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The Implications of Coastal Protection and Development on Surfing

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ABSTRACT

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The impact of coastal protection on surfing resources is poorly understood and rarely quantified prior to construction. There is an increased requirement for surfing resources worldwide as participation levels in the sport grow. There is also an increased requirement for coastal protection as the occupancy in the coastal zone increases. This research paper takes the first steps towards a schematic categorization of the effect of coastal protection on surfing resources. To do this, we sourced the data through the global network of Surfrider Foundations via questionnaires. These questionnaires enquired about wave quality, crowd levels, stakeholder participation, and the economic importance of surfing to the local area before and after the construction of coastal protection.

The results show that of the 30 surfing resources surveyed, 18 experienced a reduction in wave quality and 12 showed an enhancement, or no change, in wave quality.

The paper provides an explanation of the results by proposing mechanisms of enhancement and reduction of wave quality after the construction of coastal protection. The conclusion states that coastal protection usually has an effect on the surfing resource that may be positive or negative in terms of the outcome on wave quality and crowd levels.

ADDITIONAL INDEX WORDS: *Surfing, surfing resources, coastal erosion, Surfrider Foundation, economic impact of surfing, coastal protection*

INTRODUCTION

This paper addresses the impact of coastal protection and development on surfing. The research analyses the impact in terms of the effect on a number of elements that are considered, by the author to be relevant to the surfing experience.

The sport of surfing has seen a huge increase in participants during the past 40 years. It has developed from a minority pastime, practised in a handful of countries, to a professional sport. As of 2002 it was estimated there were 10 million surfers globally (Buckley, 2002).

Surfing is a sport that is practised in certain areas of the coastal zone where the combination of bathymetry, tide, exposure to swell, and wind patterns produce suitable conditions. Throughout the course of this research this area is referred to as the "surfing resource."

The increase in popularity of the sport has come at a time of increased occupancy of the coastal zone. Beukenkamp, Gunther *et al.* (1993) cited by Kay and Alder (1999) commented, "The world's population in coastal areas (in 1993) is equal to the entire global population in the 1950s." The large number of people living in this area has necessitated new infrastructure to serve growing communities. This infrastructure is often exposed to the dynamic forces of erosion, deposition, weather, and direct hydraulic action and therefore may require coastal protection to extend its operational lifespan. The coastal protection types most commonly used are seawalls, groynes, offshore breakwaters (submerged and emergent), beach nourishment schemes, jetties, or a combination thereof.

A hypothesis was established prior to conducting the research that the construction of coastal protection in close proximity to a surfing resource would have an impact on the wave quality and crowd levels. A questionnaire was used to determine the level of impact at various locations. In addition to wave quality and crowd levels, an attempt was made to identify whether timing, stakeholder engagement, required usage of the coastal protection, or economic value of surfing to the local area were factors in the impact of construction on the surfing resource.

Background of Published Work in the Context of This Research Project

The study of surfing is a relatively new area of research, and as such, there are a limited number of academic studies on the subject. However, an area that has seen more research is the creation of artificial surfing reefs (ASRs). This has acted as a catalyst for additional research into surf science. The two conference papers by Jackson, Tomlinson, and D'Agata (2001, 2002) refer to the issue of wave quality; this is analo-

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gous to the concept of swell quality cited by Butt and Russell (2002) in their description of surfing waves. The concept is important in qualifying the impact of coastal protection on the surfing resource because the construction does not always affect the surfing resource so as to render it unusable. Therefore, it is useful to be able to mathematically define it. This could be achieved by using the parameters outlined in various articles related to surf science: breaker type, breaker height and breaking wave celerity (Jackson, Tomlinson, and D'Agata, 2001, 2002); wave section length (Scarfe *et al.,* 2003a); wave height amplication (Turner *et al.,* 2001); and wave peel angle and vortex ratio (Black and Mead, 2001). However, this research uses the concept of wave quality as determined by the surfers at a local surfing resource; therefore the incorporation of these parameters into the analysis is beyond the scope of this research paper.

Wave quality is used in this research to quantify the impact of the construction of coastal protection on a surfing resource. To analyse this impact, it is useful to refer to other studies in the coastal zone. Pilkey and Wright (1988) discuss the mechanisms that contribute to beach narrowing in front of a seawall, and Black and Mead (2001) address the question as to how changing bathymetry affects the wave characteristics. Scarfe *et al.* (2003b) address the issue of enhancement to wave quality around a jetty structure and propose a mechanism responsible for this. The enhancement of wave quality around a jetty is also observed by Preston-Whyte (2002) in a study of surfing space in Durban, South Africa. This study analyses an important aspect of surfing culture: the identification of surfers with their favourite surfing space. This may also have an impact on the issue of crowding because surfers are attracted in increasing numbers to specific areas of the coastal zone. Buckley (2002) highlighted this as a complex issue, especially when it is viewed in the context of generating income. He describes the need for recreational capacity management at certain surfing locations. Goodhead and Johnson (1996) discuss this approach in more general recreational terms.

Other studies of relevance are the recreational value of beaches and their aesthetic value. Studies by Fiske, highlighted by Ford and Brown (2006), address surfing motivation and the value that some groups of surfers place on aesthetic conditions, of which landscape is one. This may be an important factor in the selection of a beach by a surfer, and Houston (1996) addresses the economic value of this decision at a higher level.

METHODOLOGY

To address the impact of coastal protection and development on surfing resources, there was the requirement to source original data. This was achieved by surveying surfers in the organised network provided by The Surfrider Foundation and its chapters in the United States, Australia, and Europe. The U.K. does not have an affiliated Surfrider Foundation, so the British Surfing Association was contacted. In addition, environmental groups with interests in surfing were approached; Surfers Against Sewage (U.K.), Save the Wave Coalition (United States, Chile), Surf Break Protection (New Zealand), and Wavescape (South Africa). The Surfrider Foundation and the environmental groups are referred to in the course of this research as "surfrider groups." A questionnaire (Appendix 1: Surfrider Questionnaire) was used as the means to gain this data.

Table 1. *Interpretation of surfers' terminology with reference to the type of surfing resource present at a location.*

Kind of Surfing Resource	Description
Beach break	Waves are focused onto a sandbar and break in either direction.
Point break	Waves are refracted around a headland and break in one direction.
Reef break	Waves are focused onto a shallow reef which may cause the wave to break in either direction.

The initial goal of the surfrider questionnaire was to gain information on the location of the surfing resource that had been affected by coastal protection. After this questionnaire was returned, a further questionnaire was sent to the council or local authority, referred to as the council questionnaire. This was designed to gain a better understanding of the council's or local authority's position on the importance of surfing to the local economy.

The surfrider questionnaire first ascertained the credentials of respondents by asking for details of the organization they represented and their position. In addition, respondents were asked to indicate their personal surfing experience.

The remaining part of the surfrider questionnaire was split into two sections. The first represented the surfing resource prior to the construction, and the second represented the surfing resource after the construction was complete. The respondent was first asked to identify the location and then the kind of surfing resource present. A choice was given of "beach break," "point break," "reef break," or other. Although this terminology is commonly used among surfers, other researchers may be unfamiliar with these descriptions, which are summarized in Table 1.

The surfrider questionnaire continued to ask the respondent to indicate wave quality at the surfing resource, using a scale of 1 to 6, with 1 being the highest quality. Because a scale could be interpreted subjectively, it was put into context by using a control, chosen to be a surfing resource of which there would be a high probability that all surfers of intermediate level and above would have knowledge. Number 1 on the scale was said to be of similar wave quality to the Pipeline on the North Shore of Hawaii or Padang Padang in Bali. The next question focused on the number of surfers using this resource prior to construction. It was felt that to get an accurate representation of numbers, conditions should be specified once again to place the question in context. Respondents were asked to describe the popularity of the resource on a Sunday morning with good conditions.

The next section of the surfrider questionnaire elicited information on the construction of the coastal protection with a variety of mixed and dichotomous questions. The first of these questions enquired when the construction was undertaken. This was presented to respondents as a mixed ques-

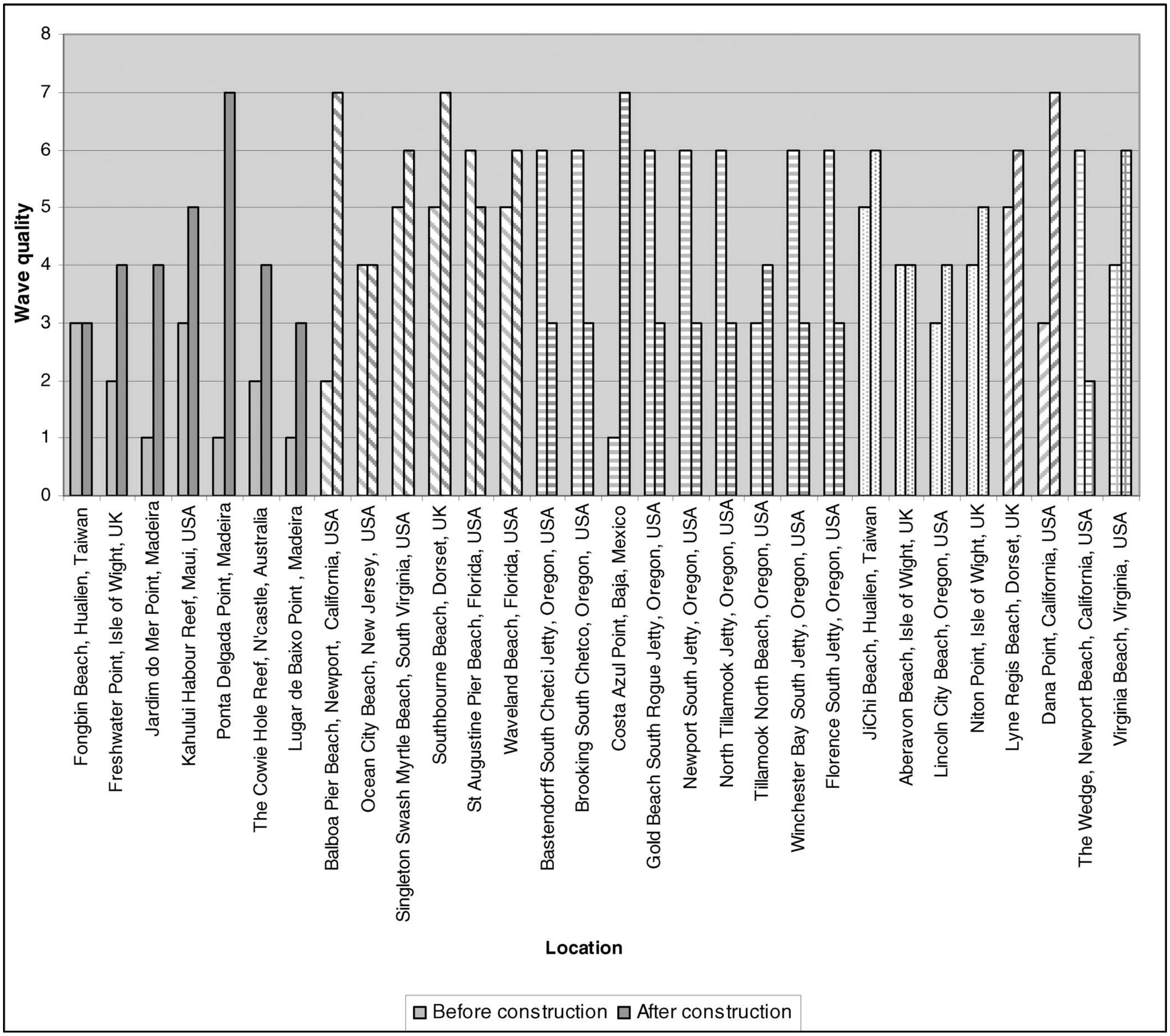

Figure 1. Results of the surfrider questionnaire with wave quality at each location before and after construction displayed with the type of coastal protection used (see Table 2 for key). Note: An increase in numerical value of wave quality in the questionnaire indicates a reduction in wave quality.

Table 2. *The key for Figures 1 and 2 to display the different types of coastal protection used at the various locations worldwide.*

	Seawall
	Beach Nourishment
	Jetty
	Other
	Offshore (emergent) breakwater
	Combination of coastal protection schemes

tion. In addition, dichotomous questions were presented to establish (1) whether the organization had been included as a stakeholder in the project, (2) whether the organization had made any recommendations, and (3) whether these recommendations had been incorporated into the design of the coastal protection (mixed question).

The remaining part of the surfrider questionnaire focused on the surfing resource after construction. The wording of the questions was similar to the previous section, creating continuity between them. Respondents were asked to indicate the surfing community's view on the effect on the surfing resource after the construction of the coastal protection. In

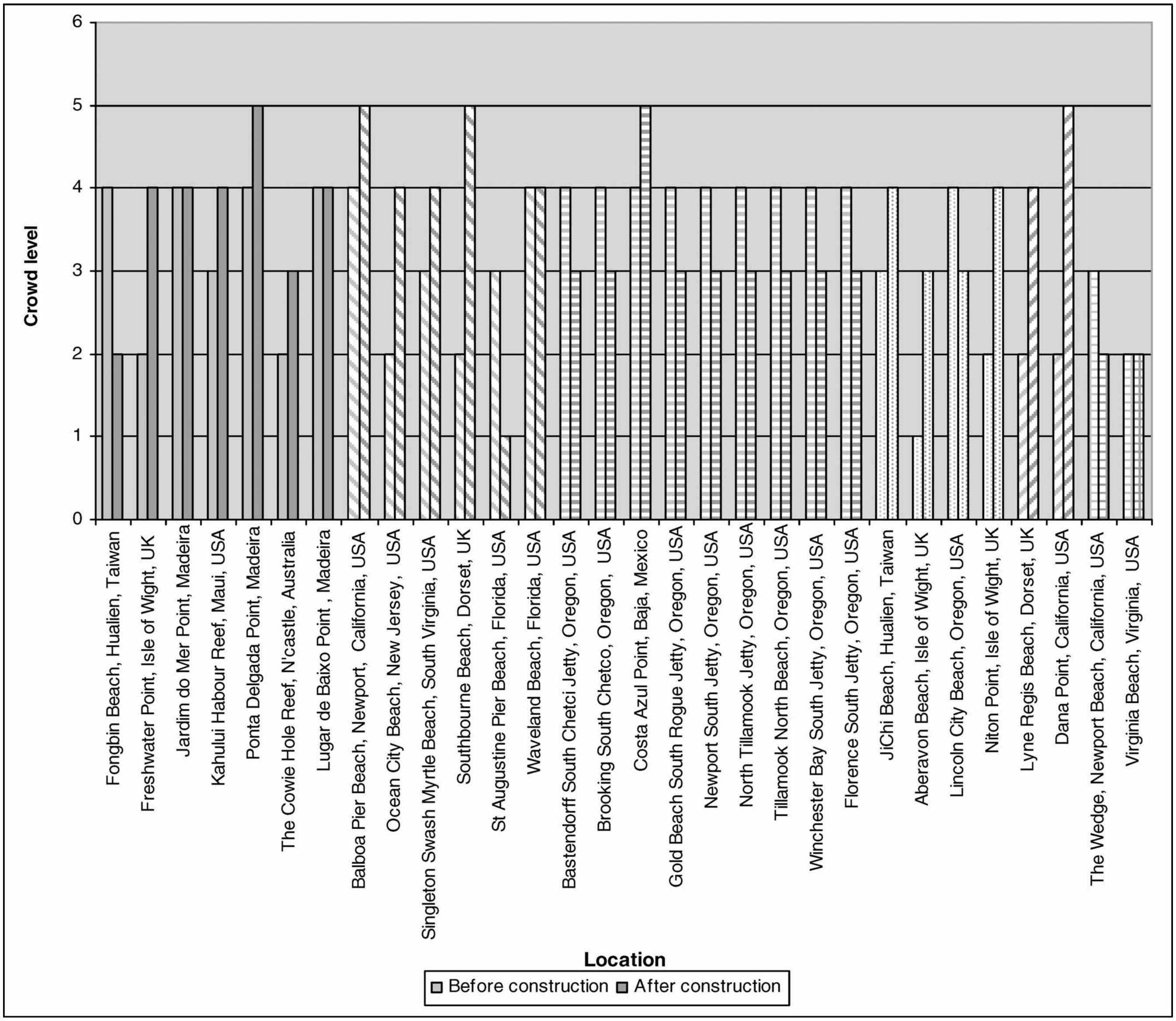

Figure 2. Results of the surfrider questionnaire with crowd level at each location and after construction displayed with the type of coastal protection used (see Table 2 for key). Note: An increase in numerical value of crowd level in the questionnaire indicates a reduction in crowd level.

addition, a scale was presented that was similar to the scale previously used.

The next question referred respondents to the crowds at the surfing resource. Using the same context as previously stated in the crowding question prior to the construction.

The final question asked respondents to specify the type of coastal protection used in the construction. The choices of coastal protection were the same as those referred to in the introduction, with the addition of an artificial surfing reef. The questionnaire concluded with a space providing the respondent with the opportunity to comment further.

The council questionnaire was sent to the beach management office, or in its absence, it was sent to the planning department. Further to the initial questions that aimed to qualify respondents, the next question asked respondents to rate the importance of surfing on the local economy. The subsequent question asked respondents to describe the need for the coastal protection scheme. This was presented as a mixed question.

The questionnaire then asked whether the Environmental Impact Assessment had considered the surfing resource, and the final question was designed to assess the authority's position when designing coastal protection in terms of the surfing resource.

The data that were gathered from both questionnaires were coded and entered into a database. This was collated and is presented in the following results section of this paper.

Table 3. *Potential mechanisms that account for the enhancement or reduction in wave quality at the locations surveyed.*

Type of Coastal Protection	Increase or Decrease in Wave Quality	Proposed Mechanism	Example	Relevant Reference
Seawall	Decrease	1. The position of the seawall directly in the surf zone has effectively removed the surfing resource. Where the wave previously broke and surfers first began their ride, there is now a wall of concrete or other material, and the waves break directly onto this.	Ponta Delgada, Madeira	
		2. Wave frequency. The seawall may cause the surfing resource to be usable only at certain tides, thereby reducing the time that it is available to surf the wave.	Jardin do Mer, Madeira	
		3. Backwash. This is caused when the incoming wave's shape is affected by the action of wave that previously hit the seawall. This can range from a "wobble" in the wave's face to the creation of dangerous conditions.	Lugar de Baixo, Madeira	
		4. A reduction of the flow of sediment to the seabed. The seawall may act to lock the previously free-flowing sediment behind it. This prevents sediment being transported into the ocean and the formation of sandbars that cause the wave to break. Therefore, the wave breaks closer to the seawall, moving the surfing resource closer and potentially causing backwash or reducing wave frequency (as previously described).	Copacabana, Brazil[1]	Pilkey and Wright (1988)
		5. Alteration of the local bathymetry. This could affect the quality of the waves. If the seabed is flattened, then a wave that previously broke with plunging characteristics that are ideal for intermediate to advanced surfers, may break with more spilling characteristics.	The Cowie Hole, N'Castle Australia	Black and Mead (2001)
		6. The seawall may prevent access to surfers and other beachgoers to the beach.	Male Point, Maldives[1]	Houston (1996)
		7. The construction of the seawall may cause a reduction in beach width and therefore decrease its recreational value.	Fongbin, Taiwan	Ford and Brown (2006)
		8. A change in environmental conditions. The seawall blocks the natural view of the coast. This may reduce the aesthetic value of the location and for some surfers may reduce the quality of the experience. Therefore, a reduction in the environmental quality of the location would be interpreted by this user group of surfers as a reduction in wave quality.		
Beach nourishment	Decrease	The addition of sediment effectively buries the sandbars. These sandbars act as focus points for the waves to break. The flattening of the seabed profile changes the wave type from plunging to spilling, thereby reducing the wave quality. This reduction in quality may only be temporary as the scheme shifts to find its equilibrium and may cause the return of the sandbars.	Singleton Swash, City of Myrtle Beach, United States	Black and Mead (2001)
Beach nourishment	Increase	The system may be returning to equilibrium after it was overloaded with sediment.	St Augustine pier beach, Florida, United States	
Jetty	Increase	The mechanism of this enhancement in wave quality is based on the structure's ability to trap sediment. The sediment forms a preconditioning element for the wave or acts as a focus for the wave to break on.	Bastendorff South Chetci, Oregon, United States	Scarfe *et al.* (2003); Preston- Whyte (2002)
Other (rip-rap)	Decrease	Reference mechanism 4. The structures interrupt the movement of sediment, which affects the wave quality.	Lincoln City Beach, Oregon, United States	Pilkey and Wright (1988)
Beach nourishment and groynes	Increase	The sandbars are artificially fed by the beach nourishment scheme and are effectively held in place by the groynes.	Newport Beach, California, United States	Scarfe *et al.* (2003)

[1] Save the Wave (2005).

RESULTS

The results of the impact of the construction of coastal protection on wave quality and crowd level are presented in Figures 1 and 2. Table 2 is the key for Figures 1 and 2 to display the different types of coastal protection used at the various locations worldwide.

The time frame of construction results showed that in the previous 2-year category, there were eight enhancements, nine reductions, and one no change in wave quality. In the 2- to 5-year section there were two examples of coastal protection highlighted; both saw a reduction in wave quality. For the 5- to 10-year category in all five surfing resources surveyed, the respondent indicated a reduction in wave quality. In the 10-year plus category, there was one enhancement, two reductions, and two no changes in wave quality.

The last area of data sourced from the surfrider questionnaire was concerned with the inclusion of the surfrider groups at the planning stage of the coastal protection. There

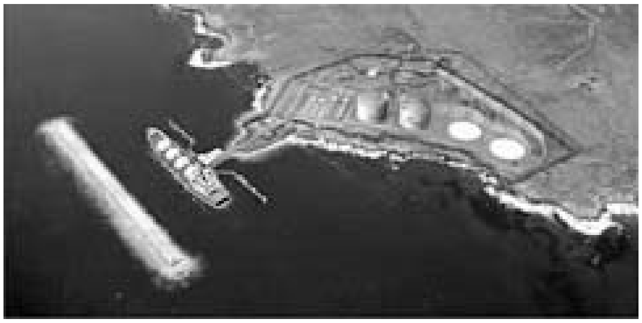

Figure 3. An aerial photograph of the newly constructed LPG terminal at Costa Azul, Baja, Mexico, which was constructed on top of world class surfing resource. (Source: Save the Wave Coalition, 2006)

were 8 inclusions compared to 10 exclusions of surfrider groups. Of the surfrider groups that were included in the planning stage, only three saw their recommendations incorporated or partially incorporated into the design of the coastal protection.

The surfing resources of which questionnaires were completed by local councils are located on the Isle of Wight in the U.K. and Newcastle, Australia. At these locations the councils described the importance of surfing to the local economy as "significant," in the case of Newcastle City Council and "somewhat significant" in the case of the Isle of Wight. The reasons behind the construction of coastal protection were described as a "need to protect an existing development" in Newcastle and "replace ageing coastal protection" on the Isle of Wight. At these locations, the approach to designing coastal protection did not consider the surfing resource and was solely designed for coastal protection.

DISCUSSION

From the results it can be seen that the majority of surfing resources experienced a reduction in wave quality after the construction of the coastal protection. The mechanisms that are proposed to account for the reduction and enhancement in wave quality are presented in Table 3, with examples from the results of this research and other quoted examples. In addition, literature references are cited where appropriate.

The mechanism that proposes an increase in wave quality cited in Table 3 does not account for a reduction in wave quality in two of the surfing resources studied. It is proposed that in one of these cases, Costa Azul, Baja, Mexico, the main cause of the reduction in wave quality was the construction of an offshore emergent structure, as can be seen in Figure 3, and not the jetty as suggested by the respondent of the questionnaire. The presence of a jetty and an emergent structure may have led the respondent to misidentify the structure. The first mechanism that accounts for the reduction in wave quality after the construction of a seawall (Table 3) is proposed to account for this reduction in wave quality in this case. The reduction in wave quality observed at the jetty on Tillamook North Beach, Oregon may be regarded as an anomalous result in terms of this research because the data for jetties generally indicates an enhancement in wave quality after construction.

In addition to wave quality, the study focused on crowd levels at the surfing resources, before and after the construction of the coastal protection. From the results, it can be seen that where the construction resulted in a reduction in wave quality, there was most often a decrease in crowd numbers. The converse was not found. An increase in wave quality at the surfing resources commonly saw crowd numbers remain static.

The reduction in wave quality and decrease in surfers could be interpreted as the requirement of the surfing population for high quality waves. Preston-Whyte (2002) describes the identification of surfers with their favourite surfing space and, by extrapolation from this concept, if there is a reduction in wave quality, then the surfer will travel to another surfing location where the wave quality is higher. However, to make this assumption would be to discount a large number of surfers who surf at the location nearest their home or a location that is most convenient. The data describe a number of surfing resources that have been removed as a result of the construction of coastal protection. In these cases the reduction in crowds is a direct result of the construction. However, where the construction decreased the wave quality marginally, or some cases significantly, there are other factors that need to be considered. The most important of these is the proximity of other surfing resources. If the surfing resource that has experienced a decrease in quality represents the only surfing resource in a large area then the effect of the reduction in wave quality is less likely to have an impact on the crowd numbers. Conversely, the same reduction in wave quality is likely to have a greater impact if there are a number of other surfing resources in the area.

With regard to the enhancement of wave quality, the majority of surfing resources saw no change in crowd numbers. This is because the data are being sourced from one surf rider group. In their area there were a number of jetties constructed. This may have resulted in an increase in crowd numbers being spread over a number of locations, so that the general increase went unnoticed.

It can be postulated in general terms that an increase in wave quality will see an increase in crowd levels, and a decrease in wave quality will cause a decrease in crowd numbers. The second half of this postulation, however, is more open to additional factors, as discussed previously.

The results of the time frame to construction were inconclusive, making analysis difficult. This could potentially be an area for future research.

In the next section, data for the input of surfrider groups as stakeholders and incorporation of their recommendations in the projects was sourced. In the majority of surfing resources highlighted, the surfrider groups were not included as stakeholders. Consultation with surfrider groups might increase the acceptance of certain projects and may even allow for the modification to reduce the impact on the surfing resource. However, often lack of investment and unwillingness from both sides (developer and stakeholder) limits the consultation with nonstatutory stakeholders.

The lack of response to the council questionnaire has prevented meaningful analysis of the results.

To effectively analyse the results of the research, the potential sources of bias need to be addressed. In the surfrider questionnaire the respondent was qualified into beginner, intermediate, or advanced surfer. This was done because a beginner to the sport is usually unable to accurately assess wave quality. A question concerning time spent surfing at the location would have further helped in qualifying the validity of the response and should be added to any subsequent questionnaire.

A further source of bias is highlighted in the assessment of crowd numbers. This measure does not take into account the increased popularity of surfing during the past 40 years, and any surfing resource is likely to have seen an increase in numbers during this period.

All of the questions in the questionnaire asked respondents to recall the state of the surfing resource and action taken some time in the past. Webb (2000) advises against the use of memory recall in the production of a questionnaire as being potentially a source of bias. However, it was felt that the action that contributed to the enhancement, reduction in quality, or the destruction of the surfing resource would be of enough significance to produce accurate recall. This could however be a potential source of bias.

CONCLUSION

There is a common theme at the coastal zone and in all nature; mankind's desire to tame and control it. In the context of this research paper, man has a need or desire to control coastal erosion. This is done through the application of coastal protection to the area that is experiencing erosion. The desire to control nature is also played out in surfing because the surfer attempts to control the power of the ocean by riding on the crest of a wave. These controlling desires have been shown, in the course of this research, as being sometimes complementary, in terms of coastal protection enhancing the wave quality at the surfing resource, but at others contradictory, in terms of the coastal protection reducing the wave quality at the surfing resource. Importantly, where coastal protection is constructed in proximity to a surfing resource there is usually an impact. Where this has a negative effect on the wave quality at the surfing resource there can be a knock-on effect, thereby reducing the numbers of surfers using the resource. It is assumed this will impact the local economy, and this could usefully be the subject of further study.

Conversely, a positive impact of coastal protection on the wave quality at the surfing resource may increase the number of surfers attracted to the area. It is assumed that this will add value the local economy.

The impact of different types of coastal protection was seen to have different effects on the surfing resource. If a structure is placed in the wave breaking zone and blocks or interferes with the passage of the waves to the focus of the wave, whether that is a sandbar or reef, there may be a reduction the wave quality. If a structure acts to trap sand to form sandbars or becomes the focus point for the waves to break, it may improve wave quality.

The conclusions drawn during the course of this research are based on data from 30 surfing resources. To increase the validity of this research, it would be pertinent to rerun the data collection aspect and contact a wider ranging sample unit, seeking the views of non–environment-based surfrider groups. In addition, further work in this area could draw upon a mathematical qualification of the concept of wave quality. This qualification could be compared to the surfer's view of this concept to allow ground truthing of the results.

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APPENDIX 1: SURFRIDER QUESTIONNAIRE

Section 1: Your organization and you

Qu1 What is the name of your organization?

Qu2 What is your position within this organization?

Qu3 What is your own personal level of surfing?

Section 2: Questions 4–11 refer to the surfing resource prior to the construction that affected it.

Qu4 What is the location and name of the surfing resource that was affected by the coastal protection?

Qu5 Which description best describes the surfing resource prior to construction?

Qu6 Please indicate the quality of the surfing resource prior to construction. 1 indicating a world class break that is very steep and hollow with very fast sections (similar to Pipeline, Hawaii or Padang Padang, Bali). 6 indicates a mushy beach break.

Qu7 Which description would best describe the popularity of the specific surfing resource (i.e. the wave that was directly affected by the construction) prior to construction, on a given Sunday morning with good conditions?

Qu8 When was construction undertaken?

☐ Less than 2 years ago
☐ 2–5 years ago
☐ 5–10 years ago
☐ More than 10 years ago

Qu9 Was your organization included as a stakeholder in the project?

Qu10 Did your organization make any recommendations to the project prior to the construction?

Qu11 Were the recommendations of your organization incorporated into the design of the coastal protection?

Section 3: Question 12–16 refer to the surfing resource after the construction was completed.

Qu12 What were the local surfing community's views on how the construction affected the surfing resource?

☐ Great improvement
☐ Small improvement
☐ No change
☐ Small reduction in quality
☐ Large reduction in quality
☐ Removal of the surfing resource

Qu13 Please indicate the quality of the surfing resource after construction. 1 indicating a world class break that is very steep and hollow with very fast sections (similar to Pipeline, Hawaii or Padang Padang, Bali). 7 representing no surfing resource present.

Qu14 After construction at the same location that was refer to in question 6 (i.e., the wave that was directly affected by the construction). On a Sunday morning with good conditions, did the number of surfers using the resource;

☐ Increase a lot
☐ Increase a little
☐ No change
☐ Decrease a little
☐ Decrease a lot

Qu15 What kind of coastal protection was used at this location?

Qu16 If you have any additional comment on the surfing resource prior to the construction, after the construction or of your organization's input into the coastal protection. Please make them below and add additional sheets if required.