trusts. The blocks range in size from two to 171 hectares and have between 7 and 1420 registered owners (see Figure 1).



**Figure 1: Area and number of owners per land block**

For the purposes of this article, most detail is given for the Ahipara 1B2B case study, although the draft plans are also included for the other two case studies. Ahipara 1B2B is approximately 17.5 hectares and is located at the southern end of Te Oneroa a Tōhē (Ninety Mile Beach) in the Far North of the North Island. It is bounded by the Paripari and Moringai streams on the east and west respectively, and fronts

Foreshore Road and Ahipara Bay. The land is primarily north-facing pasture and scrub, and slopes upwards steeply from the road frontage. At the time of the research it was owned by seven siblings<sup>1</sup>.

The key informants' visions and aspirations for the land were varied. For one owner, any previous aspirations had since been dismissed, since "they're just pipe dreams aren't they? [The other owners] block every plan you have" (Interview A)<sup>2</sup>. Others promoted productive uses such as a camping ground for caravans, building sites (particularly as it is a coastal area), and planting pine trees to contribute to rates payments and provide some revenue for owners. Consideration was also given to future generations and that the land "has significance to not only who they are but where they came from" (Interview B)<sup>3</sup>.

The main barrier to previous attempts to connect and make use of this land has been multiple ownership. Agreement between owners is rare and difficult to obtain. Previous attempts at development have been opposed by other owners before they can reach fruition, thus discouraging owners to try again in future.

### The draft plans

Areas of cultural value or use were identified and designated as 'C' codes on the plans. Similarly, those of productive use were designated by 'P' coding. In addition, cultural and productive areas were coded with either a 1 or 2, where 1 was for *existing* land use or values, and 2 was a *potential* use area.

For example, for the first case study, 'C1' areas (i.e. *existing cultural value*), include the retention of two existing dwellings, a significant tree and two areas identified as historically *tapu* (sacred) for the *hahu* customs (see Box 1).

Areas labelled 'C2' (i.e. areas with future or potential cultural value) include a site that one owner has set aside by means of

Te Rarawa and Te Aupouri, the predominant iwi in the area, were prominent fighting tribes and were the subject of many battles along *Te Oneroa a Tōhē* (Te Rūnanga o Te Rarawa 2004). As children, the present owners' father used to tell them of the sacred trees near the streams on the property after battles on the beach:

"The story goes that when the Māori parties used to move down the beach, they would go [to the stream amongst the trees] and they would wash the dead and hang them on the Pūriri trees to decompose. That made it a sacred area." (Interview B).

Once the flesh had rotted away, they took the bones and buried them in the caves on *Whangatauatia* (the mountain). This custom, of hanging the body from a tree until the flesh disintegrated and then interring the bones in a special burial area such as a cave, is termed '*hahu*' (exhumation) (Barlow 1994:15).

### Box 1: *Hahu* customs

an occupation order, areas along the road frontage suitable for future papakainga housing or development, and a potential future *whānau urupā* (cemetery).

Two areas of pasture in the northern half of the block were identified as areas of existing productive use, or 'P1' areas. Between the two is a segment of land identified as suitable for market gardening (P2), since the current owners' mother used to have a significant garden planted near that area. "Anything grows in the sand", one owner stated, and it would provide a poignant cultural space that could additionally provide productive uses. The surplus land of mainly steep gorse and shrubs (P2) might be suitable for horticulture or forestry.

These areas are depicted in the draft land-use plan in Figure 2.



**Figure 2: Draft land-use plan for Ahipara 1B2B.**

Similarly, the plans prepared for Taieri Block B and Section 1N Town of Hawksbury and circulated to their respective land



**Figure 3: Draft land-use plan for Taieri Block B**



**Figure 4: Draft land-use plan for Section 1N Town of Hawksbury**

owners accompanied by a questionnaire to gauge reactions and feedback, are shown in figures 3 and 4.

As Ahipara 1B2B is owned by only seven living siblings, questionnaires were sent to all seven using personal contact information and data obtained from Māori Land Court records. For the other two blocks, purposive (or 'judgment') sampling yielded a list of 10 to 15 owners who were living and of sound mental capacity to participate. Following their acceptance during an initial phone call, the paper-based questionnaire was posted.

Of the total 32 owners shortlisted, 28 were able to be contacted and have questionnaires sent to them, but only 15 of these were returned.

## FINDINGS

### Relationships with the land

Stemming from the key-informant interviews and questionnaires, of the respondents who had visited their respective land blocks, the most common reason for going was 'to maintain an historical or cultural connection with the land'. This immediately signalled the cultural significance of the land and the special function it holds for those owners. Other reasons were a mixture of cultural and productive-based purposes, including family gatherings, to consider opportunities, to carry out work on the land or simply to find out where it is.

The questionnaire also contained a series of Likert-type questions where participants rated the extent to which they agreed or disagreed with different statements. Six of these statements focused on relationships with land (see Table 1) and were combined using a summative scales technique adapted from Luka and Yahaya (2012) to produce a relationship score for each participant. This is called a 'subscale' and is simply the arithmetic mean of several responses related to one topic. Equation 1 shows how an individual's relationship score was derived.

$$X_{LSP} = \frac{\sum(LSP)}{N_{LSP}} \quad (1)$$

where  $X_{LSP}$  = the mean relationship score;

$\sum(LSP)$  = the sum of Likert-scale points, and;

$N_{LSP}$  = the number of Likert-scale points used.

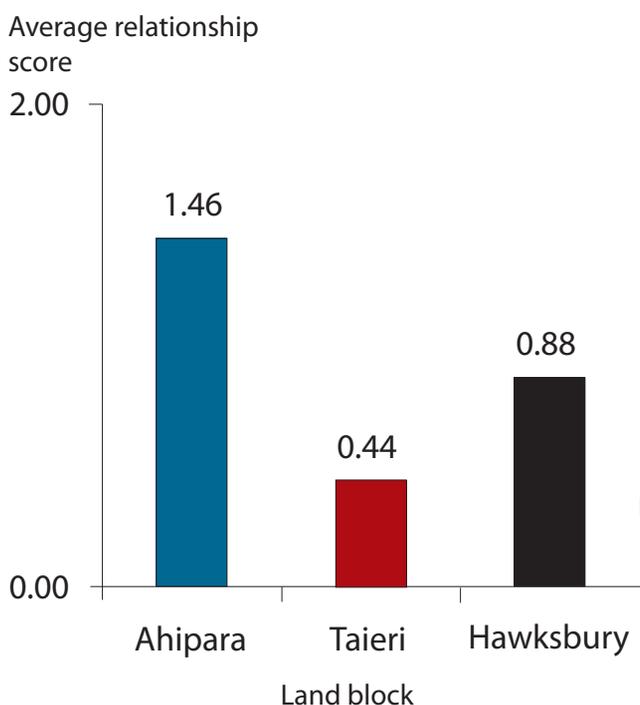
**Table 1: Relationship statements and scoring codes for each response**

| Statements - relationships with land   | Strongly agree | Agree | Neutral | Disagree | Strongly disagree |
|--|----------------|-------|---------|----------|-------------------|
| 1. I feel excluded from the land   | -2             | -1    | 0       | 1        | 2                 |
| 2. I feel no connection to the land  | -2             | -1    | 0       | 1        | 2                 |
| 3. I do not have any desire to visit the land                                | -2             | -1    | 0       | 1        | 2                 |
| 4. It is important for me to keep the “fires of occupation burning” (ahi kā) | 2              | 1     | 0       | -1       | -2                |
| 5. I feel a strong connection with the land                                  | 2              | 1     | 0       | -1       | -2                |
| 6. The land is “home” for me (tūrangawaewae)                                 | 2              | 1     | 0       | -1       | -2                |

Each scale was coded from -2 through to 2, dependent on whether the statement was worded positively or negatively. A positively worded statement such as ‘I feel a strong connection with the land’ would be scored as a 1 or 2 if the participant agreed with the statement. Conversely, a negatively worded statement (shaded in Table 1) such as ‘I feel excluded from the land’ would be scored a 1 or 2 if a participant disagreed with the statement. Thus, a relationship score of greater than zero indicates a positive affinity or relationship with the land; the higher the score, the stronger or more profound that relationship is perceived to be.

Note that statement 2 has been worded in the reverse form of statement 5. This was to minimise any distortion or acquiescence bias of the kind where a respondent simply agrees with a statement as it is presented.

Of the 12 respondents who made ratings on the Likert-type statements (3 did not complete this section), 11 gave a positive relationship score, indicating a generally affirmative attachment with land. When individual relationship scores were averaged across the different land blocks (see Figure 5), however, there is an indication of a difference.



**Figure 5: Owners' attachment to land based on land block**

Owners of Ahipara 1B2B show a high positive relationship score (1.46) while owners of Taieri Block B have a much lower but still positive score (0.44). Hawksbury owners lie somewhere in the middle (0.88).

A number of factors may be attributed to this result. As Ahipara 1B2B is owned by fewer Māori (who are also siblings), there may be greater ‘cohesiveness’ both between each owner and other owners, and between each owner and the land. They grew up on the land together, and so have a longstanding history with the particular block.

Conversely, none of the Taieri Block B questionnaire respondents had visited the land. Despite this, all had a desire to visit the land, which may indicate why the relationship score is still positive for this group of owners.

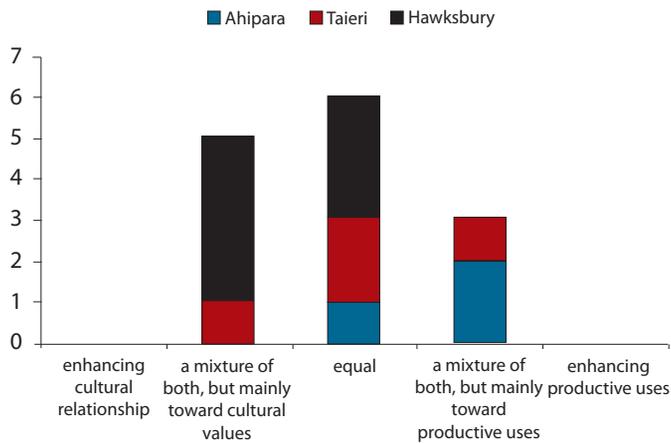
Hawksbury owners appear to express a moderate attachment to the land block. Generally, participants rated all of the statements in favour of the affirmative, though their ratings were less extreme than owners of Ahipara 1B2B.

The dissenting score, though, is just as important. It is not uncommon to assume homogeneity of Māori as a people, without recognising or accounting for perspectives that may differ from the norm. One participant did not feel a strong connection to the land, nor did she feel that it was her *tūrangawaewae*. This may be because she had not visited the land, and so did not feel a personal connection to it. Of course, we can only speculate as to why that is, but it is a reminder that people hold differing views that contradict what might be expected or seen as typical.

**Aspirations**

As a premise to testing the cultural-productive balance, aspirations were first dichotomised to reflect their cultural or productive nature. In the questionnaire, this dichotomy was made explicit. Participants were asked to select one of five categories corresponding with where they thought management decisions regarding the land should be focused. At one end, the focus could be entirely on enhancing cultural relationships, while at the other end, on enhancing productive uses. Responses are presented in Figure 6.

When all responses are considered together, there does not appear to be a strong preference for management decisions to be focused either toward enhancing cultural relationships



**Figure 6: Participants' preferences towards which management decisions should be focussed**

or promoting productive uses. However, when the responses are categorised by land block, the data indicates possible groupings. For Ahipara 1B2B, the respondents tended towards a productive focus, Taieri Block B respondents were balanced about the neutral position, whilst Hawksbury respondents tended toward cultural values.

This may be a reflection of the size of an owner's perceived shareholding. For instance, Ahipara 1B2B comprises 17.5 hectares and has seven registered owners, giving an approximate ratio of 2.5 hectares per owner. In contrast, Hawksbury has 1420 registered owners for the 2.0 hectare block, a ratio of 0.001 hectares per owner. Taieri is in the middle, with approximately 170 hectares for 150 owners, a ratio of 1.1. This supports a statement made by Dr Bill Robertson (quoted in Hutchings 2006), in which he proposes that "as the interests in Māori land become increasingly fragmented, its significance and value to its owners markedly increases". Of course, these values will differ with the shareholdings of different owners but it might indicate a general trend whereby owners with a smaller shareholding equivalent on the ground will value that land more for its cultural purposes.

Evidence of these differences can also be seen in interview and field-note comments. For instance, one owner of Ahipara 1B2B has "never doubted that there is potential for much development [on the site]" (Questionnaire 1)<sup>4</sup>, whilst another saw the feasibility of subdivisions, stating that "when you see the others around [pointing to a neighbouring subdivision], you could see how this could be self sustaining" (Interview A).

On the other hand, comments for the Hawksbury block reflected how attempts to use part of the land productively in the past "increased the sense of alienation to the land" and that "the heart of future use" should be restoring the land to its original purpose as a resource gathering reserve (Questionnaire 2).<sup>5</sup>

A report by the Ministry of Agriculture and Forestry (MAF 2011) identified several factors that may influence an owner's aspirations and expectations of Māori land, and thus how one might consider a compromise model. One of these factors

is the residence of the owner in relation to the land block in question, and how an owner living on or close to the land has easier access, so may have significantly stronger views about the land. To avoid bias, a range of owners living at varying distances from their respective land blocks were studied in this research. However, to agree with such a statement with any confidence would require a larger sample size of participants, and statistical testing.

The concept of a combination of uses of Māori land has already been idealised by Māori. A speaker at a hui in Gisborne stated "...it's either money-making or it's...cultural. I want it to be a big bang of both and that both of these, the cultural and the money thing, are both as equally as important and useful to Māori..." (Dewes et al. 2011). At this hui, owners saw the value in managing the land as an economic unit though they still emphasised their position as *kaitiaki* of the land and that the maintenance of a cultural connection was also important. These statements indicate some support for such a land-use compromise.

### Usefulness of the visualisation plan

As well as gauging opinions on the concepts presented in the plan, it was also of interest to gauge whether the plan itself was of any use to landowners in land-use decision making. Consequently, participants were asked to rate how helpful the land-use plan was in terms of visualising existing and potential uses of the land. Ratings were on a scale of 1 to 5, where 1 was not at all helpful and 5 was very helpful.

Eleven of 14 responses rated the plan as a 4 or higher on its ability to help landowners visualise the different land uses, illustrating that from a surveying perspective, a simple aerial photograph with lines delineating different use areas may be a useful tool to aid in land-use decision-making efforts. Interestingly, the plans were perceived as being equally helpful among owners who had and had not visited the land.

### Acceptance of a productive/cultural compromise

Finally, participants rated the acceptability of the land-use compromise. Ratings were made on a numerical scale from 1 to 5, where 1 was 'not at all acceptable' and 5 was 'very acceptable'. The acceptability appeared rather variable across all of the participants. However, when participant ratings are averaged across the specific land blocks, they indicate differences across the three land blocks.

The concept is rated positively for the Ahipara block, neutral for the Taieri block and less acceptable for the Hawksbury block. These views were reiterated in comments made alongside participants' ratings. For instance, a right-holder in Ahipara 1B2B was willing to accept a compromise model because "otherwise it will continue to grow gorse...and everyone will continue to argue" (Questionnaire 3)<sup>6</sup>.

Owners of Taieri Block B were less enthusiastic. One owner believed owners “should not have to give up right[s] in any area” (Questionnaire 4)<sup>7</sup> while another could “live with a compromise model” (Questionnaire 5)<sup>8</sup>.

The model was less acceptable again for the Hawksbury block, with owners citing past lease arrangements as undesirable in that they increased the sense of alienation from the land without providing any significant return. However, on the other hand, one owner saw the value in a compromise as a way of obtaining income initially to later provide for some features of cultural enhancement (Questionnaire 6)<sup>9</sup>.

## DISCUSSION

### Māori Land Geographic Information System (MLGIS)

Since 2011, Te Puni Kōkiri, in conjunction with Landcare Research, has been working to create a Māori Land Geographic Information System (MLGIS). The MLGIS is a visualisation tool being tested to inform and help owners make land use decisions (Landcare Research 2011). Using aerial photographs from Google Maps, an owner can see land features, land cover, roads and fences, and even the state of neighbouring properties. The cadastral boundaries of the land block are roughly superimposed over the aerial photograph, and the database provides information on soil properties (physical and chemical) and can show the capability of different areas of the land, for uses such as horticulture, cropping, pastoral farming and forestry (Isaac 2011).

The findings in our research suggests that the MLGIS visualisation tool will be of great assistance to Māori, both in terms of visualising the land and observing the land-use potential of different areas. The Landcare prototype of the system only assesses the land on a national, ‘broad brush’ scale and so the accuracy could be improved in future, though it is still a very practical tool.

The system does not allow for the overlay of different land-uses, however, and so the potential for a balance of uses is harder to visualise. This is particularly difficult when considering the areas that have cultural significance as well, as these are largely personal and so will generally not be mapped on the system. For owners contemplating a balance, a separate specific plan may need to be devised, with the MLGIS useful for considering different opportunities to make use of less treasured areas.

### Acceptance by land block

At the heart of the present research is whether a different balance of cultural and productive uses of land could be accepted by Māori land owners, if this meant a net improvement of cultural access. Through case studies, a range of owners were questioned as to the suitability of such a compromise for a specific block of land they held interests

in. Individual ratings of acceptance were varied, though when combined, those ratings appear to be a function of the specific land block.

Owners of Ahipara 1B2B, a moderately sized block with few owners, were receptive to a compromise model. The land is large enough that multiple use areas may be seen as more feasible, in comparison with the smaller Hawksbury block where a compromise was less acceptable. Here, owners tended to have a predominant cultural focus and, given the small size of the block, were less willing to give up further areas of the land. Taieri Block B owners overall held a neutral view of a cultural and productive land-use balance with some willing to accept a balance while others opposed to giving up rights to any part of the land.

### Owner opinions

Owners will always have differing opinions, and as one participant replied in response to the questionnaire, “that survey will put the cat among the pigeons eh!” (Questionnaire 3). Thus, the ability to compromise cannot be over-stressed.

For instance, consider partitioning the land. An owner may see this as a desirable option, particularly if their shareholding amounts to a reasonable area of the land, since it might allow them to deal with that portion to the exclusion of others, thereby avoiding the conflicts of multiply-owned land. However, when the land succeeds to the next generation, we return to the same position, whereby each owner may be tempted to partition the land. Over successive generations, eventually each person will be left with an unusable, impractical “teaspoon of soil”<sup>10</sup>.

The above highlights the need for powers of control in effective management. Māori land owners need to recognise the communal nature of the land, and that although other owners may have different perspectives, consideration needs to be given to the long-term ‘greater good’, as opposed to short-term individual gains. Management of the land in fewer, authoritative hands (as is part of the potential of separating productive land) may eventually improve the long-term connection and relationship of all owners with the land in its entirety, if such a compromise can be accepted.

### Implications for the profession

As Judge Ambler (2011:13) states, surveyors have “historical baggage” when it comes to dealing with Māori land. Some Māori may have a negative perception of surveyors due to their role in land confiscations and unjust dealings in the past. However, through education and an understanding of *tikanga* Māori, the profession can move forward and become a source of expert advice surrounding Māori land. Ambler (2011) mentions how surveyors may be approached to facilitate title innovations to utilise Māori land – this research could inform surveying policy and practice.

## Implications for Māori - the need for self-determination

Underlying any recommendations or considerations for Māori land is the understanding that owners must make decisions themselves and determine their own path, to create a successful and satisfying solution. Those who have input to the process are likely to invest more in maintaining the outcomes (NZIER 2003). Surveyors, in their capacity as land experts, can merely provide the tools and advice to assist owners to come to a solution.

## Owner response issues

Despite Māori Land Online now allowing for easy access to lists of landowners, the number of deceased owners is still an issue. Of course, this will continue to be an issue since owners generally hold registered rights until death. Perhaps a cross-agency approach to improve access to owners' contact information could be adopted as Isaac (2011) suggests, or even extended to 'flag' deceased owners as well.

The response of owners to the questionnaires was poorer than expected, particularly as all owners contacted were initially very receptive and willing to take part. The process reflects the difficulties facing landowners in contacting other land owners and getting them to attend meetings to make any land administration decisions.

## CONCLUSIONS

Māori Freehold Land has come to hold significance for its embedded cultural value. In 'unlocking' MFL, there is a case for attempts to utilise the land focusing on strengthening cultural ties, and productive reforms being directed at enhancing such connections. Compromise could involve owners relinquishing use-rights to less-treasured areas for productive use in order to enhance access and connections with those treasured areas. The research for this article tested the acceptability of such a trade-off among Māori landowners through three comparative case studies.

Reactions were mixed, and appear to be specific to the particular land block. Where owners have a reasonable shareholding equivalent to area on the ground, the concept seems to be more attractive. However, where blocks are smaller and have increasing numbers of owners, the productive and cultural balance becomes less acceptable.

The compromise model investigated is not a 'silver bullet' solution that could be adopted for all Māori Freehold Land. However, the visualisation tool described shows some potential in addressing issues facing owners frustrated by the sole cultural, sole productive, or general under-utilised state of their land. It might facilitate repatriation and reconnection with the land by Māori who are frustrated by a lack of funding. Ultimately, though, the decision to accept and actively implement such a proposal would lie with the owners.

As a consequence of time and resource constraints, the findings in the present research are merely indicative of trends that may exist across Māori landowners generally. Thus, many opportunities exist to progress this research. A larger sample size would allow differences to be tested statistically, while further interviews could ascertain the reasons for disparity between levels of acceptance of owners more clearly. In addition, further work is called for on how productive land-use areas might be managed to fund the land, and what legal mechanisms are most appropriate. Finally, evidence and discussions about land at the Māori Land Court are greatly enhanced by well-prepared plans, and the question is raised of whether surveyors and other land professionals dealing with Māori land can be better prepared to assist and advise Māori landowners on land-use opportunities. The visualisation tool described in this article may provide a constructive starting point for discussions around use and protections of Māori land, and may indirectly help to 'repatriate' Māori with their land.

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## NOTES

- 1 One sibling has subsequently put her interests into a Whanau Trust.
- 2 Interview A: Anonymous, 11 February 2012.
- 3 Interview B: J Pure, 12 February 2012.
- 4 Questionnaire 1: J Pure, 6 August 2012.
- 5 Questionnaire 2: M Ellison, 30 July 2012.
- 6 Questionnaire 3: Anonymous, 31 July 2012.
- 7 Questionnaire 4: E Stockwell, 26 July 2012.
- 8 Questionnaire 5: M Ellison, 30 July 2012.
- 9 Questionnaire 6: Anonymous, 3 August 2012.
- 10 Fieldnotes from observations at Māori Land Court session, Whangārei, 20 February 2012.

# ALIGNING THE ANCESTORS: THE ORIENTATION OF MEETING HOUSES IN NEW ZEALAND

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**Abstract** This article addresses the overarching research question of whether there is any uniformity in the pointing of meeting houses on marae in New Zealand, and it commences from an initial hypothesis that meeting houses are oriented towards the Taputapuātea marae on Raiatea, in the Society Islands in French Polynesia. Methods employed included the use Google Earth, spherical trigonometry calculations and a limited fieldwork campaign of forty meeting houses. A conclusion of the research is that there is a slightly higher chance of meeting houses being oriented towards the Taputapuātea marae on Raiatea, but that the hypothesis is not adequately supported by the provisional fieldwork done for this article. It is concluded that a number of other symbolic and practical considerations are important when orienting meeting houses, and that some of these considerations may overshadow orientation preference.

**Keywords** Meeting house orientation, marae, Polynesian navigation, home-based reference systems.

## INTRODUCTION AND RESEARCH QUESTION

This article was set in motion by a remark that some Māori meeting houses (whareniui, or whare rūnanga) in New Zealand might be oriented towards a sacred marae on the island of Raiatea. The speaker was Professor Paul Tapsell, co-founder of the Te Potiki National Trust and at the time Dean of Te Tumu, the School of Māori, Pacific and Indigenous Studies at the University of Otago. At the time, Te Potiki had relatively recently begun a Māori map project whose aim was to document marae in New Zealand, and about 170 marae had been recorded, all on the North Island and concentrated in the far north (Scoop 2011). Although these made a rather small and skewed sample on which to pin any real hope, they raised the question of whether it might be worth checking a better distributed sample to test the hypothesis that meeting houses really are parallel with one another, pointing to a small island about 200km northwest of Tahiti, or even converging measurably from Cape Reinga to Bluff.

The first task was to see what the literature said. A quick search showed some support for at least a symbolic orientation of meeting houses to Hawaiki, mythical homeland of Māori. For example, Michael Linzey states that “The ridge pole also points to Hawaiki and New Zealand (as directions in front and behind in cosmological space)” (Linzey 2004: 160), and Amoamo et al. (1984: 27) emphasise the symbolic significance of directing the tāhu (ridgepole) towards the sea and Hawaiki. Continuing to sift through the literature, it was soon apparent that other writers held divergent views, and that both practical constraints (e.g. space limitations of urban land parcels) and other symbolism were also factors when considering the

orientation of meeting houses.

But did orientation only operate on a symbolic level or was there any basis in fact? There has probably never been a better time to carry out an exploratory look into marae orientation, using the powerful new tools Google Earth has made available to surveyors and anthropologists alike. An overarching research question was posed for the research, namely whether there is any uniformity in the pointing of meeting houses on marae in New Zealand, with an initial hypothesis that meeting houses are oriented towards the Taputapuātea marae on Raiatea, in the Society Islands in French Polynesia. Specific objectives stemming from the research question and hypothesis were first, to obtain a latitude and longitude of a number of meeting houses (whareniui) in both North and South Island, New Zealand; second, to use spherical trigonometry to calculate the azimuth from there to the Taputapuātea marae; third, to obtain an azimuth of the ridge or sides of the meeting houses; and fourth, to make a comparison between the calculated and actual azimuths, together with an estimate of precision.

## BACKGROUND AND THE LITERATURE

Raiatea (or Rai’atea, Rangīatea) appears regularly in Māori and Polynesian literature in connection with the homeland of Māori. In fact, Havai’i or Hawaiki is Raiatea’s ancient name (Hiroa 1964: 68, 76). Rai’atea “was the sacred island of the homeland” (Reed 2006: 243), and a saying of the descendants of Turi, of the Aotea canoe, is: ‘He kakano i ruiruia mai i Rangiatea’, which refers to the daring and enterprise of ancestral stock from Rangīatea. Tahiti was a centre of Polynesian voyaging, and the great marae of Taputapuātea on nearby Raiatea was a principal cultural and political centre (Taonui 2006: 45). Legend

encompasses “pilgrimages from across Polynesia to the temple of Taputapuātea ...” (Finney 2006a: 145), and elsewhere Finney relates a tale told in around 1830 to a British missionary that “for many generations, ‘priests, scholars and warriors’ ... periodically set sail from their respective islands to meet at Taputapuātea and celebrate ‘great religious observances and international deliberations:’” (Finney 2000: 309,310). It seemed as if Raiatea could indeed be sufficiently important to account for meeting houses on other islands being oriented in its direction, but were they in fact?

Orientation in general has attracted some discussion in the literature. Considerable mythology is associated with the sun (Best 1922: 13-20), and in Māori ritual performances priests faced east. Tapsell recounts how “instead of orienting themselves to sit to the south of the map, the old people would often take their station to the west so that they might face the rising sun, subtly acknowledging the leeward sea-path of origin by which their Polynesian ancestors travelled some 20 plus generations ago to arrive in Aotearoa” (Tapsell 2009: 93).

Narrowing down to the orientation of meeting houses in particular, Joan Metge notes a frequently expressed opinion that these should be oriented to the rising sun, but dismisses this, saying that “many meeting-houses in fact face other directions.” She quotes architect Michael Austin as suggesting that “marae ... are almost invariably placed with hills or forest at their backs and open country in front, facing the direction from which visitors come, whether by road, river or sea.” (Metge 1976: 235). Austin (1976: 233) himself, while noting variations and exceptions in both current and excavated sites, identifies

“facing openness” to be the general rule. Amoamo et al. (1984: 29) turn Austin’s statement around to argue that, rather than being dictated to by the landscape, the meeting house in fact “defines the directions of the landscape ... as ‘front’ and ‘rear’.” Without the meeting-house at the focus of the landscape pointing out where is ‘front’ and ‘rear’, the notions of enclosure and openness would have little cultural significance”. The authors stress the importance of the meeting house as a mediator, for example between “inland bush and Hawaiki-related ocean, between autochthonous land-based ancestors, and ancestors who arrived in the Mataaua migration canoe from Hawaiki across the Pacific.” This is illustrated by Figure 1 below:

Where a meeting house is situated up against a hill, Austin’s words ring true; entrances tend to face the open country rather than into hillsides. A typical instance is the marae overlooking Lake Omapere, back to the mountains (35° 17’ 16”.7 S, 173° 39’ 09”.5 E). Both an oblique view on Google Earth and also a street view show a wharenui that backs up against the mountains, looking across river and plain, with the meeting house angled welcomingly to face the road along which most visitors could be expected to approach the marae (Figure 2). The message seems clear: visitors are more likely to approach on paths or roads over relatively level ground, and these visitors can be welcomed more conveniently and comfortably in flat, open areas than on steep hillsides.

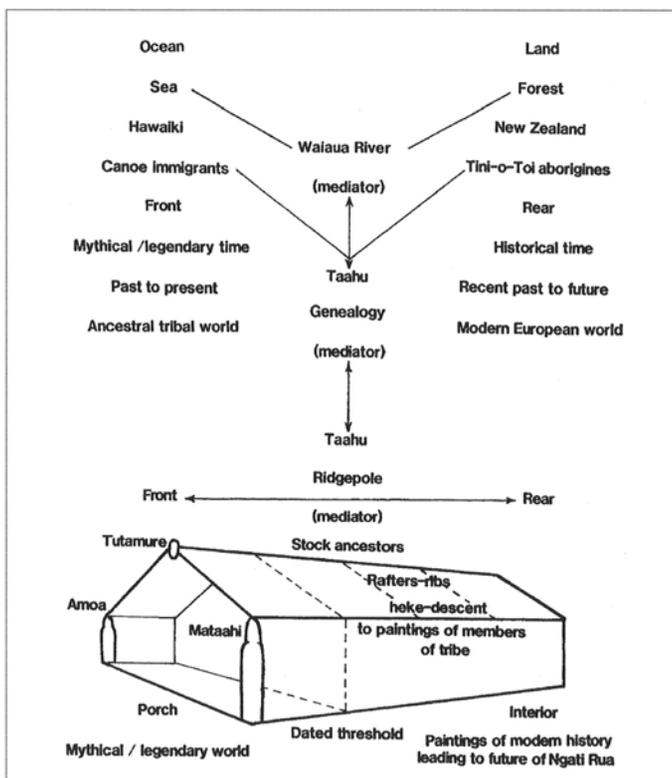


**Figure 2: An oblique view in Google Earth, showing the Piki Te Aroha marae NW of Okaihau**

Other symbolism is also employed in meeting house orientation, and practical considerations clearly play a part, as Anne Salmond reminds us:

“...East Coast meeting-houses are faced east to the rising sun, and in Northland it is said they are faced north to Cape Reinga, the mythological jumping-off place of spirits. Other factors such as orientation to the road are also important today, however, and often receive priority” (Salmond 1994: 68).

Dave Simmons’ study of decorative pare (lintels) also reminds us of the wealth of other symbolism associated with meeting houses:



**Figure 1: Tūrāmure meeting house, Ōmarumutu marae, Ōpōtiki (From Amoana et al. 1984: 31).**

"The pare is an important boundary between the world outside the meeting house and the world inside. It marks a tapu threshold into what is often called te poho, or the body of the ancestor who is te whare tipuna, the ancestor house. For the tribe and their visitors, to enter the house is to go into the body and, symbolically, to change ones state. The pare above the only entrance has an important role to play in that tapu threshold" (Simmons, 2001: 9).

Before proceeding further, two questions should be considered. First, is the idea of pilgrimages to and from Raiatea over thousands of kilometres of ocean credible? This question touches on a debate about deliberate versus accidental Polynesian voyaging that has undergone pendulum swings for several centuries. Indeed, Captain James Cook personally oscillated from, in 1769, fully supporting the idea of deliberate voyaging by the Raiateans to where, less than a decade later, he adopted "conclusions wholly at variance with his previous observations", perhaps influenced by a strong lobby that found it difficult to believe that untutored savages had long ago accomplished feats "scarcely yet attained" by European sailors and navigators (Parsonson 1972: 15). Today, the majority of scholarly opinion, coupled with an increasing number of voyage re-enactments (Finney 2006b), overwhelmingly supports the deliberate voyaging view (Golson 1972; Howe 2006; Evans 1998).

Second, bearing in mind that Polynesian navigators used a smorgasbord of techniques, some as approximate as the general direction of ocean swells and the flight of birds (Lewis 1994; Evans 1998: 30), is it fanciful to suppose that Māori could have known the direction of an island some four thousand kilometres distant with any degree of precision? However, the idea does not appear farfetched if we consider that Tupaia, the high priest navigator from Taputapuātea, impressed sailors on the Endeavour "by always being able to point accurately towards Tahiti..." (Salmond 2006: 265; Lewis 1994: 168). Best (1922) adds to this the assertion that "all natives knew the principal stars, and ... some made a close study of them" (p73), and that stars serve as a link with the past (p4) and are "Shining Ones" that "tie them to the long-lost but ever-loved home-land – that hidden home-land to which their spirits return ..." (pp74, 75). Thus, although it is now many centuries since Māori settled in New Zealand, and today it is probably fair to say that only a minority of Māori or indeed Pākehā have a close knowledge of stars and could reliably estimate the direction of Raiatea if pressed, it is probably not unreasonable to suppose that meeting houses might in the first instance have been oriented "correctly" by expert navigators and subsequent buildings erected with the same orientation even when an everyday working knowledge of stars had been lost. Looking ahead, the research for this article found a greater than random chance of meeting houses being oriented within twenty degrees of Taputapuātea, with two cases of whareniui oriented to within a few degrees of the correct bearing. For these and similar cases

it might be interesting to seek for oral tradition concerning any custom about maintaining the orientation of whareniui for any rebuilds. Even for whareniui not oriented toward Raiatea it might be interesting to ask whether there was any rationale for this orientation or if their siting was merely expedient.

Before moving on from the literature, a final question that should be addressed is whether there is likely to be better orientation of meeting houses at places in New Zealand near to where canoes landed in the mists of history? In other words, would early navigators, their recent voyages still uppermost in their minds, have been more likely to orient whareniui back towards whence they had recently come and still have had the knowledge to accomplish this? And is it fair to suppose that the importance of this requirement might have attenuated as Māori spread out over the country and epic land migrations assumed dominance in people's thoughts? In order to answer this question, we need to consider what canoes might have arrived and where they landed. Davis argues for the likelihood of the first settlers arriving between 600 and 800 AD, followed by a fleet of canoes arriving more or less together in 1350, with several of these tarrying awhile off Whangaparaoa (NE of Whakatane) before dispersing all around New Zealand (Davis 1990: 4, 5; Evans 1998: 27-29). Other writers contest the multiple canoe paradigm, pointing instead to a more complex marrying of both historical and symbolic elements in migratory traditions, and to the difficulty of decoding such traditions (Taonui 2006: 35, 36). Taonui believes the "seven canoe" myth to be conclusively debunked, arguing for a far more complex picture with at least forty human first-arrival traditions among Māori and over three hundred other canoes (p48). In that case it would be difficult to say with any confidence where exactly canoes of migrants landed, and in any case unlikely that better orientation could be demonstrated.

## METHODS

The Māori maps database was consulted in the first instance, and proved helpful both in locating marae and in many cases providing photographs of them. The latter were sometimes necessary in ascertaining which one of a group of buildings was the meeting house, as opposed to an eating hall (wharekai) or any other building. The street view facility in Google Earth proved similarly useful, and had the advantage of covering the whole of New Zealand not just parts of the North Island. Photographs also furnished additional details about marae in a non-invasive manner, such as whether or not meeting houses had an exposed tāhu.

Owing to budget constraints and the exploratory nature of this research, only forty whareniui were considered, of which thirty five were considered admissible. Selection was largely opportunistic, and comprised eleven marae visited in the course of a different research project (in February 2012) together with others chosen at random. Those marae that

were rejected either lacked a whareniui or this was still under construction, or else the meeting house was ambiguous and not visible from the road so was unable to be identified using the street view in Google Earth. Because the Māori map project only covered part of the North Island, and because the parallel research project was located there, only one South Island marae was visited (Otākou), and an attempt made to check the orientation of only six other South Island meeting houses using Google Earth. Two of these were among those that had to be discounted, with one still being under construction and the other not visible in the Google street view and unable to be identified with certainty.

For each meeting house identifiable on Google Earth, the bearing (or “heading”) of the ridge or one or other edge of the roof was determined using the “Ruler” tool. Between three and five determinations were made for each linear feature and a standard deviation calculated to obtain a sense of the precision of determinations. The roof length was also measured in case it was found that roofs below a certain length were insufficiently accurate, though this fear proved unfounded since even short roofs gave an acceptable standard deviation. Standard deviations of the bearings were always less than a degree, ranging from 0.14° to a maximum of 0.99°, with a mean of 0.47°.

In order to check that Google Earth yielded suitable azimuths, a single comparison was made between a Google Earth heading and a surveyed bearing of the School of Surveying (SoS) at the University of Otago. The ends of the SoS parapet were surveyed by RTK GPS and a meridian convergence correction applied to convert the NZGD2000 geodetic bearing to a true azimuth. This azimuth agreed with the Google Earth heading to within 0.02°, which was well within the standard deviation of 0.18° for the Google headings determined for the parapet. There seemed no reason to suppose that other Google headings would be any less accurate, so this was the only verification carried out.

Prismatic compass bearings were obtained for twelve whare at the eleven marae visited in the course of the North Island fieldwork campaign mentioned above (both a church and a whareniui were observed on one marae). The compass observations were taken partly to see if these were comparable with Google Earth, partly to identify any complicating issues visible on the ground that might remain unnoticed with Google Earth, and partly to calculate a magnetic declination in case there were instances where only magnetic bearings could be obtained, for example where cloud obscured a Google Earth image. In every case the compass was lined up by eye on one or other of the roof edges of whareniui, or in one instance of the church adjoining a meeting house. Between two and five compass readings were taken facing

Four parts formula

$$\cos(90^\circ - \Phi_{\text{NZ Marae}}) \cos(t) = \sin(90^\circ - \Phi_{\text{NZ Marae}}) \cotan(90^\circ - \Phi_{\text{Taputapuātea}}) - \sin(t) \cotan(Az)$$

Figure 4: Four Parts formula

the whare, and 180° added to the mean. The mean between the magnetic bearings and Google headings proved to be -16.7° with a standard deviation of 3.5°. This mean, of -16.7°, compares tolerably well with the mean magnetic deviation for the sites observed which, according to government figures is -18.6° for the mean Northland position (GNS Science 2012). Although the standard deviation appears to be on the large side, it is probably all that can realistically be expected from a magnetic compass and sightings to estimated roof lines, some of them quite short. The accuracy is good enough to suggest that, for future marae visits as part of the Ethnos Māori mapping project (Ethnos 2012), a compass bearing might be a worthwhile addition for at least two purposes. First, the bearing could give an approximate orientation of meeting houses whose roofs were not visible on Google Earth owing to cloud, and second, the approximate orientation of all marae could be obtained without the time investment required to measure headings in Google Earth. An approximate knowledge of orientation could help to screen out randomly oriented marae and highlight those oriented within a few degrees of Taputapuātea. The latter may be worth investigating further, including measuring a more accurate heading using Google Earth and perhaps also collecting oral tradition concerning the orientation of earlier marae on the site and whether there are any known reasons for such orientations.

A spherical triangle formula was used to compute, in Excel, an azimuth between the Google Earth latitude and longitude of the end of the ridgepole of whareniui in New Zealand and those of the Taputapuātea marae on Raiatea (16° 50' 11" S; 151° 21' 33" W). The spherical triangle and formula used are shown in Figures 3 and 4 below:

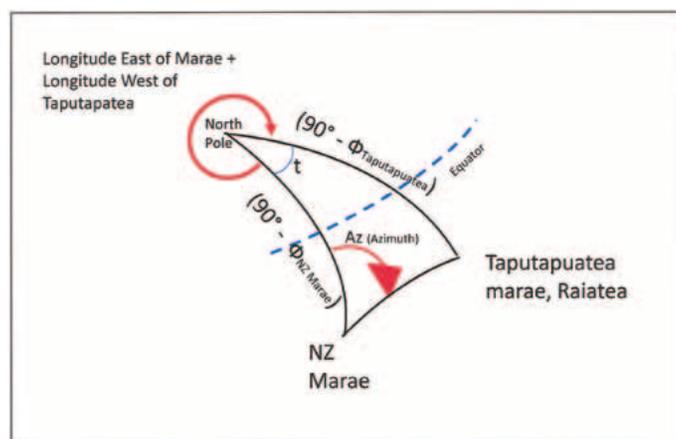


Figure 3: Spherical triangle

To give just one numerical example, the Te Tii, Te Tiriti O Waitangi meeting house in Paihia has a latitude of 35° 16' 26.7" S, longitude 174° 04' 46.2" E, making “t” (Figure 3) = 360° - (174° 04' 46.2" E + 151° 21' 33" W) = 34° 33' 40.8". Using the above formula, and making South latitudes negative, Az = 68°

03'32" which, compared with a mean Google heading of 68.7°, yields a difference of -0.6°. This is outside of the mean standard deviation of 0.47° for bearings, but nonetheless we can say that this important meeting house is approximately oriented towards the Taputapuātea marae on Raiatea.

## FINDINGS

On the basis of the thirty five whareniui used in the research (see Appendix), only two of those investigated are within 5° of the Azimuth to Taputapuātea, with a further four being within 15° either side of the correct bearing, bringing the total to six (Figure 5). Extending the band width, eight meeting houses were found to be within 20° either side of the Taputapuātea orientation. Since about four meeting houses out of a sample of 35 could be expected in an interval of 40° out of 360° if orientation was completely random, eight is appreciably higher.

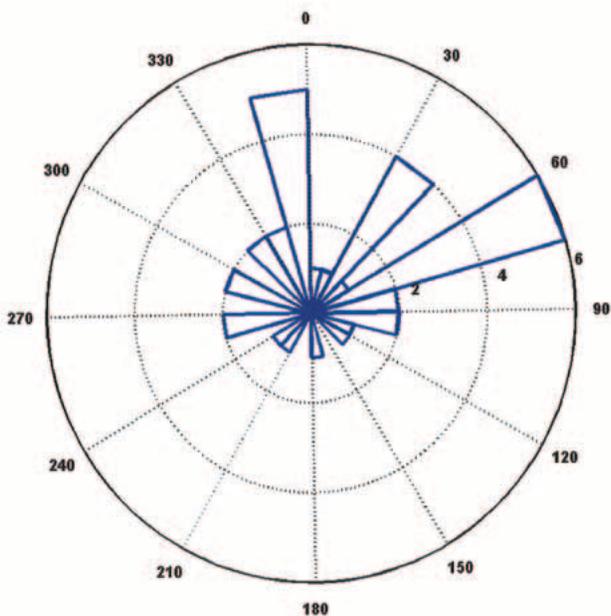
The rest of the orientations appear to be randomly distributed with the exception of a group of six whare falling within 60-75°, which raises the question of there being any significance in the two most pronounced peaks being approximately 90° apart. For example, is it likely that the same footprint and foundations were ever retained but the building changed from being parallel to the street to facing it? However, explanations are at best tenuous, and the only conclusion possible for the provisional sample of 35 meeting houses is that there is a slightly higher probability of their being

oriented to within twenty degrees of Taputapuātea. Further data would be needed to support or refute this, and further work needed to investigate other factors, such as possible significance of the rising of Matariki (the Pleiades) and the direction of sunrise in mid-winter and of the important star Canopus.

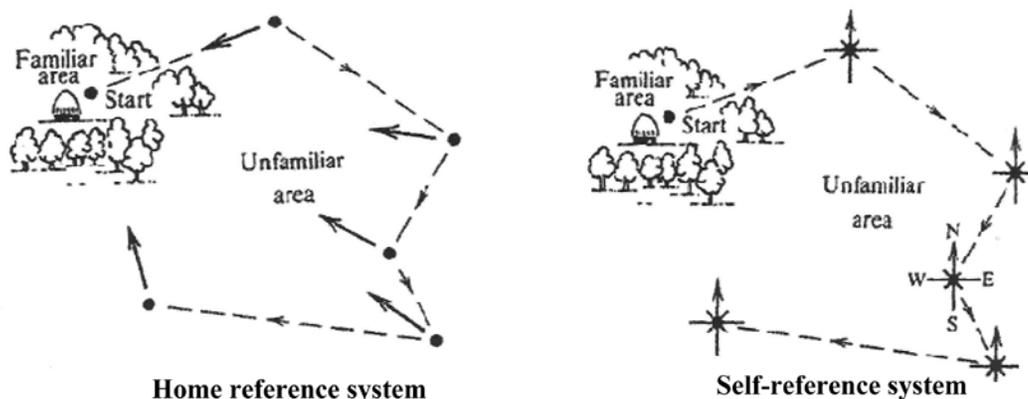
Of the two meeting houses within 5° of Raiatea, one is the Te Tii, Te Tiriti O Waitangi marae in Paihia which, as seen above, faces closely towards Taputapuātea. The other, in Ahipara, is about three and a half degrees away from the true azimuth. However, in Paihia the whareniui faces the road and is roughly parallel with the section sides, and in Ahipara it is roughly parallel with the mean road direction, meaning that both could have been sited for convenience. In both cases it would be interesting to try to delve into oral tradition to see (a) whether any earlier meeting houses existed on the same site (and if so whether the same orientation was preserved for subsequent buildings), and (b) whether any knowledge has survived about significance attached to the orientation. However, before speaking to anyone at the respective marae, cultural protocols would need to be observed. First, Iwi administrative offices would need to be contacted or newsletters such as Ngai Tahu's "te panui runaka" searched for contact details of rūnanga (assemblies, local councils). It would then be courteous to telephone or email these rūnanga to explain the purpose of the research and to request permission to speak with kaumātua (elders) about stories, karakia and waiata (prayers and songs) that have anything to say about orientation (Evans 1998: 46). A good starting point could be to begin, at least, with those whareniui aligned to Raiatea.

One meeting house that does not face Taputapuātea but whose orientation may nonetheless hold significance is Te Whare Rūnanga, the meeting house at Waitangi. Its foundation stone was laid in 1934 and the building completed in 1940 to commemorate the centennial of the signing of the Treaty of Waitangi. The meeting house embodies 'not an ancestor but the Treaty itself' (Waka Māori 2012). The meeting house faces the area where the Treaty of Waitangi was signed, and appears to hold powerful symbolism, namely that the old history of the Māori people, important as it continues to be, has been added to by a significant new location at which the realities of two peoples concatenated and continued together. This could be the kind of thing Linzey was referring to when he wrote, "A vital part of the significance of meeting houses ... seems to require their physical presence in a particular place and the symbolic transformation of the place that is achieved through this presence, pointing to local features, shaping the symbolic landscape, standing on the land as a symbol ..." (Linzey 2004: 14).

Of the remaining marae in the study, both pragmatism and personal preference are apparent. Oral evidence volunteered at one marae suggests that orientation is often arbitrary, with



**Figure 5: Rose graph of differences between meeting house orientations and that of Taputapuātea. The 0° mark is where there is no difference between the bearing of a meeting house and that of Taputapuātea, and it can be seen that five meeting houses have orientations within 15° anticlockwise from the Taputapuātea bearing and one has an orientation within 15° clockwise. A second interesting peak is the six meeting houses whose orientations are between 60° and 75° clockwise from the Taputapuātea bearing.**



**Figure 6: Reference systems (after Lewis 1994: 168; Gatty 1958: 46, 47).**

some meeting houses being moved or rebuilt over the years for a variety of reasons, or perhaps relinquished in favour of more suitable existing buildings without the luxury of being purpose designed. On the face of it, the function of a whareniui in enabling people to meet together appears to trump considerations of orientation where these fall short of being ideal. In Metge's words, "Function, not appearance, is what distinguishes a meeting-house from a hall in the final analysis" (Metge 1976: 230).

## CONCLUSIONS AND FURTHER WORK

The hypothesis that a significant proportion of meeting houses in New Zealand are oriented towards the Taputapuātea marae on Raiatea is not supported by the provisional fieldwork done for this article, although there is sufficient congruence to warrant further work. As to the overarching research question of whether there is any other basis for the orientation of meeting houses, a number of considerations were found to be significant. For a start, as the world population burgeons, practical imperatives as well as broad symbolic parameters play an increasing role in situating buildings, especially in urban centres where most meeting houses have to be aligned with their boundaries; in order to build a decent sized footprint on a finite parcel, canny positioning is imperative. One conclusion seems to be that people are pragmatic as well as aesthetically aware. If something can only work in one way, we square our consciences somehow.

The research also showed that any predilection by Māori for orientation has had to be balanced against other traditions, such as that of welcoming visitors to the marae. Indeed, welcoming ceremonies are hugely significant, and at some point in the research I began looking on Google Earth not only for evidence of orientation but also of traditions governing the approach to whareniui. It was soon apparent that often provision is made for parking, and that some form of covered gateway frequently marks the start of a well defined path to the whareniui. It has to be concluded that the tradition of a fitting karanga (welcome) may have endured better than any tradition of orienting the whareniui in sympathy with a place of origin, or at least may dovetail better with today's planning

laws and premium on space.

Regarding future work, it would be interesting to extend the work done in this research to further meeting houses, distributed more evenly over the North and South Island and also balanced with respect to East and West coasts. As mentioned above, it would also be of interest to investigate any possible significance of the rising of Matariki (the Pleiades), the direction of sunrise in mid-winter, and of the important star Canopus. It is recommended that, for the remainder of marae visited in the course of the Māori map project, a WGS84 coordinate be taken with a handheld GPS at the whareniui entrance, preferably under the ridgepole, and a compass bearing observed to one or other edges of the roof or the ridgeline. This could be a way of painlessly identifying provisional groupings of possible significance. For any hopefuls, a more accurate Google Earth bearing could be observed and oral tradition sought (Has the whareniui always faced this way? Why? Any stories, karakia, waiata?).

There are also wider, philosophical points of interest. Gatty writes of early peoples maintaining a "home reference system" as they ventured away from home (i.e. always being aware of where "home" was), and of modern man's contrasting tendency towards a "self-reference system" (Gatty 1958: 45-47; see Figure 6).

Although paucity of data may well be an insurmountable issue, in concept it would certainly be interesting to try and trace the orientation of whareniui back over the years and see whether there is a decline in orientation towards Taputapuātea (or anywhere else) that might indicate a "home-centre" reference system evolving to a more self-referenced system in New Zealand. A sense of place is a consideration in the lives of human beings in general, and an emphasis on orientation of buildings holds significance in traditions other than those of Māori. English churches have traditionally been oriented towards Jerusalem (easily confirmed by even a cursory test on Google Earth), the Old Testament specifies that the travelling tabernacle be oriented in a certain way (e.g. Exodus 27:13, 38:13, Leviticus 1:16 etc.), and surveyors are surprisingly often called upon to orient Mosques towards Mecca. Was it merely coincidence that, on

the marae where a church was observed, it was oriented far closer to Taputapuātea than the whareniui?

On a more figurative level, Tuan writes, “We are, most of the time, at ease in our part of the world. ... Above all, we are oriented” (Tuan 1977: 199), and it might even be of interest to correlate social pathologies among Māori with perceived strength of turangawaewae<sup>1</sup> connections to Māori freehold land (Knight 2007). One thing is certain: orientation remains an important and sometimes undervalued dimension of human existence.

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## APPENDIX

Meeting houses used in the research

|    | <b>Marae/Wharenui</b>               | <b>Latitude<br/>(d.mmss.s)</b> | <b>Longitude (East,<br/>d.mmss.s)</b> |
|----|-------------------------------------|--------------------------------|---------------------------------------|
| 1  | Potahi (Te Kao)                     | 34.39006                       | 172.58143                             |
| 2  | Waiora                              | 34.44346                       | 173.02504                             |
| 3  | Karikari                            | 34.49456                       | 173.23474                             |
| 4  | Haiti-tai-marangi                   | 34.52437                       | 173.24040                             |
| 5  | Te Pa a Parore                      | 34.59571                       | 173.12582                             |
| 6  | Taipa (Karepori)                    | 35.00312                       | 173.27410                             |
| 7  | Taupo; Hatepe                       | 38.51168                       | 176.00439                             |
| 8  | Whangaroa; Te Touwai,<br>Matangirau | 35.02392                       | 173.47307                             |
| 9  | Te Uri o Hina; Hohourongo           | 35.09258                       | 173.13158                             |
| 10 | Te Rarawa                           | 35.09238                       | 173.13308                             |
| 11 | Wainui                              | 35.10319                       | 173.10450                             |
| 12 | Roma; Te Ohaki                      | 35.10503                       | 173.09276                             |
| 13 | Koroukore; Wikitoria                | 35.10151                       | 173.08470                             |
| 14 | Te Paatu                            | 35.07461                       | 173.20281                             |
| 15 | Oturu; Te Mataara                   | 35.05373                       | 173.17462                             |
| 16 | Mangamuka, Puhi Moana Ariki         | 35.12317                       | 173.32206                             |
| 17 | Kahukura Ariki                      | 35.04188                       | 173.42480                             |
| 18 | Pikiparia; Ngarunui                 | 35.20473                       | 173.32220                             |
| 19 | Piki Te Aroha; Whakapono            | 35.17167                       | 173.39095                             |
| 20 | Rangatahi; Maraeroa                 | 35.20261                       | 173.38241                             |
| 21 | Mokonuiarangi                       | 35.20362                       | 173.37584                             |
| 22 | Whitiora; Rangatua-tanga            | 35.08480                       | 174.00156                             |
| 23 | Hiruharama Hou (Te Tii)             | 35.08412                       | 174.00189                             |
| 24 | Te Tiriti o Waitangi/ Te Tii        | 35.16267                       | 174.04462                             |
| 25 | Waitangi Ceremonial                 | 35.15548                       | 174.04542                             |
| 26 | Takahiwai; Rangiora                 | 35.50179                       | 174.25120                             |
| 27 | Otakou                              | 45.48101                       | 170.42428                             |
| 28 | Karitane                            | 45.39035                       | 170.38586                             |
| 29 | Nga Hau e Wha                       | 43.31167                       | 172.41573                             |
| 30 | Omaka; Te Aroha O Te<br>Waipounamu  | 41.32110                       | 173.55254                             |
| 31 | Paparoa; Werahiko                   | 37.40345                       | 176.04200                             |
| 32 | Rangiwaea; Te Haka a te<br>Tupere   | 37.38140                       | 176.07221                             |
| 33 | Okaihau College marae               | 35.19249                       | 173.46025                             |
| 34 | Te Ao Marama; Te Hana               | 36.15163                       | 174.30288                             |
| 35 | Te Rau Aroha                        | 46.36137                       | 168.20432                             |

## NOTES

1 Turangawaewae: a standing place for the feet.

# THE SEARCH FOR ACCELERATION IN NEW ZEALAND'S MEAN SEA LEVEL RECORD

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**Abstract** While long term tide gauge records indicate that global sea levels have been rising at an average rate of  $1.7 \pm 0.3$  mm/yr for over 100 years, recent satellite altimetry data collected from 1993 until 2010 give an inferred rate of sea level rise of  $3.2 \pm 0.4$  mm/yr. This higher rate may be a combination of either a new long-term trend, be the result of a periodic signal, or reflect biases inherent in the satellite reference systems used. New Zealand's long term sea level records (all of which date back to about 1900) were analysed to see if any acceleration could be detected. The records from the Auckland, Lyttelton and Dunedin tide gauges show no significant accelerations. However, an acceleration of  $0.013 \pm 0.01$  mm/yr<sup>2</sup> between 1891 and 2007 has been identified in Wellington's records, most likely as a result of regional tectonic motion.

**Keywords** sea level rise, acceleration

## INTRODUCTION

Quantifying the rate of relative sea level rise (i.e. the rise with respect to stable objects on the local shoreline) in low-lying, populated coastal areas is of considerable importance to coastal nations. Such sea level heights are relevant to many infrastructural aspects of current day societies. While the average rate of global sea level rise since the start of the 20<sup>th</sup> century until 2009 is now well determined at  $1.7 \pm 0.2$  mm/yr and at a slightly higher rate of  $1.9 \pm 0.4$  mm/yr over the 50 years since 1961 (Church and White 2011), the possibility of an acceleration in the rate of sea level rise is a point of major concern. Knowing the rate of local sea level rise, whether linear or otherwise, is essential information for all coastal communities so as to establish an 'early warning' on how sea levels are changing and what must be accommodated in the future (Woodworth 1990; Church and White 2011).

Any significant rise in global sea levels is predicted to impact areas around the world with varying levels of severity. In some places coastal erosion is expected to increase in both extent and rate with the cost of adaptation for low-lying coastal areas likely to be very high. Costs for coastal protection must be weighed up against the long-term risk associated with ongoing sea level rise, including community safety, sustainable land use, population migration, and infrastructure resilience. Adaptation measures in New Zealand are beginning to be considered by local government authorities who now have planning guidance documents that reflect a risk-based approach to various sea level rise scenarios (Ministry for the Environment 2008; Britton et al. 2011). These documents are increasingly being used to assess the risk that sea level rise

might pose to developments in coastal zones.

Whether a new or an existing development, determining a credible rate of sea level rise over a specified design life or planning timeframe is a critical first step when considering adaptation measures for vulnerable coastal communities (Mazzotti et al. 2008; Ministry for the Environment 2008). Should sea level rise be accelerating, the urgency of dealing with the impending threat will be exacerbated. While future sea level rise projections are best made using physical parameters (e.g. ice melt, thermal expansion of the oceans, etc), corroboration of changes in the rate of sea level rise and the timing of their onset must ultimately come from measurement systems such as satellite altimetry and tide gauges. With this in mind, an investigation has been carried out into whether an acceleration in sea level rise can be detected in New Zealand's long-term sea level records from the tide gauge stations located in Auckland (1899), Wellington (1891), Lyttelton (1901) and Dunedin (1899). The numbers shown in brackets indicate the first year that Mean Sea Level (MSL) records are available from that particular gauge. These gauges have by far the longest sea level records in New Zealand with their maintenance histories giving confidence in the integrity of their records (Hannah 2004).

## PREVIOUS GLOBAL STUDIES

Several studies have investigated the possibility of an acceleration in the rate of global average sea level rise over varying time periods and using different start and end years (e.g. Church and White 2006; White 2010; Church and White 2011). Satellite altimetry records from the TOPEX/Poseidon

and Jason-1 missions collected between January 1993 and August 2010 indicate that the global average sea level has been rising by around  $3.2 \pm 0.4$  millimetres per year over that period (White 2010). On a first glance this would suggest that the rate of sea level rise has increased in recent years, at least when compared with the average rate of  $1.7 \pm 0.2$  mm/yr over the 109-year period prior to 2009 (Church and White 2011). However, any such assessment can only be made once all other systematic effects and all the quasi-periodic cycles from climate variability have been isolated and removed. An earlier study by Church and White (2006), combining long tidal records with the satellite altimetry data, indicated an acceleration in the rate of global average sea level rise of  $0.013 \pm 0.006$  mm/yr<sup>2</sup> between 1870 and 2004. They also found that over the modern era (1950-2000) there was a larger linear rate of rise after 1993, plus other periods of rapid sea level rise, but no significant acceleration over this period, thus implying that most of the acceleration can be ascribed to the late 19<sup>th</sup> and early 20<sup>th</sup> centuries. The more recent study by Church and White (2011) has estimated the acceleration between 1880 and 2009 at a lower figure of  $0.009 \pm 0.004$  mm/yr<sup>2</sup> over a slightly different period than the previous 2006 study. Such acceleration is not corroborated by the tide gauge records when considered in isolation. Due to the long-term nature of sea level change and known periodic effects from climate variability, tide gauge records of at least 50 years are considered preferable, if not essential, for the accurate determination of the sea level's long term behaviour (Douglas 1991, 1992).

Given the importance of the satellite altimetry data in the "acceleration" debate, it is essential that all possible uncertainties and biases be investigated. Bindoff et al. (2007), for example, raise the possibility that such an increase may actually be a reflection of a decadal-type variation in global sea levels. Hannah and Bell (2012), show that annual mean sea levels in New Zealand are affected by a 2-4 year El Niño-Southern Oscillation cycle with a magnitude of  $\pm 0.05$  m and a 20-30 yr Inter-decadal Pacific Oscillation (IPO) with a magnitude of about  $\pm 0.04$  m. Such oscillations can have differing periods and magnitudes in different parts of the globe. This is supported by other authors such as Church et al. (2004) and Lambeck (2002). Meyssignac and Cazenave (2012) note the presence of long-term regional patterns in sea level rise (over 5–6 decades) that differ significantly from the short-term ones observed over the satellite era. Regional variations may be explained by climate change (whether natural or anthropogenic) as air-sea fluxes of heat, momentum, and freshwater change (Gregory et al. 2001). In the Australasian region, Chambers et al. (2012) detected a 60-year oscillation in mean sea level with amplitude of approximately 20 mm.

The presence of short period signals (i.e. less than 1 year) or longer period decadal and inter-decadal signals within the sea level records are an obvious source of possible bias in sea level

trends derived from a limited time series of sea level data. High frequency tidal signals are filtered out by using annual mean sea levels. Long period spectral lines, such as those associated with the 18.6 and 8.8 year lunar tidal constituents (Munk and MacDonald 1960) can either be determined analytically (e.g. Hannah 1990; Hannah and Bell 2012), or their effect eliminated from any trend by using at least 50 – 60 years of data.

## CONTRIBUTORS TO RELATIVE SEA LEVEL CHANGE

Both Church et al. (2011) and Meyssignac and Cazenave (2012) provide a helpful summary of the causes of present day global mean sea level rise. These include the following:

- Oceanic warming due to the transfer of heat between the atmosphere and the oceans. Meyssignac and Cazenave (2012) note that *in situ* oceanic temperature data collected over the past 50 years indicate that ocean heat content (and thus thermal expansion) has increased significantly since 1950. Church et al. (2011) estimate that this effect accounts for about 0.8 mm/yr of the sea level rise over the last few decades (i.e. 30%-40%).
- Glacier and ice cap melt. Small onshore ice caps have retreated worldwide over recent decades with significant acceleration noted since the early 1990s. Over the period 1972-2008, Church et al. estimate a contribution to observed sea-level rise of 0.7 mm/yr from this source. Over the shorter 1993-2010 timeframe (the high precision satellite altimetry era), Cazenave and Llovel (2010) estimate the contribution to be approximately 30% of the 3.2 mm/yr sea level rise determined from satellite altimetry observations.
- Changes in the Greenland and Antarctic ice sheet mass balance. Meyssignac and Cazenave (2012) note that both the Greenland and West Antarctic ice sheets appear to be in a negative mass balance state and are losing mass at an accelerating rate. Although this rate is variable, they note that over the period 2003-2010, ice sheet mass balance loss can explain about 25% of sea level rise. Church et al. (2011) estimate a contribution of 0.4 mm/yr from 1972 – 2008.
- Changes in aquifer and surface water storage. Church et al. (2011) estimate the aquifer contribution to sea level rise between 1972 and 2008 to be 0.3 mm/yr, fully offset by -0.4 mm/year due to the retention of water in dams.
- The addition of fresh water to the ocean produces consequential changes to water salinity, hence water density and ocean circulation. This in turn affects sea level at a regional scale (Meyssignac and Cazenave 2012).

These long-term contributions to sea level change are then overlaid by the previously described inter-decadal and multi-decadal variability in sea level, which appear to be connected to the variability of heat transported by the thermohaline circulation; driven by water movement caused by relative

temperature and salinity differences (Deser and Blackmon 1993; Rajagopalan et al. 1998; Rodwell et al. 1999). To a greater or lesser extent, non-linear, long-term changes in any or all of these factors will result in non-linear, long-term changes to relative sea levels.

## VERTICAL MOTION OF TIDE GAUGES

While the rate of relative sea level rise is considered to be the rate as determined with respect to stable objects on the shoreline, 'absolute' sea level rise reflects the rate of change of sea level relative to the centre of mass of the Earth. Absolute sea level rise thus reflects the combined influence of changes in the ocean's volume plus any vertical uplift or subsidence to the ocean basins that may result from tectonic motion. If differences exist between absolute and relative rates of sea level rise, they can be the result of crustal processes (e.g. active tectonics or glacial isostatic adjustment), changes in gravitational loading, or sediment compaction. Any vertical movement of a tide gauge from these processes affects the apparent relative rate of sea level rise. The nature of this effect is dependent on the nature of the vertical shifts; whether they are constant over time or episodic. Mitrovica et al. (2001) emphasised that sea level change may have significantly differing rates in different regions due to gravitational and loading effects. Equally, local land movement in the vertical dimension due to tectonic motion can also cause significant regional variations in calculated sea level trends. Other causes of local land motion include natural geological processes, and ground water depletion due to pumping and/or mining (Woodworth 2006). Structures to which tide gauges are fixed may also move vertically due to settling or subsidence. Without precise levelling records to maintain the integrity of gauges attached to such structures, this movement cannot be corrected and hence may incorrectly be associated with vertical deformation or sea level rise.

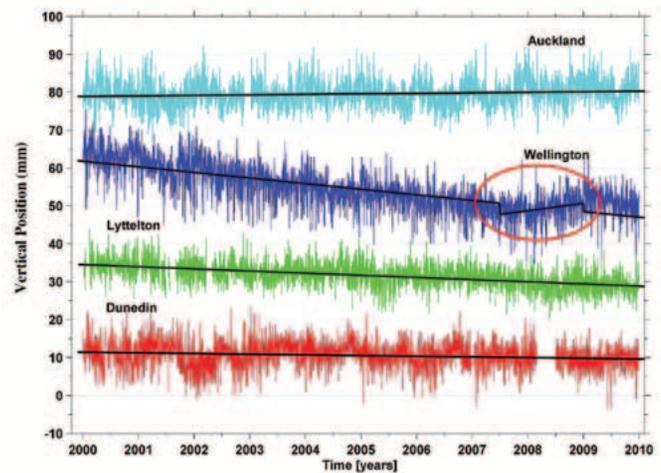
The determination of any acceleration in sea level rise is hindered by the same problems affecting the determination of a linear trend, with the important exception of linear vertical crustal movement (Douglas 1992). Tidal records contain evidence of both the rise in sea level, as well as any vertical movement of the tide gauge relative to the sea level. Evidence for a non-linear parameter in sea level rise (such as acceleration), can be derived from the tidal records independently from any linear sea level trend that might be superimposed on a linear vertical deformation, provided both have been active for the same period of time (Woodworth *et al.* 2009). Unfortunately, however, vertical deformation trends may not be constant. For this reason continuous GPS (cGPS) monitoring is typically used to monitor any vertical movements that may be occurring to tide gauges. This has been the case in New Zealand for the last 12 years (Denys et al. 2010).

## DATA PROCESSING AND METHODOLOGY

For this particular study, two primary data sets were used. The first was the cGPS data collected between 2000 and 2010 at the Ports of Auckland, Wellington, Lyttelton and Dunedin as well as the corresponding MSL data sets. No post-earthquake Lyttelton data has been included.

### cGPS Data

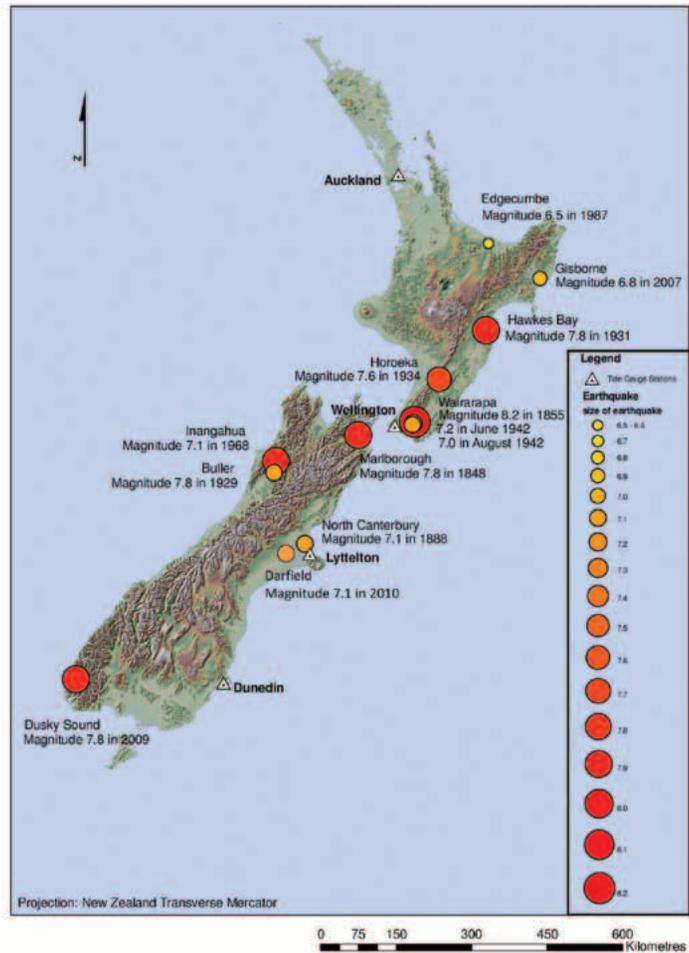
Denys et al. (2010) used continuous Global Positioning System (cGPS) measurements to measure local relative vertical deformation rates at the four stations being considered in this study between 2000 and 2010. The vertical deformation rates, illustrated in Figure 1, show some variability over time, varying from no trend to a constant or piece-wise linear trend. In particular, the highlighted section of the Wellington record suggests that the vertical deformation rate over time, which is significant, has had at least one period when it may have been non-linear. Recent solutions of this, and other data, indicate that the Wellington region has been subsiding by about 1.8 mm/yr since the start of the cGPS data record in 2000 (Denys et al. 2012). It is clear that in the last decade the Wellington tide gauge should not be considered stationary relative to mean sea level. Unfortunately, there is no way of confidently ascertaining from these records the consistency of the respective tide gauges' vertical positions prior to the cGPS records commencing.



**Figure 1: Preliminary relative change in vertical positions over time at the Auckland, Wellington, Lyttelton and Dunedin tide gauges (Denys et al. 2010).**

One possible way of making a preliminary assessment of the likely vertical stability of a tide gauge is to consider the location and size of significant New Zealand earthquakes. The dates, magnitudes and locations of these events, and their proximity to the four long-term tide gauges used in this study are shown in Figure 2. It is of particular importance to note the two significant earthquakes that occurred in the Wairarapa, near Wellington in June and August in 1942. These were the only significant earthquakes that have occurred in close proximity to any of the four tide gauges used in this

study during the periods being analysed. Subsequent to this study, the integrity of the Lyttelton tide gauge has been compromised by the magnitude 7.1 earthquake in Darfield (September 4, 2010), together with its aftershocks.



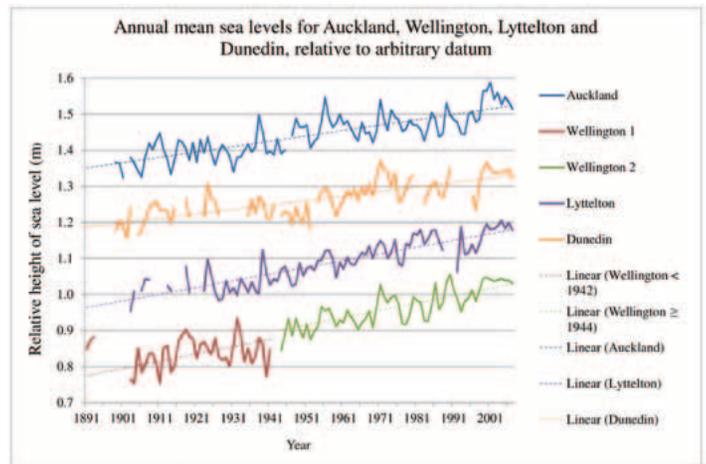
**Figure 2: Significant Earthquakes in New Zealand since 1848 in proximity to New Zealand’s four long-term tide gauges.**

### The MSL Data

The MSL data used in this study is the same data set as has been used in Denys et al. (2012) and is shown in Figure 3. These records provide the primary datasets used to investigate if there is evidence of a significant increase in the rate of sea level rise through the use of 95% confidence intervals for derived parameters. The analyses carried out on the datasets were threefold. Firstly, all datasets were used together in a single analysis to investigate if there might be any acceleration in the rate of sea level rise that is consistent between the stations, both in magnitude and in time origin. A least squares analysis was carried out using Equation 1 to model any acceleration ( $a$ ), linear components at each station ( $m$ ), standard offsets ( $c$ ), and the inter-decadal signals.

$$f = a(t_i - t_0)^2 + m_1(t_i - t_0) + \dots + m_n(t_i - t_0) + c_1 + \dots + c_n + \alpha_1 \cos \omega_1 t_i + b_1 \sin \omega_1 t_i + \dots + \alpha_n \cos \omega_n t_i + b_n \sin \omega_n t_i$$

**Equation 1: Model incorporating accelerating sea level rise trend with decadal and inter-decadal signals.**



**Figure 3: Annual mean sea levels measured at Auckland, Wellington, Lyttelton and Dunedin until 2007.**

Secondly, the total MSL record for each station was investigated in the search for acceleration at that station. Finally, these same datasets were then investigated for a statistically significant increase in the linear rate of rise. In these investigations, long-term signals were incorporated into the acceleration analyses with the objective of quantifying the effects of the signals on the respective sea level datasets, and to prevent the signals from causing biases in the derived results. Fast Fourier Transform analysis was used to convert the annual mean sea level datasets into the frequency domain so as to identify and confirm the approximate periods and significance of the decadal and inter-decadal signals. While this approach averages the amplitude of any time-varying signal, thus allowing the possibility of a residual in the sea level response to climate cycles, it is nevertheless a useful tool for identifying important periodic signals. These important signals were then modelled in the acceleration analyses and became part of the solution in the resulting least squares estimation process.

The datum shift that is believed to have occurred in Wellington between 1942 and 1944 (Hannah 1990) was incorporated through the inclusion of an additional vertical offset parameter.

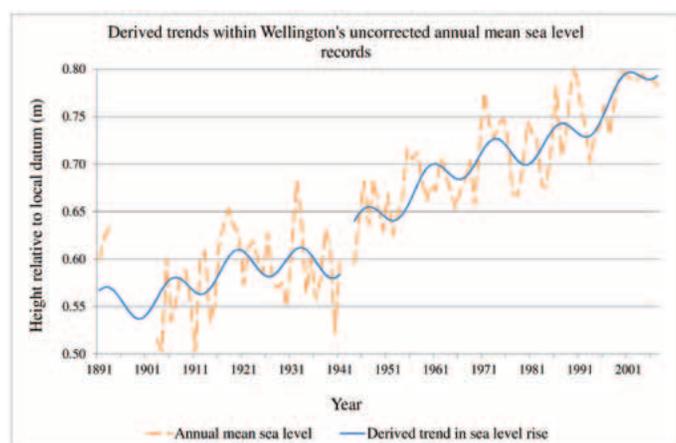
### RESULTS AND DISCUSSION

In the first instance, and given the similarity in the sea level records at each of the four tide gauges, an attempt was made to see if a common significant acceleration across all four gauges might exist. For this purpose any vertical land movement at all of the stations had to be assumed to be constant over time. This behaviour would cause the rate of acceleration in sea level rise measured at any given station to be unaffected. When tested at a 95% confidence interval using the Students t distribution, no statistically significant acceleration was found. While the local linear trends that were

calculated using the stations' datasets were found to differ (albeit with results similar to those shown in Hannah and Bell (2012)), these differences did not demonstrate significant changes in behaviour over time.

When the sea level datasets were analysed separately the only dataset to show acceleration exceeding the standard deviation of the estimate was that of Wellington, where an acceleration of  $0.013 \pm 0.01 \text{ mm/yr}^2$  was determined. The datasets were also found to contain a signal that had a period of  $44.9 \pm 7.8$  years and amplitude of  $10.9 \pm 8.9$  millimetres. This rather peculiar individual outcome led to a wider consideration of factors that may have influenced the result. For example, could the observed acceleration have a tectonic, rather than an oceanographic cause? This possibility is certainly raised by the cGPS results shown earlier in Figure 1, where irregular motion appears to have occurred between mid-2007 and early 2009, thereby compromising the assumption that any tectonic motion occurring in proximity to that station was linear. Indeed, it is also possible that the two significant earthquakes recorded in 1942 may have had some influence upon the Wellington tide gauge and hence its tidal record. Hannah (1990) assumed that the relocation of the Wellington tide gauge in 1944 marked an unrecorded change in the zero point of the tide gauge thus introducing a vertical offset into the data. Perhaps the problem assumed to have occurred with the relocation of the gauge in 1944 was in fact associated with the two large earthquakes in 1942. While this specific issue is not now able to be resolved, it does throw additional doubt on whether the marginally significant acceleration detected at Wellington is a false representation of an acceleration due to climate change or, more likely, to a distortion from either tectonic activity or an unknown datum shift. In retrospect, and following the completion of this work, we note that Chambers *et al.* (2012) have postulated the existence of a 60-year oscillation in MSL with a magnitude of about 20 mm in the Australian region. This is another possible solution to the origins of this signal.

A common acceleration in sea level rise (i.e. one that uniformly affects the New Zealand region), if physically occurring, would



**Figure 4: Derived trends within Wellington's uncorrected annual mean sea level records.**

be expected to be seen at all or most of the four stations considered in this study, provided they are not subject to any irregular vertical movement that was not incorporated into the least squares analysis. With the exception of Wellington, the recent cGPS shows no evidence of such irregularities at the other stations, although the records considered in this study did not extend into the period of significant earthquakes in the Canterbury region. The lack of any significant acceleration at the other stations or, indeed, any acceleration that is consistent between the stations analysed, displays that if the rate of sea level rise is accelerating, there is presently insufficient data to confirm this.

In practise, a common acceleration in sea level rise that was able to be identified in several tide gauge stations, all located in the same region and in stable, non-tectonically active areas, would indicate reliably the existence of such an effect. However, given New Zealand's active tectonic setting, such accelerations are only likely to be identified either by using cGPS data in conjunction with tide gauge records or by using an extended satellite altimetry data set.

The International Association for Physical Sciences of the Ocean Commission on Mean Sea Level and Tides reviewed the necessity of fixing the positions of tide gauge bench marks in a global reference frame (Carter et al. 1989). The Committee recommended that the tide gauges be monitored through episodic GPS campaigns. In the years that followed this recommendation, there were significant advances in GPS technology to make available, cheaper and more accurate receivers (Zumberge et al. 1997). In 1993, the International Association for Physical Sciences of the Ocean Committee recommended that cGPS stations should be installed at about one hundred tide gauges worldwide (Teferle et al. 2006). Despite the core network that the International Association for Physical Sciences of the Ocean Committee hoped for not being fully realised, the data, from those cGPS stations which have been set up since the 1988 and 1993 recommendations, may now be extensive enough to be used in time series regression analysis, to investigate if there are significant vertical trends detected by the measurements. It is recommended that co-located cGPS stations be established at all tide gauge stations that are utilised for the ongoing monitoring of sea level change trends, if they do not already exist (Teferle et al. 2006). The Auckland, Wellington, Lyttelton and Dunedin tide gauges all have co-located long-term cGPS stations. Resilient and reputable precise levelling processes need to be exercised at these tide gauges to tie the two sets of records together, and isolate irregular structural motion or tide gauge instability to maintain the reliability for future investigations.

## CONCLUSION

If the rate of sea level rise is indeed increasing over time, as indicated by the recent analyses of satellite altimetry data, reliable and accurate annual mean sea level datasets exceeding

at least 60 years in length (and preferably longer), will provide an important confirmation of such a signal. Given the known regional variations in sea level rise that occur, the New Zealand tide gauge data will continue to play an important role in local risk assessment procedures.

At this juncture, no significant acceleration in local relative sea level rise has been detected in the four long-term tide gauge datasets, apart from in the Wellington dataset where an acceleration slightly greater than its estimated standard deviation was detected. From a statistical point of view (95% confidence level), this acceleration cannot be deemed to be significant. Indeed, there are compelling reasons to view this apparent change in the rate of sea level rise as the product of other effects. However, new analysis methods e.g. Ezer and Corlett (2012) offer promise for the future<sup>1</sup>. With increasing polar ice-sheet discharges and on-going temperature increases, it is expected that sea level rise should begin to accelerate in the near term.

## ACKNOWLEDGMENTS

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## NOTES

- 1 Subsequent to the completion of this work, Ezer and Corlett (2012) report a novel new approach to the analyses of *in situ* sea level data that appears to have greater sensitivity to periodic sea-level signals than the techniques used here, thus allowing a better determination of any changes in the linear sea level trend.

# WATCHING THE RIVER FLOW: THE LAW, RIGHTS AND OWNERSHIP OF RIVERS IN NEW ZEALAND

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**Abstract** The strongly worded statements by the government that “no one owns water,” have caused consternation for Māori who have, since the colonisation of Aotearoa New Zealand, been anxious to defend their rights against the threats from an absolute acceptance of English common law determinations. The legally valid statement about water ownership cannot be extended to the status of rivers, although there is a tendency to confound the arguments. This paper describes the way that the common law determines rights in rivers in an attempt to bring light to the various positions defended by the Crown, by Māori and by private title holders. It concludes that the standard common law rules may well be overridden by local circumstances, including the protections of Māori interests recognised under customary law and under the Treaty of Waitangi.

**Keywords** River ownership, navigability, *ad medium filum*, Māori rights.

## INTRODUCTION

There is a widely held public belief and expectation that water is a community and public asset common to all. It is certainly a free flowing and largely un-owned component of our natural and physical environment. However, New Zealand’s English derived common law generally assumes that any property rights in tidal and navigable rivers are held by the Crown, while all other rivers are held under private title. In other words the common law has no problem with, first of all, assigning property rights (such as use of, and access) to water, and also recognising private title to rivers, neither of which have unreasonably restricted publicly asserted rights such as fishing and use of rivers.

Current debates about ‘ownership’ of water and rivers have arisen because the Crown, in proposing to sell state energy companies, is apparently (even if not legally) assigning a set of private property rights to the water and rivers involved, which may impinge on the exercise of Māori customary rights to rivers as well as compromising other publicly asserted values in water and rivers.<sup>1</sup> These issues are not new. Similar claims to land under water have been decided in our courts, reviewed by the Waitangi Tribunal, and in various forms have been acknowledged by government action and policy. It is, therefore, unfortunate that they are being played out again, in volatile public *fora*, with little acknowledgement of the legal history.

This paper reviews the English common law conceptions of water and river rights, describes the tidal and navigability tests for Crown ownership, and the *ad medium filum aquae* presumption. Relevant case law is used to record how these have been applied in New Zealand, and to illustrate that recent developments concerning Māori property rights in

waters provide for a uniquely New Zealand response to future recognition of water and river rights.

## RIVER LAW

The law about ownership of rivers is far from straightforward.<sup>2</sup> In 1983, the Property Law and Equity Reform Committee examined the unsatisfactory definitional and property entitlements situation, reported on these and made recommendations that rivers should be statutorily vested in the Crown.<sup>3</sup> This would clearly have been confiscatory of existing property rights and could have elicited a strong adverse response from property owners. The Crown was reluctant to intervene, and allowed the issues to remain in the realm of the common law. The courts are left to examine any claim or dispute and to make a determination about ownership on a case by case basis.

Various tests are used to determine river ownership, and yet none of these provide a totally clear statement about who may own any particular river. The common law does not recognise ownership of flowing water, nor of the river as a whole (Brookfield 1997). Any property right consideration or definition relates to the bed of the river and the space above and below, and while this interpretation may facilitate occupation and utilisation of the column of water above that bed, it means that neither the water as such is owned, nor any resources above the bed. A common law riparian right may allow for the extraction of water for reasonable use (often defined as for domestic rather than industrial use), and for the use of other resources from the water (e.g. fish), and for the use of the space for structures (e.g. for a landing jetty), but the water itself is always free flowing and expected to continue flowing with the same characteristics of quantity and quality through and over the owned property – the bed. The banks not only provide the separation boundary but also the link between the upland riparian parcel and the

bed of the river.

While Māori possession of their land (including their rivers) was confirmed and guaranteed by the Treaty of Waitangi, the Crown had no authority over that land until customary title was alienated to the Crown. At that point the Crown was in a position to decide how and what rights would pass with a Crown Grant. The Crown could have made an executive decision to exclude all rivers, lakes, foreshore and seabed from a Crown title, but it chose not to do so<sup>4</sup> and left the determination of the ownership of rivers to the English common law (as imported into New Zealand and confirmed by the English Laws Act 1858, “so far as applicable to the circumstances of the colony”).

The common law of ownership of waterways is generally based on presumptions of law, with two categorisations of waterways – tidal and non-tidal, and two possibilities for ownership – Crown and private.

## Tidal waters

English common law assumes that *prima facie* the Crown owns the foreshore and seabed.<sup>5</sup> There are two apparent reasons for this assumption:

- 1) the foreshore is not capable of being owned because it is not cultivatable (manorable) or able to be occupied or possessed due to the fact that, on average, half the time it is under water, and
- 2) the seabed is part of the Royal commons that should be reserved for public navigation and fishing.

Tidal rivers are considered to be extensions of the sea and are generally assumed to be a public waterway reserved for navigation and fishing, and therefore the property of the Crown.

## Navigability

Because of the importance of public navigation (especially in newly established colonies), navigability in fact and in law has assumed the role of a surrogate test for determining the ownership of a riverbed in parts of the USA, Canada, and perhaps New Zealand too,<sup>6</sup> although as a result of some uncertainty about this, the Coal-mines Act 1903 was passed to confirm this.<sup>7</sup>

In 1900, in the *Taupiri Coal-Mines* case, ownership of the Waikato River was at issue. It was accepted that the river was not tidal, so the extent of navigability was then questioned. The river was determined to be navigable in fact, given that when the surrounding land parcels were acquired and/or granted by the Crown (in the 1860s), the river was in fact used as a military highway to support the imperial forces in the invasion of the King Country. The proof of navigability was strongly supported by: 1) actual use; 2) Crown use; and 3) military use as a highway. All these factors convinced the

court that the Crown would not have intended the river to pass to the adjoining land grantees. *Taupiri* thus confirmed the significance of navigability in New Zealand common law for determining ownership of a river.

## Ad medium filum aquae

The alternative common law assumption about property rights in rivers is that if the river is not tidal then it is probably owned by the adjoining riparian owners. In the case of a parcel of land having a boundary defined or described as the river (whether or not any survey or plan indicates the bank as the extent of the parcel, and irrespective of the dimensions or areas shown<sup>8</sup>) then the common law assumes that title extends to the centre thread of the river<sup>9</sup> – *ad medium filum aquae*, with the opposite bank parcel owning the other half of the riverbed.

As with many other obscure components of the common law, the *ad medium filum* rule was imported into New Zealand “without critical consideration.”<sup>10</sup> The concept may have been appropriate in England where, in such a settled country, longstanding custom of adjoining owners’ rights in their rivers was not easily upset. Furthermore, England’s rivers are usually well defined and stable in their channel, making the spatial definition of the banks and the centre line a relatively straightforward task.

The particular circumstances of New Zealand were considered by J. T. Thompson<sup>11</sup> who stated: “The modes of survey adopted in a Parent State must differ from those adopted in a Colony; the object of the former being to map a country long peopled and divided by well known artificial boundaries; the object of the latter being to prepare a waste of undivided country for an inflowing people” (Gough 1965). This recognises one aspect of the different circumstances in New Zealand while conveniently, or perhaps innocently, ignoring the underlying fact of the existing occupation of New Zealand by Māori, and the boundaries, both natural and artificial, already in existence.

New Zealand courts have generally followed the common law presumption in assuming that a grant of riparian land includes the grant of the river *ad medium filum*. In the 1984 *Tait Jamieson* case, in a dispute about mining rights into the Manawatu river, the court was required to determine who had rights to the gravel resources in a river; the adjoining riparian owner (because of river ownership *ad medium filum*) or a mining contractor (because the river was navigable and therefore public). The court could find no evidence of actual navigation and could therefore decide against the river being under Crown title. The court decided that the assumption that a grant of a riparian title included the grant of the river *ad medium filum* was not easily rebutted.

The New Zealand courts have stated that it is inappropriate for a statement of the *ad medium filum* rights to appear on the face of the title<sup>12</sup> and therefore the assessment of whether

the *ad medium filum* rule applies is not made by the surveyor defining the parcel boundaries, nor the Land Transfer Office in describing the parcel on the registered title, but by the courts who will consider the facts on a case by case basis. In that way there continues to exist a level of uncertainty about the exact nature of a property right in any particular river, unless it has been subject to an explicit grant or the river is entirely confined within a registered title with no surveyed definition of the river or stream, nor any indication of its existence on the plan or face of the title.

## USE AND AUTHORITY OVER RIVERS

The test of tidality and evidence of navigability do not determine what sorts of rights and types of use the public can exercise over a river. Crown ownership of a river is not a necessary condition for the existence of the right of public navigation, in spite of the common law assumptions and tests:

It is an essential attribute of a waterway that is navigable in law that the public may use it as of right for purposes of passage as a public waterway or highway, even if the title to the bed is in the riparian owner or owners.... The right of navigation is paramount to the rights of the owner of the land (1983 *Coleman*).

Brookfield (1971:204) suggests that the Land Transfer Act is not binding on the Crown, and a Certificate of Title which wrongly includes a Crown owned river within its boundaries is void as to such inclusion.<sup>13</sup> The common law situation of old roads in England is illustrative. A road could be owned *ad medium filum* – to the centre line – by adjoining property owners, and therefore the road is in private title,<sup>14</sup> however, this does not impinge on the rights of public passage. There may also be a responsibility and a right for a local road authority to maintain such a private road. Such right provides some proprietary rights to the authority but only so much as is required to undertake their duties and responsibilities. This is exactly the same situation as a River Board (or now a Regional Council) in New Zealand charged with river control and flood protection works.<sup>15</sup> The responsibility to undertake flood protection and river control work has nothing to do with ownership of the river, but is a statutory and administrative duty to manage and control the river for the public benefit.

## IMPLICATIONS FOR MĀORI

The common law has evolved by following previous decisions and old common law doctrines that supported the interests of the colonial settlers. After all, the colonisers brought with them, at least by their own reckoning, the unquestioned benefits of Christianity, civilisation and a 'divinely' inspired common law that had served the British people well and elevated them to the most powerful and successful nation on earth at the time. There was inevitably a clash of cultures and a conflict of laws and practices between the colonisers and the indigenous inhabitants, and the local administrators struggled

to find common ground. It was usually taken for granted that there must be one law for all, but some believed that:

...complete fusion is neither desirable nor necessary. No doubt there are serious disadvantages in maintaining different laws for the regulation of rights in real property, notably where indigenous law recognises only tribal ownership with no more than usufructuary rights conceded to the individual; but it may take a long time to secure general acceptance of the English law (Roberts-Wray 1966: 535).

The common law rules suit the colonisers' property rights. But these common law rules have done little to support indigenous peoples. Their occupation of land and waterways is barely recognised as possession, their conception of land and waterways is not supported by the 'property as commodity' conception of the common law, and their connections with land and water have been violated by the Crown's expectations of its own radical title and its assumptions about when land and riverbed are connected and when they are not. Rights to the rivers were taken from Māori with no explicit reference, with no compensation, and with no understanding of the process.

One effect of these common law doctrines on Māori and their rights in rivers has been therefore, by the sidewind of legal assumption,<sup>16</sup> to alienate any riparian rights (including ownership of rivers) along with the alienation of adjoining land (1962 *Wanganui River*). If Māori sold land, it was assumed that title to half of any river passed with it in spite of the fact that Māori were unlikely to have contemplated the effect of a sale of the river, much less considered the foreign notion of passing just half the river.<sup>17</sup> Māori continue to be disadvantaged by such applications of common law doctrines that are retained to protect a colonial power base. "As went the land, so went the rivers, victims of the English common law rule of *ad medium filum aquae*: Māori, when they sold their land, unwittingly passed over legal control of the river banks to the new owners of the land, and of the river itself to the Crown" (Sharp 2001: 43).

Māori claims to land, rivers, foreshore and seabed have not met with great success in the courts, mainly because of some unhelpful and aberrant precedent,<sup>18</sup> but also because of a reliance on standard English common law presumptions (which clearly have not been modified by the unique "circumstances of the colony") of the doctrine of tenure and of Crown ownership of the commons; the water, rivers, sea and open wastelands.

## MĀORI PERCEPTIONS OF RIVERS

The Treaty of Waitangi clearly acknowledges and protects Māori interests in their land, forests, fisheries and other taonga; this must necessarily include the lakes, rivers and sea spaces which have so much significance to Māori. This significance

includes the use of rivers for the resource of their fisheries, for a source of clean water for its physical cleansing qualities, as an access way to lands up and down river, and for a river's spiritual attributes (wairua); resource from the gods, home of protective taniwha.

Recent judicial statements about Māori rights in rivers have shown some willingness to look beyond the common law to acknowledge an indigenous perspective. The Court of Appeal has repeated statements from the Waitangi Tribunal that has conceptualised rivers as taonga and as "a whole and indivisible entity, not separated into beds, banks and waters."<sup>19</sup> Rivers were just as much part of indigenous territories as the land. For many indigenous peoples the extent of tribal authority, the allocation of use rights, and the relationships and connections with place, were just as strong and direct over rivers as they were over dry land. Rivers provided a very direct link with the spiritual ancestors, they provided probably the most productive food gathering sites, they provided communications routes, and they often provided the most distinctive landmarks by which to identify with place.<sup>20</sup> To the extent that Māori possessed or owned the land, they just as clearly possessed and owned their rivers;<sup>21</sup> they maintained sites of occupation on rivers,<sup>22</sup> they regulated their food gathering on rivers,<sup>23</sup> and they acted as kaitiaki over their rivers. But rivers could not be conceived of as being split into banks, beds, and water, nor divided down the centreline, or carved up into separate parcels; they were entities in themselves and merged into the indigenous peoples' holistic world view.

## MĀORI CLAIMS TO RIVERS

There has been little judicial action in relation to ownership of rivers<sup>24</sup> except for the cases where Māori have claimed title to rivers on the basis that adjoining land sales did not include the riparian rights including the river *ad medium filum*.<sup>25</sup> This is best illustrated by the series of decisions surrounding the Whanganui River (see Ward 1997: 14.4.2, and MLC 1983: 96) precipitated by the destruction of eel weirs to improve navigability of the river. The case grew out of the Native Land Court decision in 1939 that at 1840 the bed of the river was customary Māori land. After appeals by the Crown and Māori to the Māori Appellate Court, the Supreme Court, the Court of Appeal and a Royal Commission, the issue was unsatisfactorily abandoned in 1962 with a conclusion that there was no Māori custom to support tribal ownership of the river "comparable with common law concepts of property" (Ward 1997: 356).

The Native Land Court was established to investigate the ownership of customary title and to issue a Crown derived title to those owners. This and other processes of alienation have extinguished all customary title to the dry land. However, as *Ngati Apa* highlighted, Māori customary title to the foreshore, the seabed, rivers and lakes may not have been extinguished and may therefore still remain. While the common law may assert that some rivers belong to the Crown, and indeed the

Coal-mines Act may make vesting statements to the same effect, the courts have stated that such assumptions and statements may not show sufficiently clear and plain intent to extinguish Māori customary title.

For Māori, there was generally quite active use of the river, and that use (access, resource gathering, spiritual connection) was often fundamental and integral to their culture and traditions. There can often be a strong case put by some iwi for their customary rights to their rivers. However, the legal tests require continuity of practice and use, and many Māori have, by various legal or social processes, been alienated from their rivers and those traditions have been abandoned and lost, although as recognised by the Waitangi Tribunal (1999), clearly not the case for iwi such as those around the Whanganui River.

## MĀORI RIGHTS IN RIVERS RECOGNISED

The philosophy of a land ethic (Leopold 1949) suggests that we are part of a community with rivers and land and the earth's resources. To this community is owed a duty and responsibility for care and maintenance. Such an ethic can exist within a private property regime but it can be more explicitly formulated with a form of communal title where a sympathetic community bound by custom and tradition takes on the role of custodian, steward or kaitiaki. Māori communities often hold such an ethic of responsibility towards their specific rivers and lands (their manawhenua) and where that relationship continues, it should be acknowledged in the formulation of their property rights.

As has been illustrated by the specific grant to iwi of the freehold titles to some lakes in New Zealand, a recognition of indigenous property rights need not derogate from a general public right of access and use. The granting of title to the bed of Lake Rotorua or Te Waihora (Ngai Tahu Claims Settlement Act 1998) has had little noticeable effect on the general public. Māori may have more say in fishing regulations or discharges to the water, but these are valid regulatory provisions that would otherwise be the duty of regional councils. Public rights may be explicitly protected if necessary, by special provisions in the grant of title (Ruru 2010). One benefit to Māori, and arguably to the country as a whole, is that Māori mana is restored. The acknowledgement of mana has been a significant aspect of Treaty settlements and it may go a long way to satisfying any loss and grievance, while restoring the morale of Māori society and thereby enhancing Māori social, health, education status. In doing this, it need not derogate from the interests of the public at large. The Crown must recognise the rights of its Māori citizens; the Treaty guaranteed it; the law supports it; and the environment benefits from it. The honour of the Crown is at stake. Understanding and good faith negotiations will be required. Recognition of the necessity to continue to spread understanding is not new. In 1863, Chief Justice William Martin advised:

Yet it is necessary to speak, because our people are as apt

to forget these facts as the natives are to remember them. I know how ignorant the larger part of our population is of the history of the Colony – how little they in general possess of that personal acquaintance with the natives which would enable them to discover how abundant is the material for good in these people (Martin 1863).

There has been ample evidence of the ‘material for good’ shown by iwi,<sup>26</sup> It is my opinion that this material for good was not reciprocated by the New Zealand Crown in the foreshore and seabed conflict (Strack 2004), and in recent government reactions to Māori assertions of their rights in rivers as a response to the proposed sales of state energy companies. On-going negotiations and possible judicial intervention may yet see the Crown change tack when it comes to recognition of indigenous peoples’ rights in rivers.

Very recent progress has been made with regard to an example of recognition of a Maori claim on their river. Following continuing negotiations between Te Atihaunui and the Crown, it was announced in late 2012, that the Whanganui River was to be given its own legal personality; it would own its own river bed, although no title would be issued. Under the agreement the river will have legal status under the name Te Awa Tupua, and will have two guardians, one from the Crown and one from a Whanganui River iwi, charged with protecting the river (NZ Herald. August 30<sup>th</sup> 2012). This is a novel tenure arrangement and the success of its application will be keenly observed.

## CONCLUSION

The question of granting a documentary title to a river is not an easy one for New Zealand’s cadastral system to deal with. No titles have been granted specifically for rivers.<sup>27</sup> There are many rivers incorporated within existing land titles, primarily because the survey did not separately define the extent of the river. The alternative situation is usually for rivers to be shown as land left over after the survey definition. Rivers have an indeterminate beginning and often a similarly indeterminate end, usually at the sea coast or the upper limit of tidality, and although the common law can apparently accept a boundary down the centreline, the concept of a boundary across a river would be foreign to most observers. Such a concept highlights our inability to confine rivers, water, fish and other resources.<sup>28</sup>

Rivers, water and the other resources associated with them are rightly subject to resource management regulations. These regulations can protect intrinsic river values, water quality and quantity, extractions and drainage, access and use. It is often considered that rivers are necessarily open to all and should not be subject to any claims of ownership. And, no matter how much the normal regulation of rivers effectively eliminates any practical rights of ownership, there remain some important symbolic values in rivers that are supported by ownership. Māori may be in a position to demonstrate and uphold such values and their rights should not be dismissed arbitrarily but

instead recognised in grants of title.

Māori customary law obviously perceives rivers differently to English common law. The Privy Council (at one time, our highest legal authority) has warned our courts against “rendering native title conceptually in terms which are appropriate only to systems which have grown up under English law” (1921 *Amodu Tijani*). In other words, New Zealand common law should accept the unique circumstances of New Zealand and incorporate components of Māori law within our legal system. This means that Māori issues should not be confined by the scope of English law. Our courts have also very assertively stated that Māori customary rights continue to exist unless they have been explicitly relinquished by the customary right holders or explicitly extinguished by the clear and plain intent of legislation. This is the exact outcome of the Court of Appeal’s decision nine years ago in relation to the foreshore and seabed. It has been the outcome of several previous court decisions in regard to rivers, and it will undoubtedly be the outcome of any potential case brought in the current debate about what will be lost and gained in any state asset sales.

Customary rights are normally held communally or collectively, and they are not individual and exclusive. The current objection to the sale of state assets is not initiated by a desire to limit public rights to rivers, but rather to ensure that those common rights are not sold into private ownership without first recognising the existence of underlying customary rights.<sup>29</sup>

In this respect again, we see history repeating itself. This was the scenario with the foreshore and seabed. Māori were quite comfortable to allow continued public use of their customary rivers (and sea), but as soon as there was a suggestion that those rights would be privatised, they were forced to defend their customary rights. The government responded by extinguishing those rights legislatively (Foreshore and Seabed Act 2004). But there are already many examples of rivers (and lakes and foreshore and seabed) being subject to private individual title, without great public concern. If the Crown chose to extinguish Māori customary title to rivers without also extinguishing general land titles to rivers, it would again be legislatively possible but clearly discriminatory.

The problem remains, that our courts only answer very specific questions and often leave the big questions unanswered. So we will still be left with some uncertainty about the scope and content of Māori customary rights to rivers, just as we have been left with few specifics about Māori customary rights in the sea. One component of a Māori customary right includes Māori role as kaitiaki; their management of rivers. Given the state of many New Zealand rivers and the state of current management, it might be a good thing if specific hapū with mana over their own rivers held and applied their management duties for the greater good of us all and of our natural environment.

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## NOTES

- 1 The Interim Report of the Waitangi Tribunal (2012) is a significant way point in this ongoing claim and counter-claim, and as this paper goes to print the High Court is about to issue a judgement on a claim from the NZ Māori Council on this matter.
- 2 For example, in the Waitangi Tribunal Pouakani Report 1993, Wai 33 (and with reference to the Waikato River which marked the northern boundary of this claim) the Tribunal observed that "[w]e find the law on rivers in this respect to be confused and confusing" (at 297). The recommendations arising from this report include the statement: "We consider the conflict between Māori rights, the Crown and public interest in general, over the ownership and use of the rivers has implications far beyond the scope of the claims before the tribunal. We therefore recommend that the Crown give urgent attention to addressing these matters in the national interest" (at 297). In 2009 a Cabinet paper states: "The rights and interests of Māori in New Zealand's freshwater resources remain undefined and unresolved..." and see Ruru 2010.
- 3 In much the same way as the government controversially legislated for Crown ownership of the foreshore and seabed in the Foreshore and Seabed Act 2004.
- 4 See Elias CJ commentary in *Paki* 2011 at para19.
- 5 This was the question being asked of New Zealand common law in the case *Ngati Apa v. AG* (2003), where the Court of Appeal judges determined that in spite of the Crown's assumption and in spite of the 1963 judgement of the *90 Mile Beach* case, that in fact that assumption was incorrect if Māori customary title to the foreshore and seabed had never explicitly been extinguished. On the basis of this case, the *prima facie* assumption should first be that the foreshore and seabed is Māori customary land unless it can be proved that that has been extinguished, then the foreshore and seabed is Crown land unless it has otherwise been granted to someone else (and it should be noted, a significant amount of the existing foreshore has been so

- granted). The government response to this decision was to enact the Foreshore and Seabed Act 2004 that specifically vested the public foreshore and seabed in the Crown. This would appear to acknowledge that in New Zealand the common law assumption was not definitive in determining the ownership of the beds of tidal waters: customary title may not have been extinguished.
- 6 The Property Law and Equity Reform Committee 1983: 6 para 6.4 suggested abandoning the test of navigability. "The common law and present statutory concept of 'navigability' as a criterion of proprietary rights should be abolished. It is considered that this too no longer serves any purpose as a means of determining the ownership of riverbeds." And "the concept of commercial navigability and notions of transport and navigation along rivers were never generally applicable in New Zealand."
  - 7 See Elias (*Paki* at para54-55) discussion of the purpose of the Coal-mines Act 1903.
  - 8 "If land adjoining a highway or a river is granted, the half of the road or the half of the river is presumed to pass, unless there is something either in the language of the deed, or in the nature of the subject-matter of the grant, or in the surrounding circumstances sufficient to rebut that presumption; and this though the measurement of the property which is granted can be satisfied without including half of the road or half of the bed of the river, and although the land is described as bounded by a river or a road, and notwithstanding that the map which is referred to in the grant does not include the half of the river or the road" (*Micklethwaite v The Newlay Bridge Company* 33 Ch D133 at 155).
  - 9 But it is not made explicit on the title document that ownership extends into the river *ad medium filum*. Survey plans invariably show the bank as the boundary, the dimensions and areas are shown to the bank, and the plans were coloured so as to indicate a clear separation of the dry land from the wet land. All this graphical and dimensional evidence is not considered by the courts to be determinative of the extent of the common law ownership. See Brookfield 1997: 72 para58.
  - 10 Elias CJ in *Paki* at para19]. The *ad medium filum* concept was perhaps an unexpected and uninvited component of an English mindset that failed to consider local circumstances.
  - 11 John Turnbull Thompson was the first Surveyor General of New Zealand 1876
  - 12 For example, see Stanton J. in *Attorney-General & Hutt River Board v. Leighton*. [1955] NZLR 750. at 779, L35. "I do not think the practice is a suitable one for adoption in New Zealand". Ownership of rivers is usually not supported by documentary evidence of a title or deed as the Crown does not need to grant itself a title. Rivers are more usually shown (on cadastral plans) as the space left over after title boundaries of the dry land have been determined, and they are rarely separately identified as Crown land, nor as owned to the centre line.
  - 13 This is the same situation with roads that are not shown on titles - because of a similar overriding importance of roads for communication - a Land Transfer title is not indefeasible with regard to a non-recorded road: "the existence of a legal road will prevail over a certificate of title even if the road is not shown on or referred to in the title document." Hayes 2008: 70. And see Bennion et al 2005: 102 s2.7.08 referring to the Land Transfer Act 1952 s77.
  - 14 This presumption as it applied to roads in New Zealand was abrogated by the Public Works Act 1876. The opportunity also existed for the Crown to similarly abrogate the presumption with respect to rivers, but it chose not to do so - at least until 1903 with the Coal-mines Act, with respect to navigable rivers.
  - 15 This issue is examined in Nash 1997 - a river board had been granted legislative jurisdiction over a river for flood control works, but the title to the river was not clear and assumed by the adjoining owners to be connected to their adjoining title. A claim arose for an extension of the riparian title by accretion and the DLR refused the application on the basis that it was river board land. The claim was left unresolved because of the inconvenience and expense of a legal challenge.
  - 16 As described by the Waitangi Tribunal 1999;265
  - 17 See for example the Waitangi Tribunal. *The Mohaka River Report* Wai 119 1992: 33 "the notion that their river could be divided into fractions was beyond their experience."
  - 18 See especially *Wi Parata v. Bishop of Wellington* and *In Re the Ninety-Mile Beach*. In *Ngati Apa* (2003 para 13), Elias CJ describes the former as discredited, and the latter as wrong in law. Hookey (quoted in Brookfield 1989;12) described Prendergast CJ's *Wi Parata* decision as "redolent of ethnic chauvinism". *Ngati Apa* provided a reversal of previous decisions that had denied customary rights, however, the effect of this decision was undermined by the Foreshore and Seabed Act 2004.
  - 19 As quoted in *Te Runanganui o Te Ika Whenua Inc Society v. Attorney-General* at 26 line 44. and see the Waitangi Tribunal 1992 *Mohaka River* report.
  - 20 Note for example, the standard pepeha or mihi - statement of whakapapa and self identification - usually includes a person's connection to a river - "Ko Waitaki te awa".
  - 21 I have tried to avoid using the term 'ownership', nevertheless the Waitangi Tribunal 1999: 263 states: "the river is a taonga and property which Māori possessed. Transposing possession to English law ... it is a taonga that they owned." And again (Waitangi Tribunal 2012: 110): "Our generic

- finding is that Māori had rights and interests in their water bodies for which the closest English equivalent in 1840 was ownership rights, and that such rights were confirmed, guaranteed and protected by the Treaty of Waitangi, save to the extent that there was an expectation in the Treaty that the waters would be shared with the incoming settlers.”
- 22 These are acknowledged in the Ngai Tahu Claims Settlement Act 1997 which explicitly re-establishes Ngai Tahu links to their rivers with the Nohoanga sites.
- 23 By means of the social control mechanisms of Rāhui.
- 24 *Taupiri Coal-mines, Tait-Jamieson* and *Leighton* are the only notable cases of relevance.
- 25 Petitions and then a series of courts heard a Māori claim to the Wanganui River from 1927 till 1962. A summary of these cases is recorded in MLC 1983: 96 *Tai Whati* and reviewed by the Waitangi Tribunal 1999.
- 26 In the Treaty negotiations and settlements achieved in the last decade.
- 27 Although, see developments with the Whanganui described in previous paragraph.
- 28 See discussion in *Paki* para58-59 regarding the patchwork of boundaries and ownership over a river that may have been avoided by looking at a ‘whole of river’ approach, but the Court of Appeal concludes that a fragmented river was an acceptable and foreseeable outcome of the interpretation of the legal rules.
- 29 As the Waitangi Tribunal (2012:14-15) states: “Māori want their authority over and custodianship of water bodies to be acknowledged and respected. They want to protect their taonga for present and future generations.”

# WHAT IMPACT DO HIGHER-EDUCATION EXPERIENCES HAVE ON THE ENVIRONMENTAL ATTITUDES OF SURVEYING STUDENTS?

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**Abstract** That New Zealand's surveyors develop an 'environmental consciousness', or 'concern for environmental issues', is an objective of our National School of Surveying, a policy element of the New Zealand Institute of Surveyors, and likely to be a hope expressed by all environmentally-concerned citizens. But 'environmental consciousness' and 'concern for environmental issues' are not easily defined, or assessed as part of a conventional educational programme. Our research uses the New Ecological Paradigm (NEP) to question and record the environmental attitudes of tertiary level surveying students. Ultimately the research seeks to determine how attitudes may change as students experience higher education. Initial analysis concludes that surveying students begin their tertiary studies having lower mean levels of environmental attitude than some other science-course students (particularly zoologists); that over some time of higher education attitudes may become slightly more 'green', and that perhaps the School of Surveying may consider a more proactive approach to environmental education if it is serious about environmental consciousness as a graduate attribute.

**Keywords** environmental literacy, NEP, surveying education.

## INTRODUCTION

The project described here is part of an on-going and wider institutional exploration designed first, to assess the environmental attitudes of students by means of the New Ecological Paradigm (NEP) research tool, and second, to monitor changes in environmental attitudes in selected cohorts of students who volunteer to be involved. The broader project is described in more detail in other publications and this article focuses on students enrolled in surveying and related programmes of study. The research presented should be considered as work in progress and is presented here primarily to stimulate discussion within the profession and its educational partners about the need for environmental education, and how this may be provided.

Reference to sustainability is so endemic in educational and professional forums that there is a growing expectation and even requirement that environmental awareness is part of all professional and citizen engagement. The NEP research tool (see details below) gives us a method of evaluating how participants rank on a measure of environmental awareness.

Given that environmental consciousness/concern for environmental issues are objectives of our National School of Surveying and of the NZIS, and international concern for the extent to which higher education is encouraging graduates to develop sustainability perspectives, our own research seeks a greater understanding of the environmental attitudes of higher education students, and how they may change.

The authors of this article are aware of just one substantial published account of developments in higher education relating specifically to sustainability-teaching within surveying departments, suggesting that possible limited engagement with sustainability issues has become a concern elsewhere. In the UK an extensive survey of recent graduates from 23 programmes to assess the current state of knowledge and understanding of the issues confronting the profession with regard to the impact of climate change, suggested a degree of unpreparedness amongst the surveying community regarding issues around climate change and the built environment (Dent and Dalton 2010). Approximately 50 per cent of respondents considered that there was no, or little, reference to the issue in their own programmes.

Why would surveyors need to develop environmental awareness? And how do we expect surveyors to develop such awareness? These are questions that the profession needs to ask of itself. In fact, in a presentation of this research at the recent NZIS conference (Strack 2012), an introductory question to the audience of around 100, about whether surveyors needed environmental literacy as part of their education, elicited only about 10 positive responses. It is hoped that the subsequent presentation and this article provide cause for reconsideration in support of environmental education.

## SURVEYORS AND SUSTAINABILITY

The early history of surveying in New Zealand features an ambiguous role for surveyors. They are guardians of the

environment (exploring, identifying and setting aside lands for conservation and protection) (Smith 1916) but also exist alongside a tradition of exploitation (clearing bush and wetlands for pastoral and agricultural production) (Strack 2009 & 2011). In providing their professional services to the Crown and to land owners and developers, surveyors continue to have a huge impact on the environment: on our land and resources. Surveyors may have close links to the land and land owners, and they may have an intuitive awareness of landscape, ecological systems (e.g hydrological cycles), land use limitations, scarce land and other natural resources, and management of the built environment, but it is far from clear that surveyors are proactive leaders in these areas. Surveying is at least part Art; concerned with creating aesthetically pleasing environments, making planning and quasi-legal decisions about land use and land rights, and managing scarce resources. On the other hand, surveyors' primary work is land development (modifying the natural environment to suit human needs), with a duty to their clients to make economically profitable decisions, and a desire to optimise resource use.

Historically, it is not particularly apparent that the surveying profession in New Zealand questioned its role in environmental change, but instead, as responsible servants of the Crown and their clients, surveyors continued to apply their practical skills and expertise to contribute to economic wellbeing through land development. More recently, there is some evidence that the profession is applying some introspection. The New Zealand Institute of Surveyors (NZIS) released its Environment Policy (NZIS 2005) in 1993. Surveyors were no doubt responding to developing international awareness of human impact on the environment; such as the 1992 Earth Summit and national legislative and policy goals including "the sustainable management of natural and physical resources" (as prescribed in the NZ Resource Management Act 1991, RMA). The NZIS Environment Policy seeks "to ensure that an environmentally sound approach is used in all aspects of professional practice as far as it is practicable." The objectives include "Support and promote environmental education," and the guidelines include "Maintaining and enhancing the level of environmental consciousness of all involved in the survey profession; and ensuring that survey education programmes include measures to enhance the environmental awareness and understanding of all participants." Clearly there is a high level of direction from the Institute to guide a curriculum focus on environmental literacy and sustainability.

Other related professions, and surveying professional bodies elsewhere, have followed the NZIS. In 2004 the Engineering Council UK required chartered engineers to demonstrate commitment to sustainable development for registration, and the Royal Academy of Engineering produced guidelines on how they would do this (Dodds and Venables 2005). The Royal Institute of Chartered Surveyors (RICS) followed in

2007 by publishing its intention to place sustainability at the heart of all its activities and adopting a set of Sustainability Policy Principles (See Dixon et al. 2008). The Commonwealth Association of Surveying and Land Economy (CASLE) clearly also expects surveyors to demonstrate a high level of environmental awareness: "the education and experience of surveyors may be drawn upon to provide advice on the effective use of resources in new projects, and the long-term resource and cost consequences of planning, design, and construction decisions". Furthermore "CASLE believes that the modification of the environment to serve human needs can and must be more sensitively managed" (CASLE n.d.).

There should, perhaps, be some doubt that professionals within the professions have made equivalent transformations. An extensive survey of RICS professionals in 2008 suggests that "although sustainability is highly relevant to RICS members' work, a lack of knowledge and expertise is making it more difficult for sustainability tools and other information to be used effectively" (Dixon et al. 2008). A survey of planning professionals in Australia identified that the professionals themselves perceived gaps in environmental knowledge and skills (Hurlimann 2009). The perceived knowledge gaps included climate change and water management. The key skill gaps highlighted included critical thinking and independent inquiry. Hurlimann suggested a need to review and possibly update current urban planning curricula in Australia, and to offer continual education modules for planners in practice (who have already graduated) to address these gaps.

For a profession that has often been viewed as at the forefront of land development and resource exploitation, it remains concerning that there has been no overt shift in educational curricula or in the professional guidelines towards a concern for sustainability. Many other professions have embraced a new paradigm – engineers, architects, and landscape architects regularly contribute to sustainability initiatives in their practice and education (green building certification, lowering carbon footprints, energy efficient processes and monitoring among many such examples). Research into engineering students has recorded that they "believe that sustainable development is important for engineers, although they often have difficulties in making a direct link between the theory of sustainable development and engineering practice" (Azapagic et al. 2005). Surveyors have been conspicuously silent on environmental concern, codes of ethics and environmental policies notwithstanding. These have been written, but evidence of implementation is rare.

There is also, within this rhetoric, an expectation that the profession will be a leader in sustainability efforts. "Surveyors could be an intrinsic part of developing sustainable societies. If we can successfully educate ourselves, we can then take part in the much wider education process for a more sustainable society" (Calvin 2007). There are also opportunities identified in newly developed programmes that provide strong support

for a new environmental paradigm to inform engineers:

If we are to achieve harmony between development and nature on a global scale, we need to combine our engineering knowledge with the knowledge contained in natural systems, rather than just extracting resources from it, to deliver solutions that are *well-adapted* to our global environment... (Natural Edge Project n.d.).

It is interesting, therefore, to reflect on where current survey educational programmes and survey students fit within the continuum of environmental literacy.

## EDUCATION FOR SUSTAINABILITY

The School of Surveying's Teaching and Learning Plan (2010) does aim to develop in its students a range of disciplinary attributes including: "To have an understanding of the field of geographic information science and its relevance to society, economy, and the natural and built environments" and "Be ethical in their behaviour with regard to clients, society, the environment and, where appropriate, the Crown." The Plan does include, as one of its objectives, "To develop the lifelong learning skills of students" contextualised as: "To ... include the ability to adapt to rapid change, to tolerate uncertainty, to be open to new ideas, to invest time and energy in keeping current in the field of Surveying and cognate fields of knowledge, and to develop a concern for social, ethical and environmental issues".

Whatever the School does to promote these aims and objectives, it clearly hopes that its students will develop concern for environmental themes. In fact the theme is potentially well distributed throughout the programme. It is clear that the ethic of sustainability has a primary influence on planning under the RMA, on subdivision and urban design, and on infrastructure engineering. But beyond that there is a strand of environmental thinking incorporated throughout all papers of the BSurv degree. The practical application of sustainability is a strong theme of the advanced Urban Design course; Land Tenure obviously affects our relationship with land and resources; Remote Sensing and GIS enables us to monitor and illustrate environmental changes, and our view of the world is expressed through Professional Practice.

From the University of Otago's point of view, the graduate attributes have recently been updated to include:

**ENVIRONMENTAL LITERACY:** Basic understanding of the principles that govern natural systems, the effects of human activity on these systems, and the cultures and economies that interact with those systems (UoO 2011).

This is in line with some other universities, and it illustrates how the tertiary sector is beginning to establish these views on their world (e.g. Deakin University n.d.). It may be expected that academic departments develop discipline specific responses to environmental literacy and encourage

understanding and application of sustainability principles.

An awareness of environmental issues and sustainability thinking is being promoted in many degree courses, and serious discussions about multi-disciplinary and core courses for all degrees, but there is sparse evidence of these issues in most surveying curricula. Even a paper with the promising title of "Contemporary Surveying Education Changing with the Times" (Young et al. 2012:1) only investigates teaching and learning paradigms that either emphasise the importance of content, and therefore a transmission model, or a more progressive student centred learning model that arises in "response to the dynamism that currently pervades the geomatics discipline." Both implicitly focus on providing for the needs of the profession, but both also suggest that the profession is interested in an education system focussed on skills acquisition and the practical application of survey techniques. It says nothing of the more responsible professional attributes of ethical and environmental awareness.

So how might we progress our understanding of how tertiary education may affect students' environmental awareness?

## RESEARCH METHODS

Students applying for the BSurv degree take a module of a Statistics Maths paper in their first year. The NEP questionnaire was administered to that student cohort, and then subsequently again in other second and third year surveying papers. This enabled an analysis of how surveying students compared with other science students (zoology, nutrition and health science, who take the same Maths paper), and potentially enables the changes of environmental attitudes over time to be observed.

Environmental attitudes were measured using the 15-item Revised New Ecological Paradigm scale (NEP) (Dunlap et al. 2000) (Table 1). Participants were all volunteers (under a University Category B research ethics application) and were asked to rate their level of agreement for each statement in the NEP on a 5-point Likert-like scale. The Revised NEP scale, has been extensively used for classifying the views that people have about the natural environment (styled as 'ecological worldview' by Dunlap et al. (2000); as 'environmental attitude' by Hawcroft & Milfont (2010) and more generically as 'environmental concern'; and more recently for monitoring how these change (Teisl et al. 2011)). The NEP's 15 statements relate to limits to growth, the position of humans in the environment, the fragility of nature and the imminence of ecocrisis. The participants were also asked to provide, on the research form, some additional socio-demographic information to aid the analysis (year of study, gender and self-reported program affiliations). To allow for follow up of individuals and at the same time to preserve anonymity, participants were asked to write a confidential code word on their survey that they would remember or could re-calculate in subsequent years. The great majority of students in all

programmes and papers chose to complete the survey, but a significant proportion forgot their code words between 2009 and 2010. The process was refined each year in an attempt to develop codes that students would remember. The methodology is described in more detail elsewhere (Harraway et al. 2012, Shephard et al. 2012).

|    |  |
|----|--|
| 1  | We are approaching the limit of the number of people the earth can support.                        |
| 2  | Humans have the right to modify the natural environment to suit their needs.                       |
| 3  | When humans interfere with nature it often produces disastrous consequences.                       |
| 4  | Human ingenuity will ensure that we do not make the earth unlivable.                               |
| 5  | Humans are severely abusing the environment.   |
| 6  | The earth has plenty of natural resources if we just learn how to develop them.                    |
| 7  | Plants and animals have as much right as humans to exist.  |
| 8  | The balance of nature is strong enough to cope with the impacts of modern industrial nations.      |
| 9  | Despite their special abilities humans are still subject to the laws of nature.                    |
| 10 | The so-called "ecological crisis" facing humankind has been greatly exaggerated.                   |
| 11 | The earth is like a spaceship with very limited room and resources.                                |
| 12 | Humans are meant to rule over the rest of nature.  |
| 13 | The balance of nature is very delicate and easily upset.   |
| 14 | Humans will eventually learn enough about how nature works to be able to control it.               |
| 15 | If things continue on their present course we will soon experience a major ecological catastrophe. |

For the research described here, the NEP was initially used in a first-year statistics course in 2009 attended by all first-year surveying students as well as by students from a number of other programmes (including anatomy, physiology or biochemistry major, nutrition or food science major, zoology major, and 'other' majors). The NEP was used again with the same students during their second year (2010) and third year (2011) in several of the surveying programmes. A fourth year is envisaged (2012). The NEP was also re-administered during the first-year statistics paper again in 2010 and 2011, and in subsequent second year surveying paper and anticipating subsequent third year papers in 2012. Individuals' responses were combined into a summated overall NEP score where higher overall scores indicate stronger pro-environmental attitudes (on a scale of 1-5).

Statistical analysis involved factor analysis, paired t-tests (for normally distributed data based on whole NEP aggregates) and multinomial logistic regression (to analyse changes). Typically, 25% of the students who complete the NEP in the first year statistics paper, and who self-identify as surveying students, are not admitted to the BSurv programme or withdraw. Subsequent surveys within the School were administered in classes that are not limited to BSurv students (but include BSc

Land Planning and Development students and others). For these reasons, interpretations based on mean NEP scores need to be interpreted with caution; following individual students is a more complete process and will be continued in subsequent research involving the development of a longitudinal study.

Multinomial logistic regression (MLR) can be used to identify aspects of the data that may be hidden when analysis is performed on the mean alone. For example, a group of students with a high proportion of both high and low NEP scores could potentially have the same mean as a group of students with moderate NEP scores. Teisl et al. (2011) used three logistic regression models to investigate changes in environmental attitudes in response to different courses and teachers. We used MLR because of its improved efficiency (only one model is fitted) and it is easier to interpret the results. The focus of our analysis was to determine whether or not sustainability attitudes differ in response to the number of years of study at university, and whether this difference is different for the various programmes of study. The NEP responses of all 521 students sampled (from all the participating programmes) in 2010 were analysed. The students in the sample came from first and second year papers and there were no repeat observations on individual students.

The response variable in the MLR model had three levels constructed from the total NEP score. The students with a total NEP score in the lower tertile (i.e. the students with weaker sustainability attitudes) were allocated a score of 1 (and were labelled "Grey"), those in the middle tertile were allocated a score of 2 (and were labelled "Neutral") and those in the upper tertile (i.e. the students with stronger sustainability attitudes) were allocated a score of 3 (and were labelled "Green").

The predictor variables in the model were: Year of study (*Year*) and Programme of study (*Programme*). *Programme* depended on the nominated major subjects of the students and consisted of: Surveying, Human Nutrition, Health Science, Zoology and Other, with surveying as the reference category. *Year* was binary with values 0 and 1 allocated to Year 1 and Year 2+ students respectively. The interaction, between *Programme* and *Year*, was included to determine if the students from the various programmes, respond differently in terms of how their attitudes change during their time at university.

## RESULTS

### 1. Socio-demographic characteristics

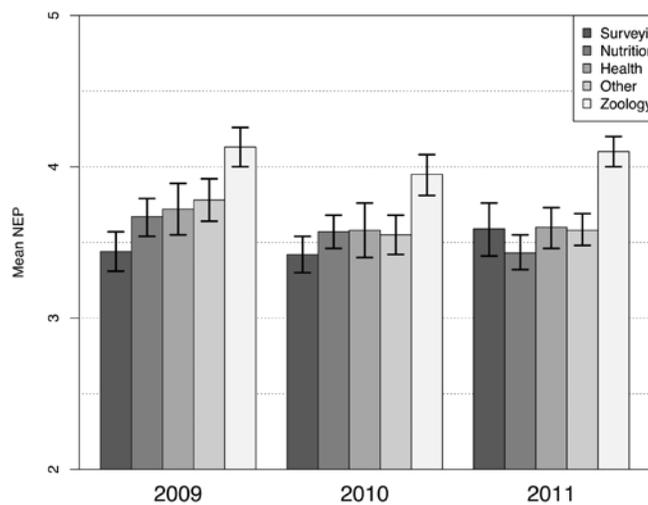
Surveying students enrolled in the first year statistics course completed the research instrument in 2009, 2010 and 2011 where the number of forms filled in by the surveying students was 70, 77 and 39 respectively.

In all three years, the majority of sampled surveying students in the first year statistics course were male (93.9% in 2009, 81.6% in 2010 and 78.8% in 2011). In comparison, the majority of the other programmes of study had fewer than 50% males with

Human Nutrition as low as 11% in 2010. The age distribution was similar between years and programme of study, with 74% to 79% of students aged less than 20. Ethnicity distribution was similar between the programmes of study and between the three years. For example, for surveying in 2009, 86.6% were New Zealand European, 4.4% Maori and Pacific Island and 9% "other".

## 2. Initial NEP scores for surveying students in comparison with other students

Figure 1 shows the mean NEP scores for first year surveying students and students in other programmes who started at university in the years 2009, 2010 and 2011.



**Figure 1: Mean NEP scores for the different programmes of study in 2009-2011, with 95% Confidence Intervals.**

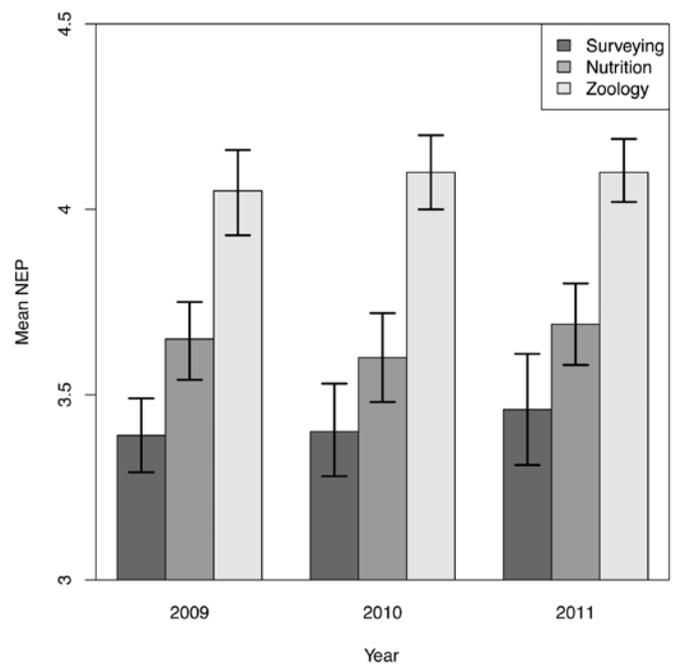
Note that the 95% confidence intervals for the zoology students in all three years are entirely above the confidence intervals for the other programmes, indicating consistent and significant differences within the cohorts. The attitudes of incoming students do not appear to be changing significantly between years. For example, an unpaired t-test produces a non-significant ( $p=0.189$ ) difference in means when surveying students in 2009 and 2011 are compared. This data is analysed in greater detail in Harraway et al. (2012).

## 3. Changes in mean NEP scores for 1 cohort (2009)

Following individual students through their programme, whilst maintaining their anonymity, required successful use of matching code words. We have this for some students. We measured the extent of attitude change with time at university by repeating observations in 2010, on the students who started in 2009. We obtained matched responses on 30 surveying students. The mean of the NEP differences of -0.12 is not significant ( $p=0.13$ ). Given this result, it appears that the sustainability attitudes of surveying students starting study in 2009 did not change significantly during their study to the time when they were next surveyed. Too few students remembered their code-words through to 2011 to extend the

analysis. By utilising a different code system in subsequent years, we hope for better matched data in future.

At this stage in our analysis, substantial changes in the ecological worldviews of surveying students seem unlikely. Figure 2 (adapted from Shephard et al. 2012) shows the NEP means of the students in the cohort starting in 2009 across three programmes of study over the years 2009 to 2011. As in Figure 1, Zoology students have by far the highest mean followed by Human Nutrition and Surveying. Also, the similarity of the means across the years suggests that the environmental concern of this particular cohort of students did not change greatly over time.

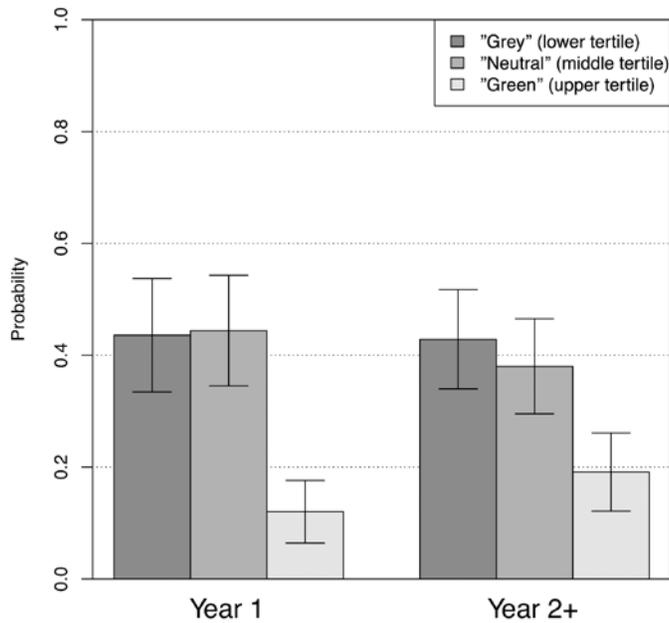


**Figure 2: NEP means and 95% confidence intervals for the cohort of students starting university in 2009. The sample sizes were, in the order they appear in the figure from left to right, 70, 72, 51, 80, 85, 82, 39, 75, and 78. It is important to note that a comparison of means, to determine the statistical significance of change over time, would not be valid due to the lack of independence between observations made over time on individual students. Independence of data is a strict statistical limitation in simple significance tests.**

## 4. Changes in surveying students and other students based on multinomial regression modelling

The MLR model also allows for the calculation of estimated probabilities (and confidence intervals) of being in any one of the three response categories. The analysis was implemented using software packages STATA and SPSS. Both the forwards and backwards "Stepwise Elimination" model selection procedures showed the interaction effect was not important confirming that the Year effect was consistent across all programmes. A Pearson Goodness of Fit test was carried out to determine how well this multinomial model based on all students fitted the data. Under the null hypothesis that the model fits the data, the Pearson statistic comparing the observed to the model

predicted counts was 6.755 ( $p=0.344$ ) indicating good model fit. Figure 3 gives these results for surveying students where it can be seen that the probability of being categorised as Green is low in comparison to the probability of being Neutral or Grey. However, the shape of the probability distribution is markedly different for Year 2+ students compared with Year 1 in the year in which this analysis occurred. This difference is expressed by the Green to Neutral probability ratio for Year 2+ students:  $0.194/0.377=0.51$ , which is significantly higher ( $p=0.004$ ) than the same ratio for Year 1 students:  $0.112/0.442 = 0.25$ . This model is analysed in more detail in Shephard et al. (2012).



**Figure 3: Estimated probabilities and 95% confidence intervals of being classified as "Grey", "Neutral" or "Green" for surveying students.**

## DISCUSSION

Our work with the NEP and University of Otago students in general suggests that it is possible to use this tool to record the ecological worldview, or environmental attitude, of students and to monitor changes as these students progress through their programmes. We are confident that our work addresses issues of anonymity and that the responses given by students are not influenced by perceptions of what their attitudes ought to be. We think that most students approach the process seriously. We are less confident that we know precisely what we are monitoring! Concepts such as *ecological worldview* and *environmental attitude* are necessarily highly subjective. We are clearly monitoring a complex phenomenon and would not wish to underestimate the complexities involved.

Nevertheless, our research suggests that in their first year, students enrolled in particular programmes already have distinctive ecological worldviews. A similar result was obtained in recent research in a polytechnic (Shephard et al. 2009). Students who intend to major in Zoology have, on average, significantly higher NEP scores than those who

intend to focus on Surveying. Taking these as initial scores we might assume that the National School of Surveying, and the University of Otago, are not responsible for the difference. This basic pattern is repeated for the three cohorts between 2009 and 2011, indicating in a general sense that we are not in a rapidly-changing social situation.

The NEP has been used to record the environmental concern of many groups over the past 30 years, allowing for some comparisons. Surveying students may have NEP scores slightly on the low side of other student-groups internationally (see Hawcroft and Milfont 2010, for comparative data), but perhaps not by a great margin.

Of greatest interest to the profession, and to its educational partners, is data on change. We do not yet have sufficient matched data to report change with confidence. Our mean changes for complete cohorts are not significant. Our matched data changes based on individual students are too few at present, but our multinomial regression modelling data is more promising. It suggests that there are subtle, and positive, differences in the distribution of NEP scores between the three tertiles that relate to the time that students have spent in higher education. For example, the model suggests that the ratio of the probability of being green compared to being neutral increases with time at university. The model fits the data well and the difference is significant.

Many factors influence students' environmental awareness: maturity, living away from home, exposure to friends, activists and advertising, amongst many others. This research has made no significant attempt to link student environmental awareness to the curriculum as taught at the School of Surveying, but merely to observe how the experience of tertiary education may affect their world view. The courses, whose students have been recruited to complete the NEP, have no explicit focus on the environment or on sustainability. This perhaps helps students feel on neutral ground; after all, their perspectives are not being assessed as part of the course. However, given the explicit focus on sustainability in a couple of the 400 level papers, there may be scope to observe, in the longitudinal study, and in the final year of the degree, the actual effects of direct instruction about some of the issues raised in the NEP survey.

In relation to the Teaching and Learning Plan of the School, the trend is positive. It is also not necessarily characteristic of higher education internationally. The higher-education literature casts doubts on the extent to which higher education, in general, has adopted the principles of sustainability and this particularly applies to curriculum change, as opposed to campus sustainability and research (Cotton et al. 2009; Shephard 2010). As Cotton et al. (2009) suggest; "Despite widespread policy support for education for sustainable development in higher education, and a strong academic literature arguing for a radical rethink of curriculum, pedagogy and institutional culture, progress towards the educational

reforms advocated remains limited.” This study provides the School with some discussion opportunities, particularly in respect to curriculum development and evaluation of graduate attributes. How much should the BSurv curriculum focus on the development of environmental awareness and sustainability (or are the skills and practice of surveying our only concerns)? Similarly, how important is it that we can confirm that graduates can respond to the expectations of an environmentally concerned profession? How much change is appropriate?

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## BOOK REVIEW

# REMINISCENCES OF A PIONEER SURVEYOR BY S PERCY SMITH

Edited by: Richard S Hill and Brad Patterson.

Treaty of Waitangi Research Unit, Stout Research Centre for NZ Studies, Victoria University of Wellington. 2011. 233p.

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Reviewed by Mick Strack. School of Surveying. University of Otago

The text of this book was written by Stephenson Percy Smith (1840-1922); his intended audience was his family so that they may know something of their father's, and grandfather's life, work and contribution to the development of colonial New Zealand. And it is a fascinating story.

S Percy Smith was born in Suffolk, England in 1840 and immigrated to New Plymouth, New Zealand with his family in 1849. He was soon getting what appeared to be a basic formal education, but a very active informal education in seamanship, bush craft and colonial and Māori life. By the age of 15 he was taken on as a survey cadet, an occupation and life's work that he excelled at. The stories of his expeditions around and through New Zealand provide a great insight into early New Zealand, and in this newly developing colony, he appeared to have contact with anybody who was anybody in colonial times. In fact, his narrative reads like a kiwi version of Forrest Gump, although he does admit to using this opportunity for "Blowing my own Horn". S Percy Smith apparently met and negotiated with most of the power brokers in Colonial and Māori society; governors, judges, soldiers, chiefs and warriors. He was a major contributor to developing new survey techniques: using steel bands instead of Gunter's chains; developing the methods of triangulation to control and coordinate all local surveys; and using cosecant tables for survey reductions. He was called upon to negotiate with many Māori chiefs for land sales and for peace, for example with the Taranaki and Waikato iwi in the 1860s. He was surveying the Chatham Islands while Te Kooti was there imprisoned and during his escape and return to the Bay of Plenty. He played his part in writing and implementing various Land Acts for providing more land for settlement. Scattered amongst these accounts are the stories of his household, family, social activities and visitors and notable events that add an enjoyable personal touch to the narrative.

The stories of the hardships endured by surveyors in this land leave the reader in awe of the efforts. The surveys required expeditions on foot or horseback, being away from any civilised contact and left to one's own wits for sometimes months at a time, to be wet, cold, hungry, waist deep in water or mud; to be snow bound, cloud bound, and unable to make progress on observations; to work in constant fear of attack from hostile Māori warriors; and then to struggle to get paid

and even to have access to appropriate theodolites, showed that it was all a constant battle that puts modern surveyors' complaints to shame.

Smith rose through the ranks of the surveying profession to become, in 1889, the Surveyor General, Secretary of Crown Lands, and Secretary of Mines. He also accepted several additional commissions: to settle the allocation of land to the South Island landless natives, to establish a system of government for Niue, to negotiate the tenure arrangements of Tuhoie in the Ureweras. Many of these issues are still alive and of current concern, not because of any deficiencies of Smith's arrangements but because later governments have failed to uphold the bargains made. It is fascinating, for example to read in regard to the Urewera block that: "The Act under which it was dealt with provides that not an acre shall be alienated except by an act of Parliament. It was to be kept as a Native Reserve for all time; and a beautiful place it might become (and is) a delight for the future tourist. But now I hear it is to be sold to the Crown. What a mistake!"

Smith clearly had a gift for languages, and from an early stage of his career was able to communicate with Māori, to negotiate his presence on the land, inform Māori of government policy and new legislation, and translate for others. He further demonstrated this gift in his ability to pick up different Polynesian dialects on his travels to the Cook Islands, Tonga, Niue, and to a lesser extent Tahiti. Acquisition of language also set Smith up for observing and recording tikanga Māori, expertise which he later used to good advantage when he was instrumental in establishing the Polynesian Society and being an active contributor to and editor of the Journal.

Similarly, Smith was a keen observer of scenery and landscape, and his travels and explorations throughout the whole of the country induced frequent commentary about the splendour of the scenery, and although as a surveyor he was actively involved in opening up huge expenses of the land for settlement and production, he well recognised the loss of what existed "before the destructive axe of the Pakeha".

The editors of this publication note that it was (and perhaps still is) the intention to publish these Reminiscences with annotations and illustrations. Such a publication could

attract wider readership; along with the text providing an excellent 'flavour' of the times, illustrations, including field note sketches, paintings, photographs of people and places, and maps would flesh out the text, and enhance the written descriptions to great effect. The present volume is published in spiral-bound A4 format which seems to symbolise its temporary and incomplete status. An annotated and fully illustrated edition would benefit from being published in book form. Such a volume would be a welcome addition to any surveyor's collection, but would have much wider appeal to anyone interested in our colonial past, and the efforts of a man of his time to contribute to the work of those times.

Co-editor, Brad Patterson has contributed an excellent introductory essay about Stephenson Percy Smith that also warrants much wider circulation, and this in itself would contribute immensely to the modern surveyors' historical

perspective on the profession and the formative role of surveying on our society, and on the contributions of Smith.

The name of Stephenson Percy Smith is well recognised by surveyors and the profession, and his legacy is here, and in Smith's other writings, laid out for all to see. Smith's wider contribution to colonial society is usually observed in his writings in the *Journal of the Polynesian Society*. Smith's perspective on Māori society was inevitably influenced by the mores of his time, and indeed some of his conclusions about Māori have been subject to modern critique and revision. But in delving into this very personal work of Smith's, the personal integrity of the man, his strong work ethic, and his duty to public service is what stands out.

Read this, and for a while, get drawn back into the pleasures and the rigours of colonial life.

# INSTRUCTIONS FOR AUTHORS

The *New Zealand Surveyor* is the journal of the New Zealand Institute of Surveyors. It publishes original research papers and in-depth papers on topics of professional interest related to land surveying, which have been written by researchers or professional surveyors working anywhere in the world. Review articles, book reviews, and letters to the Editor are also published. The *New Zealand Surveyor* is published annually.

Papers previously published or under consideration elsewhere will not be accepted.

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Figures should be numbered in order, using Arabic numerals (Figure 1, 2, 3...), and placed in the text as close as possible to their first mention. The positions of figures in the text are to be marked by the figure number and caption.

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