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“THE HEALTH OF WAIKIKI BEACH IS  
VERY CENTRAL TO HAWAII’S IMAGE”

Waikiki Improvement Association

# 05 Global Comparative Study

WAIKIKI BEACH,  
OAHU, HAWAII, USA



## KEY INQUIRY QUESTION

IF BEACH EROSION IS THE  
PROBLEM AT WAIKIKI BEACH,  
IS A SAND BYPASSING SYSTEM  
A POTENTIAL SOLUTION?

KN UN AP AN EV CR





# PART 5

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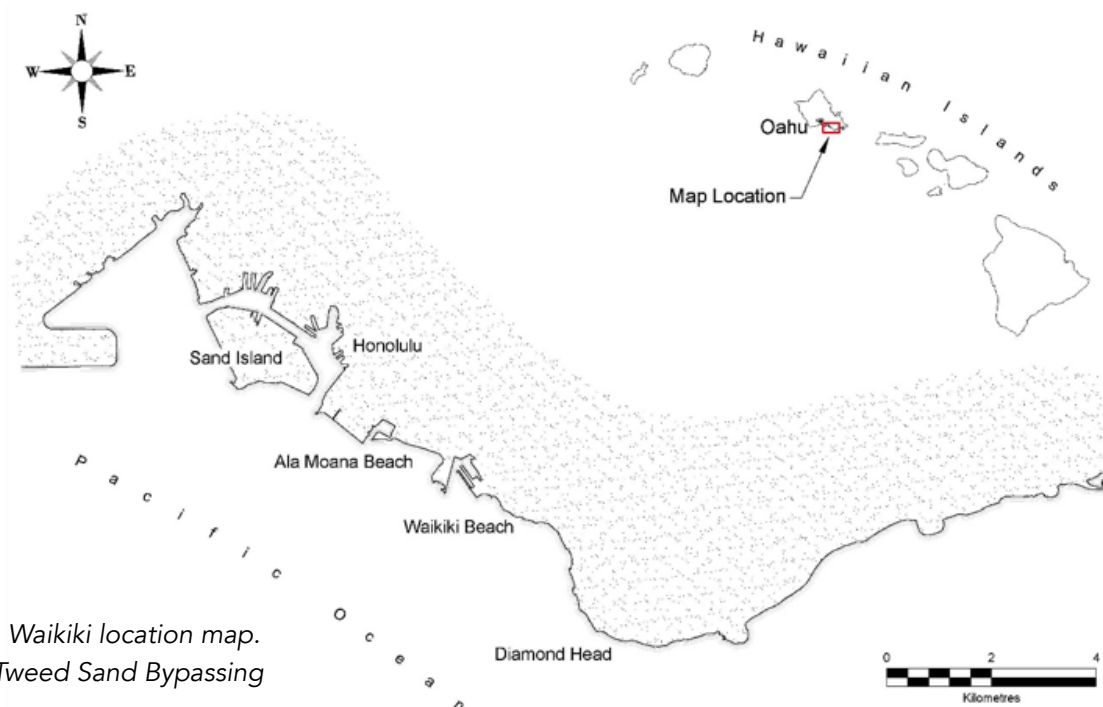


Figure 1: Waikiki location map.  
Source: Tweed Sand Bypassing

## INTRODUCTION

Waikiki is a neighbourhood of Honolulu on the southern shores of the island of Oahu. Oahu is one of many islands in the state of Hawaii, which is located in the Pacific and is part of the United States of America. Figure 1, Figure 2.

The Waikiki Beach coastline contains eight named beaches, including the famous Waikiki Beach, which draws millions of tourists to Hawaii each year. These tourists contribute over \$US2 billion to the Hawaiian economy

every year. A report by the Waikiki Improvement Association stated that 58 per cent of tourists wouldn't stay in Waikiki if there was no beach.

In the 1800s Waikiki Beach was one continuous 3.2 kilometre white sandy beach. It had nearshore fringing reefs that were broken in places by ancient, sand-filled river channels. Today the beach is a segmented, principally man-made beach. It is made up of artificially transported sand that requires constant management to maintain its existence. The fringing reef channels have been altered in places by dredging activities.



Figure 2a and 2b: Waikiki Beach. Source: Adobe Stock

# STUDENT ACTIVITIES

KN	KNOW
UN	UNDERSTAND
AP	APPLY
AN	ANALYSE
EV	EVALUATE
CR	CREATE

1. Use Google Earth to locate Hawaii, Honolulu and the Waikiki neighbourhood.

AN CR

- i. Locate Waikiki Beach Neighbourhood and Waikiki Beach. (Select map with no labels).
- ii. Name the beaches. (Turn all labels on).
- iii. Zoom in on Waikiki Beach
  - › What do you see?
  - › Describe the location (latitude & longitude) of Waikiki Beach.
  - › Record observations about Waikiki Beach and its coastal features.
  - › Provide commentary on human developments along or on the beach.
  - › Predict the coastal management issues that would confront the managers of Waikiki Beach.
- iv. Draw a sketch map of Waikiki beach with annotations showing natural and human features.

# ENVIRONMENTAL FUNCTIONING

## Coastal processes

Most of the sand at Waikiki is moved by longshore drift. When waves break over the fringing reef, water accumulates landward and moves in a current along the shore before moving back to sea through the channels. Sand is also transported by cross-shore drift. This is usually a destructive process caused by storms and king tides and leads to beach erosion.

## Seasonal sand movement

In the summer, Waikiki experiences powerful long-period swells generated in the southern hemisphere that produce good-quality surfing waves. In winter, Waikiki experiences extratropical cyclones called Kona Storms. These produce strong westerly winds and large waves that can cause coastal erosion. Erosion is increased by king tides and rising sea levels.

The width of Waikiki's beaches varies both between beaches (spatial change) and seasonally (temporal change). Generally, the beach is wider where there is no fringing reef and where groynes have been constructed and in summer. In summary, Waikiki Beach experiences general erosion during winter wave conditions, and beach recovery in the summer.



Figure 3a & 3b: Erosion on Waikiki Beach.  
Source: Lorraine Chaffer

# ENVIRONMENTAL CHANGE AND MANAGEMENT

For the past 50 years, Waikiki Beach has eroded by about 30 cm a year due to king tides, storms and rising sea levels. Erosion problems began with coastal development in the late 1800s when tourist hotels, homes and seawalls were built too close to the natural shoreline. By 1950 there were over 80 structures on the shoreline. This development both removed sand from the beach so hotels could be constructed, and interrupted the natural sand movement.

Management has included:

- › **seawalls** to protect properties from damage (shoreline hardening) or located offshore to break wave power and reduce erosion
- › **groynes** to trap sediment moving along the beach
- › **nourishment**, a "soft" (non-permanent) solution that creates a large sand reservoir and pushes the shoreline seaward.

Nourishment is popular because it preserves beaches and avoids the negative effects of hard structures. However, it is expensive and needs to be repeated over time.

## Beach nourishment and groynes

Regular beach nourishment and groyne construction were used to replace and retain sand removed during storms and king tide events. Since 1951, an estimated 80,000 cubic metres of sand have been added to restore Waikiki beaches. Until the 1970s sand was imported from as far away as Southern California by boat and barge. Importation of sand into Hawaii ceased in the 1970s after which Hawaiian sources, such as dunes at other beaches, were used.

More recent nourishment projects, including those completed at Kuhio and Royal Hawaiian Beaches in 2012, used sand offshore at Waikiki, effectively recycling sand back to the beach where it originated. It is important that the sand is the same colour, grain size and quality as existing sand to maintain the aesthetic values of the beach and to avoid the fast erosion that occurs if grains are too small or a different composition. Sources of appropriate local sand for nourishment are limited. This will impact the ability of authorities to continue nourishment in the future. Groynes retain the sand on nourished beaches until the next big storm event.

## Maintaining and replacing groynes and seawalls

Many older seawalls and groynes such as the Royal Hawaiian groyne are ageing and falling apart, creating dangerous conditions for tourists and threatening the existence of the adjacent beaches. Where two old groynes were removed completely at Kuhio Beach in 2012, the location became an erosion hotspot. State and local funding (the Waikiki Beach Special Improvement District tax on commercial businesses) was used to restore Kuhio beach by installing a 30 metre long sandbag groyne in 2019 and in 2020 will fund the replacement of the important Royal Hawaiian Groyne with an engineered wall.

The objective of this project is to maintain the beach's recreational and aesthetic values, improve access along the shore, and provide a first line of defence to properties in the event of storm-wave attack. Seawalls are also being repaired despite the understanding that seawalls increase sand erosion through wave reflection.





Figure 4: Beach management strategies at Waikiki Beach (showing groynes and sea walls). Source: Adobe Stock

### **The future of Waikiki Beach**

What are the options for the future management of Waikiki Beach? The conversation is now turning to managed retreat, although unlike other Hawaiian beaches the extent of development on the Waikiki shoreline may make retreat a difficult option. (In managed retreat the shoreline is left to erode, while relocating buildings and infrastructure further inland over time.)

Climate change must also be a consideration for future management as sea levels are predicted to rise and severe weather events increase. Flooding of the Waikiki Beach neighbourhood is projected to be a major impact from climate change along with threats to the future of its beaches.



# STUDENT ACTIVITIES

- KN KNOW
- UN UNDERSTAND
- AP APPLY
- AN ANALYSE
- EV EVALUATE
- CR CREATE

Compare Figures 2 and 3. Study all of the images in this case study.

1. Identify stakeholders who would be concerned about erosion at Waikiki Beach.  
UN AP AN
2. Use a *consequence diagram* to illustrate how beach erosion would impact these stakeholders. CR

# STUDENT ACTIVITIES

- KN KNOW
- UN UNDERSTAND
- AP APPLY
- AN ANALYSE
- EV EVALUATE
- CR CREATE

1. The past and future of Waikiki Beach are linked to sand. Explain this statement. AN
2. Complete some research on seawalls. Explain how seawalls can increase beach erosion. Include a labelled diagram in your answer. KN UN AN CR
3. Compare the management strategies implemented at Waikiki Beach with those used on the Tweed/Gold Coast. Explain any similarities and differences. AP AN
4. How viable is managed retreat as a short-term management strategy for:
  - › Waikiki Beach? EV
  - › Southern Gold Coast beaches? EV
5. Is a sand transfer system similar to Tweed Sand Bypassing appropriate for Waikiki Beach? EV  
Consider the following points to justify your answer:
  - › TSB is about restoring natural sand movement
  - › there is a natural or human barrier that needs to be bypassed
  - › natural processes are used to move sand that is relocatedIf your answer is yes, draw a diagram to illustrate how the project might look. EV
6. What challenges will decision-makers for the management of Waikiki Beach and Tweed/Gold Coast beaches face in the future? AP
7. **Imagine:** Draw a sketch of a future Waikiki Beach that is wide, sandy and aesthetically pleasing with features that satisfy all stakeholders including local residents, businesses, tourists and governments (economically, socially and environmentally sustainable). CR





Aerial drone shot view of Waikiki beach in Honolulu in Hawaii in summer time. Source Adobe Stock

## KEY LEARNING

- › The environmental processes moving sand on Waikiki beaches are longshore and cross-shore drift.
- › Waikiki beach has changed from a natural, continuous, wide, white sandy beach to a segmented, human-managed environment.
- › The beaches at Waikiki suffer from erosion during storms and king tides and also due to general sea level rise.
- › Management actions to maintain the values of Waikiki beach have included seawalls, groynes and nourishment.

## END OF TOPIC

### Concluding activity

Complete Activity Worksheet 5: COASTAL ENVIRONMENTAL CHANGE and MANAGEMENT: GLOBAL SCALE to demonstrate the knowledge and understanding you have developed about global environmental change and management of coasts at a global scale.







# FURTHER READING & REFERENCES

## Further reading

Honolulu Magazine: [Our Waikiki: King Tides, Beach Erosion and Water Pollution—Can Waikiki Be Saved?](#)

Hawaii News Now: [Engineers hope high-tech sandbags will keep the beach in Waikiki from disappearing](#)

Hawaii News Now: [Major project begins to tackle erosion hotspot on Oahu's most famous shoreline](#)

University of Hawaii: [Study says efforts to protect Hawaii from beach erosion are failing](#)

The Honolulu Advertiser: [Beach erosion widespread](#)

University of Hawaii Video: [As sea levels rise, short-term fixes along Hawaii beaches might hasten erosion.](#)

NY Times: [Hawaii's beaches are in retreat](#)

Hawaii News Now: [One third of Hawaii's coasts are moderately or highly vulnerable to rising seas](#)

Huff Post: [Waikiki Beach Is Totally Man-Made \(And Disappearing\). Can Hawaii Save It?](#)

## References

Charles H. Fletcher, Bradley M. Romine, Bruce M. Richmond et al;  
National assessment of shoreline change: Historical shoreline change in the Hawaiian Islands. Accessed from [www.semanticscholar.org/paper/National-assessment-of-shoreline-change%3A-Historical-Fletcher-Romine/99d5c3f26b5d47c0127e675246a7cfbc42ab20e0](http://www.semanticscholar.org/paper/National-assessment-of-shoreline-change%3A-Historical-Fletcher-Romine/99d5c3f26b5d47c0127e675246a7cfbc42ab20e0)

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Habel, S. et al; The influence of seasonal patterns on a beach nourishment project in a complex reef environment published in Coastal Engineering 116 (2016). Accessed from [www.pelagicos.net/MARS6910\\_fall2018/Readings/Habel\\_et\\_al.\\_2016.pdf](http://www.pelagicos.net/MARS6910_fall2018/Readings/Habel_et_al._2016.pdf)