

West Coast Shoreline Change Over the Last Century: Results from the USGS National Assessment of Shoreline Change Studies

1890's



1970's



2006



Natural Bridges, Santa Cruz, CA
Photographs Courtesy of Gary Griggs, UCSC

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"It's" Beach, Santa Cruz, CA



October

December



January

February

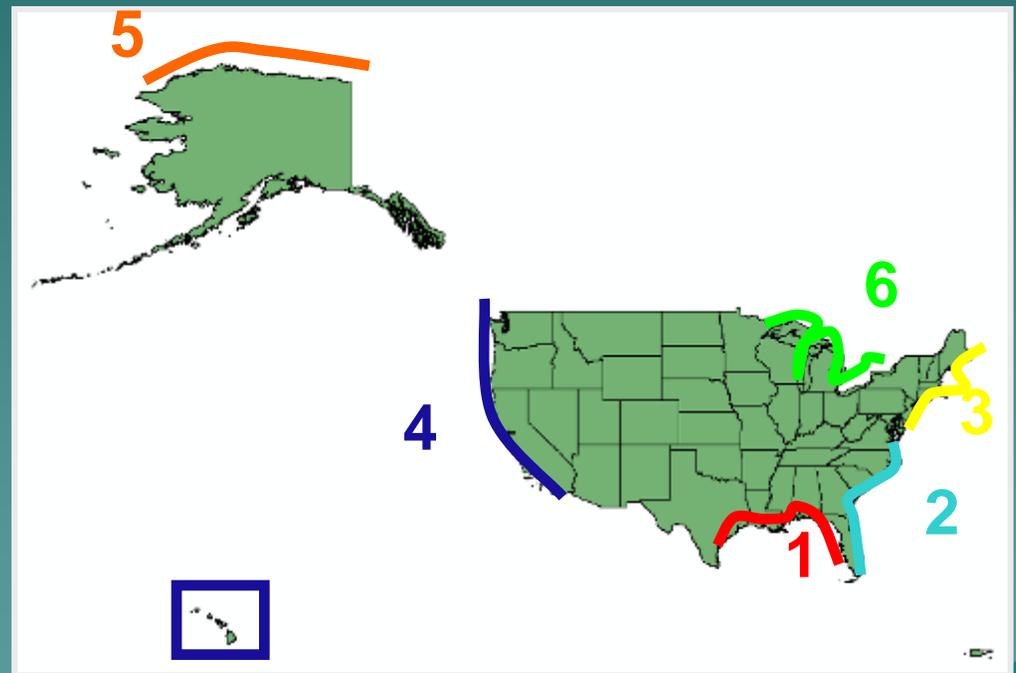


USGS National Assessment of Coastal Change Hazards

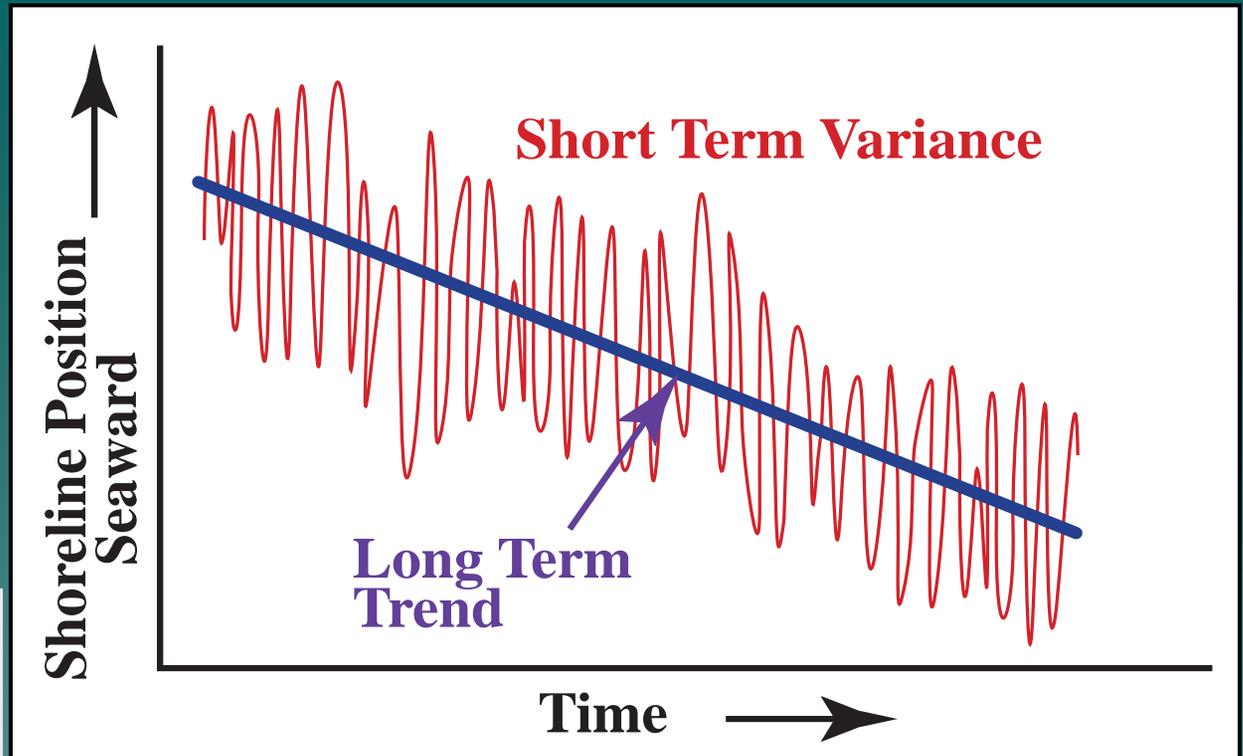
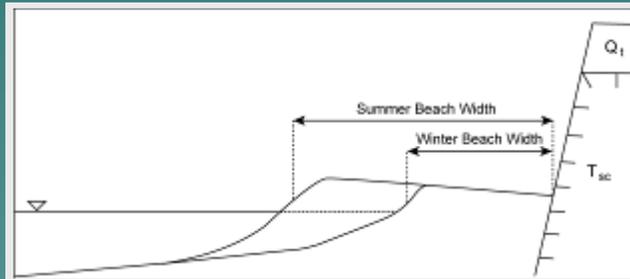
- Long-term change: shoreline & cliffs
- Extreme storms: vulnerability & forecasting
- Sea-level rise: vulnerability

USGS National Assessment of Shoreline Change Objectives

- ◆ Develop a national record of shoreline positions and assessment tools.
- ◆ Apply standard and uniform methods of shoreline change analysis.
- ◆ Establish procedures for future comparisons of shoreline position.
- ◆ Contribute to prediction of future coastal conditions.



Time Scales of Coastal Change



SHORT TERM VARIANCE

Storm impact/
recovery 10^{-1} years
Annual cycles 10^0
El Niño 10^1

LONG TERM TREND

Sea-level rise $10^2 +$ years
Changes in sand
supply $10^2 +$

Historical Shoreline Change

Four Shorelines

- *Late 1800s*
- *Mid-late 1920s*
- *1950s – 1970s*
- *Modern (Lidar)*

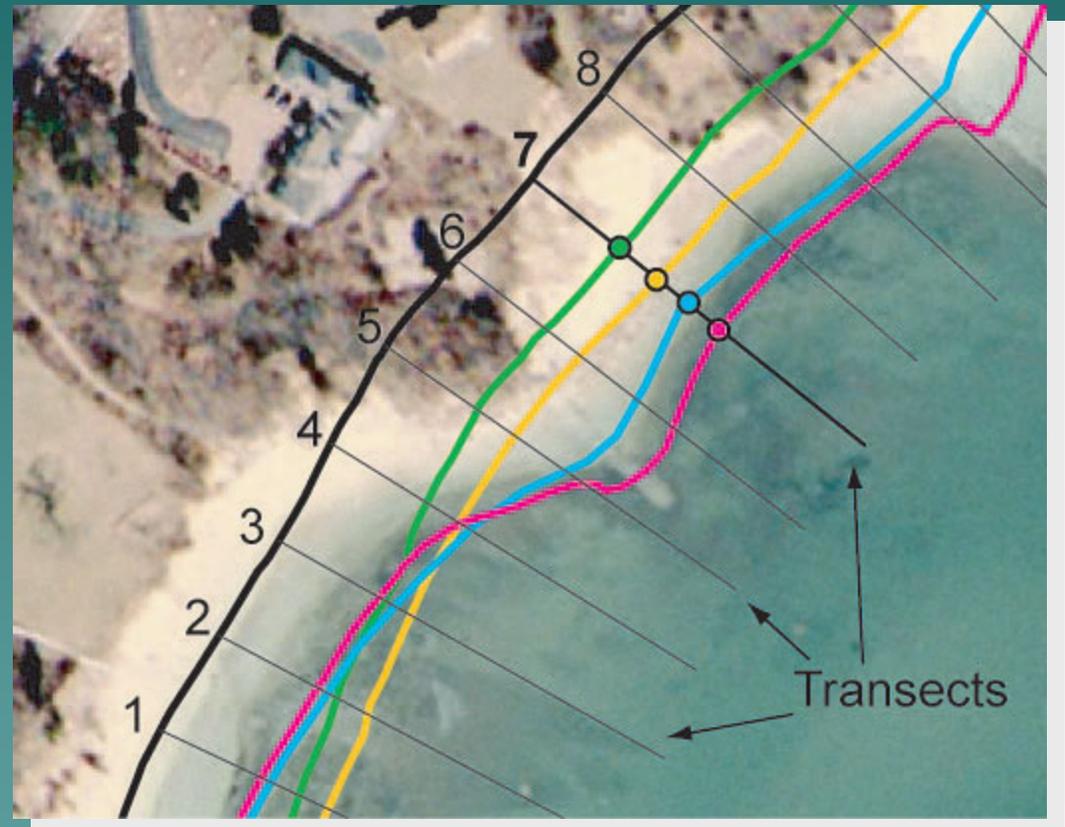
MHW elevation

DSAS analysis

- *50 m transect spacing*
- *End-point method*

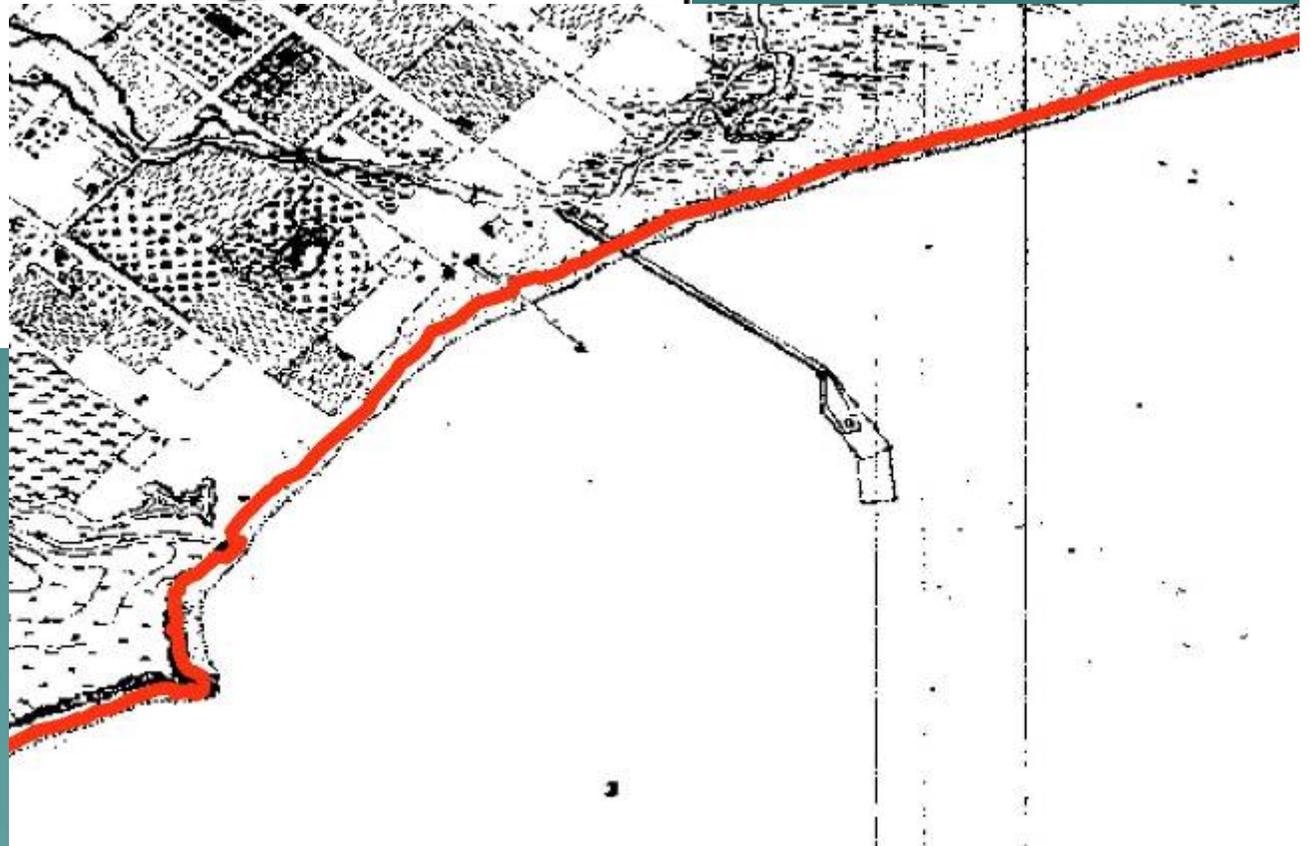
Long-term change (1800s-modern)

Short-term change (1950/70s – modern)

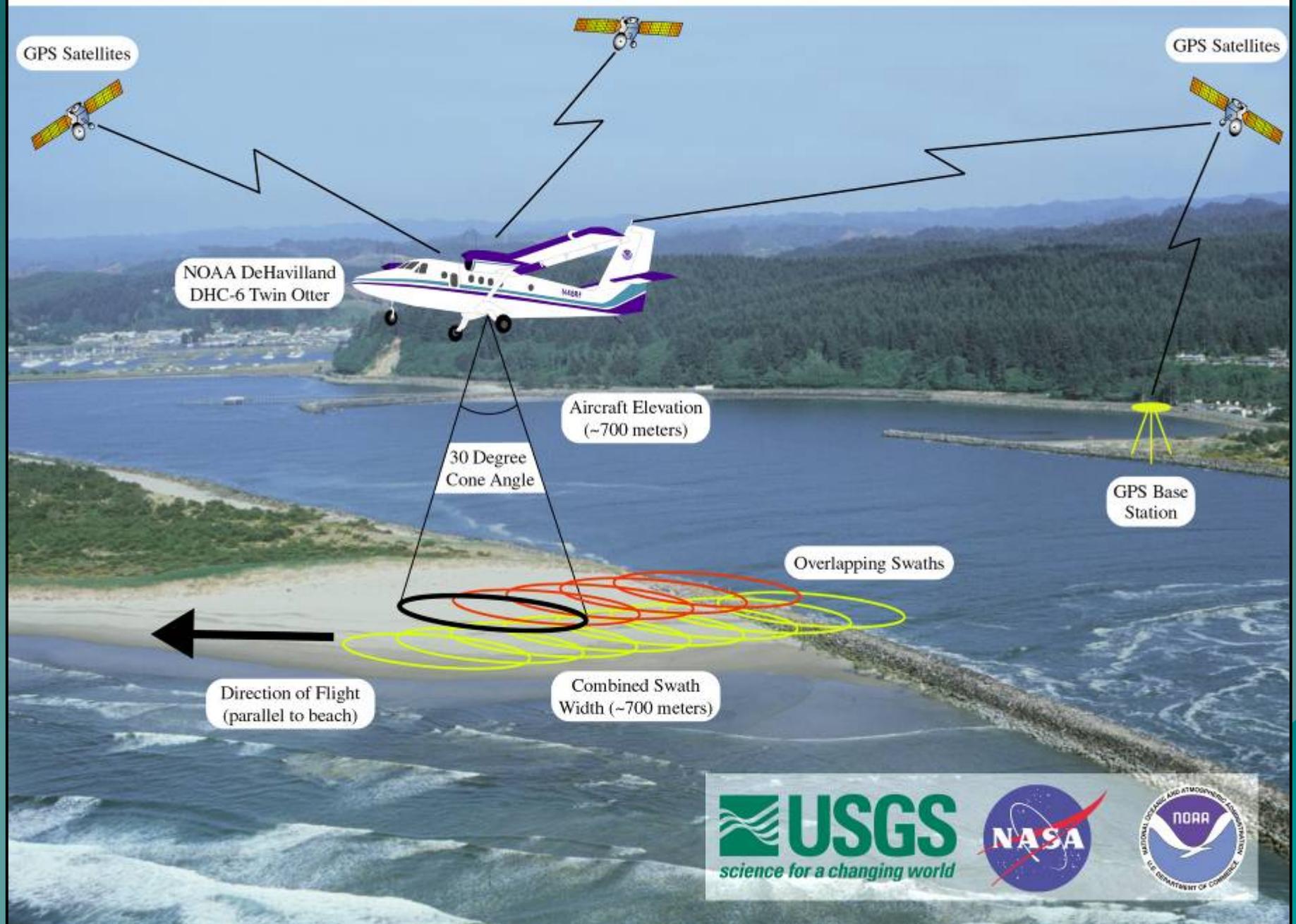


T-Sheet Sources

Santa Barbara 1870
Shoreline

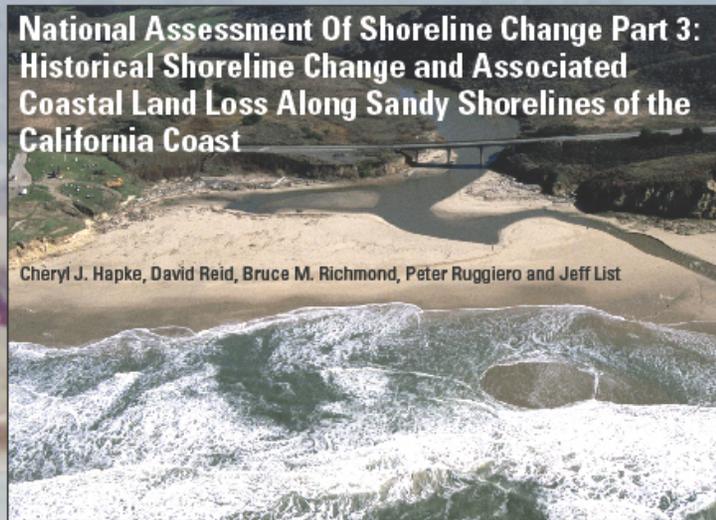


Mapping Beach Topography Using Scanning Airborne Laser Altimetry



National Assessment Of Shoreline Change Part 3: Historical Shoreline Change and Associated Coastal Land Loss Along Sandy Shorelines of the California Coast

Cheryl J. Hapke, David Reid, Bruce M. Richmond, Peter Ruggiero and Jeff List



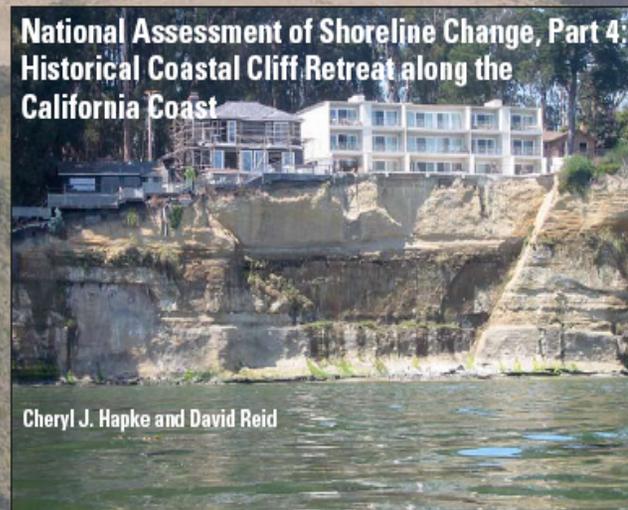
<http://pubs.usgs.gov/of/2006/1219>

Open-File Report 2006-1219

U.S. Department of the Interior
U.S. Geological Survey

National Assessment of Shoreline Change, Part 4: Historical Coastal Cliff Retreat along the California Coast

Cheryl J. Hapke and David Reid



<http://pubs.usgs.gov/of/2007/1133>

Open-File Report 2007-1133

U.S. Department of the Interior
U.S. Geological Survey

Associated GIS data also available for download

15 analysis regions

Transects spaced 50m

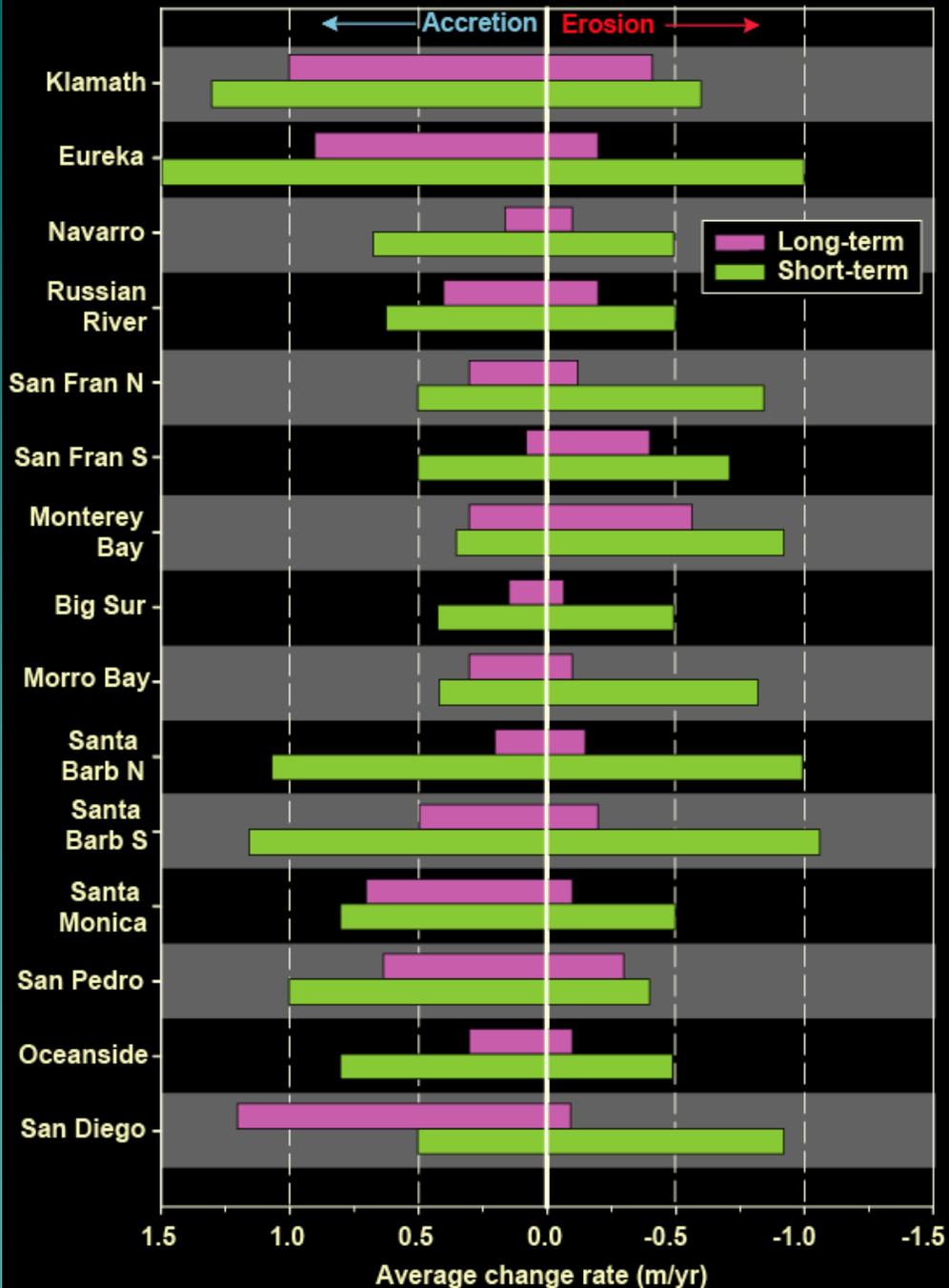
Long-term: 14,923 transects

Short-term: 16,348 transects

(LT = 1800s to 1998;
ST = 1970s to 1998)



Average Shoreline Change Rates (Shifted Data)



LONG-TERM:

Average erosion rate: -0.2 m/yr

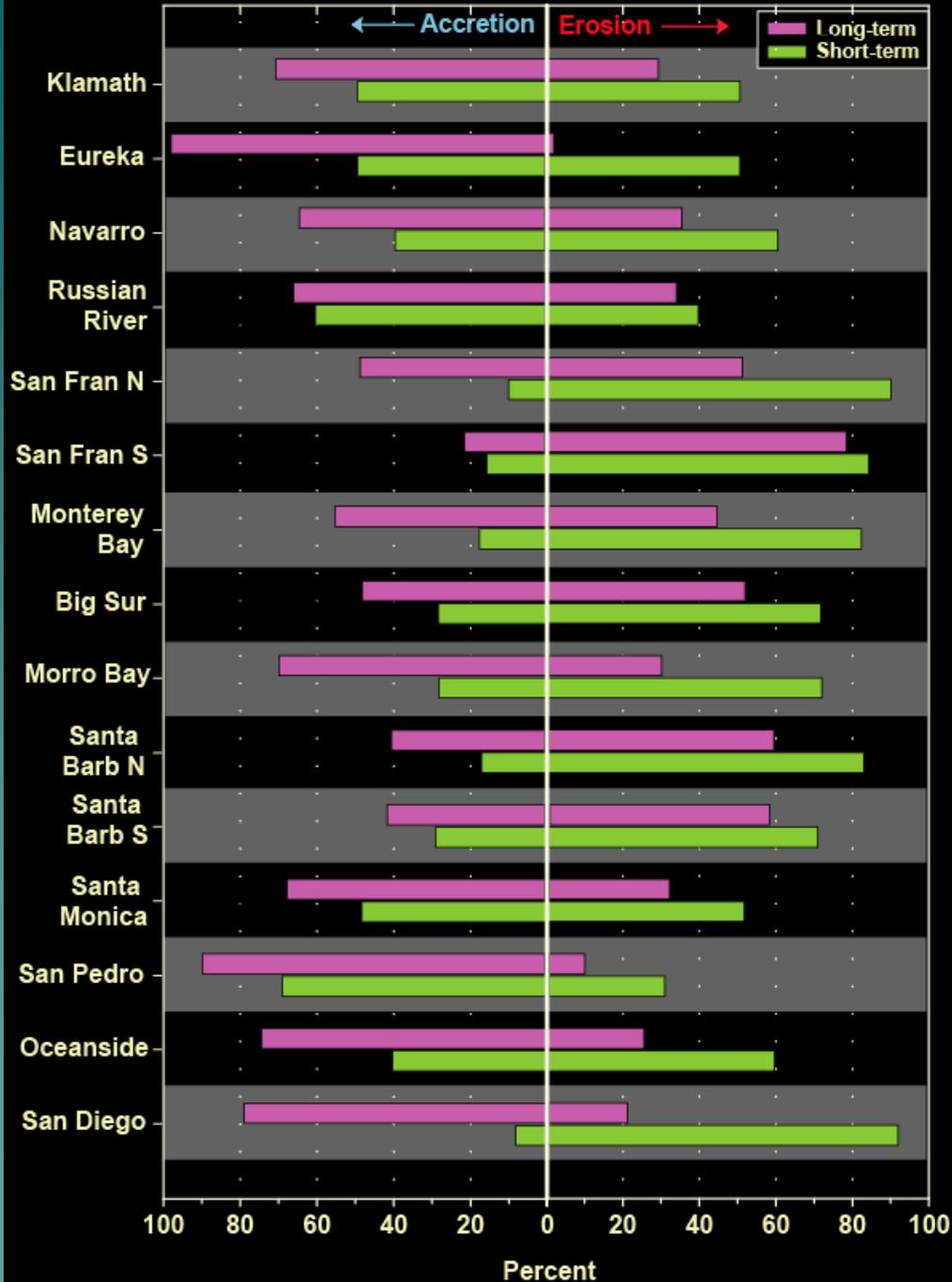
Average accretion rate: 0.5 m/yr

SHORT-TERM:

Average erosion rate: -0.7 m/yr

Average accretion rate: 1.2 m/yr

Percent of Shoreline Changing (Shifted Data)

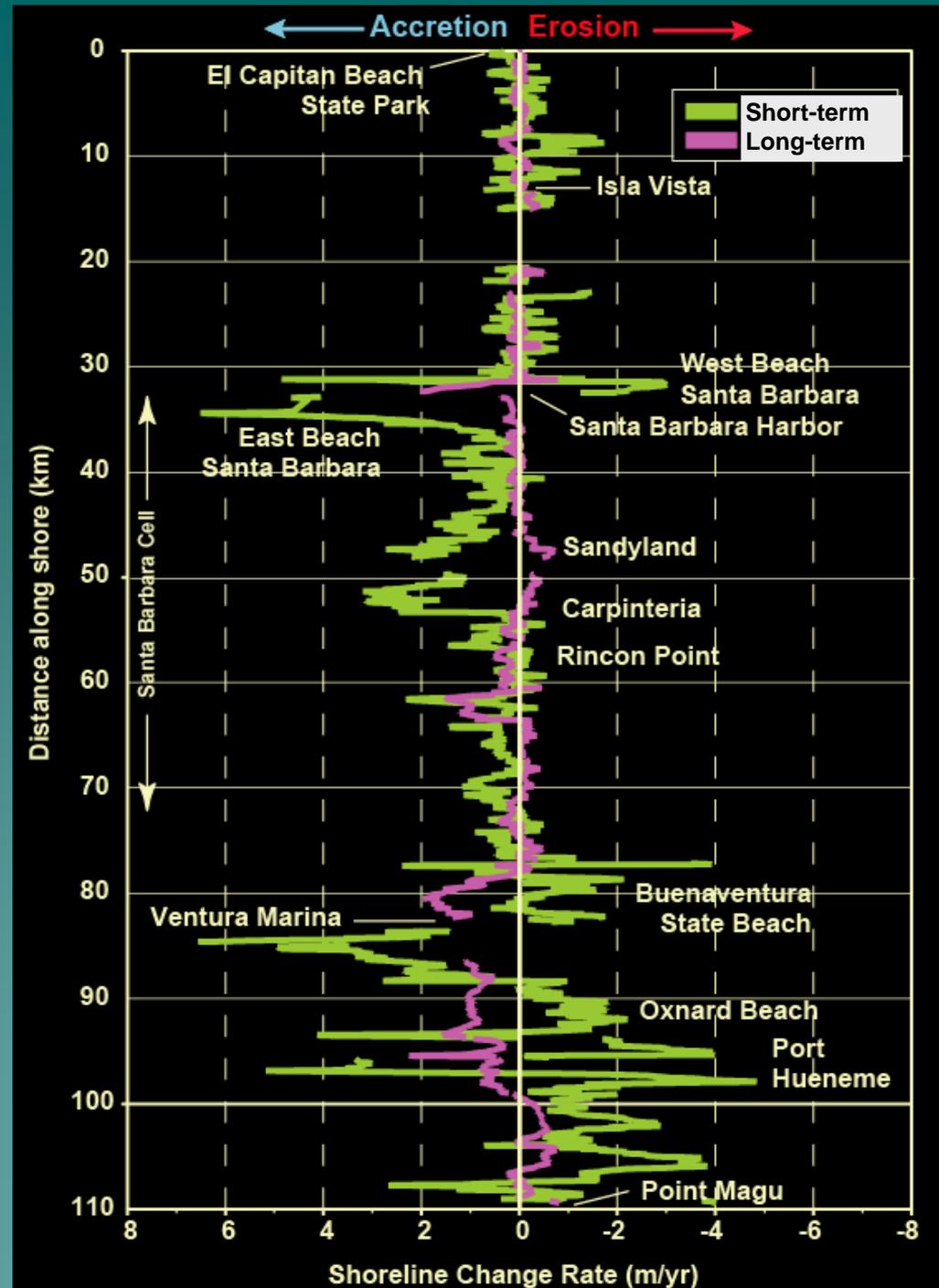


LT: 42% CA beaches eroding

ST: 68% CA beaches eroding

Shoreline Change Santa Barbara South Region

- Large variation indicative of highly engineered and/or irregular coast
- Large accretional spikes related to sand impoundment by groins and jetties, harbor bypassing, or natural headlands



National Assessment of Shoreline Change Part 3: Historical Shoreline Change and Associated Coastal Land Loss Along Sandy Shorelines of the California Coast

U.S. Geological Survey
Open File Report 2006-1219

by: [Cheryl J. Hapke](#), David Reid, Bruce M. Richmond, Peter Ruggiero and Jeff List

2006

Standard-resolution version: Open this 79-page publication in Adobe® Reader [of2006-1219.pdf - 3.9 MB PDF](#)



National Assessment Of Shoreline Change Part 3: Historical Shoreline Change and Associated Coastal Land Loss Along Sandy Shorelines of the California Coast



Open-File Report 2006-1219
U.S. Department of the Interior
U.S. Geological Survey

"National Assessment of Shoreline Change Part 3: Historical Shoreline Change and Associated Coastal Land Loss Along Sandy Shorelines of the California Coast" is a 79-page, full-color discussion of historical shoreline change and coastal land loss along the U.S. California coast.

NOTE: You will need to have the free [Adobe® Reader](#) (v.6.0 or higher) installed on your computer to view and print this publication.

Standard-quality version: [of2006-1219.pdf](#) (3.9 MB PDF). This version was produced at 300 dpi with jpg-medium (lossy) compression for smaller size. It looks good on the screen, contains "bookmarks" in the margin, and makes a fairly good printout.

High-quality version: [of2006-1219_hi-qual.pdf](#) (87.7 MB PDF) This version was produced at 300 dpi with zip (lossless) compression for sharper images. It is over 20 times as large so only download it if you want to make a particularly good printout.

Plain Text version (open this file in any text editing program): [of2006-1219.txt](#) (308 KB ASCII). This version is raw text and has no illustrations.

Data compilations—see also:

[Open-File Report 2004-1089](#) The National Assessment of Shoreline Change: A GIS Compilation of Vector Shorelines and Associated Shoreline Change Data for the U.S. Gulf of Mexico

[Open-File Report 2006-1251](#) The National Assessment of Shoreline Change; A GIS Compilation of Vector Shorelines and Associated Shoreline Change Data for the Sandy Shorelines of the California Coast

[Open-File Report 2007-1112](#) The National Assessment of Shoreline Change; A GIS Compilation of Vector Cliff Edges and Associated Cliff Erosion Data for the California Coast



Related Research Projects:

[National Assessment of Coastal Change Hazards](#)

USGS Coastal & Marine Geology Program

[Coastal Classification Mapping Project](#)
USGS Coastal & Marine Geology Program

Related Links:

[National Assessment of Shoreline Change...](#)

[Historical Shoreline Changes and Associated Coastal Land Loss...](#)

[Part 1, Along the U.S. Gulf of Mexico - USGS Open-File Report 2004-1043](#)

[Part 2, Along the U.S. Southeast Atlantic Coast - USGS Open-File Report 2005-1401](#)

[Historical Coastal Cliff Retreat...](#)

[Part 4, Along the California Coast - USGS Open-File Report 2006-1219](#)

The National Assessment of Shoreline Change: A GIS Compilation of Vector Shorelines and Associated Shoreline Change Data for the Sandy Shorelines of the California Coast

By Cheryl Hapke¹ and David Reid²

2006

¹U.S. Geological Survey, Patuxent Wildlife Science Center, Coastal Field Station, Department of Geosciences, University of Rhode Island, Kingston, RI 02881

²U.S. Geological Survey, Pacific Science Center, 400 Natural Bridges Drive, Santa Cruz, CA 95060

Introduction

The [Coastal and Marine Geology Program](#) of the [U.S. Geological Survey](#) has generated a comprehensive data clearinghouse of digital vector shorelines and shoreline change rates for the sandy shoreline along the California open coast. These data, which are presented herein, were compiled as part of the U.S. Geological Survey's National Assessment of Shoreline Change Project.

Beach erosion is a chronic problem along many open-ocean shores of the United States. As coastal populations continue to grow and community infrastructures are threatened by erosion, there is increased demand for accurate information including rates and trends of shoreline migration. There is also a critical need for shoreline change data that is consistent from one coastal region to another. One purpose of this work is to develop standard, repeatable methods for mapping and analyzing shoreline movement so that periodic, systematic, and internally consistent updates of shorelines and shoreline change rates can be made at a National Scale.

This data compilation for open-ocean, sandy shorelines of the California coast is one in a series that already includes the Gulf of Mexico and the Southeast Atlantic Coast (Morton et al., 2004; Morton et al., 2005) and will eventually cover Washington, Oregon, and parts of Hawaii and Alaska. Short- and long-term shoreline change evaluations are determined by comparing the positions of three historical shorelines digitized from maps, with a modern shoreline derived from LIDAR (light detection and ranging) topographic surveys. Historical shorelines generally represent the following time-periods: 1850s-1880s, 1920s-1930s, and late 1940s-1970s. The most recent shoreline is from data collected between 1997 and 2002. Long-term rates of change are calculated by linear regression using all four shorelines. Short-term rates of change are end-point rate calculations using the two most recent shorelines. Please refer to our full report on shoreline change of the California coastline at <http://pubs.usgs.gov/of/2006/1219/> for additional information regarding methods and results (Hapke et al., 2006).

Data in this report are organized into downloadable layers by region (Northern, Central and Southern California) and are provided as vector datasets with metadata. Vector shorelines may represent a compilation of data from one or more sources and these sources are included in the dataset metadata. This project employs the Environmental Systems Research Institute's (ESRI) ArcGIS as it's GIS mapping tool and contains several data layers (shapefiles) that are used to create a geographic view of the California Coast. These vector data form a basemap comprised of polygon and line themes that include a U.S. coastline (1:80,000), U.S. cities, and state boundaries.

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[GIS Data Layers](#)

[Data Files](#)

[Base Layers](#)

[About Data Collection](#)

[Index Map](#)

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[Contacts](#)

see also:

**USGS OFR 2006-1219:
National Assessment of
Shoreline Change Part 3:
Historical Shoreline
Change and Associated
Coastal Land Loss Along
Sandy Shorelines of the
California Coast**

**USGS Western Coastal &
Marine Geology (WCMG)**

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**USGS Coastal & Marine
Geology Program**

GIS Data Layers

Data in this publication are intended to be integrated into a GIS. A GIS is defined as a system of hardware and software to support the display, manipulation, and analysis of spatial data for mapping and complex data analysis. This integrated package provides researchers the ability to analyze and map the various datasets to help with research, economic and social policy-making decisions regarding the environment.

All of the files necessary to run shoreline change analysis are provided. This includes ten GIS data layers (shapefiles) for each region along the sandy shoreline of California. These include: three historical and one modern vector shorelines, an offshore baseline used for generating shore-normal transects, shore-normal transects for long- and short- term shoreline change rates, transect/shoreline intersection positions for long- and short-term shoreline change rates as a point shapefile, and a vector shapefile containing bias values for the MHW - HWL shoreline proxy offsets. The GIS data layers from this publication are cataloged below by region for easy access. Please refer to <http://woodshole.er.usgs.gov/project-pages/dsas/> for information about the Digital Shoreline Analysis System (DSAS) used for the analysis of this data.

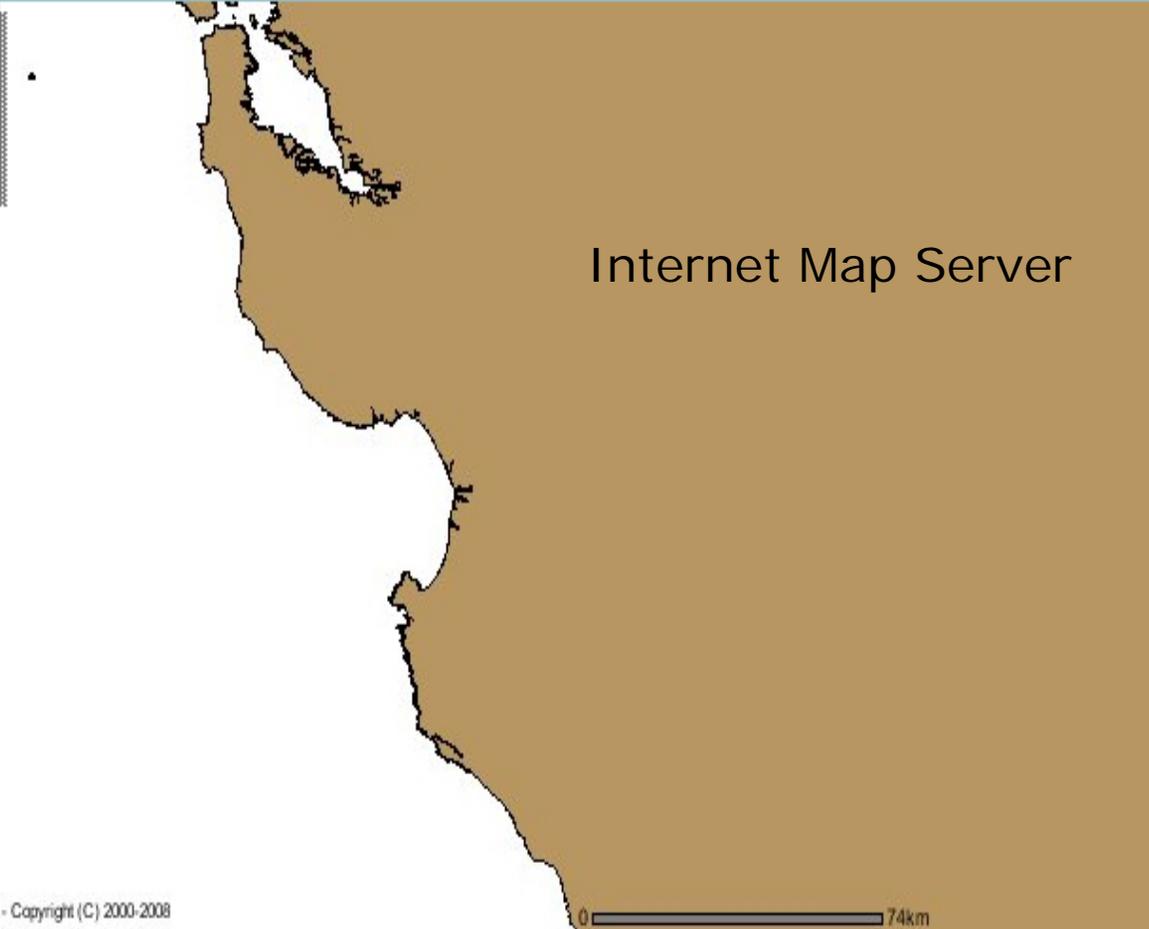


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Data Files

Region	Layer Name and Description	Metadata	Files
Southern index map	SoCal1852_1889 - Vector shoreline derived from 1852-1889 source data	HTML , FAQ , text , xml	SCal.zip
	SoCal1920_1934 - Vector shoreline derived from 1920-1934 source data	HTML , FAQ , text , xml	
	Socal1971_1976 - Vector shoreline derived from 1971-1976 source data	HTML , FAQ , text , xml	
	Socal1998 - Vector shoreline derived from 1998 source data	HTML , FAQ , text , xml	
	SoCal_baseline - Offshore baseline for generating shore-normal transects	HTML , FAQ , text , xml	
	Socal_biasvalues - Shoreline MHW - HWL Bias offset Values	HTML , FAQ , text , xml	
	Socal_transects_lt - Shore-normal transects with associated long-term rates of shoreline change	HTML , FAQ , text , xml	
	Socal_transects_st - Shore-normal transects with associated short-term rates of shoreline change	HTML , FAQ , text , xml	
	Socal_intersects_lt - Transect/Shoreline intersection positions associated with long-term rates	HTML , FAQ , text , xml	
	Socal_intersects_st - Transect/Shoreline intersection positions associated with short-term rates	HTML , FAQ , text , xml	

USGS California Coast Shoreline Change



California Coast Shoreline Change Report Data Catalog

LAYERS

- All Layers
- Northern CA
 - short-term shoreline
 - long-term shoreline
 - bias values - Northern CA
 - offshore baseline
 - Historic Shoreline
 - Transect Intersection
- Central CA
 - short-term shoreline
 - long-term shoreline
 - bias values - Central CA
 - offshore baseline
 - Historic Shoreline
 - Transect Intersection
- Southern CA
 - short-term shoreline
 - long-term shoreline
 - bias values - Southern CA
 - offshore baseline
 - Historic Shoreline
 - Transect Intersection
- Basemap Layers

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0 74km

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Regional Map Sites:

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Go to

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Santa Cruz Wharf

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0 1.16km

California Coast Shoreline Change Report Data Catalog

LAYERS

- All Layers
- Northern CA
 - short-term shoreline
 - long-term shoreline
 - bias values - Northern CA
 - offshore baseline
 - Historic Shoreline
 - 2002 shoreline
 - 1952-1971 shoreline
 - 1928-1936 shoreline
 - 1854-1880 shoreline
 - Transect Intersection
- Central CA
 - short-term shoreline
 - long-term shoreline
 - bias values - Central CA
 - offshore baseline
 - Historic Shoreline
 - Transect Intersection
- Southern CA
 - short-term shoreline
 - long-term shoreline
 - bias values - Southern CA
 - offshore baseline

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 - long-term shoreline
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 - offshore baseline
 - Historic Shoreline
 - Transect Intersection
- Southern CA
 - short-term shoreline
 - long-term shoreline
 - bias values - Southern CA
 - offshore baseline

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DSAS

DIGITAL SHORELINE ANALYSIS SYSTEM

Computer Software for Calculating Shoreline Change (and other problems dealing with the positional change of a boundary over time)

The Digital Shoreline Analysis System (DSAS) is computer software that computes rate-of-change statistics from multiple historic shoreline positions residing in a GIS. It is also useful for computing rates of change for just about any other boundary change problem that incorporates a clearly-identified feature position at discrete times.

The DSAS software is freely available.

CURRENT VERSION

The current version is 3.2 and is available [here](#).

If you use it, please cite the following publication:

Thieler, E.R., Himmelstoss, E.A., Zichichi, J.L., and Miller, T.L., 2005, Digital Shoreline Analysis System (DSAS) version 3.0: An ArcGIS extension for calculating shoreline change: U.S. Geological Survey Open-File Report 2005-1304.

A public bulletin board for DSAS support is available to report bugs, as well as to exchange tips and techniques with the authors and other DSAS users.

<https://woodshole.er.usgs.gov/cgi-bin/discuss/show.cgi?2/2>

CONVERSION UTILITY

DSAS transects created in the previous DSAS v.2x (for ArcView 3.x) can now be imported for use in DSAS v.3.0+ (for ArcGIS 9+) using the stand-alone utility available for download below.

http://woodshole.er.usgs.gov/project-pages/dsas/Transect_converter/DSAS_convert_transects.zip



Required inputs:

- Multiple shoreline positions
- User-generated baseline

DSAS generates transects that are cast perpendicular to the baseline at a user-specified spacing alongshore.

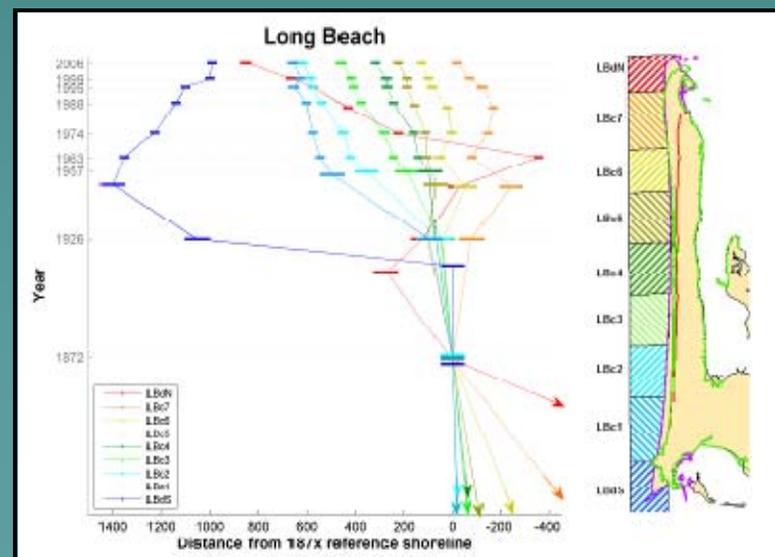
The transect/shoreline intersections along this baseline are then used to calculate the rate-of-change statistics.

Oregon Shoreline Change (progress)

- ◆ Oregon Historical Shorelines:
 - 1880s – Completed
 - 1930s – Completed
 - 1950s-1970s (<25% of Shoreline) – Completed
 - 1960-1980s DRGs – Completed
 - 1967 Aerial Photography – scanning complete, orthorectification and mosaic creation complete, shoreline vectorization in progress (WA Dept. of Ecology)
 - 2002 Lidar
 - ◆ Shoreline and beach slopes – Completed
 - ◆ Proxy-datum bias and bias uncertainty - Completed
 - ◆ DSAS Analysis:
 - Baseline Generation - Completed
 - Transects Generation - Completed
 - ◆ Long-Term – 6175 = 309 km
 - ◆ Short-Term – 7146 = 357 km
 - Edits of Transects – Completed
- DSAS Analysis awaits final shorelines

Washington Shoreline Change (progress)

- ◆ Washington Historical Shorelines:
 - 1880s – 90% Completed
 - 1930s – Completed
 - 1950s-1970s – 90% Completed
 - 2002 Lidar
 - ◆ Shoreline and beach slopes – Completed
 - ◆ Proxy-datum bias and bias uncertainty - Completed
 - ~5 other high quality shorelines – Completed
- ◆ DSAS Analysis:
 - Baseline Generation - Completed
 - Transects Generated
 - ◆ Long-Term
 - ◆ Short-Term
 - Edits of Transects – Completed



Concluding Remarks

- ◆ Can documenting past shoreline positions be used to adequately predict future trends?
- ◆ How will climate change and accelerated sea-level rise impact shorelines?
- ◆ Impact of anthropogenic changes such as engineering structures and changes to sediment supply – complex issue.
- ◆ Plan to periodic update shorelines and DSAS program including statistical tools.

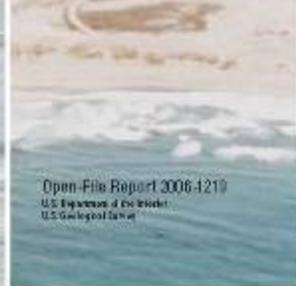
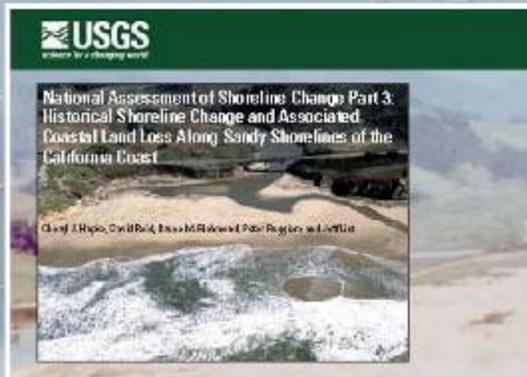
USGS Shoreline Change Web Sites (West Coast)

- ◆ California Sandy Shoreline Change Open File Report:
<http://pubs.usgs.gov/of/2006/1219/>
- ◆ California Sandy Shoreline GIS Data:
<http://pubs.usgs.gov/of/2006/1251/>
- ◆ California Sandy Shoreline Internet Map Server:
http://coastalmap.marine.usgs.gov/ArcIms/Website/usa/westcoast/shoreline_change/ca_coast/viewer.htm
- ◆ California Cliff Change Open File Report:
<http://pubs.usgs.gov/of/2007/1133/>
- ◆ California Cliff GIS Data:
<http://pubs.usgs.gov/of/2007/1112/>
- ◆ National Assessment of Shoreline Change Project:
<http://coastal.er.usgs.gov/shoreline-change/>
- ◆ USGS Western Coastal and Marine Geology Team Page:
<http://walrus.wr.usgs.gov/>
- ◆ DSAS: <http://woodshole.er.usgs.gov/project-pages/dsas/>

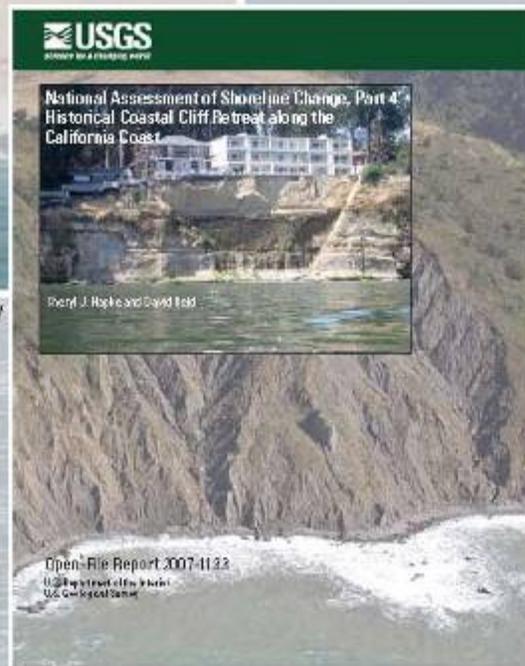
USGS National Assessment of Shoreline Change

Publications from Western States

Now online:



<http://pubs.usgs.gov/of/2006/1219/>



<http://pubs.usgs.gov/of/2007/1133/>

In preparation:

