It's a wind generator Jim, just not as we know it
Making the Case for a Modern Commercial Application of Sail in Fiji

Peter Nuttall

Introduction

The closing lines of Alistair Couper's summary of the region's sailing and trading history states:

> The maritime history of the Pacific peoples is recognised as part of the shaping of Pacific societies but is also a basis for comparison in making changes for the future. Not least is the possibility of a renaissance of commercial sail under changing economic relationships between distance, rising cost of fuel, environmental concerns, and the always available Pacific wind systems for assistance in ship propulsion (2009: 208).

What is the future practical application of sail technology and does it meet any criteria of a sustainable adaptation in the face of changing environmental, social, economic and political environments? Industrial, small-scale sea-transport ventures are always at best marginally profitable and high-risk[1]. Dick (1989) advises that 'sail technologies must be commercially viable if they are to be any more useful than wings for flying pigs' (in Couper, 2009: 168). For an alternative approach to current fossil-fuel powered options to be successfully explored, the full scope of potential constraints and barriers needs to be assessed.

Global sea-transport, despite being the most efficient bulk transporter of goods, is highly inefficient in terms of fossil-fuel use. Globally, sea transport emits as much greenhouse gas (GHG) as Germany, the world's 5th largest emitter. Sail has not generally been considered as a viable alternative.

[1]By way of example of the extreme risk involved in island shipping, Fijian government records for the period 1956-64 show 52 major shipping incidents, most involving loss of vessels (Couper, 2009:170).

Fiji appears ideally situated to demonstrate that a fleet of sail powered trading catamarans can provide a carbon-positive and practical sea-transport alternative with strong potential to deliver economic, social and environmental benefits at both village/island and national level:

- Fiji historically was a vital link in a highly sophisticated sail trading network that linked island/village communities from Samoa, Tonga, Rotuma, Niue and beyond using large, sophisticated vessels.
- Current sea transport options are limited to marginally economical, usually second-hand, fossil-fuel powered ships and barges.
- Fiji has an established and proven capacity to build and operate high-quality, small and medium scale vessels in-country, with sound support and maintenance infrastructure.
- Fiji has well established facilities and processes for commercial crew training and qualifications that could be easily adapted to include sail operations.
- Research in the 1980s by Southampton University (and also FAO) means that much of the preliminary research for route planning and practical application of sail powered vessels has already been completed for Fiji waters.
- Fiji has well recognised and proven models for undertaking collaborative practical research involving multi-stakeholder groups including communities, government agencies, NGO's, businesses and researchers – e.g. FLMMA.
- There is likely to be strong political support for such a venture. A carbon positive sea transport option is fully compliant with the government's goal of reducing Fiji's oil import bill by $100m in the next 3 years.
- Fiji is currently developing national policy on carbon trading that would allow the potential for carbon credits to subsidise or offset sail trading costs.

Such a pilot venture would not be without significant risk and would require careful planning and execution and the active collaboration of a number of key stakeholders.

Historical Context

Sails are to Oceania as cars, trucks and trains are to continents. The capability to colonise one-third of the globe is arguably the greatest tech-

nological intellectual property right of Oceanic peoples, especially as it was achieved without recourse to mining and metals. Across Oceania all recent historic maritime analyses (e.g. Finney, 1976,1 994, 2003; Irwin, 1992; D'Arcy 2006, 2008; Howe, et. al. 2006; Couper 2009) concur on a common picture at the time of European contact of an ocean heavily populated with indigenous sailing vessels of size and capacity comparable to or greater than that of the arriving Europeans. Such technology was highly developed, diverse in type, readily available and an essential facet to all aspects of life – from artisanal fishing and local village transport to inter-island/inter-archipelago warfare, trade, and diplomacy. All was indigenously owned and operated and village/island centred. Yet, within a space of decades this sail transport supremacy was almost entirely displaced with, first, European sailing technology and, ultimately, by largely externally-owned, carbon-fuelled, mechanically-propelled vessels. Today indigenous sea technology of more than nominal capacity is the rare exception, particularly at village level.

Issues of sea-transport remain universal and primary to all Oceanic peoples. They appear to make a logical starting point when looking for sustainable adaptation entry points. Current transport options owe nothing to the Pacific's rich, indigenous, historic, sustainable, legacy of vessel/sail technology development. They are also almost exclusively fossil-fuel powered. Small 'fibers' and occasional launches aside, they are largely owned from urban centres outside of the village margins. I contend that current transport options are not ultimately sustainable for small island communities and reliance on such technologies make communities (at village, province, and country levels) extremely vulnerable to changes in transport availability and fluctuations in fuel prices and security.

In Fiji only isolated cases of sail use remain, either in a recreational tourism-related capacity or small remnant pockets of indigenous sailing knowledge in the Lau group and Rabi Island. Yet industrial application of sails and sail technology promises immense potential as a practical response to issues of current and future sea-transport. Such a re-association would be a practical Oceanic response to critical issues of climate change adaptation and the region's extreme dependence on imported fossil-fuel as well as a much deeper reclaiming/re-invigoration of a central iconic pillar of Oceanic identity and culture.

If Couper (1973) is correct, Pacific Islanders' attempts to establish locally owned and operated sea-transport ventures in the past has not failed because of a lack of seamanship or from an inability of Islanders to manage the complexities of operating commercial sea-transport enterprises. 'Seafaring is about more than technology and seafaring skills. Activities at sea need to be viewed in their wider social context. Voyaging is a social process that also involves onshore infrastructure to provide logistical and organisational needs as well as training and motivational influences' (D'Arcy, 2006). The failure would be because of more intricate reasons, which include the need for commercial application to include/acknowledge/allow for cultural imperatives within the commercial operating *modus.* Even if shown to be viable, substantive challenges exist to re-association of Pacific Island communities with sail technology, many of which are perceptual, social, and cultural as well as actual or physical/economic. Only through serious analysis of them can we evaluate whether the effort of overcoming them warrants achieving the benefits application of the technology might accrue.

If, as is strongly indicated by the preliminary research to date, there is a low potential for globally-led sustainable adaptation of marine technology, what models are available to a small island state to develop a local solution through collaboration of multiple and potentially competing agencies and stakeholders? Again Fiji appears well situated with the shining example of Fiji Local Marine Management Area (FLMMA) network[2] and other Participatory Learning and Action frameworks to draw on and adapt from, should they choose to do so.

The argument for adoption of sail technology in facing a range of increasing critical pressures/challenges to Oceania appears logical and rational. It is an accessible, extremely cost effective, carbon positive (or at least neutral), renewable, low-impact technology, as rooted in Oceania as coconuts and kava, with an indisputable local claim to the intellectual property right of the technology for which there is an identified need. Yet Oceania's proud maritime legacy has not resulted in sustainable use of that technology at any industrial scale today.

'It is essential, for those who wish to help these Pacific island communities, to acknowledge that they will achieve far more by seeking first an understanding of the social organisation and social geography of Pacific seafaring than by continuing with policies of Eurocentric ideas of the sea business and virtually ignoring the wealth of the maritime heritage of the Pacific islanders' (Couper, 1973). Darcy (2006) offers similar directives:

The many requirements for seafaring were hard to maintain,

[2] This is an internationally recognised highly successful collaborative management/ PLA action research programme bringing together multiple stakeholders under a shared 'Learning Portfolio' with the participants joined by a 'Social Contract' (see Veitayaki et. al., 2003).

> and communities were always vulnerable to forces from beyond the horizon and beyond their control. Islander societies needed flexibility and adaptability to deal with external influences. Survival in the sea of islands also involved a high level of organisation. Islanders should not only have pride in the achievements of their ancestors, but also learn from them' (D'Arcy 2006: 173).

The literature on the historical record and context is increasingly broad.

Over the past 6,000 years ancestors of today's Pacific Islanders found, explored, and colonised all known islands in the world's largest ocean by exploiting learned knowledge of navigation, ship design and construction, and particularly the ability to sail windward on an apparent wind (Lewis, 1978, in Gunson et al, Howe 2006). Despite some initial academic debate in the latter half of the twentieth century (Sharpe 1956) it is now generally held that such voyaging was widespread, diverse in use of technological adaption, and deliberate. Finney (1976, 2003), Irwin (1993), Howe et. al. (2006), D'Arcy (2006), Couper (2009) and others have now extensively documented this incredible legacy, made on a variety of vessels, employing a wide range of approaches to vessel design, construction and operation.

The Technological Legacy

There is a (relatively) complete range of literature sources concerning the technology itself. The historical development of the vessels, their evolution at the point of European contact, particularly from the 18th century, is well documented. Hornell and Haddon (1936) are the prime secondary source and give a concise summary with most aspects of design, construction, and materials adequately characterised. An updated and succinct summary of the diversity of canoe designs across Australasia and the Pacific is found in Oliver's 1989 work, *Oceania* (D'Arcy 2006: 176).

Early European explorers (Tasman, Cook, Bligh, Wallis, Paris, D'Urville, Wilkes, etc) regularly described large fleets of vessels, often larger than their own and capable of out-sailing the European designs of that time with ease. The Fijian *drua*, for example, had on average greater overall dimensions than Cook's *Endeavour* (Couper 1973). The sheer scale of maritime activity in the region needs to be appreciated. In Tahiti 'Wallis reckoned that 300 canoes manned with fully 2000 men thronged around his ship.... Cook counted one fleet of 330 double canoes carrying about 7760 men and another of 210 war vessels with a host of smaller attendant craft carrying perhaps 9000 men' (Lewthwaite 1966: 28). Long voyages between archipelagos were still undertaken in several areas after the 1770's. Regular voyaging occurred between the Societies and Tuamotus in central eastern Polynesia; between Tonga, Samoa and Fiji in western Polynesia and between the coral islands of the western Carolines and their high island neighbours in Micronesia. The seas of Oceania were bridges as well as barriers. The sheer volume of movement attests to Islanders' willingness and ability to travel (D'Arcy 2006: 64).

The Pacific was an ocean of sails, a truly sustainable transport technology built out of renewable resources and exploiting complicated knowledge of physics and aero/hydrodynamics to exploit renewable wind energy as its primary motive power. Not only were iconic large vessels used for ocean exploration and naval domination across vast distances, but sailing and sailing technology were also integral parts of daily life (spiritual, social, political, and economic), essential for all levels of social interaction, transport, warfare, trade, and fishing.

Fiji (Feegee, Viti) sailing culture is less well recorded and has not received any of the recent attention reserved for 'Polynesian' sailing history. Again there is evidence in the museums, logbooks, and accounts of early explorers of a large range and complexity of vessel design. Lewis (1978) makes passing reference to the 'great' *Drua* and is then quoted by others. Williams (1858) has the most primary data but provides insights only prior to his writings. Gillett et. al. (1993) give a detailed discussion of existing *Camakau* and their history. Fergus Clunie's monographs and books (1986, 1987) make him the acknowledged font of current knowledge. The technicality of the vessels themselves is well characterised in the sources listed above.

The Fijian *Drua* represents the apex of Pacific sailing technology. The vessels are an amalgam of adaptations of Micronesian sail technology (a perfection of the so-called 'crab-claw' rig[3]) coupled with a 'proa' or 'shunting' (as opposed to a tacking technology) sewn-plank hull that exploited the outstanding qualities of *vesi* timber – the titanium of the Pacific boat building materials (Clunie, 1986; D'Arcy 2006:79). This timber was so superior that Tongans established communities of boat builders in the Lau islands to gain access to the material (Rayawa, 2001, Lessin &

[3] Famed aerodynamics researcher C. A. Marchaj (1996) claimed the crab-claw to achieve more than 90% efficiency over conventional Bermudan rigs. It should be noted that other commentators have questioned this. However the criticism appears restricted to the *degree* to which crabclaw design is more efficient rather than a challenge to the overall argument that it is *more* efficient.

Lessin, 1970). Describing *drua* building in Fiji in 1829, Twyning claims it was 'surprising to see the accuracy with which these planks are joined to each other...' He went on to say that the design and building of the ship would have received the 'admiration of even the most skilled and scientific naval architect in Europe' (1829: 28). Although *Drua* carried hundreds of passengers, most tasks onboard were left to specialist seamen (D'Arcy 2006: 82). They appear to have become multi-purpose ships after Christianity but their original function was as an unparalleled naval attack vessel. It also appears that Fijian sailing history may have varied from 'Polynesian'[4] sailing history in that there was no great emphasis on ocean voyages of long-distance discovery/flight. The vessels were designed and built to travel (and dominate) largely between islands that were known and often visible. Fijian *drua* were still being built as late as 1943, and pockets of islander seafaring survived the colonial era reasonably intact – especially on small, isolated islands (D'Arcy 2006: 166).

The Historical Trading Legacy

The literature on the use of technology as the key trading vector in the region also requires distilling and compiling. Again, it requires an in-depth understanding of the historical context. 'The community of world history scholars largely ignores trans-Pacific trade prior to the twentieth century.... It turns out that trade history is intimately intertwined with epidemiological, ecological, demographic, and cultural histories. None can be properly understood without consideration of the others' (O'Flynn, D and A. Giraldez, in D'Arcy 2008: xiv)

The people of the sea travelled and traded beyond their immediate landscapes and seascapes for a variety of reasons. The desire for certain material goods figured prominently in accounts between 1770 and 1870 (D'Arcy 2006: 52). It was evident in early contact times that every community in the Pacific Islands was engaged in some form of trade (Couper 2009: 49). 'Canoes were a major investment. Great care was taken of them .... the construction and maintenance of canoes was a community effort. Only chiefs could muster the manpower and resources needed to construct large voyaging canoes in Polynesia.... at least three years of sustained community effort was required to build a *drua*' (D'Arcy 2006: 92). Canoes were not just physical assets; they were also symbols of community *mana*. The completion of a large canoe was a source of great pride.

[4] Dividing the Pacific into Polynesia, Melanesia, etc is fraught with difficulty, not least of where one places Fiji.

'When Tui Nayau sailed his new *Drua*, *Rusa i vanua*, from Vulaga to Lakeba in November 1842 his followers were thrilled to note that the hulls were longer than those of *Ra Marama*, the canoe being built at Somosomo for their rival Bau' (Derrick 1957: 81).

The importance of advancing sail and vessel technology, in particular the central role of *vesi*[5], is critical to understanding the extensive historical Tonga/Samoa/Fiji trade networks. The Europeans who first came to the Central Pacific found established networks of trade linking the archipelagos of Fiji, Tonga and Samoa. Within each of these island groups were complex local trading chains which operated through intermediate villages and even through professional middlemen. Commander Wilkes in 1841, for example, described communities of trading specialists in Fiji which had no fixed place of residence. The missionary Thomas Williams (1848) also remarked on these seafaring 'Levukians', and he noted the important role of women as traders and ordinary seamen. European travellers also describe Tongan traders who voyaged between Fiji, Tonga and Samoa. Erskine noted in 1830 that there were in Tonga several natives from Eromanga in the New Hebrides who, he said, had been brought to Tonga by Tongan trading canoes (in Couper, 1968b).

Hau'ofa concurs: 'Fiji, Samoa, Tonga, Niue, Rotuma, Tokelau, Tuvalu, Futuna, and Uvea formed a large exchange community in which wealth and people with their skills and arts circulated endlessly' (1994: 54). Detail of this network, and the formidable naval power used to enforce and patrol it, has been usefully summarised by D'Arcy (2006) and Couper (2009), both drawing on numerous primary and secondary sources:

> By the late C18th Tongans were increasingly drawn to eastern Fiji for items that were rare in Tonga... These exchanges were as much about forging and reinforcing social and political relations as they were about supply and demand. The process mattered as much as the goods exchanged... Tongans were perhaps the most wide-ranging travellers in western Polynesia. In addition to the frequent voyages within the archipelago and visits to Fiji, strong links were maintained between Tongan and Samoan communities... Tongan fleets that sailed to Samoa between 1770 and 1870

[5] *Vesi* (*Intsia bijuga*) is an ironwood much prized and sought after for hull construction. Predominate sources are in the southern Lau of the Fiji group. This timber can be considered the 'titanium' of Pacific boatbuilding. In pre-contact times with no metals, this became a central resource to the trading and conquest networks of the central Pacific. Domination of this resource meant domination of naval supremacy.

consisted of 300-500 people in 7-10 double canoes. (D'Arcy, 2006: 54-7).

Lessin & Lessin (1970) also detail the role of Tongan influence in Lau in their seminal case study of Sawana.

Erskine (1853: 269) provides a glimpse of Fijian trading enterprise, 'Feejeeans have a decided turn for commerce, a constant internal trade being carried on in their own canoes, which we constantly saw either arriving or sailing, heavily laden with bales of cloth, rolls of cordage, and quantities of earthen pots'. In the webs of sea trading, nodal islands emerged where goods from several places were stored and ships called on a multilateral trading basis. These included the islands of Moce and Lakeba in Lau (Couper, 2009: 49 quoting Brookfield, 1971: 238-9). In Fiji local scarcity created regional exchanges. Areas with advantages in natural resources tended to develop craftsmen skilled in manufacturing items from them. Islands such as Kabara, rich in the hardwood *vesi* were renowned for their wooden bowl and ocean-going canoes (Couper, 2009: 53). Cultural ecologist, Laura Thompson (1949) characterised the islands of southern Lau as a 'naturally balanced self-sufficient trade area' and gives a detailed account of the interisland trade (in Hage and Harary, 1996: 166). Reid (1977) and Sahlins (1962) also detail the traditional trade relationships of eastern Fiji, emphasising the critical role played by islands such as Lakeba that lie at 'cross roads of the sea' (Reid, 1977: 3). Many of the trading voyages were closely directed on a kinship basis, including long distance marriage parties between Tonga, Fiji, and Samoa. There were even more frequent and bigger events with archipelagic groups. The Fijian *solevu* is typical of a range of such kinship-related gathering and exchanges. Major *solevu* involved large parties on fleets of vessels carrying enormous quantities of goods (Couper 2009: 53). Women sometimes led the trading parties on both sides and made sea voyages for marriage and mortuary occasions and major ceremonies such as the *solevu*.

The demise of indigenously controlled sea commerce wasn't due to a lack of desire to maintain participation (even domination) in the industry by local chiefs. Their attempts to maintain independence of their own transport networks were widespread. Firth and Davidson (1942) said of the Pacific people in this period of change, late 18th Century: 'to them the ship was among the most remarkable of the material changes that Europeans had introduced into the life of the Pacific. They threw themselves into the task of building and handling these vessels with the same enthusiasm with which their fathers had perfected their knowledge of canoes' (in D'Arcy 2008: 99).

The Demise of Locally Controlled Sustainable Trading

In the space of only a few decades, the complex trading network facilitated by large fleets of locally owned and controlled vessels disappeared from Fiji and the region. The analysis of the historical decline and subsequent changes in Fiji sea-transport, especially in the C20th falls largely to two commentators: Couper (1967, 1968a, 1973, 2009) and D'Arcy (2006, 2008).

How was the indigenous culture of sail powered trade so completely displaced? Couper does not find fault in the seamanship or ship management of the islanders.

> 'Islanders who were demonstrably able to marshal and distribute resources over large areas in the indigenous economy have often failed in their efforts to participate in modern trading systems.... the sea played a major part of the ecology of Pacific Island communities and extensive voyaging supported a complex system of trading and island or village specialisation... ....But the assumption that Pacific Islanders have failed in commercial shipping and trade because of the complications of such enterprises will not stand up to examination (Couper, 1973).

He concludes, prophetically, '[f]or the future of these island countries, few areas of enterprise are more important than the marine sector, for without an effective presence on the sea they are but fragments of land and people in a foreign ocean'.

In Fiji, the *waqi ni tikina* (vessel of the villages and provinces) were controlled by the *buli* (government official), and numerous small craft were increasingly owned and operated by the *mataqali (*extended family). From the 1880's onward there was a marked revival in commercial trade, with schooners and cutters owned by communities in many outer islands where chiefs once again became enthusiastic for their own ships. This was made more necessary by the rationalising of the steamship services of merchant companies as they sought economies of full loads with their expensive vessels. The company steam and motor powered ships began to concentrate on the shortest distance and the highest producing areas. This 'left smaller, less productive and remoter islands marginalised in the commercial system....The necessity of acquiring their own vessels for carrying goods and passengers were allied to a natural desire and pride of the people for ships and their abilities to sail them (Couper 2009: 157). By European standards this boom in local shipping represented a gross oversupply of vessels beyond the needs of most islands. It appeared a waste of

time, resources, and capital and was considered by officialdom as a process leading to impoverishment, not development: 'Oppression is frequently felt and privations endured by communities providing the price of too large vessel or too many vessels.... Much of this unnecessary expenditure is caused by the rivalry of tribes and chiefs as to the size of cutters' noted the government in 1896 (158).

The erosion of the seafaring skills and the reduction of crew employment by Pacific peoples were some of the results of commercial and colonial policies. In this period [late C19th, early C20th] seafaring became more nationally homogenous to the countries of ship owners and elements of racism now entered into the relationships of the multi-ethnic seafarers. By 1890, Gordon's successors had decided that the *solevu* was a burden on the people, and in any case 'had lost much of their native character'. Attempts followed to curtail large-scale inter-island exchanges in Fiji. It was much the same story in several other parts of the Pacific. The decline in sail and the use of steam became widespread in the Pacific at the turn of the century. On the steamships, changes in social structure and divisions of labour were considerable. The technology involved was beyond the everyday experience of most Pacific islanders (Couper 2009, 145-7). By the turn of the century, bigger foreign merchant companies with steamships were dominant. This accelerated the pace of colonization. Among other effects were the actions by Australasian and American maritime trade unions in defence of their members against the use of cheap labour by ship owners on their national flag vessels. This saw most Pacific seafarers confined to employment on small interisland traders within specific colonial territories (Couper 2009: 4).

The Fiji Shipping Commission of 1915 did have some misgivings about the pattern of subsidized shipping and trade in Fiji and recommended that subsidies should 'not as a rule be granted to firms or companies trading as merchants in the colony'. Nevertheless, subsidies remained and the merchant companies continued to be the major beneficiaries. The Fijian *waqa ni koro* still amounted to a substantial tonnage in this period [1906-1927], but other owners of small cutters were emerging, especially those of mixed European and Fijian parentage. The entrepreneurial role of the part-European sector was increasingly in the ownership of small shipping companies. The reality that some administrators could not appreciate was that island ships owned by communities had important functions that were beyond the criteria of efficiency as measured by Western economics. They fulfilled a dual role; serving social as well as economic needs. Because the ships were owned by the community, most people felt they had a call on the use of the ships, and the ships sailed only when there

was a need, not to any schedules or fixed routes (Couper 2009: 159-162).

Cash flow imbalances and related indebtedness eventually became chronic problems for most island community–owned shipping enterprises. They were usually overcome for a while by raising more money in the community. This was a price many island people were apparently willing to pay for the values a ship had for them. Damages and losses from weather and reefs would also lead to the abandonment of a vessel and the acquisition of another. This resulting pessimism is reflected in the Fijian proverbs: *rekirekilaki waqa vou* (literally: rejoicing over new boats), used generally when showing enthusiasm for something that is later neglected, and '*e Drua na nomu waqa levu, e dua na nomu vusi levu'* literally means you have a large boat, you have a large cat (on your back as a burden) (Couper, 2009: 163).

Couper (2009) also updates his earlier writings with a comprehensive overview of Fijian shipping from 1960 to the present day. This shows ever declining use of local transport and increasing private sector control of ever larger inter-island vessels. Many structural and social changes took place in maritime activities by the 1980's and onward, although there were still navigational hazards and causalities. New port developments, including ramps and other landing facilities, were established at selected central places in several islands at which Ro-Ro vessels, ferries and barges could berth. The large numbers of passengers and baggage rooms on these vessels obscured any traditional exchange activities (Couper, 2009: 175). Couper concludes that 'the dependence of the Pacific Islands on sea trade has continuously increased, and multiplicities of social and economic activities are related to the cargoes and the people flowing through island ports' (2009: 207).

Despite an absence of applied sailing culture in modern Fijian life, the *drua* remains an iconic symbol of cultural pride present in all aspects of Fijian society – from the national Coat of Arms to phone boxes, coins, stamps, tourist gimmicks, government letterheads and logos, building design and adornment. It is one of the most instantly recognisable Fijian motifs. It just isn't active on the water! Despite a lack of sails, Fijians still maintain living daily tradition as marine people. They are shackled to an increasingly expensive and insecure fossil-fuel dependency to do so.

Sustainability, climate change, fuel dependency, and adaptation lessons from global shipping and maritime technological adaptation

Our ocean covers a large part of the earth's surface; the land component is minute and made up of thousands of small islands. The popula-

tion of this region is also numerically minute, less than 0.1% of the world's total. At a global level those voices are almost unheard, drowned out by a cacophony of larger states and superpowers and alliances whose consumer development, fossil-fuel addictions and security interests easily outweigh any Pacific voice. Unfortunately, the same Oceanic states, along with indigenous communities at the polar extremes, will be in the front-line of causalities to the increasing threat posed by an anthropocentrically caused global climate change not of the Pacific's design or making (Radio NZ, 2010; Overton and Scheyvens, 2009). 'In the Pacific, the next few decades will see climate change of unprecedented rapidity taking place. Not only will temperatures rise but also the ocean surface which will create new sources of stress for human livelihoods. Our understanding of what is likely to happen in the future allows humanity an excellent opportunity to plan ahead, to anticipate the probable changes and to take action to minimise their undesirable effects' (Nunn, 2010).

Weir (2006) summarises: 'Global warming emissions continue to rise steeply. If this trend is not reversed soon, temperatures will reach a dangerous level as early as 2035; the Stern report noted in October 2006 (10-14). Unchecked greenhouse gases will lock us into terrible consequences, floods, droughts, hurricanes, and ultimately sea levels rising 25 metres higher than they are today, destroying the lives of hundreds of millions of people. Even before the end of the century, small island nations, including many of our Pacific neighbours will have been submerged with a one-to three meter rise seeing to this (Stern report 2004: 9-15). As the Stern report also reminds us, global warming is the historic responsibility of a few rich countries that since 1850 have produced 70% of all carbon dioxide emissions due to energy production.

Merson (Radio NZ, 2010) is amongst those climate change experts of the region who are increasingly saying that we need to move beyond considering measures of mitigation for the causes of climate change to developing and implementing adaptation measures and technologies. He considers we have, at best, this decade in which to make and enact fundamental decisions about our resource consumption habits and environmental management or face an essentially bleak and uncertain future. I contend that the uniqueness of the Pacific (ocean-centred, non-continental, scattered landmasses, village dominated, culturally rich and economically poor) suggests that such adaptations will need to be tailored to Pacific needs and conditions to prove effective and durable. Continental centred or focussed solutions may prove inadequate or highly inappropriate here (Barnett 2001). McNamara's (2008) work at a regional level indicates that specific relief for the Pacific from the international community is unlikely. '[T]hree key discourses emerged – that the international community would only respond in a 'crisis' situation and, in the interim, solutions such as local adaptation mechanisms or bilateral agreements between Pacific countries will emerge'.

Barnett (2001) considers 'adaption to be an imprecise policy goal' and that Pacific countries lack adequate 'development' of adaptive capacity to successfully respond. 'Small Pacific island states are not like small continental states, and standard development models often fail to deliver sustainable human development'. Barnett's closing shot is the most telling: 'Ultimately, environmental security for Pacific people requires human and institutional development policies that increase and complement the existing abilities of those people to do what they have always done with considerable success — adapt to change'.

Fiji, like other Oceanic Countries is precariously dependent on imported fossil-fuel, which account for between 8-37% of total imports to Pacific Island states, raising critical issues of fuel price and security of supply (Woodruff, 2007a: 3). Pacific Island Countries, despite their abundance of renewable energy resources, remain almost completely dependent on imported fossil fuels. Imported petroleum products account for an average of 40% of the countries' GDP. Fuel imports for Fiji in 2005 totalled $US340M (Woodruff, 2007b: 15)[6]. With rising petroleum prices, and growing trade deficits, the current situation is likely to be unsustainable in the future. Pacific Islands have few indigenous sources of fossil fuel (Woodruff, 2007b: 7). The reliance of South Pacific countries on oil imports represents a major drain on their economies, a barrier to development, and a source of vulnerability (Jafar, 2000). Fossil fuel use is also responsible for rapid growth in South Pacific countries' carbon emissions, albeit from a very low starting point, undermining their claim to international sympathy in the debate on global warming (Asafu-Adjaye 2008, Grasso 2006). Woodruff also notes that 'the size and structure of Pacific Island economies also makes them vulnerable to trade shocks, which can compromise economic stability by affecting variables such as the exchange rate, inflation and debt levels.... it is important to look at ways in which these chronic balance of payment problems can be eased, especially through the development of renewable energy technologies'(2007b:16).

Given the current global awareness and debate on climate change and fossil-fuel dependency issues, it is surprising that greater attention

[6] I am currently unable to ascertain the percentage of fuel used in sea-transport

has not been given to developing alternatives to our current reliance on inefficient fossil-fuel powered sea-transport options. However, within the sector of sea-transport, there is little evidence that global initiatives will supply alternatives to current transport options. World transport predominantly relies on a single fossil resource, petroleum, that supplies 95% of the total energy used by world transport. Shipping is estimated to use 9.5% of the world's transport energy budget (Kahn Ribeiro, 2009: 325, 328). Globally, sea-transport is a major contributor to greenhouse gas emissions. Estimates of total emissions vary, reflecting systemic issues of data capture, between 1.8 and 3.5%, making the industry an emitter on the scale of Germany and on par with aviation (IMO 2009, www.carbonwarroom.com). The most authoritative figures for the impact of shipping on GHG emissions are to be found in the Second IMO GHG Study, 2009. It is essentially a monopoly industry which moves 90% of the world's goods and raw material (Kahn Ribeiro, 2009: 335). Mid-range emission scenarios suggest that by 2050, in the absence of reduction policies, ship emissions may grow by 150 per cent to 250 per cent (compared to the emissions in 2007) as a result of the growth in world trade. In terms of CO_2 emissions per tonne of cargo transported one mile, shipping is recognized as the most efficient form of commercial transport.

It is also generally recognised by the industry that fuel efficiency has not been a motivating factor for the world's shipping industry and increased fuel charges are generally passed on directly to the consumer. This is likely to change in the future with rising fuel costs and international pressure. Unfortunately, most commentators do not expect this to transform into any quick or large changes to the current status quo. For example, IMO background papers regularly contain statements such as:

> it has been suggested that, by 2020, a combination of regulatory, design and operational measures might possibly deliver a reduction of around 17 to 32 per cent in the fuel consumed by ships per tonne/mile of cargo transported. However, it is important to stress that work on these complex issues is still continuing, that more efficient and sophisticated ships will be more expensive and that many measures may not be cost-effective for a range of ships and trades (IMO 2009: 6).

Of the more than 200 reports available via the IMO website reviewed thus far, only two mention potential for sail technology, albeit briefly, and both are sceptical of its viability. The 3rd IPCC report has only two pages of content (out of 56) in its Transport Chapter devoted to sea-transport. This is despite international shipping producing more sulphur-dioxide emissions than the entire terrestrial vehicle fleet and 27% of global nitrous oxide emissions. Sail is only mentioned in regards to the possible potential to retrofit some large ships with auxiliary sails (Kahn Ribeiro, 2009). Globally current efforts to increase sea-transport fuel efficiency are primarily limited to either improved motors, fuel or vessel hull design. There is some interest in 'kite-sails' with some manufacturers claiming in 2007 that up to 60% of the world's approximately 100,000 commercial transport vessels could be retro-fitted with such technology (www.skysails.com). There are as yet no commercially working models and numerous technical issues remain. Some work, of course, has been ongoing in regards to nuclear propulsion technologies led largely by the US military industrial complex and this still remains the Pentagons' preferred alternative shipping fuel technology today (O'Rourke, 2006).

Lessons from the last oil crisis

A similar pattern emerged during the oil shock of the 1970s. With the exception of a handful of important experiments, the low cost of fuel as an overall component of the industry and the relatively short duration of the event[7] saw some rhetoric but little action on either making current modes of sea-transport more efficient or developing alternative technologies to fossil-fuel powered propulsion. In Fiji in 1984 the Asian Development Bank funded Southampton University to experiment with retrofitting a 300ton cargo/passenger ferry with auxiliary sails. Contrary to predictions the vessel preformed exceptionally well, realising none of the concerns over ultimate stability and leeward, and resulting in 23% overall fuel savings plus multiple benefits in terms of increased stability and greatly reduced engine wear (Satchwell, 1985). Unfortunately, the vessel was lost on Maola reef in a developing cyclone in early 1985 but not before she was able to escape the cyclone under sail after the engines failed and thus preserved the life of the Fijian PM, onboard at the time. In a similar experiment, Japanese oil tanker owners' trialled modern square sails on 900 tonne vessels using aircraft wing technology and computer controlled rigs. Again the results were impressive with overall fuel savings of more than 30%, increased passage speeds, increased stability and greatly reduced engine wear (UNESCAP, 1985). Over three years, a fleet of eight such ships were established. However, plummeting oil prices meant the IRR on the technological investment was uneconomical and the experi-

[7] By 1985 oil was at its lowest wholesale price since WWII.

ment was discontinued (Satchwell, 1985, 1986). The results of both experiments though, were well documented, including full wind route planning data for Fijian waters, and should prove invaluable in the future.

In related work by FAO (1986) in this period, an experimental fleet of more than 300 artisanal fishing vessels ranging from single fisher outriggers to 11m trimarans were built in eight Pacific Island countries, many as either pure sail or wind assist designs. The uptake of the sail powered vessels were minimal (Gillett, R. pers. com 2010). FAO concluded that 'the only places where a new type of sailing craft has gained acceptance are those where there is a living tradition of the use of sail'. (FAO, 1986). Gillett and Savins have begun an analysis of the lessons learned from the FAO programme regarding re-introduction of sailing technology, at least in as much as it pertains to use for artisanal fishing. Other key lessons learnt include the need for any alternative technology to be proven to have direct overall economic benefits or savings to the user and the need for an entire sailing culture to be re-instilled.

Frameworks for development of alternative adaption sea-transport technology and application.

A number of small but potentially critical projects are in preparation in Fiji, seeking to develop a practical working example of sail-based trading craft. There are other initiatives to do with revitalization of traditional Fijian sailing craft and practice. Informal discussions with numerous interested parties and potential stakeholders related to sea-transport and sail technology in Fiji in 2010 received high and informed levels of support for any serious research or initiatives to advance thinking around sail (and other alternative) sea-transport options. This has included a wide range of views including relevant central and local government bodies, both University of the South Pacific and Fiji National University researchers and academics, local and international NGOs, village chiefs, provincial councils, regional agencies and maritime-related business representatives. International donors and philanthropists are also known to be actively interested in this area.

Any durable initiative in this area, either theoretical or practical, will require the active collaboration of some or all of these parties. It seems advantageous, therefore, to consider what frameworks can be utilized to facilitate this process. Fortunately, the already proven FLMMA network underpinned by PLA methods provides such a model. It is one that many of the potential stakeholders to any future Fijian pilot will already be well versed in. A summary of the FLMMA experience is given below.

The Local Marine Management Area programme was an outcome of various global coral reef awareness and action campaigns during the 1990s. It is an evolving network consisting of multiple stakeholders in the Pacific and Asian region. The LMMA learning portfolio (Parks and Salafsky, 2001) is a collection of projects that use a common strategy to achieve three common goals, namely, 'implement more effective projects; systematically learn about the conditions under which this strategy works best and why; and improve the capacity of the members of the portfolio to practice adaptive management' (LMMA Network, 2002). In Fiji some parts of the programme approach resonated strongly with a number of local initiatives at local, district, research, NGO and government agency levels. It was brought home and 'Fijianised' – molded and adapted to allow for a distinct culturally situated delivery. The FLMMA model is now well recognized nationally, regionally and internationally and is being increasingly adopted across the region and in other small island states in other oceans:

> The LMMA network partners collaborate on the basis of a Social Contract that they agreed to work together to make conservation better for the people involved and the marine environment. The Social Contract … demands that the members observe common values that emphasise good social relations. The core values include commitment, teamwork, transparency, empowerment, respect, fun and the belief that practitioners can make a difference …. These barriers to genuine partnership cannot be easily untangled through legal contracts as such, but through a social commitment to doing our work better (Veitayaki, et. al., 2003).

The experience of the FLMMA network provides an illustration of how to mainstream community-based resource management that began with local communities, and were in turn supported by a government which has witnessed the success of community-based intervention. To improve the success of conservation in the communities and attract attention to its approach, FLMMA formed a learning portfolio, 'a network of projects that use a common strategy to achieve a common end and agree to work together to collect, test and communicate information about the conditions under which the strategy works to enable the partners to exchange ideas and experiences. The learning portfolio enhances collaboration and also ensures lessons learnt are shared widely with people in the network' (Veitayaki, et. al., 2003). An ethos of 'experts on tap not on top'

prevails. The Social Contract was the means of providing this agreement on operating principles, recognising the internal differences between partners and allowing for this diversity to support the common objective at village level (Tawake, pers. com. 2010).

Conclusion

Sail technology is one of a range of possible adaptations that Oceanic states such as Fiji could consider as they look at adopting alternative technologies and more sustainable forms of energy. It certainly appears to have strong potential to deliver a range of benefits. The barriers to practical application of sail technology at any industrial scale are broader than just technological, and include administrative, economic and socio-cultural factors. Previous experiments during the period of the last oil crisis provide us with valuable learnings. The economic viability of any such initiative will need to be carefully considered and evaluated and the positive collaboration of a broad base of stakeholders is needed. The FLMMA model provides a positive and robust example for undertaking this research and planning. This paper is offered as a broad think-piece to provide context and hopefully stimulate further discussions.

References

Asafu-Adjaye , J. (2008). Environmental Quality and Economic Growth: The Case of Pacific Island Countries, *South Pacific Studies* 29(1):43-62

Barnett, J. (2001), Adapting to climate change in Pacific island countries: the problem of uncertainty, *World Development*, 29(6), 977–93.

Barnett, J. (2002) Environmental change and human security in Pacific Island Countries, *Development Bulletin* No. 58, July, ANU, Canberra

Clarke, W.C. (1990) Learning from the Past: traditional knowledge and Sustainable Development, *The Contemporary Pacific* 2(2), 233-253.

Clunie, F. (1986) Yalo i Viti. Shades of Viti*: A Fiji Museum Catalogue*, Fiji Museum. Suva.

Clunie, F. (1987) Ndrua and Kalia: the Great Tongan Voyaging Canoe, *Islands* (Jan-Mar): 11-16.

Corbett, J. and H. Koehler (2003) Updated emissions from ocean shipping, *Journal of Geophysical Research* 108(D20): 4650-64.

Couper, A.D. (1967) *The Island Trade: An analysis of the environment and operation of seaborne trade among three island groups in the Pacific.* Australian National University, Dept of Geography.

Couper, A.D. (1968) Indigenous trading in Fiji and Tonga: a study of changing patterns, *NZ Geographer*, 24/1 pp 50-60.

Couper, A.D. (1973) Islanders at sea: change and the maritime economies of the Pacific. In Brookfield H.C. (ed), *The Pacific in Transition: geographical perspectives on adaption and change*, Edward Arnold, London.

Couper, A.D. (ed), (1989) Development and social change in the Pacific islands. Routledge, London.

Couper, A.D. (2009) *Sailors and Traders: A Maritime History of the Pacific Peoples*, University of Hawai'i Press, Honolulu.

D'Arcy, P. (2006) *The People of the Sea – Environment, Identity and History in Oceania*, University of Hawai'i Press, Honolulu.

D'Arcy, P. (ed) (2008) *Peoples of the Pacific – The History of Oceania to 1870*, Ashgate Publishing, Aldershot.

Derrick, R.A. (1957) *A history of Fiji, v.1.* ,Government Press, Suva.

Endresen, Ø., E. Sørgård, et al. (2003). "Emission from international sea transportation and environmental

impact." *J. Geophys. Res* 108(D17): 4560.

Feinberg, R. (ed) 1995. *Seafaring in the Contemporary Pacific Islands: Studies in Continuity and Change* Northern Illinois University Press. DeKalb..

Food and Agriculture Organisation of the United Nations (1987) *Artisanal Fishing Craft of the Pacific Islands. Based on the Work of Ø. Gulbrandsen and M. Savins.* FAO/UNDP Regional Fishery Support Programme Suva, Fiji. RAS/87/002

Finney, B. (ed) (1976) *Pacific Navigation and Voyaging*, The Polynesian Society Inc, Honolulu.

Finney, B. (ed) (1994) *Voyage of Discovery, a cultural odyssey through Polynesia*, University of California Press, Berkley.

Finney, B. (ed) (2003) *Sailing in the Wake of the Ancestors: Reviving Polynesian Voyaging*, Bishop Museum Press, Honolulu.

Gillett, R. et al. 1993. *Traditional sailing canoes in Lau – Na Camakau mai na yatu Lau.* Institute of Pacific Studies/University of the South Pacific, Suva.

Grasso, M. (2006) An Ethics-based Climate Agreement for the South Pacific Region. *International Environmental Agreements* 6:249-270.

Gunson, N. (ed) (1978) *The Changing Pacific: Essays in Honour of H E Maude.* Oxford University Press, Melbourne.

Hage, P. and F. Harary (1996). *Island Networks: Communication, Kinship and Classification Structures in Oceania.* Cambridge University Press, Cambridge.

Hau'ofa, E. (1994) *Pasts to Remember.* Paper delivered as an Oceanic Lecture, USP, Suva.

Hau'ofa, E. (2008) *We are the Ocean, Selected Works.* Hawaii University Press, Honolulu.

Hornell, J. and A. Haddon (1936) Canoes of Oceania. Volume 1, Bishop Museum, Honolulu.

Howe, K.R. (ed) (2006) *Vaka Moana – Voyages of the Ancestors.* David Bateman, Auckland.

Hviding, E. (1996). *Guardians and Marovo Lagoon.* University of Hawai'i Press, Honolulu.

International Maritime Organisation (2009) *Climate change: A challenge for IMO too! Background paper*, IMO website accessed 8/2/11. www.imo.org

Jackson, J. (1853) Feejeean Islands in Erskine, J. *Journal of a Cruise among the Islands of the West Pacific.* John Murray, London.

Jafar M, (2000). Renewable energy in the South Pacific - options and constraints. *Renewable Energy* 19:305 309.

Kahn Ribeiro, S., S. Kobayashi, M. Beuthe, J. Gasca, D. Greene, D. S. Lee, Y. Muromachi, P. J. Newton, S. Plotkin, D. Sperling, R. Wit, P. J. Zhou, (2007): Transport and its infrastructure, in Metz B., O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds),*Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* Cambridge University Press, Cambridge and New York.

Kane. H.K. (1991) *Voyagers – a collection of words and images*. WhaleSong Inc, ISBN: 0-9627095-1-4

Lessin, A.P. and P.J. Lessin (1970), *Village of the conquerors; Sawana: a Tongan village in Fiji*, Dept of Anthropology, University of Oregon, Eugene

Marchaj, C. A. (1996) *Planform Effect of a Number of Rigs on Sail Power* in *Adlard Coles, Sail Performance, Nautical, London*.

MARINTEK (2000). *Study of Greenhouse Gas Emissions from Ships. Final Report to the International Maritime Organization*. Trondheim, Norway.

Morrison R John, Ursula Kaly, Alifereti Tawake and Batiri Thaman (2002) Low-cost technology for monitoring sustainable development , *Development Bulletin* No. 58 July 2002 ANU Canberra

Overton, J. (1994). *A Future in the Past* in Waddell, E. and Nunn, P. (eds) *The Margin Fades: Geographical Itineraries in a World of Islands.* IPS/USP, Suva.

Radio New Zealand (2010) *The Environment and the Economy: interview with Prof John Merson and Rod Oram*, Smart Talk Podcast series, http://podcast.radionz.co.nz/doco/doco-20100117-1600-smart_talk_for_17_January_2010

Rayawa, S. (2001) Fijian Canoes*. Domodomo* Vol 13 No.1, Friends of the Fiji Museum, Suva.

Reid, A.C. (1977) The Fruit of the Rewa, *Journal of Pacific History*, 12: 2-24

Sahlins, M.D. (1962) *Maola,* , University of Michigan Press, Ann Arbour.

Satchwell, C.J. (1985) *Windship technology: proceedings of the International Symposium on Windship Technology (Windtech '85)*, Southampton, U.K., April 24-25, 1985, Part 1

Satchwell, C.J. (1986) *Preliminary analysis of log data from the Fiji windship 'Cagidonu'*. Southampton, UK, University of Southampton, 27pp. (Ship Science Reports, 24)

Sharpe, A. (1956) *Ancient Voyagers in the Pacific*. Memoirs of the Polynesian Society no.32, Wellington.

Tawake, A., et. al. (2001) *Report on training of Trainers in the Planning and Facilitation of Community Participatory Learning and Action (PLA) Workshop for Natural Resource Use Planning in East Timor*. IAS-USP, Suva.

Thompson, L. (1949) The cultural history of the Lau Islands, Fiji. *American Anthropologist* 40, 181-97.

United Nations Economic and Social Commission for Asia and the Pacific. 1984. *Wind-Powered Vessels for Coastal and Inter-Island Use in the Asian and Pacific Region.* Technical papers submitted to the Meeting of Experts on the Application of Windpower in Shipping. 14-16 April 1984, Tokyo/Niigata, Japan.

Veitayaki, J et al. (2003) Mainstreaming resource conservation: the Fiji Locally Managed Marine Area Network and its influence on National Policy Development, *Resource Management in Asia-Pacific Working Paper No. 42*, Resource Management in Asia-Pacific Program, Research School of Pacific and Asian Studies ANU, Canberra

Weir, Kay (2006) Principles to reverse global warming and end poverty. *Pacific Ecologist*, June, Pacific Institute of Resource Management.

Williams, T. (1858) *Fiji and the Fijians.* Heylins, London

Woodruff, Allison (2007a) *The Potential for Renewable Energy to Promote Sustainable Development in Pacific Island Countries*, SOPAC Miscellaneous Report 692, SOPAC, Suva

Woodruff, Allison (2007b) *An economic assessment of renewable energy options.*

Author

Peter Nuttall is a PhD candidate, School of Development Studies, Victoria University of Wellington.