Craig Schaller

Writing 50-Dr. Coloura

Erosion in Santa Barbara

Beaches, especially in Santa Barbara, are an important economic entity. In California, tourism based on the Pacific Ocean was valued at 9.9 billion dollars in 1992 according to the California Research Bureau for the Resources Agency. Santa Barbara is a city built around its beaches. Popular hang out spots such as Surfers Point, Sterns Wharf, Leadbetter, West Beach, and Gaviota are centers for the cities community. Beach parks are popular for barbeques, parties, and general relaxation. The offshore waves draw surfers from all over the region, giving rise to a healthy local surf industry.

Unfortunately a combination of human and environmental factors are slowly destroying the California coastline. “The coast is actively eroding due to complex oceanographic and geologic conditions as well as by human activities affecting site conditions and the deliveries and movement of sand to and along the coast” (California Resources Agency 1) Throughout the state, beaches are degrading, in Santa Barbara, sand supply has decreased rapidly. “Sediments [or sand], are the building blocks for beaches that provide not only habitat and outstanding recreational opportunities but also provide a safety buffer between the ocean and our costal communities.” (California Resources Agency 2)

Santa Barbara has a unique set of beaches and coast layout. The west-east situated coastline makes incoming currents a source from extra tropical cyclones what come form the northeast Pacific and travel east. (Chambers Group V-23) The velocity of these (and all) waves “depends on the depth of water in which the wave propagates”

(Chambers Group V-23). Santa Barbara's deep off shore waters allow cyclone-based waves to reach the shores with considerable velocity and force. Wave action, is vital for the health of any given beach. High tides remove degrading matter, clear the sand, and take away any extra sand buildup from inland. In Santa Barbara, as well as the rest of California, human influences have changed the relationship between waves and beaches. Human usage and structures have blocked wave action in some areas, and increased wave force in others. As a result, beaches are eroding in a faster and un-natural pace in certain areas.

A history of Erosion:

In the Santa Barbara County, little attention has been given to erosion. One group, the FISH team, has documented changes in local beaches and composed warnings about future erosion (State of California 20). However the FISH team's primary concern is local underwater habitat, not the destruction of actual beaches. (State of California 20) Erosion in Santa Barbara was first seriously considered in 1983, where a strong storm during the winter season destroyed much of the coastline. Emergency repair crews placed rubble for temporary protection from further damage. Fate had finally caught up with the developers of Santa Barbara. Unprotected beaches and overbuilt coastlines were beginning to show their faults (Final Environmental III-I). The Santa Barbara City council "conducted a cost-benefit analysis" that found 6 ton protective structures were necessary to protect the shores. Later that year, the Shoreline Drive Protective Structure was constructed, it is 400 feet in length and is made of graded rock. The structure acts as a barrier between storm waves and the Shoreline Drive road (Final Environmental III-3). This structure was an important landmark for

Santa Barbara's coastline. It was the first effort made to protecting Santa Barbara's shores from future damage.

Since then, no other major action has been taken to protect the coastline. Beaches, such as Surfer's Point, have periodically had sand added. Erosion still plagues the Santa Barbara County as a sleeping giant. Over time, as coastline continues to wear inland, beaches will be damaged and or completely destroyed in storms to come (Griggs xi). The main issues that need to be addressed are: 1. What are the different problems along the Santa Barbara coast leading to beach destruction? 2. What are the possible solutions for these problems (both physical and legislative)? 3. What of these solutions are feasible/worthwhile? After looking at county issues of sand blockage, drainage, man-made construction, and natural disasters, it is clear a combination of unique solutions and environmental policy are needed.

Sand Blockage:

One of the major threats to local beaches comes form the areas inland. The Santa Barbara coast is supplied with sand from landmasses behind the beaches. "Sand is deposited from streams and creaks along the coast" (Master Plan 6). In Santa Barbara, as well as the rest of California, "ill advised construction of breakwater, groins, jetties, and piers" have interrupted the natural sand sources supplying the coastline (Master Plan 6).

On California's coast, a sandstone bluff backs most of the beaches. Sandstone is a soft rock and naturally erodes, crumbling to form much of the sand below. Unfortunately, due to landscaping done by humans in the last century in and around beaches, sandstone in popular areas is wearing faster than normal (Final

addendum). Structures built on sandstone cliffs, add pressure to the bluff, causing premature crumbling during storms. Areas cut away to make roads and walking paths to beaches create fractures throughout the cliff, decreasing its stability. Scientists for the state of California working for the Coastal and Marine and Geology program have named this problem "sea cliff retreat" and defined it "as the progressive landward recession of the shoreline due to both natural and manmade failure processes" (USGS). During rain, the clay in sandstone absorbs water and swells. The swelling pressure "triggers slope failure" and can have disastrous results (USGS). Sandstone is the most dangerous of beach problems in Santa Barbara County. It is also an example of a problem that requires both policy and physical change to remedy the coastline.

Drainage:

To stop sandstone erosion in areas already built on, drainage is extremely important. In Isla Vista, beachfront properties along Del Playa Drive come within feet of the cliffs (Norris). It is possible that with a heavy storm, the combination of housing weight pressure, swelling of sandstone clay, and pre-made crack lines from beach walkways could cause the bluff to crumble and fall (Norris). Figure 1 shows several larger houses built right up to the side of the cliffs. It seems logical to reinforce the cliffs from beachside, so no further erosion can occur. Unfortunately simply supporting a sandstone cliff is not feasible. The bluffs need to be able to grow and erode slightly based on season. During Winter months when waves are stronger, the current depletes rock from the side. In summer months, sand gradually accumulates. This cycle is what keeps beaches at a constant sand level throughout the years. Reinforcing the cliffs from further erosion would lead to the depletion of sand from beaches below. The best

solution is drainage control for the sandstone cliffs. Drainage control eliminates the possibility of clay swelling causing slope failure (Draft Policy iv). A system of water outlets would allow cliffs to not take on additional water weight after a storm. The small cyclical growth and erosion of the cliffs would still go on to keep the beaches healthy.

Wharf Issues and Seawalls:

Sandstone construction is not the only problem leading to beach degradation. Several structures such as piers and oil pipelines affect the condition of surrounding beaches. The local hot sport Sterns Wharf in downtown Santa Barbara is an example of such construction. Sterns Wharf is a man made problem that requires a man made solution to save the surrounding beach. The historic wharf rests on a series of concrete pillars starting at the beach line, extending a quarter of a mile out to sea. When at the wharf, it is obvious the construction has had an impact on the surrounding shoreline. When looking westward, one can observe a healthy current as waves ebb towards the beach. On the eastward side, where current has been blocked by underwater concrete pillars supporting the wharf, no waves roll in. The water is for the most part, still standing. Waves are a vital part of a beach's cycle. "Waves and currents are the primary forces that move sediment in the littoral zone and annual wave height is responsible for seasonal erosion and accretion patterns." (National Assessment, 19) Based on personal observations, it is obvious the difference in current has lead to an unfortunate pattern of erosion. The west side, subject to uninterrupted current, is about 18 feet inward of the east side. The difference in beach size between the two sides can best be seen in Figure 2. Although the east side has a bigger beach due to the wharf's blockage, it does not have a continuous replenishment of sand, or the currents ability to wipe away decaying

marine life (such as seaweed). Sterns Wharf is one area where man interrupted erosion needs to be addressed.

Historically, the best treatment against erosion is the use of "Hard Protection Devices" (Draft Policy, pg iv). These are man made structures created to stop erosion is specific areas. The most significant hard protection device is a seawall. Seawalls are built in the water next to a shore. They are most commonly made of concrete or mesh tubes filled with pebbles. Seawalls work by dissipating larger waves into smaller ones before hitting the shores (Norris). There are two main kinds of seawalls. Vertical seawalls are completely straight structures that work well in stormy conditions; an example shown in Figure 4. The steepness of the wall shatters incoming waves. However, vertical walls sometimes produce a standing wave due to currents (Norris). The second and more effective type of seawall is a curved seawall. The slope of this design allows waves to break in a less violent manner. As a result, less water topples over the edge of the structure (Norris).

In California, one of the largest and most effective seawalls is a 6000-foot long concrete structure in Carlsbad. The wall "protects a utility corridor as well as an important north-south thoroughfare along the coast" (Draft Policy pg iv). What makes this wall so effective is its minimally invasive presence. The wall is made of a sand colored rock, blending well into the side slope. The wall is also not in the way of beach goers, it hugs the inland curb leaving the sand area of the beach undisturbed, as shown in Figure 5. As a result, the Carlsbad Seawall is a good combination of function and form. Inland roads and structures are well protected, yet the presence of the wall is almost unnoticeable. A seawall such as this is a possible solution to Santa Barbara's

erosion problems. Like San Diego County, Santa Barbara County's main freeway (the 101) follows the coast line and in certain spots comes very close to the shoreline. Both areas are subject to similar weather conditions and have the same coastline geography.

Although seawalls are extremely effective, they come with major drawbacks. With such large structures protruding across the shoreline, public access is limited. Stairwells, such as the two in Isla Vista, that take beachgoers from the cliffs above to the shoreline cannot be used. Allowing room for a stairway would compromise the design of the seawall. Alternatively, pedestrians have to walk long distances around seawalls to access the beach. Seawalls are also expensive, concrete structures cost between $75-1500 per meter to construct (Draft Policy iv). Due to the price of seawalls, these structures often do not span an entire beach, but only protect the most vulnerable areas, leading to another problem. The shoreline on either side of a seawall will continue to erode, and at a faster pace than the shoreline the wall protects (Draft Policy v). Seawalls also make beach maintenance extremely difficult. Often times, after storms, some beaches need sand to be added in order to maintain the usability of the beach. Seawalls make sand importation extremely difficult (Draft Policy iv) as well. Larger, more elaborate solutions such as Seawalls are examples of solutions that are effective but not always feasible.

As far as the use of seawalls in Santa Barbara, there is only one beach where the cost of the seawall would be worth the benefit. This is the westward side of Sterns Wharf. An effective structure here would reduce erosion down to the same pace as the erosion on the East side. There are no bluffs behind the Wharf's beaches so effecting sandstone cycles would not be an issue.

California Coastal Act:

Building structures and re-landscaping beaches solve only half the problem of costal erosion. In order to properly fix our coasts, laws need to be put in place that protect the shoreline. Changing environmental policy is the ultimate key to preserving Santa Barbara county beaches. In the history of environmental law, the most significant law protecting against erosion has been the California Coastal Act. The most important clause in this act states that new development should "Assure stability and structural integrity and neither create nor contribute significantly to erosion, geologic instability or destruction of the site surrounding area or in any way require the construction of protective devices that would substantially alter natural landforms along bluffs and cliffs." (Draft Policy iv). The California Coastal Act "also allows local governments to implement policies for costal erosion hazard mitigation." (National Assessment 33) The act gives the responsibility of erosion to local governments. Unfortunately, because erosion is slow and constant, it is hard to decide when a good time is to invest in protection.

Ultimately, the best solution would be to make erosion the responsibility of landowners near the beach. Beachfront houses are responsible for the added weight on sandstone bluffs ultimately leading to their breaking. A reasonable solution could require all new coastal developments to also pay for a drainage system underneath the sandstone bluffs that would keep cliffs stable during storms. Unfortunately this proposal does not take into account existing structures. It is far too expensive and risky to renovate underneath already built structures. From personal observation, beach front property in constant demand, old structures are torn down and rebuilt with some

frequency. In popular areas there could be drainage systems under all structures within a couple decades.

Besides where landowners are causing destruction, there are beaches where public work has hurt ecosystems. The West Beach of Santa Barbara has the fastest eroding coast in the entire county. On average, this beach looses 2 meters of land a year (National Assessment 56). West Beach, as well as surrounding beaches are narrower (as seen in Figure 6), and will undergo more drastic fluxuations in beach volume (National Assessment 56). No houses line this beach, and although no research has been done to pinpoint the reason this beach erodes so quickly, one can infer it is because of a lack of a natural barrier stopping the faster cyclonal waves from hitting. Most natural barriers along the coast are formed from sand buildup out to sea (Thousand Florida).

Precious Sand:

Before Santa Barbara was inhabited, sand bars off shore may have stopped such waves. But now, the dredging of these sand bars has left areas like West Beach susceptible to the full force of cyclonal waves (Noble Consultants). To help West Beach, a seasonal supply of new sand is needed. The beach is far too narrow for a seawall. Also, a seawall would impair harbor traffic; the reason the sand bar was removed in the first place. Sand supplying is effective but not permanent (Noble Consultants). Often times it can be a drain on financial resources to haul in sand. So the question becomes, who should pay for the sand replenishment, and how to go about refilling an entire beach?

The State of California Costal Impact Assistance Program Draft Plan outlines issues of budget allocation for California's beaches. The budget is broken down as

follows. *The California Master Plan for Comprehensive Costal Sediment Management* is a plan developed by the California Department of Boating and Waterways in which $800,000 is allocated each year to state beaches based on "sediment management needs." (State of California 233) The Santa Barbara County's Energy Division is in charge of regulating all offshore oil and gas development. This branch of government allocates $20,000 a year to costal impact assistance. (State of California 311) Both of these funds could be used to buy and layer outside sand to replenish the beach after storms in the winter season. Estimating that a ton of beach sand costs $370, ten tons of sand could be purchased for $3700 (Drenth Brothers). Adding an additional $4000 for hauling and dispersing the sand, replenishing the beach could be done at roughly $7700 a year (Drenth Brothers). This money could be granted from the local Energy Division fund for coastal impact as well as from the California Department of Boating and Waterways fund for "sediment management needs."

The second issue with sand replenishment is how to go about dispersing sand effectively throughout some of Santa Barbara's beaches. There are three basic ways to deliver sand to an entire beach. The first, called "Up Sand Filling" involves leaving a thick wall of sand near the top of a beach (SANDAG). During the winter months, when tides grow larger and stronger, waves during high tide will slowly drag this sand wall down across the rest of the beach and slowly into the ocean. "Up Sand Filling" has the advantage of easy deposit. Dump trucks merely unload heaps onto the upper part of the beach and let the waves take care of the rest, as seen in Figure 7 (SANDAG). Drawbacks to this method include a long wait time (as in years) for the sand to completely disperse itself, the disruption of beach activity (due to large heaps of sand

strewn all over), and eventually, all the added sand will retreat back into the ocean, leaving the beach in the same condition it was (Wefer 204).

The second option for sand addition is far more complex. Using offshore dredging, sand destined to replenish a beach can strategically be added in the ocean (SANDAG). During the summer months, when tides are less powerful, a pile of sand 20 feet or so out to sea would be carried in by tidal action. Adding sand (or any other barrier) at the wave breakpoint of a beach changes the function of the wave. Wave energy that normally is dissipated at the shoreline, is absorbed by the underwater sand bar. After passing the sand bar, the new lower energy waves, saturated with underwater sand, carry their contents into the beach and deposit them. By disrupting the tidal action, the waves are no longer taking sand away from the beach, but adding to the shoreline. The fundamental problem with this plan is added expense. Dredging sand is a costly process, requiring offshore machinery and many more labor hours (SANDAG). Sand Dredging can also ruin the draw of some beaches; the sand bar disrupts the surf, and can turn a surfing hot spot into a choppy low swell experience. The main advantage to this method is its more permanent (SANDAG). The sand bar would be depleted until the beach was full and were rolling in normally once more. If the sand were to become low again, more of the sand bar would be used up until the beach was in equilibrium.

The third solution is a kind of combination of the first two methods. A breakwater, as shown in Figure 8, is a structure usually 200 feet out to sea that disrupts wave action. In using a breakwater, sand could be deposited and dispersed just as it was in the first proposal. The offshore breakwater would dissipate larger waves during the winter months that typically bring the sand back into the ocean.(Tamski 30)

Breakwaters, made of stone, have the same disadvantages of a sand bar. Constructing an underwater wall 200 feet out to shore is expensive. Breakwaters also disrupt surfing waves, though not as much as a close to shore sand bar. (Tamski 34)

Some beaches of Santa Barbara have already had sand replenished. Gaviota, one of the southern beaches in the county, had over 3 tons of sand delivered and dispersed using a backhoe eight years ago (National Park Service). The past conservation effort has maintained Gaviota as a popular surf and hang out spot to present day. However Gaviota beach is still eroding (National Park Service). In areas such as this, erosion control is about mending previous installations. The goal of helping Gaviota is to keep the already hauled sand in place, before erosion over the next couple decades remove it once again. Groins, are structures that provide such a holding feature for beaches in currently good condition but in danger of future erosion (NOAA). An example of a well working groin can be seen in Figure 9, where the groin keeps the sand on the left side of the beach. To remedy Gaviota, the best solution is the construction of a groin. Groins are structures that run vertically up a beaches shoreline. They act as roots for the sand. The development and implementation of Groins has been the result of The National Oceanic and Atmospheric Administration. The Administration describes how Groins "act like fingers running up and down the shore…and can be Y or T shaped" (NOAA). "Groin fields are designed to trap and retain sand, nourishing the beaches in-between them" (NOAA). There are a number of substances that groins can be made with. Short-term structures can be created using timber or light rock. For more permanent structures, groins are created with concrete, rock, or metal. The figure 9 example has been constructed with steel and serves as a permanent structure. In Santa Barbara,

particularly Gaviota, a permanent groin is the best solution. With an effectively acting structure, a groin at Gaviota would allow the beach to preserve itself, requiring little or no maintenance. Sand wearing in Gaviota is slow (National Park Service). A concrete groin barrier would dissect the beach into parts and would supply unneeded hold on the sand. A rock groin would allow sand to be trapped within the beach, without destroying the aesthetic of the shoreline. Rock groins are more subtle and would allow beach growers to cross them. Rock would be easy to quarry, as to Santa Barbara mountains would supply a sufficient amount of small boulders to be laid down.

There are many interesting proposals to fight erosion in Santa Barbara, the most drastic of them is the use of sills throughout the county. Sills are, effectively, underwater walls. With sills in place, sediment carrying waves deposit sand onto the beach where it is sucked back out into the ocean until meeting with the sill wall. At the wall, sand begins to collect (Kuhn). Over time, this collected sand will breach the shoreline, and continue to crawl up the land. A sill can effectively create a beach from nowhere. With the use of sills, Santa Barbara would not have to battle erosive beaches. Areas such as the southern part of Goleta, where there is no sand, could be turned into a new fully functioning beach. Beaches that are too expensive to maintain could be left to the elements. Sills could provide Santa Barbara with an entirely new set of beaches. Using sills, beaches could be created in opportune areas where surf is promising and land could maintain a large volume of people (Kuhn).

These artificial beaches give rise to a whole other set of issues. With new beaches, is there reason to maintain the old areas. Also, where is the best place to install sills. The only really feasible place for a sill would be in the southern coastline of

Goleta as described before. In this area, rocky inlets mean waves crash onto cliffs without having a sand buffer. A sill here would allow a natural deposit of sand to build up over the rocks, eventually creating a new beach. In this area, a new beach in Goleta would not replace one beyond repair, but be an alternative from other beaches. Having more areas for recreation and building means less damage due to public use over the years.

Preparing for the Worst:

Part of protecting Santa Barbara's beaches is being prepared for natural erosion. In strong weather systems such as El Nino in 1998, coastline destruction can be astronomical (National Assessment 19). Aside from building protection, the county should also consider an emergency relief fund for storm related rapid destruction. The goal of a fund like this would be to clear beaches of storm destruction, replenish lost landscape and sand, as well as repair any damaged erosion barriers such as drains, jetties, and seawalls.

The biggest obstacle for an emergency relief fund is financing the project. The best solution is to leave the funding for the City of Santa Barbara Office of Emergency Services to delegate. The Office describes its own purpose in its mission statement as to "mitigate, prepare for, respond to, and recover from the effects of major emergencies that threaten lives, property, and the environment" (The City of Santa Barbara). Beach destruction from a natural disaster qualifies as an emergency that threatens both property and the environment.

The BEACH study program or Beach Erosion and Land Use Alternatives Control at the Harbor is a project composed of engineers and urban designers in Santa

Barbara county to look at some of the problems associated with downtown Santa Barbara's beaches. The group analyzed the area of Leadbetter beach in Santa Barbara and proposed the following solutions to erosion along this particular coastline Instill offshore breakwaters at Leadbetter Beach. Breakwater is a "low-crested structure that allows the passage of some energy or can be high enough to completely block waves." (Beach Study 4-9). Offshore breakwaters allows beaches to become wider. Another solution for some of Santa Barbara's beaches would be to build a Rock Revetment. It is the most common type of shore protection in Southern California. A rock revetment has a layer of stone covered by a layer of smaller quarry stone. Revetments unlike seawalls can settle without causing structural failure (Beach Study 4-7).

Both of these solutions could be applied to beaches throughout the rest of Santa Barbara. In particular, a Rock Revetment would be easy to quarry (from the Santa Barbara mountains) and would not require maintenance. As for the rest of Santa Barbara, it is clear a combination of the above treatments would work for different beaches. In areas like Isla Vista. The primary concern is safety for private structures already built. Isla Vista's beaches are not in danger of sand depletion thanks to the sandstone cliff backing, but heavy weight on cliffs could lead to the cliff fracturing and falling. The solution here is to install and adequate drain system to allow the cliffs to expand only slightly during heavy rains.

Everywhere else in Santa Barbara the issues with beach erosion revolve around sand depletion. The use of seawalls, jetties, groins, breakwaters, and sills are work to provide two basic functions, to move and keep sand on beaches. A sill, as described could create a new beach in basically only one area, the southern Goleta coastline.

Solutions become more complex when looking at the rest of Santa Barbara. As previously discussed, the use of seawalls is an effective way to dissipate the erosive forces of waves. Seawalls would benefit at Sterns Wharf, but convincing the Santa Barbara government to fund this project would be tough. Seawalls are incredibly expensive projects; the construction of the Carlsbad Seawall was valued at over 20 million dollars. Although the Seawall by Sterns Wharf would not be as tall or long, the project would still cost in the millions. This is an expensive alternative to fixing a very slow developing problem. The other issue is do the citizens of Santa Barbara care enough to put a seawall in place. The stagnant depleting sand does wear away at a beautiful beach but with so many other beaches to choose from it would be difficult to argue that the Sterns Wharf beach is vital to the Santa Barbara community. From research done in this paper, the cost of installing such a wall is too great. The beach next to the Wharf is slowly wearing away, but the little usage of the east side beach means a multimillion-dollar seawall would not be worthwhile.

This kind of cost-benefit evaluation is critical to perform for all problem areas along the coastline. The same principles can be applied to West Beach. As previously stated, to help West Beach, a seasonal supply of new sand is needed. The two feasible options for sand replenishment are sand dumping or constructing a sill. In this case, the more costly sill makes more economic sense. West Beach is a popular beach and the continuing sand depletion would eventually lead to an unusable coastline, declining from the beach economy in Santa Barbara. A sill, typically priced at $70,000 (Khun); would be worthwhile in the long run to keep a healthy beach for consumers to use.

After looking at county issues of sand blockage, drainage, man-made construction, and natural disasters, it is clear a combination of unique solutions and environmental policy are needed. Overall, problems plaguing the Santa Barbara coast are sandstone destruction, sand blockage, and sand depletion. Solutions for these problems require the implementation of physical devices. The crumbling Sandstone in Isla Vista needs drains, the depleted beaches of Gaviota and Goleta need sand replenishment and sills, the eastward side of Sterns Wharf needs a seawall to block waves. Budgeting for private property problems is not an issue; make the beachfront owners pay for the installation of drains. Along public beaches, cost-benefit analysis reveals physical solutions are feasible everywhere except Sterns Wharf. After dealing with Santa Barbara's current erosive problems, it is clear the future of erosion protection lies in changing laws to take erosion into consideration. New laws such as all sandstone property owners must install drains and all beaches will be carefully monitored for increasing erosion will protect Santa Barbara for years to come.