1	00:29:39:13	00:29:42:25	Annenberg Media
2	00:29:42:27	00:30:33:22	§
3	00:30:33:24	00:30:36:01	*WHEN WE LOOK AT A SUNSET,*
4	00:30:36:03	00:30:38:05	*WE SEE WAVES OF LIGHT ENERGY*
5	00:30:38:07	00:30:40:04	*THAT HAVE TRAVELED AN IMMENSE DISTANCE*
6	00:30:40:06	00:30:41:24	*TO REACH OUR EYES.*
7	00:30:45:21	00:30:47:19	*WHEN WE LOOK AT AN OCEAN,*
8	00:30:47:21	00:30:49:24	*WE SEE WAVES OF WATER ENERGY*
9	00:30:49:26	00:30:52:08	*THAT MAY HAVE JOURNEYED THOUSANDS OF KILOMETERS*
10	00:30:52:10	00:30:53:23	*TO REACH OUR SHORES.*
11	00:30:59:17	00:31:03:04	*MOST WAVES DERIVE THEIR ENERGY FROM THE WIND.*
12	00:31:03:06	00:31:06:05	*AS THE WIND BLOWS OVER THE OCEAN,*
13	00:31:06:07	00:31:09:05	*SOME OF ITS ENERGY IS TRANSFERRED TO THE SURFACE,*
14	00:31:09:07	00:31:11:15	*FORMING WAVES THAT MOVE THROUGH THE WATER.*
15	00:31:11:17	00:31:15:16	*AND IT IS IN LARGE PART THE POWER OF THESE WAVES*
16	00:31:15:18	00:31:17:10	*THAT MAKES THE COASTAL ENVIRONMENT*
17	00:31:17:12	00:31:20:06	*SUCH A DYNAMIC PLACE.*
18	00:31:20:08	00:31:23:05	COASTAL AREAS ARE AMONG THE MOST BEAUTIFUL
19	00:31:23:07	00:31:25:21	AND DESIRABLE PLACES ANYWHERE ON EARTH.
20	00:31:25:23	00:31:29:04	THE COAST AND COASTAL LAND FORMS LIKE THIS BEACH
21	00:31:29:06	00:31:31:16	ARE THE RESULT OF A DYNAMIC INTERACTION
22	00:31:31:18	00:31:34:10	BETWEEN TWO COMPETING GEOLOGIC AGENTS--
23	00:31:34:12	00:31:35:23	THE ROCKY LAND MASSES
24	00:31:35:25	00:31:38:02	AND THE ENERGY OF THE OCEAN.
25	00:31:38:04	00:31:40:02	PEOPLE TEND TO THINK OF THESE
26	00:31:40:04	00:31:42:13	AS SEPARATE AND INDEPENDENT FROM ONE ANOTHER,
27	00:31:42:15	00:31:44:12	BUT BY IGNORING THE INTIMATE CONNECTION
28	00:31:44:14	00:31:45:21	BETWEEN LAND AND SEA,
29	00:31:45:23	00:31:47:08	THEY FAIL TO REALIZE
30	00:31:47:10	00:31:49:07	THAT THIS DELICATELY BALANCED SYSTEM
31	00:31:49:09	00:31:52:01	IS SUBJECT TO CONTINUAL CHANGE.
32	00:31:52:03	00:31:54:16	BUILDING WALLS AND BOARDWALKS AND HOMES

33 00:31:54:18 00:31:55:29 ON A SHIFTING COASTLINE
34 00:31:56:01 00:31:57:16 IS A GAMBLE WITH NATURE
35 00:31:57:18 00:32:00:05 THAT SOMETIMES PAYS OFF
WITH DISASTROUS CONSEQUENCES.
36 00:32:00:07 00:32:01:06 CLEARLY, THEN,
37 00:32:01:08 00:32:03:21 THE COAST
IS A PART OF OUR WORLD
38 00:32:03:23 00:32:05:26 THAT NEEDS TO BE OBSERVED
AND UNDERSTOOD.
39 00:32:05:28 00:32:07:11 CONSIDER THE WAVES,
FOR EXAMPLE.
40 00:32:07:13 00:32:08:25 THEIR RHYTHMIC MOTION
AND SOUND
41 00:32:08:27 00:32:11:07 HAS MADE WATCHING THEM
A POPULAR PASTIME,
42 00:32:11:09 00:32:13:16 YET FEW PEOPLE
HAVE A REAL UNDERSTANDING
43 00:32:13:18 00:32:16:17 OF WHAT A WAVE IS
AND HOW IT WORKS.
44 00:32:16:19 00:32:18:01 UNDERSTANDING OCEAN WAVES
IS VITAL
45 00:32:18:03 00:32:19:17 TO PREDICTING THEIR IMPACT
46 00:32:19:19 00:32:21:16 ON NOT ONLY
THE BEACH ENVIRONMENT
47 00:32:21:18 00:32:22:26 BUT ON
COASTAL DEVELOPMENT.
48 00:32:24:06 00:32:26:00 *WHEN A WAVE*
APPROACHES THE BEACH,
49 00:32:26:02 00:32:28:14 *IT'S NOT THE WATER ITSELF*
THAT'S ADVANCING,
50 00:32:28:16 00:32:30:08 *BUT A SURGE OF ENERGY*
51 00:32:30:10 00:32:32:12 *WHICH IS MOVING*
THROUGH THE WATER.
52 00:32:33:28 00:32:35:06 *IT'S LIKE THE RIPPLE*
53 00:32:35:08 00:32:37:13 *THAT RUNS*
ACROSS A FIELD OF GRAIN
54 00:32:37:15 00:32:39:01 *WHEN THE WIND BLOWS.*
55 00:32:39:03 00:32:42:06 *THE INDIVIDUAL STALKS*
DON'T RUN ACROSS THE FIELD.
56 00:32:42:08 00:32:45:05 *THEY SIMPLY BEND*
AS THE WIND STRIKES THEM.
57 00:32:47:14 00:32:50:06 *OR TAKE THE WAVE*
AT A FOOTBALL GAME,
58 00:32:50:08 00:32:51:24 *WHICH CREATES THE ILLUSION*
59 00:32:51:26 00:32:53:09 *THAT THE SPECTATORS*
60 00:32:53:11 00:32:55:08 *ARE RIPPLING*
AROUND THE STADIUM,
61 00:32:55:10 00:32:57:07 *WHEN ALL THEY'RE*
ACTUALLY DOING
62 00:32:57:09 00:33:00:27 *IS STANDING UP*
AND SITTING DOWN.
63 00:33:02:09 00:33:05:05 *THE SAME PRINCIPLE APPLIES*
TO WATER WAVES.
64 00:33:05:07 00:33:07:20 *CONSIDER WHAT HAPPENS*
TO A FLOATING OBJECT
65 00:33:07:22 00:33:11:11 *AS A WAVE OF ENERGY*

PASSES THROUGH THE WATER.

66 00:33:11:13 00:33:14:16 *THAT OBJECT TENDS*
TO STAY IN THE SAME PLACE,

67 00:33:14:18 00:33:18:15 *TRACING A CIRCULAR MOTION*
AS IT BOBS UP AND DOWN.

68 00:33:18:17 00:33:22:01 *THE INDIVIDUAL PARTICLES*
COMPOSING THE WAVE

69 00:33:22:03 00:33:24:05 *BEHAVE IN A SIMILAR WAY.*

70 00:33:25:14 00:33:27:22 *AS THE CREST*
OF THE WAVE ARRIVES,

71 00:33:27:24 00:33:30:07 *IT LIFTS THE PARTICLE*
UP AND FORWARD,

72 00:33:30:09 00:33:33:06 *AND THEN, WHEN THE TROUGH*
OF THE WAVE FOLLOWS,

73 00:33:33:08 00:33:35:23 *THE PARTICLE FALLS DOWN*
AND BACKWARD.

74 00:33:37:16 00:33:40:28 *LIKE THE STALK OF GRAIN*
OR THE FOOTBALL FAN,

75 00:33:41:00 00:33:43:15 *THE PARTICLE RETURNS*
TO ITS ORIGINAL POSITION

76 00:33:43:17 00:33:45:18 *AFTER THE DISTURBANCE*
HAS PASSED.

77 00:33:48:01 00:33:49:13 *AT THE WATER'S SURFACE,*

78 00:33:49:15 00:33:51:23 *THE CIRCULAR ORBIT*
OF THE WATER PARTICLE

79 00:33:51:25 00:33:53:11 *HAS A DIAMETER*

80 00:33:53:13 00:33:56:13 *THAT IS ROUGHLY EQUAL*
TO THE HEIGHT OF THE WAVE.

81 00:33:59:02 00:34:01:24 *AS ONE LOOKS*
BELOW THE SURFACE, HOWEVER,

82 00:34:01:26 00:34:03:29 *THE ORBIT*
GETS SMALLER AND SMALLER

83 00:34:04:01 00:34:07:13 *UNTIL THERE IS VIRTUALLY*
NO MOTION OF WATER AT ALL.

84 00:34:15:11 00:34:18:13 *THE DOWNWARD LIMIT*
OF WAVE MOTION IN THE WATER

85 00:34:18:15 00:34:20:28 *IS CALLED THE WAVE BASE,*

86 00:34:21:00 00:34:22:15 *AND IT'S DIRECTLY RELATED*

87 00:34:22:17 00:34:26:12 *TO HOW FAR APART THE WAVES*
ARE AT THE SURFACE.

88 00:34:27:20 00:34:29:29 *THE DEPTH OF THE WAVE BASE*

89 00:34:30:01 00:34:32:18 *IS EQUAL TO ABOUT HALF*
THE WAVELENGTH,

90 00:34:32:20 00:34:33:29 *WHICH IS THE DISTANCE*

91 00:34:34:01 00:34:37:05 *BETWEEN THE CRESTS*
OF TWO WAVES.

92 00:34:37:07 00:34:39:29 *AS THE WAVE*
APPROACHES THE SHORE

93 00:34:40:01 00:34:42:14 *AND THE WATER*
BECOMES SHALLOWER,

94 00:34:42:16 00:34:45:13 *THE SEA FLOOR*
INTERSECTS THE WAVE BASE,

95 00:34:45:15 00:34:47:19 *CONFINING THE WAVE ENERGY.*

96 00:34:47:21 00:34:50:18 *THE WAVE NOW STARTS*
TO SLOW DOWN

97 00:34:50:20 00:34:52:05 *AS THE SEA FLOOR*

98 00:34:52:07 00:34:54:28 *BEGINS TO INTERFERE*
WITH THE ORBITAL MOTIONS.
99 00:34:57:01 00:35:00:27 *THIS FORCES THE WAVE UP*
AND SHORTENS ITS LENGTH,
100 00:35:00:29 00:35:04:14 *BECAUSE WAVES BEHIND IT,*
STILL IN DEEPER WATER,
101 00:35:04:16 00:35:08:17 *ARE ADVANCING FASTER*
AND BEGIN TO OVERTAKE IT.
102 00:35:11:00 00:35:13:28 *AS THIS HAPPENS*
TO A SUCCESSION OF WAVES,
103 00:35:14:00 00:35:17:13 *THEY BUNCH UP*
LIKE CARS IN A TRAFFIC JAM.
104 00:35:17:15 00:35:19:29 *AS THE BOTTOM OF EACH WAVE*
IS SLOWED
105 00:35:20:01 00:35:22:18 *BY THE FRICTIONAL DRAG*
OF THE SEA BED,
106 00:35:22:20 00:35:25:07 *THE TOP CONTINUES*
TO SURGE FORWARD,
107 00:35:25:09 00:35:28:03 *MAKING THE WAVES*
STEEPER AND STEEPER.
108 00:35:30:15 00:35:31:28 *EVENTUALLY,*
THIS STEEP FRONT
109 00:35:32:00 00:35:34:12 *CAN NO LONGER*
SUPPORT THE WAVE,
110 00:35:34:14 00:35:36:15 *AND IT BREAKS INTO SURF.*
111 00:35:39:27 00:35:41:26 PERHAPS THE ULTIMATE
OCEAN WAVE
112 00:35:41:28 00:35:43:27 IS THE SEISMIC SEA WAVE,
113 00:35:43:29 00:35:45:26 OTHERWISE KNOWN
AS A TSUNAMI.
114 00:35:45:28 00:35:47:26 TSUNAMIS CAN STRIKE COASTS
WITHOUT WARNING.
115 00:35:47:28 00:35:50:07 WITH WAVE HEIGHTS SOMETIMES
EXCEEDING 30 METERS,
116 00:35:50:09 00:35:53:07 THESE WAVES HAVE A POTENTIAL
FOR DEATH AND DESTRUCTION
117 00:35:53:09 00:35:55:16 THAT MAKES THEM
THE SUBJECT OF LEGEND
118 00:35:55:18 00:35:56:27 THROUGHOUT THE WORLD.
119 00:35:56:29 00:35:58:26 UNLIKE ORDINARY
WIND-GENERATED WAVES,
120 00:35:58:28 00:36:02:01 TSUNAMIS ARE CAUSED BY
A MUCH MORE POWERFUL FORCE--
121 00:36:02:03 00:36:03:06 HQUAKES.
122 00:36:02:03 00:36:03:06 EA
123 00:36:03:08 00:36:04:22 UNDERSEA
AND COASTAL EARTHQUAKES
124 00:36:04:24 00:36:07:22 CAN CAUSE THE OCEAN FLOOR
TO SHIFT SUDDENLY.
125 00:36:07:24 00:36:09:22 THIS MOVEMENT
OF THE OCEAN FLOOR
126 00:36:09:24 00:36:12:21 DISPLACES A VAST VOLUME
OF THE OVERLYING WATER,
127 00:36:12:23 00:36:14:21 CREATING
THESE UNUSUAL WAVES.
128 00:36:14:23 00:36:16:21 TSUNAMIS ARE TREMENDOUSLY

FAST-MOVING,
129 00:36:16:23 00:36:20:21 SOME TRAVELING IN EXCESS
OF 800 KILOMETERS PER HOUR.
130 00:36:20:23 00:36:23:26 THE WAVELENGTH OF A TSUNAMI
MAY BE 150 KILOMETERS,
131 00:36:23:28 00:36:25:07 AND SO THE MOVEMENT
132 00:36:25:09 00:36:27:15 OF THE WATER PARTICLES
WITHIN THE WAVE
133 00:36:27:17 00:36:29:15 WILL STIR UP
DEEP-SEA SEDIMENTS
134 00:36:29:17 00:36:31:00 EVEN IN THE MID-OCEAN.
135 00:36:31:02 00:36:32:11 REMARKABLY, HOWEVER,
136 00:36:32:13 00:36:35:24 SUCH A TSUNAMI MAY MEASURE
ONLY A METER OR SO HIGH
137 00:36:35:26 00:36:37:04 IN THE OPEN OCEAN,
138 00:36:37:06 00:36:39:04 BUT AS TSUNAMIS
APPROACH THE COAST,
139 00:36:39:06 00:36:42:15 THEY BUNCH UP AND RISE,
MONSTERLIKE, FROM THE SEA.
140 00:36:42:17 00:36:43:28 IN A FEW MINUTES,
141 00:36:44:00 00:36:45:28 TSUNAMIS CAN
COMPLETELY DEVASTATE
A COASTAL COMMUNITY.
142 00:36:47:10 00:36:49:00 *ONE COASTAL COMMUNITY*
THAT EXPERIENCED
143 00:36:49:02 00:36:51:26 *THE CRUSHING POWER*
OF A TSUNAMI FIRSTHAND
144 00:36:51:28 00:36:54:02 *WAS HILO, HAWAII.*
145 00:36:54:04 00:36:57:11 *ON APRIL 1, 1946,*
146 00:36:57:13 00:37:00:02 *FOLLOWING AN EARTHQUAKE*
OFF THE COAST OF ALASKA,
147 00:37:00:04 00:37:03:18 *ONE OF THE MOST DESTRUCTIVE*
TSUNAMIS OF MODERN TIMES
148 00:37:03:20 00:37:05:14 *SPED ACROSS THE PACIFIC*
149 00:37:05:16 00:37:08:12 *AND OBLITERATED THE ENTIRE*
SHORE ZONE AT HILO.
150 00:37:08:14 00:37:12:23 *THE DEATH TOLL THAT DAY*
WAS 159.
151 00:37:15:22 00:37:19:20 *FORTUNATELY, TSUNAMIS*
ARE NOT EVERYDAY EVENTS,
152 00:37:19:22 00:37:22:10 *BUT EVEN ORDINARY WAVES*
HAVE SOME IMPACT
153 00:37:22:12 00:37:23:18 *ON THE SHORELINE.*
154 00:37:25:06 00:37:28:17 *ONE VERY IMPORTANT PROCESS*
AT WORK HERE IS REFRACTION,
155 00:37:28:19 00:37:32:12 *THE BENDING OF WAVE FRONTS*
AS THEY APPROACH THE SHORE.
156 00:37:34:18 00:37:37:16 *WHEN A WAVE APPROACHES*
THE SHORE AT AN ANGLE,
157 00:37:37:18 00:37:39:25 *THE NEAR SHORE*
STRETCH OF WAVE FRONT
158 00:37:39:27 00:37:41:24 *REACHES*
THE SHALLOW WATER FIRST
159 00:37:41:26 00:37:44:15 *AND IS THEREFORE*
SLOWED DOWN FIRST.
160 00:37:45:24 00:37:48:10 *THIS LOCAL DECREASE*

IN VELOCITY

161 00:37:48:12 00:37:51:11 *CAUSES THE WAVE FRONT*
TO BEND OR REFRACT

162 00:37:51:13 00:37:54:11 *BECAUSE THE DEEPER WATER*
PORTION OF THE WAVE

163 00:37:54:13 00:37:57:10 *CONTINUES TO MOVE*
AT ITS ORIGINAL SPEED.

164 00:37:57:12 00:37:59:24 *AS A CONSEQUENCE*
OF THIS REFRACTION,

165 00:37:59:26 00:38:01:25 *THE WAVES NEAR SHORE*

166 00:38:01:27 00:38:04:26 *TEND TO APPROACH THE COAST*
NEARLY HEAD-ON,

167 00:38:04:28 00:38:06:25 *WHILE THOSE*
IN DEEPER WATER

168 00:38:06:27 00:38:08:25 *CONTINUE ALONG*
THEIR ORIGINAL COURSE.

169 00:38:11:22 00:38:14:10 *WAVE REFRACTION*
HAS ITS GREATEST EFFECT

170 00:38:14:12 00:38:16:06 *ON IRREGULAR SHORELINES*

171 00:38:16:08 00:38:19:20 *WITH DEEP BAYS*
AND PROJECTING HEADLANDS.

172 00:38:21:28 00:38:24:25 *WAVES ARE REFRACTED*
TOWARDS HEADLANDS,

173 00:38:24:27 00:38:27:25 *SMASHING INTO THEM*
FROM BOTH SIDES.

174 00:38:27:27 00:38:31:10 *AT THE SAME TIME, THEY*
ARE SPREAD OUT IN BAYS.

175 00:38:31:12 00:38:32:23 *IN OTHER WORDS,*

176 00:38:32:25 00:38:35:10 *WAVE ENERGY IS CONCENTRATED*
ON HEADLANDS

177 00:38:35:12 00:38:38:18 *AND DISPERSED ALONG*
THE SHORELINE OF BAYS.

178 00:38:40:10 00:38:43:08 *THE NET EFFECT OF REFRACTION*
ON IRREGULAR COASTLINES

179 00:38:43:10 00:38:45:12 *IS TO STRAIGHTEN THEM OUT.*

180 00:38:45:14 00:38:47:28 *AS THE WAVES CRASH*
AGAINST THE HEADLANDS,

181 00:38:48:00 00:38:49:23 *THEY ERODE SEDIMENT,*

182 00:38:49:25 00:38:53:07 *THEN DEPOSIT IT AS SAND*
IN THE BAYS.

183 00:38:55:10 00:38:58:07 *SO THE WAVES PERFORM*
A DOUBLE ACTION--

184 00:38:58:09 00:39:00:12 *SIMULTANEOUSLY*
WEARING AWAY THE HEADLANDS

185 00:39:00:14 00:39:02:29 *AND FILLING UP THE BAYS.*

186 00:39:03:01 00:39:04:28 *THE EROSION*
OF COASTAL HEADLANDS

187 00:39:05:00 00:39:08:23 *IS BY NO MEANS*
THE ONLY SOURCE OF SAND.

188 00:39:08:25 00:39:11:08 *MOST BEACH SAND*
COMES FROM SEDIMENT

189 00:39:11:10 00:39:13:18 *THAT IS BROUGHT*
DOWN TO THE OCEAN

190 00:39:13:20 00:39:15:08 *BY RIVERS AND STREAMS.*

191 00:39:19:01 00:39:21:14 *ONCE THE SAND*
REACHES THE OCEAN,

192 00:39:21:16 00:39:24:28 *THE WAVES DISTRIBUTE IT*
ALONG THE COASTLINE.
193 00:39:25:00 00:39:27:28 *THIS OCCURS AS A RESULT*
OF WAVE MOVEMENT
194 00:39:28:00 00:39:31:09 *UP ONTO THE SLOPING*
PART OF THE BEACH,
195 00:39:31:11 00:39:32:25 *THEN BACK DOWN AGAIN.*
196 00:39:32:27 00:39:35:09 *EACH CYCLE OF WAVE MOVEMENT*
CARRIES PARTICLES
197 00:39:35:11 00:39:37:17 *UP AND DOWN*
THE BEACH SLOPE.
198 00:39:40:01 00:39:41:13 *BECAUSE WAVES USUALLY BREAK*
199 00:39:41:15 00:39:43:28 *AT A SLIGHT ANGLE*
TO THE SHORE,
200 00:39:44:00 00:39:46:13 *THE GRAINS OF SAND*
IN THIS CYCLE
201 00:39:46:15 00:39:48:13 *ARE GRADUALLY*
WORKED ALONG THE SHORELINE
202 00:39:48:15 00:39:49:27 *IN A ZIGZAG PATH.*
203 00:39:51:11 00:39:54:06 SAND GETS MOVED
ALONG THE BEACH FACE
204 00:39:54:08 00:39:56:20 BY WAVES APPROACHING
THE COASTLINE
AT AN ANGLE,
205 00:39:56:22 00:39:58:08 AND WHEN THE WAVES
BREAK,
206 00:39:58:10 00:39:59:23 THEY HAVE
THE MOMENTUM
207 00:39:59:25 00:40:02:09 FROM THEIR
FALLING FORWARD
AT THAT ANGLE,
208 00:40:02:11 00:40:05:09 SO THE WAVES RUSH
UP THE BEACH FACE
209 00:40:05:11 00:40:07:23 IN THE SWASH ZONE
AT AN ANGLE,
210 00:40:07:25 00:40:10:03 BUT THEN
GRAVITY'S GOING
TO PULL THAT WATER
211 00:40:10:05 00:40:12:02 STRAIGHT BACK DOWN
THE BEACH FACE.
212 00:40:12:04 00:40:13:22 WHAT YOU AND I SEE
213 00:40:13:24 00:40:17:09 IS KIND OF
AN ARC SHAPE
OF WATER SWASHING UP
214 00:40:17:11 00:40:19:09 AND THEN GOING
STRAIGHT BACK DOWN,
215 00:40:19:11 00:40:20:24 AND THE RESULT IS
216 00:40:20:26 00:40:23:17 THAT AS THIS OCCURS
THOUSANDS OF TIMES
A DAY,
217 00:40:23:19 00:40:25:28 THE SAND MOVES
IN A ZIGZAG MOTION
218 00:40:26:00 00:40:27:25 UP AND DOWN
THE BEACH FACE.
219 00:40:27:27 00:40:31:12 *THE YELLOW DYE*
SHOWS THIS MOVEMENT.

220 00:40:31:14 00:40:34:02 *THIS FLOW OF WATER*
ALONG THE SHORELINE
221 00:40:34:04 00:40:36:09 *IS KNOWN*
AS THE LONGSHORE CURRENT.
222 00:40:38:11 00:40:40:24 *SAND SPITS*
AND BAY-MOUTH BARS
223 00:40:40:26 00:40:43:23 *ARE COMMON PRODUCTS*
OF LONGSHORE CURRENTS.
224 00:40:44:29 00:40:46:01 WHAT HAPPENS
225 00:40:46:03 00:40:48:07 IS THAT THE SAND
IS BEING CARRIED
226 00:40:48:09 00:40:50:20 ALONG THE COASTLINE,
THE BEACH SAND,
227 00:40:50:22 00:40:52:06 AND WHEN THE
COASTLINE REACHES,
228 00:40:52:08 00:40:55:05 SAY,
A RIGHT-ANGLE TURN,
AN ABRUPT BEND,
229 00:40:55:07 00:40:57:26 THE BEACH WILL
TEND TO BE CARRIED
230 00:40:57:28 00:40:59:25 STILL BY THAT
LONGSHORE CURRENT,
231 00:40:59:27 00:41:01:27 STRAIGHT
ALONG THE COASTLINE,
232 00:41:01:29 00:41:04:27 SO THAT THE BEACH
WILL START
BUILDING OUT,
233 00:41:04:29 00:41:07:21 CREATING
A EXTENSION
OF THE BEACH
234 00:41:07:23 00:41:10:07 THAT WILL NOT
NECESSARILY FOLLOW
235 00:41:10:09 00:41:12:08 THE BEND
IN THE COASTLINE.
236 00:41:12:10 00:41:15:07 *IN THIS CASE,*
A SAND SPIT HAS FORMED
237 00:41:15:09 00:41:17:21 *OFF THE END*
OF THIS BREAKWATER.
238 00:41:17:23 00:41:22:01 *THIS WAVE TANK SHOWS*
HOW THE SAND SPIT BUILT UP.
239 00:41:22:03 00:41:24:25 *THE WAVES STRIKE*
THE BREAKWATER AT AN ANGLE
240 00:41:24:27 00:41:27:16 *AND BEND AROUND IT*
INTO THE HARBOR.
241 00:41:28:26 00:41:30:20 *WHEN SAND IS ADDED,*
242 00:41:30:22 00:41:33:06 *THE WAVES CARRY IT*
INTO THE HARBOR,
243 00:41:33:08 00:41:36:03 *WHERE IT BUILDS INTO A SPIT*
BEHIND THE BREAKWATER.
244 00:41:37:28 00:41:41:05 *TO PREVENT THE HARBOR*
FROM BEING SEALED OFF
245 00:41:41:07 00:41:44:21 *AND THE BEACH BEYOND FROM*
BEING DEPRIVED OF SAND,
246 00:41:44:23 00:41:47:07 *ENGINEERS INSTALLED*
A DREDGE
247 00:41:47:09 00:41:50:20 *TO PUMP THE SAND BACK*

INTO THE LONGSHORE CURRENT

248 00:41:50:22 00:41:54:04 *BY PICKING IT UP*
IN THE HARBOR

249 00:41:54:06 00:41:57:03 *AND DUMPING IT*
FURTHER DOWN THE COAST.

250 00:41:59:02 00:42:01:14 *NOT ONLY DO BEACHES*
CHANGE CONTINUOUSLY

251 00:42:01:16 00:42:03:14 *AS SAND IS MOVED*
THROUGH THEM

252 00:42:03:16 00:42:05:11 *BY THE LONGSHORE CURRENT,*

253 00:42:05:13 00:42:08:12 *BUT SEASONAL CHANGES*
OCCUR AS WELL.

254 00:42:08:14 00:42:11:11 THE BEACHES CHANGE
FROM SEASON
TO SEASON.

255 00:42:11:13 00:42:12:17 BY SUMMERTIME,

256 00:42:12:19 00:42:15:21 THE WAVES ARE FAIRLY
LOW AND GENTLE,

257 00:42:15:23 00:42:17:22 AND THAT
HAS A TENDENCY

258 00:42:17:24 00:42:19:27 TO DRAG SAND
TOWARDS THE BEACH

259 00:42:19:29 00:42:21:11 AND BUILD UP
THE BEACH

260 00:42:21:13 00:42:22:29 AND MAKE IT BROADER,
WIDER,

261 00:42:23:01 00:42:24:13 AND AS IT PILES UP,

262 00:42:24:15 00:42:27:14 THE SAND HAS A
FAIRLY GENTLE SLOPE.

263 00:42:27:16 00:42:28:27 IN THE WINTERTIME,
THOUGH,

264 00:42:28:29 00:42:31:09 THE LARGER WAVES,
MORE ENERGETIC
WAVES,

265 00:42:31:11 00:42:32:19 PICK UP THAT SAND,

266 00:42:32:21 00:42:34:18 TEND TO MOVE IT
OFFSHORE,

267 00:42:34:20 00:42:37:02 AND STORE IT
IN LARGE SAND WAVES,

268 00:42:37:04 00:42:39:01 ALMOST
LIKE UNDERWATER
SAND DUNES.

269 00:42:39:03 00:42:41:22 AND SO THE BEACH
BECOMES VERY NARROW.

270 00:42:41:24 00:42:45:05 WHAT SAND IS THERE
IS VERY, VERY STEEP
IN SLOPE,

271 00:42:45:07 00:42:47:07 AND MOST
OF THE BEACH

272 00:42:47:09 00:42:48:22 IS REALLY LOCATED
OFFSHORE,

273 00:42:48:24 00:42:51:00 FINDING A MORE
STABLE POSITION

274 00:42:51:02 00:42:53:20 UNDER THE BIGGER
STORM WAVES.

275 00:42:59:15 00:43:03:12 THE BEACH IS JUST ONE PART

OF A MUCH LARGER SYSTEM
276 00:43:03:14 00:43:05:02 THAT REGULATES
THE FORMATION, SUPPLY,
277 00:43:05:04 00:43:08:04 AND DEPOSITION OF SEDIMENT
ALONG THE SHORE.
278 00:43:08:06 00:43:09:18 THIS SYSTEM
INCLUDES THE MOUNTAINS,
279 00:43:09:20 00:43:12:19 WHERE WEATHERING PROCESSES
TURN ROCK INTO SEDIMENT,
280 00:43:12:21 00:43:15:18 THE RIVERS, WHICH TRANSPORT
THAT SEDIMENT TO THE COAST,
281 00:43:15:20 00:43:18:09 AND COASTAL PROCESSES,
LIKE THE LONGSHORE CURRENT,
282 00:43:18:11 00:43:20:23 THAT REDISTRIBUTE THE
SEDIMENT ALONG THE SHORE.
283 00:43:20:25 00:43:22:29 AS WE'VE SEEN
WITH BREAKWATERS, HOWEVER,
284 00:43:23:01 00:43:24:14 PEOPLE CAN EASILY DISRUPT
285 00:43:24:16 00:43:26:19 THE NATURAL BALANCE
OF THIS SYSTEM
286 00:43:26:21 00:43:28:27 AND ALTER ITS ABILITY
TO OPERATE NORMALLY.
287 00:43:28:29 00:43:30:27 DAMS ARE ANOTHER EXAMPLE
288 00:43:30:29 00:43:34:09 OF OUR ATTEMPTS TO CONTROL
NATURAL PROCESSES.
289 00:43:34:11 00:43:37:07 THESE STRUCTURES
SERVE A VARIETY
OF VALUABLE FUNCTIONS--
290 00:43:37:09 00:43:39:10 THE GENERATION
OF HYDROELECTRIC POWER,
291 00:43:39:12 00:43:42:12 THE ESTABLISHMENT OF LAKES
FOR RECREATIONAL PURPOSES,
292 00:43:42:14 00:43:44:12 AND IN THIS CASE,
FLOOD CONTROL
293 00:43:44:14 00:43:47:12 AND THE STORAGE OF WATER
FOR DRINKING AND IRRIGATION.
294 00:43:47:14 00:43:48:27 DESPITE THEIR VALUE,
295 00:43:48:29 00:43:51:04 DAMS ARE NOT WITHOUT
SIGNIFICANT DRAWBACKS.
296 00:43:51:06 00:43:53:20 SEDIMENT THAT'S NORMALLY
CARRIED DOWN-RIVER
297 00:43:53:22 00:43:54:22 TO THE BEACHES,
298 00:43:54:24 00:43:56:19 IS TRAPPED IN
THE RESERVOIR INSTEAD.
299 00:43:56:21 00:43:58:04 BEACHES THAT
DON'T RECEIVE
300 00:43:58:06 00:43:59:28 A STEADY SUPPLY
OF RIVER SEDIMENT
301 00:44:00:00 00:44:01:06 WILL SOON DISAPPEAR.
302 00:44:01:08 00:44:04:23 IT IS TEMPTING TO CAST
PEOPLE AS THE VILLAINS
303 00:44:04:25 00:44:06:22 IN THIS APPARENT
CONFLICT WITH NATURE,
304 00:44:06:24 00:44:08:21 BUT THE ISSUE'S
NOT THAT SIMPLE.
305 00:44:08:23 00:44:11:05 WHAT WOULD HAPPEN

IF WE DIDN'T DAM RIVERS?
306 00:44:11:07 00:44:13:18 WOULD WE BE WILLING
TO RISK THE EXPOSURE
307 00:44:13:20 00:44:15:03 TO CATASTROPHIC FLOODS
308 00:44:15:05 00:44:17:18 AND TO GIVE UP
THE ELECTRICAL POWER
309 00:44:17:20 00:44:19:02 AND THE FRESH WATER
DAMS PROVIDE?
310 00:44:19:04 00:44:21:16 IF NOT, IS THE DAMAGE
THEY CAUSE
311 00:44:21:18 00:44:23:29 TO COASTAL PROPERTY
AND TO THE BEACH ENVIRONMENT
312 00:44:24:01 00:44:25:29 TOO HIGH A PRICE TO PAY?
313 00:44:26:01 00:44:27:13 THESE ARE
DIFFICULT CHOICES,
314 00:44:27:15 00:44:29:24 AND THERE ARE NO
PERFECT SOLUTIONS.
315 00:44:29:26 00:44:32:03 *PROBLEMS OFTEN ARISE*
316 00:44:32:05 00:44:35:08 *AS A RESULT OF*
SPECIAL CIRCUMSTANCES.
317 00:44:35:10 00:44:37:15 *DURING SEVERE STORMS,*
FOR EXAMPLE,
318 00:44:37:17 00:44:41:18 *CRASHING WAVES CAN BATTER*
COASTLINES.
319 00:44:41:20 00:44:45:15 *SUCH STORMS OCCUR ONLY ONCE*
EVERY FEW DECADES,
320 00:44:45:17 00:44:47:29 *BUT IN THE QUIET PERIODS*
IN BETWEEN,
321 00:44:48:01 00:44:49:14 *PEOPLE TEND TO IGNORE*
322 00:44:49:16 00:44:50:28 *THE HISTORICAL RECORD*
OF EROSION
323 00:44:51:00 00:44:53:27 *AND BUILD ALONG*
THE EDGES OF THE SHORE.
324 00:44:56:13 00:44:59:10 *TO PROTECT THE OCEAN-VIEW*
HOMES AND HOTELS
325 00:44:59:12 00:45:01:08 *THAT ARE PERCHED ATOP*
SEA CLIFFS
326 00:45:01:10 00:45:02:25 *AND ALONG BEACHES,*
327 00:45:02:27 00:45:04:10 *SEA WALLS*
HAVE BEEN ERECTED
328 00:45:04:12 00:45:07:10 *THAT REFLECT THE ENERGY*
OF THE WAVES
329 00:45:07:12 00:45:08:24 *AWAY FROM THE COAST*
330 00:45:08:26 00:45:10:09 *AND SLOW DOWN EROSION.*
331 00:45:11:14 00:45:13:14 *HOWEVER,*
WHAT MAY HAVE SOUNDED
332 00:45:13:16 00:45:15:07 *FAIRLY STRAIGHTFORWARD*
IN THEORY
333 00:45:15:09 00:45:17:27 *HAS BECOME QUITE*
CONTROVERSIAL IN PRACTICE.
334 00:45:19:01 00:45:20:27 *THOSE IN FAVOR*
OF SEA WALLS
335 00:45:20:29 00:45:23:27 *ARGUE THAT THE CLIFFS*
MUST BE PROTECTED
336 00:45:23:29 00:45:27:21 *TO SAFEGUARD*
THE REAL ESTATE ABOVE THEM.

337 00:45:27:23 00:45:29:06 *THOSE WHO ARE OPPOSED*
338 00:45:29:08 00:45:31:09 *MAINTAIN THAT*
IN THE LONG RUN,
339 00:45:31:11 00:45:33:24 *SEA WALLS DO MORE HARM*
THAN GOOD
340 00:45:33:26 00:45:36:26 *BECAUSE THEY REPRESENT*
A THREAT TO THE BEACH ITSELF.
341 00:45:36:28 00:45:39:04 COASTAL EROSION IS
A NATURAL PROCESS,
342 00:45:39:06 00:45:42:03 AND AS WE BEGIN
TO PUT HOUSES
343 00:45:42:05 00:45:43:23 ON THE EDGES
OF COASTLINES,
344 00:45:43:25 00:45:45:07 WE'RE CONCERNED
ABOUT LOSING
345 00:45:45:09 00:45:46:22 SOME OF THOSE HOMES,
346 00:45:46:24 00:45:49:06 SO YOU WANT TO
SLOW THE EROSION.
347 00:45:49:08 00:45:51:05 WELL, YOU'RE TRYING
TO SLOW SOMETHING
348 00:45:51:07 00:45:52:20 THAT'S
QUITE NATURAL.
349 00:45:52:22 00:45:54:05 WHEN YOU DO THAT,
350 00:45:54:07 00:45:56:04 YOU UPSET THE
BALANCE OF THINGS.
351 00:45:56:06 00:45:58:03 SEA WALLS,
TO LIMIT EROSION,
352 00:45:58:05 00:45:59:18 ARE ALSO CUTTING
SAND SUPPLY,
353 00:45:59:20 00:46:01:18 SO PUTTING IN
A SEA WALL
354 00:46:01:20 00:46:03:17 WILL,
FOR A SHORT TIME,
355 00:46:03:19 00:46:05:01 LESSEN THE AMOUNT
OF EROSION,
356 00:46:05:03 00:46:06:14 BUT WHAT
THE RESULT IS
357 00:46:06:16 00:46:08:29 IS THAT SEDIMENT
IS NO LONGER THERE
358 00:46:09:01 00:46:11:16 TO BE TAKEN
TO THE BEACHES.
359 00:46:11:18 00:46:13:29 THE BEACHES
RECEIVE PART OF
THEIR SAND SUPPLY
360 00:46:14:01 00:46:15:14 FROM CLIFF SIDES.
361 00:46:15:16 00:46:18:12 AS YOU SLOW DOWN
THE EROSION
OF CLIFF SIDES,
362 00:46:18:14 00:46:20:27 THEN THE BEACHES
ARE LOSING A SOURCE,
363 00:46:20:29 00:46:23:00 AN IMPORTANT SOURCE
OF THEIR SEDIMENTS.
364 00:46:24:05 00:46:25:16 *ANOTHER PROBLEM*
365 00:46:25:18 00:46:28:02 *IS THAT THE FLAT SURFACE*
OF A SEA WALL
366 00:46:28:04 00:46:30:00 *REFLECTS MUCH*

OF THE WAVE ENERGY

367 00:46:30:02 00:46:32:01 *DIRECTLY BACK TOWARD*
THE BEACH.

368 00:46:32:03 00:46:34:16 *UNFORTUNATELY,*
THIS CAN ERODE THE SAND

369 00:46:34:18 00:46:36:14 *AT THE FOOT OF THE WALL,*

370 00:46:36:16 00:46:37:29 *EVENTUALLY UNDERMINING IT.*

371 00:46:40:11 00:46:43:10 *AT THE SCRIPPS INSTITUTION*
OF OCEANOGRAPHY,

372 00:46:43:12 00:46:46:11 *SCIENTISTS DEAL WITH THIS*
CONTROVERSIAL ISSUE

373 00:46:46:13 00:46:48:25 *ON A CONTINUING BASIS.*

374 00:46:48:27 00:46:50:07 *SCOTT JENKINS*

375 00:46:50:09 00:46:52:01 *OF SCRIPPS CENTER*
FOR COASTAL STUDIES

376 00:46:52:03 00:46:53:22 *IS ONE OF THOSE INVOLVED*

377 00:46:53:24 00:46:57:00 *IN THE DESIGN OF SEA WALLS,*
BREAKWATERS,

378 00:46:57:02 00:46:58:16 *AND OTHER*
COASTAL STRUCTURES.

379 00:46:58:18 00:47:00:27 ABOUT 20 DEGREES
OF OBLIQUITY.

380 00:47:00:29 00:47:02:15 ALL RIGHT.

381 00:47:02:17 00:47:06:07 *THE GOAL IS TO DESIGN*
STRUCTURES THAT DO THE JOB

382 00:47:06:09 00:47:09:17 *WITH A MINIMAL NEGATIVE IMPACT*
ON THE ENVIRONMENT.

383 00:47:11:04 00:47:12:18 *JENKINS AND HIS COLLEAGUES*

384 00:47:12:20 00:47:15:02 *USE A WAVE TANK*
AND SCALE MODELS

385 00:47:15:04 00:47:16:23 *TO TEST THEIR DESIGNS--*

386 00:47:16:25 00:47:19:09 *IN THIS CASE, A BREAKWATER.*

387 00:47:19:11 00:47:21:09 *SENSORS PLACED*
AROUND THE TANK

388 00:47:21:11 00:47:23:24 *MEASURE THE HEIGHTS*
OF THE WAVES

389 00:47:23:26 00:47:25:22 *BOTH INSIDE AND OUTSIDE*
THE BREAKWATER,

390 00:47:25:24 00:47:28:06 *GIVING JENKINS AN INDICATION*
OF ITS EFFECTIVENESS

391 00:47:28:08 00:47:30:16 *AT REDUCING WAVE ENERGY.*

392 00:47:30:18 00:47:34:09 *DATA FROM THE EXPERIMENT*
IS FED INTO A COMPUTER,

393 00:47:34:11 00:47:35:22 *ALLOWING THE SCIENTISTS*

394 00:47:35:24 00:47:38:07 *TO REFINE AND RETEST*
THE DESIGN

395 00:47:38:09 00:47:40:21 *BEFORE AN ACTUAL PROTOTYPE*
IS BUILT.

396 00:47:43:14 00:47:45:07 *WHEN DESIGNING*
THE SEA WALL,

397 00:47:45:09 00:47:46:23 *JENKINS AND HIS COLLEAGUES*

398 00:47:46:25 00:47:49:07 *TURNED TO NATURE*
FOR INSPIRATION.

399 00:47:49:09 00:47:51:23 *THE IRREGULARLY SHAPED*
SURFACES

400 00:47:51:25 00:47:54:09 *OF SEA CLIFFS*

AND CORAL REEFS

401 00:47:54:11 00:47:57:21 *REFLECT A MINIMAL AMOUNT*
OF WAVE ENERGY,

402 00:47:57:23 00:48:00:20 *SO THE SCRIPPS SCIENTISTS*
DECIDED TO INCORPORATE

403 00:48:00:22 00:48:02:04 *NATURE'S*
ENERGY-ABSORBING DESIGN

404 00:48:02:06 00:48:03:28 *INTO THEIR SEA WALL.*

405 00:48:05:16 00:48:08:15 *SO FAR, THIS WALL HAS BEEN*
A SUCCESS.

406 00:48:08:17 00:48:11:14 *THE PROPERTY HAS BEEN PROTECTED*
FROM FURTHER EROSION

407 00:48:11:16 00:48:14:13 *WITHOUT DESTROYING THE BEACH*
AT THE WALL'S BASE.

408 00:48:14:15 00:48:16:05 *BUT WHILE JENKINS*
IS COMMITTED

409 00:48:16:07 00:48:19:05 *TO BUILDING THE MOST*
EFFECTIVE SEA WALLS HE CAN,

410 00:48:19:07 00:48:23:16 *HE RECOGNIZES THAT THEY ARE*
ONLY A SHORT-TERM SOLUTION,

411 00:48:23:18 00:48:26:16 *AND HE IS SENSITIVE*
TO THE ARGUMENTS OF THOSE

412 00:48:26:18 00:48:28:10 *WHO OPPOSE ATTEMPTS*
TO REDIRECT

413 00:48:28:12 00:48:31:10 *OR IN ANY WAY*
MODIFY NATURAL PROCESSES

414 00:48:31:12 00:48:32:25 *ALONG THE COAST.*

415 00:48:34:13 00:48:35:24 THERE'S
A WIDE VARIETY

416 00:48:35:26 00:48:38:24 OF ENVIRONMENTAL
GROUPS,

417 00:48:38:26 00:48:41:23 AND THERE'S
A WIDE RANGE OF
GOVERNMENT OFFICIALS

418 00:48:41:25 00:48:43:24 AND UNIVERSITY
PROFESSORS

419 00:48:43:26 00:48:46:04 WHO OPPOSE
CONSTRUCTION

420 00:48:46:06 00:48:47:29 AND STRUCTURAL
INTERVENTION

421 00:48:48:01 00:48:49:13 ON THE SHORELINE,

422 00:48:49:15 00:48:51:14 AND THE REASON
IS PHILOSOPHICAL--

423 00:48:51:16 00:48:53:19 THAT WE
WANT TO PRESERVE
THE SHORELINE

424 00:48:53:21 00:48:55:06 IN ITS
NATURAL STATE.

425 00:48:55:08 00:48:58:18 THOSE WHO ARE GOING
TO LOSE PROPERTY

426 00:48:58:20 00:49:01:00 IF EROSION CONTINUES

427 00:49:01:02 00:49:02:14 ALSO HAVE A CONCERN,

428 00:49:02:16 00:49:05:14 AND THOSE ARE
THE PEOPLE WHO,
OF COURSE,

429 00:49:05:16 00:49:07:13 ARE GOING TO FAVOR

THESE STRUCTURES.

430 00:49:07:15 00:49:08:25 AND MY
PERSONAL BELIEF

431 00:49:08:27 00:49:10:25 IS WE SHOULD
ADOPT THE POLICY

432 00:49:10:27 00:49:12:09 OF MAINTAINING
THE COASTLINE

433 00:49:12:11 00:49:13:25 IN ITS
NATURAL STATE,

434 00:49:13:27 00:49:17:11 AND A LARGE PART
OF THAT POLICY
WOULD INVOLVE

435 00:49:17:13 00:49:20:04 BYPASSING
OF SEDIMENTS
AROUND DAMS

436 00:49:20:06 00:49:22:04 AND PREVENTING
FURTHER ENCROACHMENT

437 00:49:22:06 00:49:23:20 OF COASTAL
STRUCTURES

438 00:49:23:22 00:49:25:24 IN THE NEAR SHORE
AREA.

439 00:49:25:26 00:49:27:24 AND THEN
I WOULD SAY,

440 00:49:27:26 00:49:29:09 HAVING MADE
THOSE FIXES,

441 00:49:29:11 00:49:32:08 LET THE SYSTEM
ADJUST TO ITS OWN
EQUILIBRIUM.

442 00:49:32:10 00:49:34:22 THERE'S FAR TOO MUCH
ENERGY OUT THERE

443 00:49:34:24 00:49:36:20 FOR MAN TO
COMPETE AGAINST.

444 00:49:38:24 00:49:41:23 *JENKINS CONTENDS*
THAT DOING A BETTER JOB

445 00:49:41:25 00:49:43:23 *OF TRANSPORTING SEDIMENT*
AROUND DAMS

446 00:49:43:25 00:49:46:07 *WOULD BE AN IMPORTANT*
LONG-TERM SOLUTION

447 00:49:46:09 00:49:49:11 *TO THE PROBLEM*
OF BEACH EROSION.

448 00:49:49:13 00:49:51:26 BASICALLY, IT'S
AN EARTH-MOVING
PROBLEM,

449 00:49:51:28 00:49:54:25 AND WE ALREADY HAVE
A WELL-DEVELOPED
TECHNOLOGY

450 00:49:54:27 00:49:55:29 IN EARTH MOVING.

451 00:49:56:01 00:49:57:16 NOW, IN SOUTHERN
CALIFORNIA

452 00:49:57:18 00:49:59:29 AND IN MANY OTHER
AREAS AS WELL,

453 00:50:00:01 00:50:01:22 THERE ARE SEASONAL
FLUCTUATIONS

454 00:50:01:24 00:50:03:07 IN THE LAKE LEVEL.

455 00:50:03:09 00:50:06:13 TYPICALLY,
LAKE LEVELS ARE LOW

IN THE SUMMER,
456 00:50:06:15 00:50:07:27 BUT WHATEVER SEASON
THEY'RE LOW,
457 00:50:07:29 00:50:10:12 EARTH-MOVING
EQUIPMENT
CAN COME IN
458 00:50:10:14 00:50:11:27 AND EXCAVATE
THESE SANDS
459 00:50:11:29 00:50:13:27 FROM THE DRY
FORESHORE AREA.
460 00:50:13:29 00:50:16:13 THE FORESHORE DELTAS
IN THESE RESERVOIRS
461 00:50:16:15 00:50:19:13 CONTAIN MOST OF
THE BEACH-SIZE SAND,
462 00:50:19:15 00:50:22:12 AND THESE WILL BE
HIGH AND DRY
463 00:50:22:14 00:50:23:27 WHEN LAKE LEVELS
ARE LOW.
464 00:50:23:29 00:50:25:11 SO THEY CAN BE
COLLECTED
465 00:50:25:13 00:50:27:10 WITH STANDARD
EARTH-MOVING
EQUIPMENT
466 00:50:27:12 00:50:29:09 AND TRUCKED DIRECTLY
TO THE BEACH
467 00:50:29:11 00:50:31:19 OR REINTRODUCED
TO THE STREAM BEDS
DOWNSTREAM.
468 00:50:33:05 00:50:35:29 *IF THERE IS TECHNOLOGY*
AND ENGINEERING AVAILABLE
469 00:50:36:01 00:50:38:08 *FOR TRANSPORTING SAND*
AROUND DAMS,
470 00:50:38:10 00:50:40:08 *WHY ISN'T THIS BEING DONE?*
471 00:50:41:20 00:50:43:03 *ONE REASON MAY BE*
472 00:50:43:05 00:50:46:02 *THAT MANY SCIENTISTS*
ORIGINALLY REJECTED THE IDEA
473 00:50:46:04 00:50:48:16 *THAT DAMS ACTUALLY*
CONTRIBUTE TO EROSION.
474 00:50:49:24 00:50:52:06 *BUT THAT IS NO LONGER*
THE CASE.
475 00:50:52:08 00:50:54:20 *THE PROBLEM CURRENTLY*
SEEMS TO BE
476 00:50:54:22 00:50:58:05 *THAT THE VALUE OF SAND*
AS A COASTAL RESOURCE
477 00:50:58:07 00:51:00:19 *MAY STILL NOT BE*
FULLY RECOGNIZED.
478 00:51:02:13 00:51:05:13 A LOT OF THIS SAND
IS ALREADY EXCAVATED
479 00:51:05:15 00:51:07:13 BY SAND AND GRAVEL
COMPANIES
480 00:51:07:15 00:51:09:13 FOR CONSTRUCTION
MATERIAL.
481 00:51:09:15 00:51:12:12 IT SHOULD BE TREATED
AS A PUBLIC
RESOURCE
482 00:51:12:14 00:51:14:26 AND A FAIR MARKET

VALUE PAID FOR IT.

483 00:51:14:28 00:51:17:11 FOR INSTANCE,
PEOPLE ON THE BEACH

484 00:51:17:13 00:51:20:25 WOULD BE WILLING
TO PAY MANY DOLLARS
PER CUBIC YARD

485 00:51:20:27 00:51:22:12 FOR NOURISHMENT
SANDS,

486 00:51:22:14 00:51:25:11 SANDS THAT
SAND AND GRAVEL
COMPANIES HAUL AWAY

487 00:51:25:13 00:51:28:26 AT JUST A FRACTION
OF A DOLLAR
A CUBIC YARD.

488 00:51:28:28 00:51:32:08 SO THIS NEEDS
TO BE REGULATED
JUST LIKE WATER--

489 00:51:32:10 00:51:35:00 TREATING SAND AS
A PUBLIC RESOURCE.

490 00:51:36:12 00:51:38:10 *REGARDLESS*
OF HOW THE BATTLE

491 00:51:38:12 00:51:40:26 *OVER SEA WALLS*
AND SEDIMENT SUPPLY

492 00:51:40:28 00:51:42:09 *EVENTUALLY TURNS OUT,*

493 00:51:42:11 00:51:45:11 *COASTAL DWELLERS*
WILL ALWAYS HAVE TO DEAL

494 00:51:45:13 00:51:47:14 *WITH INCURSIONS*
FROM THE OCEANS.

495 00:51:47:16 00:51:51:09 *IN ADDITION TO PROBLEMS*
CAUSED BY CRASHING WAVES,

496 00:51:51:11 00:51:53:22 *THERE ARE A NUMBER*
OF OTHER FACTORS

497 00:51:53:24 00:51:56:14 *THAT AFFECT THE LEVEL*
OF THE WATER.

498 00:51:56:16 00:51:59:28 *THE MOST FAMILIAR*
IS THE ACTION OF THE TIDES.

499 00:52:00:01 00:52:02:29 *TIDES ARE PRIMARILY*
THE WORK OF THE MOON,

500 00:52:03:01 00:52:06:01 *AND TO A LESSER DEGREE,*
THE SUN.

501 00:52:07:19 00:52:10:02 *AS THE MOON*
ORBITS THE EARTH,

502 00:52:10:04 00:52:12:23 *IT EXERTS A POWERFUL*
GRAVITATIONAL PULL.

503 00:52:15:01 00:52:16:14 *THIS CAUSES THE OCEAN*

504 00:52:16:16 00:52:19:28 *ON THE SIDE OF THE EARTH*
FACING THE MOON

505 00:52:20:00 00:52:21:12 *TO BULGE OUT SLIGHTLY.*

506 00:52:23:18 00:52:25:00 *ANOTHER TIDAL BULGE*

507 00:52:25:02 00:52:27:29 *OCCURS ON THE OTHER SIDE*
OF THE PLANET

508 00:52:28:01 00:52:29:15 *AS WATER LAGS BEHIND*

509 00:52:29:17 00:52:31:14 *DUE TO WEAKER*
GRAVITATIONAL ATTRACTION

510 00:52:31:16 00:52:33:00 *FROM THE MOON.*

511 00:52:34:16 00:52:37:09 *THESE BULGES CREATE*

A HIGH TIDE.

512 00:52:42:25 00:52:45:08 *HIGH TIDES CAN CREATE TREMENDOUS HAVOC,*

513 00:52:45:10 00:52:49:10 *ESPECIALLY IF THEY'RE COMBINED WITH VIOLENT STORMS.*

514 00:52:49:12 00:52:53:22 *THIS IS WHAT HAPPENED IN 1970 IN BANGLADESH*

515 00:52:53:24 00:52:56:22 *WHEN A CYCLONE COMBINED WITH A SPRING TIDE*

516 00:52:56:24 00:52:59:26 *FLOODED THE DELTA OF THE GANGES RIVER,*

517 00:52:59:28 00:53:03:00 *DROWNING A QUARTER OF A MILLION PEOPLE.*

518 00:53:03:02 00:53:06:12 *BUT SUCH TIDAL DISASTERS ARE RARE.*

519 00:53:07:16 00:53:08:28 *MOST OF THE TIME,*

520 00:53:09:00 00:53:12:02 *THE TWICE-DAILY EBB AND FLOW OF THE TIDES*

521 00:53:12:04 00:53:14:17 *ONLY BRINGS ABOUT SMALL, BRIEF CHANGES*

522 00:53:14:19 00:53:16:02 *IN THE WATER LEVEL,*

523 00:53:16:04 00:53:19:12 *BUT THERE'S ALSO A LONG-TERM CHANGE GOING ON*

524 00:53:19:14 00:53:20:27 *ALL THE WHILE.*

525 00:53:24:03 00:53:27:00 *SINCE THE PEAK OF THE LAST ICE AGE*

526 00:53:27:02 00:53:28:28 *TENS OF THOUSANDS OF YEARS AGO,*

527 00:53:29:00 00:53:30:14 *MELTING GLACIERS HAVE SPILLED*

528 00:53:30:16 00:53:33:13 *IMMENSE QUANTITIES OF WATER INTO THE OCEANS,*

529 00:53:33:15 00:53:37:13 *CAUSING A RISE IN SEA LEVEL OF OVER 100 METERS.*

530 00:53:39:18 00:53:43:01 *SUCH A GLOBAL CHANGE IN THE VOLUME OF WATER*

531 00:53:43:03 00:53:44:16 *IN THE OCEAN*

532 00:53:44:18 00:53:47:12 *IS KNOWN AS A EUSTATIC CHANGE.*

533 00:53:48:29 00:53:51:25 *ALTHOUGH TODAY'S SEA LEVEL IS MUCH MORE STABLE*

534 00:53:51:27 00:53:55:17 *THAN IT WAS AT THE TIME THE ICE AGE ENDED,*

535 00:53:55:19 00:53:58:15 *A SMALL EUSTATIC CHANGE IS STILL GOING ON.*

536 00:53:58:17 00:54:00:29 *THE GLACIERS OF GREENLAND AND ANTARCTICA*

537 00:54:01:01 00:54:03:29 *ARE CONTINUING TO MELT FASTER THAN THEY GROW.*

538 00:54:04:01 00:54:06:29 *THIS CAUSES A SMALL BUT STEADY RISE*

539 00:54:07:01 00:54:09:04 *IN SEA LEVEL WORLDWIDE.*

540 00:54:11:15 00:54:14:15 *HOWEVER, BETWEEN NOW AND THE YEAR 2100,*

541 00:54:14:17 00:54:17:29 *THERE MAY BE A SIGNIFICANT INCREASE IN SEA LEVEL*

542 00:54:18:01 00:54:20:29 *DUE TO THE SO-CALLED GREENHOUSE EFFECT.*
543 00:54:24:07 00:54:27:03 *CARBON DIOXIDE AND WATER VAPOR IN THE ATMOSPHERE*
544 00:54:27:05 00:54:30:04 *ACT LIKE THE GLASS OF A GREENHOUSE.*
545 00:54:30:06 00:54:31:26 *THEY LET IN THE SUNLIGHT,*
546 00:54:31:28 00:54:34:17 *BUT TRAP SOME OF THE RERADIATED*
547 00:54:34:19 00:54:36:15 *INFRARED HEAT ENERGY.*
548 00:54:36:17 00:54:38:00 *WITHOUT THIS GREENHOUSE EFFECT,*
549 00:54:38:02 00:54:40:15 *THE EARTH WOULD BECOME TOO COLD*
550 00:54:40:17 00:54:42:14 *TO SUPPORT HUMAN LIFE.*
551 00:54:45:04 00:54:47:02 *BUT SINCE THE INDUSTRIAL REVOLUTION*
552 00:54:47:04 00:54:49:02 *BEGAN TO MECHANIZE OUR WORLD*
553 00:54:49:04 00:54:51:07 *IN THE LATE 18th CENTURY,*
554 00:54:51:09 00:54:53:07 *WE'VE BEEN ADDING TREMENDOUS QUANTITIES*
555 00:54:53:09 00:54:55:21 *OF CARBON DIOXIDE TO THE ATMOSPHERE*
556 00:54:55:23 00:54:57:06 *BY BURNING FOSSIL FUELS.*
557 00:54:57:08 00:54:59:21 *THE FIRST OF THESE WAS COAL--*
558 00:54:59:23 00:55:01:26 *THE FOSSIL REMAINS OF VEGETATION.*
559 00:55:01:28 00:55:03:27 *BURNING COAL PRODUCED THE STEAM*
560 00:55:03:29 00:55:08:14 *WHICH POWERED STEAMSHIPS, FACTORIES, AND LOCOMOTIVES.*
561 00:55:08:16 00:55:11:13 *IT ALSO RELEASED VAST AMOUNTS OF CARBON DIOXIDE,*
562 00:55:11:15 00:55:14:12 *WHICH UNTIL THEN HAD BEEN STORED UNDERGROUND*
563 00:55:14:14 00:55:15:27 *FOR MILLIONS OF YEARS.*
564 00:55:17:26 00:55:20:24 *SINCE THE EARLY DAYS OF THE INDUSTRIAL REVOLUTION,*
565 00:55:20:26 00:55:23:09 *THE WORLD'S RELIANCE ON FOSSIL FUELS*
566 00:55:23:11 00:55:24:29 *HAS INCREASED DRAMATICALLY.*
567 00:55:25:01 00:55:29:05 *TODAY, THESE FUELS INCLUDE NOT ONLY COAL,*
568 00:55:29:07 00:55:31:16 *BUT GASOLINE AND OIL.*
569 00:55:31:18 00:55:35:23 *IF WE CONTINUE TO BURN THESE AT OUR PRESENT RATE,*
570 00:55:35:25 00:55:38:28 *THE AMOUNT OF CARBON DIOXIDE IN THE ATMOSPHERE*
571 00:55:39:00 00:55:40:14 *WILL INCREASE SIGNIFICANTLY.*
572 00:55:43:14 00:55:45:27 *THIS COULD MAGNIFY THE GREENHOUSE EFFECT*
573 00:55:45:29 00:55:47:17 *TO SUCH AN EXTENT*
574 00:55:47:19 00:55:51:23 *THAT AIR TEMPERATURES COULD*

RISE BY SEVERAL DEGREES

575 00:55:51:25 00:55:54:22 *AND ACCELERATE POLAR ICE MELTING,*

576 00:55:54:24 00:55:57:13 *WHICH WOULD RESULT IN A RISE IN SEA LEVEL*

577 00:55:57:15 00:55:59:03 *OF A FEW METERS.*

578 00:55:59:05 00:56:01:07 *THIS MAY NOT SEEM LIKE MUCH,*

579 00:56:01:09 00:56:03:08 *BUT IT WOULD BE ENOUGH*

580 00:56:03:10 00:56:06:12 *TO FLOOD MANY OF THE WORLD'S COASTAL COMMUNITIES.*

581 00:56:10:10 00:56:12:23 ALTHOUGH THE COASTLINE APPEARS TO BE

582 00:56:12:25 00:56:15:07 A STABLE AND PERMANENT FIXTURE OF THE LANDSCAPE,

583 00:56:15:09 00:56:17:21 IT'S, IN FACT, A PLACE OF INEVITABLE CHANGE.

584 00:56:17:23 00:56:19:20 WHEN PEOPLE CHOOSE TO LIVE HERE,

585 00:56:19:22 00:56:21:19 THEY BECOME SUBJECT TO THAT CHANGE

586 00:56:21:21 00:56:24:19 AND RUN THE RISK OF LOSING EVERYTHING,

587 00:56:24:21 00:56:27:05 EITHER SUDDENLY OR STEADILY OVER TIME.

588 00:56:27:07 00:56:29:05 PERMANENT PROTECTION FOR COASTAL DEVELOPMENT

589 00:56:29:07 00:56:30:19 SIMPLY DOESN'T EXIST,

590 00:56:30:21 00:56:32:04 AND MANY PROTECTION SCHEMES

591 00:56:32:06 00:56:34:18 ACTUALLY DEGRADE THE QUALITY OF THE BEACH

592 00:56:34:20 00:56:37:00 THAT ATTRACTED PEOPLE HERE IN THE FIRST PLACE.

593 00:56:37:02 00:56:38:07 AS A RESULT,

594 00:56:38:09 00:56:39:17 IT'S BECOMING INCREASINGLY IMPORTANT

595 00:56:39:19 00:56:42:00 TO DEVELOP A WISE COASTAL MANAGEMENT POLICY

596 00:56:42:02 00:56:44:14 THAT INCORPORATES THE MOST CURRENT SCIENTIFIC KNOWLEDGE

597 00:56:44:16 00:56:46:13 WITH THE NEEDS OF THE ENVIRONMENT

598 00:56:46:15 00:56:47:29 AND OF OUR COMMUNITIES.

599 00:56:48:01 00:56:50:28 IT'S CLEAR THAT THERE'S A SIGNIFICANT ROLE FOR GEOLOGISTS,

600 00:56:51:00 00:56:53:12 AND INDEED, FOR ALL OF US TO PLAY

601 00:56:53:14 00:56:55:26 IN LEARNING TO PROTECT THE COASTLINE FOR OURSELVES

602 00:56:55:28 00:56:57:10 AND FOR FUTURE GENERATIONS.

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