1	00:59:05:23	00:59:09:05	Annenberg Media
2	00:59:09:07	00:59:59:16	§
3	00:59:59:18	01:00:01:07	*THIS ANCIENT MEANDERING RIVER*
4	01:00:01:09	01:00:02:23	*PROVIDED SUSTENANCE*
5	01:00:02:25	01:00:05:20	*FOR ONE OF THE EARLIEST CIVILIZATIONS ON EARTH.*
6	01:00:05:22	01:00:08:29	*THE CULTURE WHICH THRIVED ALONG ITS FERTILE VALLEYS*
7	01:00:09:01	01:00:11:09	*FOREVER CHANGED WESTERN CIVILIZATION.*
8	01:00:11:11	01:00:13:19	*"EGYPT," SAID HERODOTUS,*
9	01:00:13:21	01:00:16:03	*"IS THE GIFT OF THE NILE."*
10	01:00:18:02	01:00:20:20	*PUZZLED BY THE SOURCE OF ALL THIS WATER,*
11	01:00:20:22	01:00:22:10	*MANY EARLY PHILOSOPHERS THEORIZED*
12	01:00:22:12	01:00:24:16	*THAT THE WATERS OF THE NILE,*
13	01:00:24:18	01:00:26:29	*AS WELL AS ALL OTHER RIVERS,*
14	01:00:27:01	01:00:28:13	*ORIGINATED FROM A SYSTEM*
15	01:00:28:15	01:00:30:00	*OF BOUNDLESS UNDERGROUND FOUNTAINS.*
16	01:00:30:02	01:00:32:17	*THEN IN THE 17th CENTURY,*
17	01:00:32:19	01:00:34:19	*FRENCH SCIENTIST PIERRE PERRAULT*
18	01:00:34:21	01:00:36:03	*CONDUCTED A SIMPLE EXPERIMENT*
19	01:00:36:05	01:00:38:19	*THAT WOULD YIELD A STARTLING DISCOVERY.*
20	01:00:50:17	01:00:51:22	PERRAULT REASONED
21	01:00:51:24	01:00:53:29	THAT RIVERS TRANSPORT SNOW AND RAIN
22	01:00:54:01	01:00:56:08	FROM THE LAND TO THE OCEANS.
23	01:00:56:10	01:00:57:23	TO TEST THIS HYPOTHESIS,
24	01:00:57:25	01:00:59:10	HE COMPARED RAINFALL
25	01:00:59:12	01:01:02:04	WITH THE FLOW, OR DISCHARGE, OF A RIVER.
26	01:01:02:06	01:01:04:22	HE FIRST MEASURED THE AMOUNT OF WATER
27	01:01:04:24	01:01:07:13	FLOWING ANNUALLY IN THE RIVER SEINE IN FRANCE.
28	01:01:07:15	01:01:09:01	THEN HE CALCULATED RAINFALL
29	01:01:09:03	01:01:11:17	FOR THE UPSTREAM DRAINAGE BASIN SURROUNDING THE RIVER.
30	01:01:11:19	01:01:13:18	PERRAULT FOUND TO HIS SURPRISE
31	01:01:13:20	01:01:16:12	THAT RAINFALL WAS

SIX TIMES AS LARGE

32 01:01:16:14 01:01:18:27 AS THE FLOW
OF THE RIVER.

33 01:01:18:29 01:01:20:29 SO EARLY SPECULATION
ABOUT RIVERS

34 01:01:21:01 01:01:22:28 ACTUALLY ADDRESSED
THE WRONG QUESTION.

35 01:01:23:00 01:01:24:13 THE PROBLEM WAS NOT...

36 01:01:24:15 01:01:26:29 WHERE DOES RIVER WATER
COME FROM?

37 01:01:27:01 01:01:29:18 BUT...WHERE DOES ALL
THE EXCESS RAINFALL GO?

38 01:01:29:20 01:01:32:11 ONLY ABOUT 1/4 OF EARTH'S
ANNUAL PRECIPITATION

39 01:01:32:13 01:01:33:26 FLOWS IN RIVERS.

40 01:01:33:28 01:01:36:27 THE REST SEEPS UNDERGROUND
TO BECOME GROUND WATER

41 01:01:36:29 01:01:40:07 OR IS STORED AS GLACIAL ICE
OR SOIL MOISTURE

42 01:01:40:09 01:01:42:17 OR IS RETURNED
TO THE ATMOSPHERE

43 01:01:42:19 01:01:44:18 BY EVAPORATION
AND GROWING PLANTS.

44 01:01:44:20 01:01:47:17 RIVERS ARE AMONG THE MOST
COMMON LAND FORMS ON EARTH.

45 01:01:47:19 01:01:50:12 ALTHOUGH THEY APPEAR
TO VARY A GREAT DEAL

46 01:01:50:14 01:01:52:08 IN THEIR BEHAVIOR
AND CHARACTERISTICS,

47 01:01:52:10 01:01:53:23 CAREFUL STUDY HAS SHOWN

48 01:01:53:25 01:01:57:01 THAT ALL RIVERS HAVE
A GREAT DEAL IN COMMON.

49 01:01:58:18 01:02:01:13 *THE IMPACT OF RIVERS*
ON THE LANDSCAPE

50 01:02:01:15 01:02:02:26 *IS OFTEN SPECTACULAR.*

51 01:02:02:28 01:02:05:25 *THEY CAN GOUGE OUT*
DEEP CANYONS,

52 01:02:05:27 01:02:10:01 *CREATE GENTLE VALLEYS*
WITH VERDANT MEADOWS,

53 01:02:10:03 01:02:12:25 *OR BUILD ENORMOUS DELTAS.*

54 01:02:12:27 01:02:14:15 *IN CREATING*
THESE DIVERSE LANDSCAPES,

55 01:02:14:17 01:02:17:15 *ALL RIVERS FUNCTION*
IN THE SAME MANNER.

56 01:02:17:17 01:02:21:19 *THEY ERODE, TRANSPORT,*
AND DEPOSIT SEDIMENT.

57 01:02:23:27 01:02:25:25 *THESE PROCESSES*
ENABLE RIVERS

58 01:02:25:27 01:02:29:21 *TO CONTINUOUSLY RESHAPE*
THE SURROUNDING LAND.

59 01:02:29:23 01:02:32:00 *ONE OF THE MOST*
IMPORTANT FACTORS

60 01:02:32:02 01:02:35:08 *INFLUENCING THE GEOLOGIC*
IMPACT OF A RIVER

61 01:02:35:10 01:02:37:19 *IS THE VELOCITY*
OF ITS WATER.

62 01:02:39:21 01:02:41:04 *A SWIFTLY FLOWING RIVER*
63 01:02:41:06 01:02:43:03 *ERODES AND TRANSPORTS MORE SEDIMENT*
64 01:02:43:05 01:02:45:12 *THAN A SLOW RIVER.*
65 01:02:45:14 01:02:46:27 *VELOCITY GENERALLY INCREASES*
66 01:02:46:29 01:02:49:05 *WITH THE SLOPE OF THE RIVER,*
67 01:02:49:07 01:02:51:29 *BUT CHANNEL SHAPE ALSO PLAYS A ROLE.*
68 01:02:52:01 01:02:55:00 IF A CHANNEL HAS A NEARLY PERFECT
69 01:02:55:02 01:02:56:16 SEMICIRCULAR CROSS-SECTION,
70 01:02:56:18 01:02:59:00 THE FRICTIONAL RESISTANCE IS THE MINIMUM,
71 01:02:59:02 01:03:02:00 SO THE WATER LOSES VERY LITTLE ENERGY
72 01:03:02:02 01:03:03:19 FLOWING OVER THE CHANNEL.
73 01:03:03:21 01:03:06:03 IF IT'S A WIDE, FLAT CHANNEL,
74 01:03:06:05 01:03:07:19 A FAIRLY SHALLOW RIVER,
75 01:03:07:21 01:03:09:13 THERE'S A GREATER SURFACE AREA
76 01:03:09:15 01:03:11:23 ALONG THE BANKS AND THE BOTTOM,
77 01:03:11:25 01:03:14:19 AND THAT SLOWS THE STREAM DOWN, TOO.
78 01:03:14:21 01:03:17:14 *THE TEXTURE OF A STREAM BED*
79 01:03:17:16 01:03:20:04 *ALSO INFLUENCES STREAM VELOCITY.*
80 01:03:21:25 01:03:23:07 ROUGHNESS IS A FUNCTION
81 01:03:23:09 01:03:25:28 OF THE MATERIALS OVER WHICH IT FLOWS,
82 01:03:26:00 01:03:28:12 SO IF IT'S FLOWING OVER GRAVEL AND BOULDERS,
83 01:03:28:14 01:03:30:28 THERE'S MORE RESISTANCE TO THE FLOW.
84 01:03:31:00 01:03:32:11 THAT SLOWS THE RIVER.
85 01:03:32:13 01:03:35:11 IF IT'S FLOWING OVER MUDS AND CLAYS,
86 01:03:35:13 01:03:37:28 LIKE ALONG THE LOWER MISSISSIPPI RIVER,
87 01:03:38:00 01:03:39:12 THERE'S LESS RESISTANCE,
88 01:03:39:14 01:03:41:13 AND IT FLOWS

A LITTLE FASTER.

89 01:03:44:00 01:03:46:28 *THE VELOCITY OF A RIVER*
ALSO TENDS TO INCREASE

90 01:03:47:00 01:03:48:28 *IF THE AMOUNT OF WATER*

91 01:03:49:00 01:03:51:07 *IN THE RIVER CHANNEL*
INCREASES.

92 01:03:51:09 01:03:53:28 *THE QUANTITY OF WATER*
MOVING THROUGH A RIVER

93 01:03:54:00 01:03:55:28 *IS CALLED*
ITS DISCHARGE.

94 01:03:56:00 01:03:58:10 THE DISCHARGE
OF A RIVER

95 01:03:58:12 01:04:00:23 IS HOW MUCH WATER
IT'S ACTUALLY
CARRYING.

96 01:04:00:25 01:04:02:07 WE USUALLY
MEASURE THIS

97 01:04:02:09 01:04:04:16 AS A VOLUME
PER UNIT TIME.

98 01:04:04:18 01:04:06:12 THE UNITED STATES
COMMONLY SAYS

99 01:04:06:14 01:04:07:28 CUBIC FEET
PER SECOND.

100 01:04:08:00 01:04:11:12 MOST OF THE WORLD
USES CUBIC METERS
PER SECOND

101 01:04:11:14 01:04:13:20 MOVING DOWN
THE CHANNEL.

102 01:04:13:22 01:04:16:11 DISCHARGE INCREASES
FROM THE HEAD
OF THE STREAM

103 01:04:16:13 01:04:17:26 TO THE STREAM MOUTH

104 01:04:17:28 01:04:19:25 AS THE DRAINAGE
BASIN INCREASES.

105 01:04:19:27 01:04:21:25 THERE'S SIMPLY
A LARGER AREA

106 01:04:21:27 01:04:23:11 TO CONTRIBUTE
DISCHARGE,

107 01:04:23:13 01:04:25:05 TO CONTRIBUTE FLOW
TO THE STREAMS.

108 01:04:26:18 01:04:28:00 THE PRIMARY WAY

109 01:04:28:02 01:04:30:02 THAT A RIVER
FUNCTIONS GEOLOGICALLY

110 01:04:30:04 01:04:32:17 IS TO TRANSPORT
NOT JUST WATER,

111 01:04:32:19 01:04:33:22 BUT SEDIMENT,

112 01:04:33:24 01:04:35:15 DOWN SLOPE
AND TOWARD THE OCEANS.

113 01:04:35:17 01:04:37:16 THE FASTER
A RIVER FLOWS,

114 01:04:37:18 01:04:40:01 THE MORE EFFICIENT
THIS PROCESS BECOMES,

115 01:04:40:03 01:04:41:27 SO GEOLOGISTS
ARE ACUTELY INTERESTED

116 01:04:41:29 01:04:43:12 IN FLOW VELOCITY.

117 01:04:43:14 01:04:46:02 WHEN THE FLOW VELOCITY

OF A STREAM

118 01:04:46:04 01:04:47:17 IS RELATIVELY HIGH,

119 01:04:47:19 01:04:49:25 THE ENERGY
OF THE MOVING WATER

120 01:04:49:27 01:04:51:08 IS CONVERTED
INTO PROCESSES

121 01:04:51:10 01:04:53:01 THAT LIFT
CHUNKS OF BEDROCK

122 01:04:53:03 01:04:55:12 OR SEDIMENTARY PARTICLES
FROM THE BOTTOM

123 01:04:55:14 01:04:56:27 AND CARRY THEM
DOWNSTREAM.

124 01:04:56:29 01:04:58:21 THIS IS KNOWN AS EROSION.

125 01:04:58:23 01:05:00:26 THERE ARE THREE DIFFERENT
EROSIONAL PROCESSES

126 01:05:00:28 01:05:02:08 THAT OPERATE IN RIVERS.

127 01:05:02:10 01:05:04:09 THE FIRST
IS HYDRAULIC ACTION.

128 01:05:04:11 01:05:07:04 THE TURBULENCE
OF A RAPIDLY FLOWING STREAM

129 01:05:07:06 01:05:08:18 APPLIES VERTICAL FORCES

130 01:05:08:20 01:05:11:11 THAT LIFT SEDIMENTARY GRAINS
OFF OF THE BOTTOM.

131 01:05:11:13 01:05:14:10 THE FLOWING CURRENT
ALSO PUSHES AGAINST
THESE PARTICLES

132 01:05:14:12 01:05:15:24 AND CARRIES THEM
DOWNSTREAM.

133 01:05:15:26 01:05:18:14 IF YOU'VE EVER
WADED ACROSS A RIVER

134 01:05:18:16 01:05:21:15 AND FELT THE SANDY BOTTOM
MOVING BENEATH YOUR FEET,

135 01:05:21:17 01:05:22:29 YOU'VE EXPERIENCED
HYDRAULIC ACTION.

136 01:05:23:01 01:05:25:00 THE FASTER
THE RIVER FLOWS,

137 01:05:25:02 01:05:26:14 THE GREATER
THE TURBULENCE,

138 01:05:26:16 01:05:29:13 AND THE SWIRLING FLOW
OF A VERY RAPID STREAM

139 01:05:29:15 01:05:32:09 CAN EVEN WRENCH CHUNKS
OF FRACTURED BEDROCK

140 01:05:32:11 01:05:34:13 OFF OF THE CHANNEL BOTTOM.

141 01:05:34:15 01:05:37:00 THE RAPID CURRENT
OF A SEDIMENT-LADEN RIVER

142 01:05:37:02 01:05:39:15 CAN ALSO GENERATE
A SAND-BLASTING EFFECT

143 01:05:39:17 01:05:42:05 WHICH CAN SCOUR ITS WAY
DOWN THROUGH SEDIMENT

144 01:05:42:07 01:05:43:19 OR EVEN SOLID ROCK.

145 01:05:43:21 01:05:45:14 IN THIS PROCESS,
CALLED ABRASION,

146 01:05:45:16 01:05:47:24 THE ENERGY
OF THE MOVING WATER

147 01:05:47:26 01:05:50:15 IS CONVERTED INTO COLLISIONS
BETWEEN SEDIMENTARY GRAINS

148 01:05:50:17 01:05:53:07 AND THE BEDROCK
OF THE CHANNEL BOTTOM.
149 01:05:53:09 01:05:56:09 ABRASION NOT ONLY
SMOOTHS RIVER COBBLES
INTO ROUNDED SHAPES,
150 01:05:56:11 01:05:59:05 IT CAN ALSO
WEAR AWAY THE BEDROCK
151 01:05:59:07 01:06:02:03 MANY TIMES FASTER
THAN HYDRAULIC ACTION ALONE.
152 01:06:02:05 01:06:04:18 RUNNING WATER ALSO,
TO SOME DEGREE,
153 01:06:04:20 01:06:07:23 DISSOLVES ANY TYPE
OF ROCK OR MINERAL.
154 01:06:07:25 01:06:09:27 THIS PROCESS OF EROSION,
CALLED DISSOLUTION,
155 01:06:09:29 01:06:11:08 IS CONTROLLED IN PART
156 01:06:11:10 01:06:13:22 BY THE MINERAL COMPOSITION
OF THE BEDROCK.
157 01:06:13:24 01:06:16:13 FOR EXAMPLE, A RIVER BED
MADE OF LIMESTONE
158 01:06:16:15 01:06:19:12 WILL DISSOLVE MORE RAPIDLY
THAN ONE MADE OF GRANITE.
159 01:06:19:14 01:06:21:23 THE RATE OF EROSION
BY DISSOLUTION
160 01:06:21:25 01:06:23:23 IS ALSO CONTROLLED
BY TEMPERATURE,
161 01:06:23:25 01:06:25:17 THE ACIDITY
OF THE WATER,
162 01:06:25:19 01:06:27:10 AND BY FLOW VELOCITY.
163 01:06:27:12 01:06:29:07 EROSION IN ITS
VARIOUS FORMS
164 01:06:29:09 01:06:31:19 IS ONLY ONE WAY
RIVERS INTERACT
165 01:06:31:21 01:06:34:07 WITH THE SEDIMENT
AND BEDROCK
OF EARTH'S CRUST.
166 01:06:34:09 01:06:36:06 ONCE THIS MATERIAL'S
PICKED UP
167 01:06:36:08 01:06:37:23 AND PUT INTO MOTION,
168 01:06:37:25 01:06:40:11 IT BECOMES PART
OF THE RIVER'S FLOW
169 01:06:40:13 01:06:42:08 AND IS TRANSPORTED
DOWNSTREAM
170 01:06:42:10 01:06:45:14 BY ONE OF SEVERAL PROCESSES
OF SEDIMENT TRANSPORT.
171 01:06:47:09 01:06:50:08 *THE SHAPE, SIZE,*
AND COMPOSITION
OF SEDIMENT
172 01:06:50:10 01:06:51:22 *INFLUENCE*
HOW THE SEDIMENT
173 01:06:51:24 01:06:54:23 *WILL BE CARRIED ALONG*
IN THE STREAM
174 01:06:54:25 01:06:57:02 *AND WHERE*
IT WILL BE DEPOSITED.
175 01:06:57:04 01:07:00:02 LARGER PARTICLES
STAY NEAR THE BED

OF THE STREAM
176 01:07:00:04 01:07:02:21 AND IS TRANSPORTED
BY ROLLING
OR BOUNCING
177 01:07:02:23 01:07:04:20 OR SKIDDING
ALONG THE BOTTOM.
178 01:07:04:22 01:07:07:02 THIS IS CALLED
BED LOAD.
179 01:07:07:04 01:07:09:29 WHEN MATERIAL'S
MOVED AS BED LOAD
IN A STREAM,
180 01:07:10:01 01:07:11:16 EXACTLY HOW IT MOVES
181 01:07:11:18 01:07:13:24 IS LARGELY
A FUNCTION OF SIZE.
182 01:07:13:26 01:07:15:10 LARGER PARTICLES--
183 01:07:15:12 01:07:17:06 GRAVEL, COBBLE,
OR BOULDER SIZE--
184 01:07:17:08 01:07:19:15 STAY IN CONTACT
WITH THE BED
185 01:07:19:17 01:07:21:00 VIRTUALLY
ALL THE TIME,
186 01:07:21:02 01:07:22:29 EXCEPT IN EXTREME
DISCHARGE EVENTS
187 01:07:23:01 01:07:25:16 WHERE THE VELOCITIES
ARE VERY HIGH.
188 01:07:25:18 01:07:27:15 THESE PARTICLES
MOVE BY ROLLING
189 01:07:27:17 01:07:29:01 OR BY BEING PUSHED
190 01:07:29:03 01:07:31:15 OR BY SLIDING
ALONG THE BOTTOM.
191 01:07:31:17 01:07:34:06 THIS IS THE TRACTION
LOAD OF THE STREAM,
192 01:07:34:08 01:07:37:08 CONTINUOUSLY
IN CONTACT
WITH THE BED.
193 01:07:37:10 01:07:39:26 SMALLER PARTICLES
IN TRANSPORT
AS BED LOAD--
194 01:07:39:28 01:07:41:05 SAND GRAINS,
FOR EXAMPLE--
195 01:07:41:07 01:07:43:05 STAY CLOSE
TO THE BED,
196 01:07:43:07 01:07:45:12 BUT AREN'T
IN CONTACT
CONTINUOUSLY.
197 01:07:45:14 01:07:47:10 THESE PARTICLES
ACTUALLY MOVE ALONG
198 01:07:47:12 01:07:49:09 IN A SERIES
OF JUMPS--
199 01:07:49:11 01:07:51:06 HOPPING UP
INTO THE FLOW,
200 01:07:51:08 01:07:53:15 BEING PULLED FORWARD
BY THE DISCHARGE,
201 01:07:53:17 01:07:55:15 HITTING BOTTOM,
BOUNCING UP AGAIN,
202 01:07:55:17 01:07:59:02 OR EJECTING

			ANOTHER PARTICLE FROM THE BED
203	01:07:59:04	01:08:01:10	WHICH JUMPS UP INTO THE FLOW.
204	01:08:01:12	01:08:04:20	THIS STYLE OF BED-LOAD TRANSPORT IS CALLED SALTATION.
205	01:08:04:22	01:08:06:19	*ALTHOUGH CONSIDERABLE* *AMOUNTS OF SEDIMENT*
206	01:08:06:21	01:08:09:06	*ARE TRANSPORTED* *AS BED LOAD,*
207	01:08:09:08	01:08:11:09	*MOST OF A STREAM'S* *SEDIMENT*
208	01:08:11:11	01:08:13:08	*IS TYPICALLY* *CARRIED IN SUSPENSION*
209	01:08:13:10	01:08:14:23	*AND IN SOLUTION.*
210	01:08:16:19	01:08:20:11	*SUSPENDED LOAD* *INCLUDES MATERIAL* *LIKE SILTS OR CLAYS.*
211	01:08:20:13	01:08:23:17	*IT'S LIGHT ENOUGH TO BE* *SWEPT ALONG IN THE CURRENT*
212	01:08:23:19	01:08:25:20	*WITHOUT TOUCHING BOTTOM.*
213	01:08:25:22	01:08:27:04	*DISSOLVED LOAD* *IS INVISIBLE.*
214	01:08:27:06	01:08:30:10	*IT IS THE EVER-PRESENT* *SOLUBLE MATERIAL*
215	01:08:30:12	01:08:32:09	*WHICH RESULTS* *FROM CHEMICAL WEATHERING*
216	01:08:32:11	01:08:35:15	*OF THE ROCKS* *ALONG THE CHANNEL.*
217	01:08:35:17	01:08:36:29	BECAUSE PRECIPITATION VARIES SEASONALLY,
218	01:08:37:01	01:08:39:17	AS WELL AS FROM YEAR TO YEAR,
219	01:08:39:19	01:08:42:18	THE DISCHARGE AND VELOCITY OF A STREAM ALSO FLUCTUATES.
220	01:08:42:20	01:08:44:19	AS THE RIVER SLOWS DOWN,
221	01:08:44:21	01:08:46:27	THE TURBULENCE OF THE MOVING WATER
222	01:08:46:29	01:08:48:12	BEGINS TO SUBSIDE,
223	01:08:48:14	01:08:50:08	AND THE AMOUNT OF ENERGY
224	01:08:50:10	01:08:52:18	AVAILABLE TO ERODE AND TRANSPORT SEDIMENT
225	01:08:52:20	01:08:54:02	DECREASES ABRUPTLY.
226	01:08:54:04	01:08:56:22	MUCH OF THE SEDIMENT NO LONGER REMAINS IN MOTION,
227	01:08:56:24	01:08:58:07	AND IS DEPOSITED, INSTEAD.
228	01:08:58:09	01:09:00:04	THE SEDIMENT IS USUALLY DEPOSITED
229	01:09:00:06	01:09:02:03	IN THE RIVER CHANNEL ITSELF
230	01:09:02:05	01:09:04:29	IN A SERIES OF PILES, CALLED BARS.
231	01:09:05:01	01:09:07:29	MOST RIVER BARS ARE RIDGES MADE OF SAND AND GRAVEL
232	01:09:08:01	01:09:10:29	THAT ARE COVERED WITH SMALL MIGRATING RIPPLES.

233 01:09:11:01 01:09:12:28 IN FACT,
THE BARS THEMSELVES
234 01:09:13:00 01:09:15:27 ARE ACTUALLY LARGE RIPPLES
THAT MIGRATE DOWNSTREAM
235 01:09:15:29 01:09:20:16 DURING SPORADIC CYCLES
OF EROSION AND DEPOSITION.
236 01:09:22:19 01:09:25:13 *BARS ARE ESPECIALLY COMMON*
IN BRAIDED STREAMS
237 01:09:25:15 01:09:28:04 *WHICH FORM WHERE*
SEDIMENT-CHOKED RIVERS
238 01:09:28:06 01:09:31:09 *FLOW ACROSS BROAD,*
EASILY-ERODED SLOPES.
239 01:09:33:11 01:09:36:27 *BARS ALSO COMMONLY OCCUR*
IN MEANDERING RIVERS.
240 01:09:36:29 01:09:38:14 *A MEANDERING RIVER*
241 01:09:38:16 01:09:40:13 *TYPICALLY WANDERS*
ACROSS WIDE VALLEYS
242 01:09:40:15 01:09:41:23 *AND LOWLANDS*
243 01:09:41:25 01:09:45:19 *IN A SERIES*
OF S-SHAPED CURVES.
244 01:09:45:21 01:09:47:19 *EROSION AND DEPOSITION*
OCCUR CONTINUOUSLY,
245 01:09:47:21 01:09:49:23 *SIDE BY SIDE,*
246 01:09:49:25 01:09:52:02 *ALONG THE BANKS*
OF MEANDERING RIVERS.
247 01:09:52:04 01:09:55:08 *LOW VELOCITY ON THE INSIDE*
OF A MEANDER CURVE
248 01:09:55:10 01:09:58:19 *RESULTS IN THE DEPOSITION*
OF POINT BARS.
249 01:09:58:21 01:10:00:28 *ON THE OUTSIDE*
OF A CURVE,
250 01:10:01:00 01:10:02:12 *WHERE VELOCITY IS HIGH*
251 01:10:02:14 01:10:04:11 *AND EROSION*
NORMALLY TAKES PLACE,
252 01:10:04:13 01:10:06:01 *CUT BANKS FORM.*
253 01:10:08:04 01:10:10:22 *BECAUSE OF THIS EROSION*
AND DEPOSITION,
254 01:10:10:24 01:10:13:15 *BOTH THE SIZES*
AND POSITIONS OF MEANDERS
255 01:10:13:17 01:10:15:10 *CONTINUOUSLY CHANGE.*
256 01:10:17:08 01:10:20:06 WE'RE NOT ALTOGETHER
CLEAR WHY MEANDERING
OCCURS,
257 01:10:20:08 01:10:22:21 OMMON PHENOMENON.
258 01:10:20:08 01:10:22:21 WHY IT'S SUCH
ú
259 01:10:22:23 01:10:26:16 IT PROBABLY HAS TO DO
WITH THE EQUALIZATION
OF ENERGY DISTRIBUTION
260 01:10:26:18 01:10:28:15 AS THE FLOW MOVES
DOWN VALLEY.
261 01:10:28:17 01:10:30:15 BY MEANDERING,
THE AMOUNT OF WORK
262 01:10:30:17 01:10:33:16 DONE BY A STREAM
IN SOME UNIT
OF DISCHARGE

263 01:10:33:18 01:10:35:17 IS MORE
OR LESS CONSTANT,
264 01:10:35:19 01:10:38:16 AND THAT SEEMS TO BE
A PRINCIPLE OF NATURE--
265 01:10:38:18 01:10:41:01 TO TRY TO EQUALIZE
THE AMOUNT OF WORK
266 01:10:41:03 01:10:42:06 AND MINIMIZE
THE AMOUNT OF WORK
267 01:10:42:08 01:10:43:17 AT THE SAME TIME
IT'S BEING DONE.
268 01:10:43:19 01:10:46:01 *THE MISSISSIPPI*
IS A PRIME EXAMPLE
269 01:10:46:03 01:10:47:16 *OF A MEANDERING RIVER.*
270 01:10:47:18 01:10:49:03 *AS THE CROW FLIES,*
271 01:10:49:05 01:10:52:02 *THE DISTANCE BETWEEN*
NEW ORLEANS AND MEMPHIS
272 01:10:52:04 01:10:54:01 *IS ABOUT 550 KILOMETERS.*
273 01:10:54:03 01:10:56:05 *BY BOAT,*
IT'S OVER 1,000.
274 01:10:58:03 01:10:59:29 *MEANDERING RIVERS*
ARE ASSOCIATED
275 01:11:00:03 01:11:01:15 *WITH ONE OF THE WORLD'S*
276 01:11:01:17 01:11:03:28 *MOST SIGNIFICANT*
GEOLOGICAL HAZARDS--
277 01:11:04:00 01:11:05:03 *FLOODING.*
278 01:11:06:14 01:11:08:27 FLOODS ARE ABSOLUTELY
A NATURAL PART
279 01:11:08:29 01:11:10:12 OF THE RIVER'S CYCLE.
280 01:11:10:14 01:11:13:12 IN FACT, FLOODING,
THAT IS TO SAY,
281 01:11:13:14 01:11:15:13 OVERBANK DISCHARGE,
IS COMMON ENOUGH
282 01:11:15:15 01:11:17:03 THAT IT SHOULDN'T
SURPRISE ANYONE.
283 01:11:17:05 01:11:19:13 GEOLOGISTS HAVE LOOKED
AT THIS PRETTY CAREFULLY
284 01:11:19:15 01:11:21:14 OVER THE PAST FEW YEARS.
285 01:11:21:16 01:11:23:14 WE HAVE RECORDS
WHICH INDICATE
286 01:11:23:16 01:11:25:04 MOST STREAMS
OVERTOP THEIR BANKS
287 01:11:25:06 01:11:27:04 ABOUT EVERY TWO
AND A HALF YEARS.
288 01:11:27:06 01:11:28:20 THAT'S NOTHING
UNUSUAL AT ALL.
289 01:11:28:22 01:11:31:00 ANYONE WHO IS SURPRISED
BY FLOODING
290 01:11:31:02 01:11:33:29 ARE THE ONES THAT ARE
NOT PAYING ATTENTION.
291 01:11:34:01 01:11:37:14 *SHIFTING MEANDERS*
AND REPEATED FLOODING
ALONG RIVERS
292 01:11:37:16 01:11:42:15 *PRODUCE BROAD FLATLANDS*
CALLED FLOOD PLAINS.
293 01:11:42:17 01:11:44:15 WHEN RIVER
GOES INTO FLOOD,

294 01:11:44:17 01:11:46:29 THE WATER LEVEL
IN THE RIVER CHANNEL RISES
295 01:11:47:01 01:11:49:14 UNTIL WATER SPILLS
OVER THE RIVER BANK,
296 01:11:49:16 01:11:50:29 DROWNING
THE ADJACENT LANDSCAPE
297 01:11:51:01 01:11:53:13 AND GIVING
THE FLOOD PLAIN ITS NAME.
298 01:11:53:15 01:11:56:14 HUMAN POPULATION CENTERS
HAVE HISTORICALLY BEEN
CLOSELY LINKED
299 01:11:56:16 01:11:59:00 TO THE FLOOD PLAINS
OF MAJOR RIVERS
300 01:11:59:02 01:12:01:27 LIKE THE TIGRIS AND EUPHRATES
IN ANCIENT MESOPOTAMIA,
301 01:12:01:29 01:12:04:26 THE YANGTZE AND HUANG HO
IN CHINA,
302 01:12:04:28 01:12:06:28 AND THE NILE IN EGYPT.
303 01:12:07:00 01:12:09:27 FLOOD PLAINS ARE GOOD PLACES
TO GROW CROPS
304 01:12:09:29 01:12:12:11 BECAUSE AS EACH FLOOD
INUNDATES THE PLAIN,
305 01:12:12:13 01:12:14:26 IT CARRIES WITH IT
A MUDDY SEDIMENT
306 01:12:14:28 01:12:16:27 RICH IN ORGANIC MATTER
AND NUTRIENTS.
307 01:12:16:29 01:12:19:11 THE SEDIMENT IS DEPOSITED
IN FLAT LAYERS
308 01:12:19:13 01:12:22:01 ATOP THE FLOOD PLAIN
AND IS NATURALLY IRRIGATED
309 01:12:22:03 01:12:23:12 BY THE FLOOD WATERS.
310 01:12:23:14 01:12:25:12 BUT LIFE
ON THE FLOOD PLAIN
311 01:12:25:14 01:12:26:27 IS A DOUBLE-EDGED SWORD.
312 01:12:26:29 01:12:29:11 THE AGRICULTURAL BENEFITS
OF THOSE PERIODIC FLOODS
313 01:12:29:13 01:12:32:12 ARE OFFSET BY DAMAGE
TO HOMES AND CITIES,
314 01:12:32:14 01:12:33:27 AND, IN SOME CASES,
315 01:12:33:29 01:12:36:07 TO THE PEOPLE
WHO INHABIT THEM.
316 01:12:38:15 01:12:41:27 *THE EDGES OF FLOOD PLAINS*
ARE MARKED BY LEVEES-
317 01:12:41:29 01:12:45:12 *RIDGES OF SEDIMENT LEFT ATOP*
RIVER BANKS BY FLOODS.
318 01:12:45:14 01:12:48:12 *ONCE FORMED, LEVEES SERVE*
AS NATURAL BARRIERS
319 01:12:48:14 01:12:52:13 *CONFINING RIVERS DURING*
PERIODS OF ORDINARY FLOW.
320 01:12:52:15 01:12:56:27 *THEY MAY EVEN PROTECT*
LOW-LYING AREAS FROM FLOODING
321 01:12:56:29 01:13:00:11 *IF THE LEVEL*
OF A RIVER ISN'T TOO HIGH.
322 01:13:00:13 01:13:01:26 *FOR THIS REASON,*
323 01:13:01:28 01:13:04:25 *ARTIFICIAL LEVEES DESIGNED*
TO CONTAIN A RIVER

324 01:13:04:27 01:13:06:24 *DURING FLOOD STAGES*
ARE OFTEN BUILT.
325 01:13:08:16 01:13:11:09 *BUT ARTIFICIAL LEVEES*
CAN THEMSELVES CREATE PROBLEMS.
326 01:13:11:11 01:13:14:11 *BY CONFINING THE RIVER*
TO A NARROW CHANNEL,
327 01:13:14:13 01:13:17:11 *LEVEES ACCELERATE*
THE BUILD-UP OF SEDIMENT,
328 01:13:17:13 01:13:20:09 *RAISING THE RIVER BED*
HIGHER AND HIGHER.
329 01:13:23:02 01:13:26:14 *AND LEVEES CAN PROVIDE*
A FALSE SENSE OF SECURITY.
330 01:13:27:24 01:13:30:00 *IF A RIVER*
OVERTOPS ITS LEVEES
331 01:13:30:02 01:13:31:26 *TO FLOOD*
THE SURROUNDING LAND,
332 01:13:31:28 01:13:33:25 *THE LEVEES CAN ACTUALLY*
PROLONG FLOODING
333 01:13:33:27 01:13:35:25 *BY PREVENTING WATER*
FROM DRAINING
334 01:13:35:27 01:13:37:09 *BACK INTO THE RIVER.*
335 01:13:39:11 01:13:41:23 MOST PEOPLE DON'T
APPRECIATE THE FACT
336 01:13:41:25 01:13:43:08 THAT THE FLOOD PLAIN
337 01:13:43:10 01:13:46:10 IS A PART OF
THE STREAM ITSELF.
338 01:13:46:12 01:13:48:26 THE FLOOD PLAIN IS
WHERE RIVERS
STORE DISCHARGE
339 01:13:48:28 01:13:50:10 DURING PERIODS
OF HIGH FLOWS
340 01:13:50:12 01:13:53:10 AND ALSO PLACES
WHERE RIVERS STORE
SEDIMENT.
341 01:13:53:12 01:13:56:09 WHEN WE MOVE ON
TO THE FLOOD PLAIN,
342 01:13:56:11 01:13:58:09 WE'RE MOVING
ON TO THE RIVER.
343 01:13:58:11 01:13:59:12 IT'S NOT
VERY DIFFERENT
344 01:13:59:14 01:14:01:10 FROM BEING
IN THE CHANNEL.
345 01:14:01:12 01:14:02:23 IT'S JUST THAT
THE RIVER
346 01:14:02:25 01:14:04:18 DOESN'T USE IT
ALL THE TIME.
347 01:14:06:11 01:14:09:09 *ONE WAY TO REDUCE FLOODS IS*
BY CONSTRUCTING DAMS
348 01:14:09:11 01:14:11:08 *THROUGH WHICH A RIVER'S*
DISCHARGE
349 01:14:11:10 01:14:12:22 *CAN BE REGULATED.*
350 01:14:14:04 01:14:16:23 *BUT WHILE DAMS SOLVE*
SOME PROBLEMS,
351 01:14:16:25 01:14:18:07 *THEY CAN CREATE OTHERS.*
352 01:14:19:21 01:14:21:29 ALL MAN-MADE
STRUCTURES

IN A RIVER VALLEY

353 01:14:22:01 01:14:24:00 HAVE AN EFFECT
UPON THE STREAM,

354 01:14:24:02 01:14:26:09 THE MOST PROFOUND
EFFECT CAUSED
BY DAMS.

355 01:14:26:11 01:14:28:22 A DAM CREATES
AN ARTIFICIAL
BASE LEVEL--

356 01:14:28:24 01:14:30:08 SEA LEVEL,
FOR EXAMPLE,

357 01:14:30:10 01:14:32:23 THAT CAUSES THE
STREAM TO DEPOSIT

358 01:14:32:25 01:14:35:00 ALL OF THE LOAD THAT
IT'S BEEN MOVING.

359 01:14:35:02 01:14:36:29 THE QUIET WATER
OF THE LAKE

360 01:14:37:01 01:14:39:00 DOESN'T ALLOW
SEDIMENT TO MOVE,

361 01:14:39:02 01:14:41:18 SO IT'S DUMPED
AT THE UPPER END
OF THE RESERVOIR.

362 01:14:41:20 01:14:43:11 THE WATER
WHICH COMES

363 01:14:43:13 01:14:45:25 THROUGH THE
SPILLWAYS OF THE DAM

364 01:14:45:27 01:14:47:26 IS NOW WITHOUT
THE SEDIMENT

365 01:14:47:28 01:14:49:11 THAT IT'S BEEN
TRANSPORTING

366 01:14:49:13 01:14:51:24 AND WILL GO ABOUT
ERODING NEW SEDIMENT

367 01:14:51:26 01:14:54:08 TO REPLACE THAT
WHICH HAS BEEN LOST.

368 01:14:56:17 01:14:58:15 *A RIVER REPLACES*
THIS SEDIMENT

369 01:14:58:17 01:15:00:08 *BY ERODING THE RIVER*
CHANNEL

370 01:15:00:10 01:15:01:21 *DOWNSTREAM FROM THE DAMN.*

371 01:15:01:23 01:15:04:06 *SOMETIMES THIS EROSION*
CAN BE SEVERE.

372 01:15:06:23 01:15:10:06 *THE BASIS OF RIVER DYNAMICS*
IS A STATE OF BALANCE

373 01:15:10:08 01:15:11:22 *BETWEEN EROSION,*
TRANSPORTATION,

374 01:15:11:24 01:15:12:22 *AND DEPOSITION.*

375 01:15:14:16 01:15:17:13 *THIS IS WHAT EVERY BODY*
OF RUNNING WATER

376 01:15:17:15 01:15:20:13 *NATURALLY SEEKS FROM ITS*
HEADWATERS TO ITS MOUTH.

377 01:15:24:08 01:15:27:05 *WATER LITERALLY HAS*
THE POWER TO MOVE MOUNTAINS

378 01:15:27:07 01:15:29:21 *IN ITS QUEST*
FOR EQUILIBRIUM.

379 01:15:32:17 01:15:34:28 THE STREAM WILL
ALWAYS TRY TO EXIST

380 01:15:35:00 01:15:36:18 IN A STATE
OF EQUILIBRIUM
381 01:15:36:20 01:15:38:18 BETWEEN THE LOAD
IT'S CARRYING
382 01:15:38:20 01:15:40:18 AND THE DISCHARGE
THAT IT HAS.
383 01:15:40:20 01:15:42:03 IF THE LOAD
DECREASES,
384 01:15:42:05 01:15:43:17 THE STREAM HAS
EXCESS ENERGY
385 01:15:43:19 01:15:45:00 WHICH WILL
USUALLY BE USED
386 01:15:45:02 01:15:47:00 TO ERODE
THE BED AND BANKS.
387 01:15:47:02 01:15:48:15 IF THE LOAD
INCREASES,
388 01:15:48:17 01:15:50:29 THE STREAM WON'T BE
ABLE TO HANDLE IT,
389 01:15:51:01 01:15:52:28 SO SOME OF IT
WILL BE DEPOSITED.
390 01:15:54:23 01:15:56:20 *ONE PLACE*
WHERE HUMAN ACTIVITY
391 01:15:56:22 01:15:59:21 *HAS COME INTO CONFLICT*
WITH A GREAT RIVER
392 01:15:59:23 01:16:02:03 *SEEKING TO MAINTAIN ITS*
EQUILIBRIUM,
393 01:16:02:05 01:16:03:17 *IS THE MISSISSIPPI.*
394 01:16:05:02 01:16:08:00 *STRETCHING ALMOST*
4,000 KILOMETERS,
395 01:16:08:02 01:16:10:28 *THE MISSISSIPPI*
DRAINS APPROXIMATELY 42%
396 01:16:11:00 01:16:12:12 *OF THE UNITED STATES.*
397 01:16:13:22 01:16:16:04 *IT IS*
A SEDIMENT-LADEN RIVER,
398 01:16:16:06 01:16:19:21 *SHIFTING AN ESTIMATED*
516 MILLION TONS PER YEAR
399 01:16:19:23 01:16:21:21 *FROM ITS HEADWATERS*
IN MINNESOTA
400 01:16:21:23 01:16:24:20 *ALL THE WAY TO THE GULF*
OF MEXICO.
401 01:16:26:26 01:16:29:04 *ALONG THE GREAT LENGTH*
OF THIS RIVER,
402 01:16:29:06 01:16:30:19 *THE PROCESS OF DEPOSITION*
403 01:16:30:21 01:16:34:00 *SOMETIMES CAUSES SERIOUS*
PROBLEMS.
404 01:16:34:02 01:16:35:15 *IF BARS BUILD UP*
405 01:16:35:17 01:16:37:15 *IN IMPORTANT AREAS*
OF NAVIGATION,
406 01:16:37:17 01:16:40:19 *THEY CAN DISRUPT SHIPPING*
AND REGIONAL COMMERCE.
407 01:16:42:01 01:16:43:15 *IN THE INDUSTRIAL CORRIDOR*
408 01:16:43:17 01:16:46:06 *BETWEEN NEW ORLEANS*
AND BATON ROUGE,
409 01:16:46:08 01:16:48:07 *LIES ONE*
OF NORTH AMERICA'S
410 01:16:48:09 01:16:50:11 *MOST IMPORTANT*

NAVIGATIONAL ROUTES.

411 01:16:52:01 01:16:54:21 *IN ORDER TO KEEP*
THE RIVER OPEN

412 01:16:54:23 01:16:56:13 *TO THE MANY*
OCEAN-GOING VESSELS

413 01:16:56:15 01:16:58:02 *WHICH USE IT YEAR-ROUND,*

414 01:16:58:04 01:17:01:01 *THE UNITED STATES ARMY*
CORP OF ENGINEERS

415 01:17:01:03 01:17:02:03 *MUST CONTINUALLY GRAPPLE*

416 01:17:02:05 01:17:04:02 *WITH THE FORCES*
OF NATURE.

417 01:17:04:04 01:17:05:17 *ONE FREQUENT TROUBLE SPOT*

418 01:17:05:19 01:17:08:01 *LIES JUST SOUTH*
OF BATON ROUGE

419 01:17:08:03 01:17:10:16 *IN A STRETCH*
OF THE RIVER

420 01:17:10:18 01:17:11:28 *CALLED RED EYE CROSSING.*

421 01:17:13:08 01:17:15:26 *HERE THE RIVER TENDS*
TO DEPOSIT SEDIMENT,

422 01:17:15:28 01:17:17:10 *THREATENING TO CLOSE*
THE CHANNEL

423 01:17:17:12 01:17:18:25 *TO DEEP-WATER SHIPS.*

424 01:17:24:02 01:17:26:29 *A DETAILED STUDY*
OF RED EYE CROSSING

425 01:17:27:01 01:17:28:15 *IS CURRENTLY UNDERWAY*

426 01:17:28:17 01:17:31:07 *AT THE ARMY CORPS' WATERWAYS*
EXPERIMENT STATION,

427 01:17:31:09 01:17:34:06 *OR WES, IN VICKSBURG,*
MISSISSIPPI.

428 01:17:36:17 01:17:37:29 *TOM POKREFKE IS CHIEF*

429 01:17:38:01 01:17:40:00 *OF THE RIVER*
ENGINEERING BRANCH

430 01:17:40:02 01:17:43:01 *AND HEADS THE RED EYE*
INVESTIGATION.

431 01:17:43:03 01:17:44:28 THE PROBLEM THAT
WE'RE STUDYING

432 01:17:45:00 01:17:46:15 ON THE RED EYE
CROSSING

433 01:17:46:17 01:17:48:00 IS THE CROSSING
ITSELF.

434 01:17:48:02 01:17:50:14 WHEN YOU GO FROM A
LOW WATER SITUATION

435 01:17:50:16 01:17:52:13 TO A HIGH WATER
SITUATION,

436 01:17:52:15 01:17:55:09 IT TENDS TO FILL
WITH SEDIMENT.

437 01:17:55:11 01:17:58:08 WHERE YOU GO FROM HIGH
WATER TO LOW WATER,

438 01:17:58:10 01:18:00:06 THERE'S NOT ENOUGH
ENERGY IN THE WATER

439 01:18:00:08 01:18:01:20 TO CLEAR THAT
CROSSING OUT

440 01:18:01:22 01:18:03:19 AND MAINTAIN THE
CHANNEL DEEP ENOUGH

441 01:18:03:21 01:18:05:03 FOR SHIP-TYPE
NAVIGATION

442 01:18:05:05 01:18:07:05 IN THAT PART
OF THE RIVER.
443 01:18:07:07 01:18:09:04 BASICALLY,
THE RED EYE
CROSSING AREA
444 01:18:09:06 01:18:12:18 HAS BEEN KEPT OPEN
IN THE PAST
USING DREDGING.
445 01:18:12:20 01:18:14:05 WHEN THE
WATER FILLED
446 01:18:14:07 01:18:16:04 GOING FROM A
LOW WATER SITUATION
447 01:18:16:06 01:18:18:04 TO A HIGH WATER
SITUATION,
448 01:18:18:06 01:18:20:04 THE ENGINEERS
DREDGED THE CHANNEL
449 01:18:20:06 01:18:22:11 TO MAKE SURE IT
WAS DEEP ENOUGH.
450 01:18:23:18 01:18:25:14 *THE ARMY CORPS*
OF ENGINEERS
451 01:18:25:16 01:18:28:07 *WOULD LIKE TO MINIMIZE*
THE AMOUNT OF DREDGING
452 01:18:28:09 01:18:30:21 *NECESSARY TO KEEP*
THE CHANNEL CLEAR.
453 01:18:32:22 01:18:34:27 *AT THE CORE OF THEIR STUDY*
454 01:18:34:29 01:18:37:03 *IS A SCALE MODEL*
OF THE RIVER.
455 01:18:37:05 01:18:39:03 *GRADED, CRUSHED COAL*
IS USED
456 01:18:39:05 01:18:42:04 *TO REPRESENT*
THE BED MATERIAL.
457 01:18:42:06 01:18:44:18 *BY STUDYING*
HOW THE COAL MOVES
458 01:18:44:20 01:18:46:17 *AS WATER IS DISCHARGED*
THROUGH THE MODEL,
459 01:18:46:19 01:18:49:18 *THE CORPS' HOPE*
HOPE TO BETTER UNDERSTAND
460 01:18:49:20 01:18:51:18 *THE RED EYE CROSSING*
PROBLEM
461 01:18:51:20 01:18:53:20 *AND COME UP*
WITH SOLUTIONS.
462 01:18:53:22 01:18:56:09 *EACH EXPERIMENT*
WITH THE MODEL
463 01:18:56:11 01:18:59:15 *HAS A KNOWN FIXED AMOUNT*
OF WATER DISCHARGE.
464 01:18:59:17 01:19:01:02 *WATER FILLS THE CHANNEL*
465 01:19:01:04 01:19:06:10 *AND IS ALLOWED TO RUN*
FOR A MEASURED LENGTH OF TIME.
466 01:19:06:12 01:19:07:17 *ALMOST IMMEDIATELY,*
467 01:19:07:19 01:19:10:04 *THE BED LOAD BEGINS*
TO MOVE.
468 01:19:11:13 01:19:13:22 *CONFETTI THROWN*
ON THE WATER SURFACE
469 01:19:13:24 01:19:15:08 *DURING THE EXPERIMENT,*
470 01:19:15:10 01:19:17:23 *CLEARLY INDICATES*
THE WATER'S FLOW PATTERNS

471 01:19:17:25 01:19:19:12 *THROUGH THE CROSSING.*
472 01:19:23:00 01:19:25:13 *THE WHITE BEADS ARE ANOTHER INDICATOR*
473 01:19:25:15 01:19:28:17 *OF HOW THE MODEL IS PERFORMING.*
474 01:19:28:19 01:19:31:02 *THE BEADS BUILD UP WHERE EXPECTED,*
475 01:19:31:04 01:19:34:02 *AT THE PLACE WHERE, IN NATURE ITSELF,*
476 01:19:34:04 01:19:35:16 *THE POINT BAR EXISTS.*
477 01:19:37:07 01:19:38:20 *THIS INDICATES THE MODEL*
478 01:19:38:22 01:19:40:10 *SIMULATES NATURE ACCURATELY.*
479 01:19:42:08 01:19:45:01 PLUS FOUR.
480 01:19:45:03 01:19:47:21 *PERIODICALLY, THE MODEL IS DRAINED,*
481 01:19:47:23 01:19:50:06 *AND ITS SEDIMENT IS CAREFULLY MAPPED.*
482 01:19:50:08 01:19:52:07 *THIS DETAILED MAPPING GIVES ENGINEERS*
483 01:19:52:09 01:19:54:23 *A BETTER UNDERSTANDING OF SEDIMENTATION PROCESSES*
484 01:19:54:25 01:19:56:07 *IN THE RIVER.*
485 01:19:56:09 01:19:59:08 *USING DATA FROM THE MOVABLE BED MODEL*
486 01:19:59:10 01:20:00:20 *AND FROM THE FIELD,*
487 01:20:00:22 01:20:04:00 *WES ENGINEERS HAVE COMPLETED A COMPUTER MODEL*
488 01:20:04:02 01:20:06:15 *WHICH CALCULATES THE MOVEMENT OF SEDIMENT*
489 01:20:06:17 01:20:08:01 *THROUGH RED EYE CROSSING.*
490 01:20:08:03 01:20:10:12 *IT MIMICS THE SEDIMENT'S BEHAVIOR THROUGH TIME*
491 01:20:10:14 01:20:12:27 *AS WATER DISCHARGE AND VELOCITIES CHANGE.*
492 01:20:14:26 01:20:17:29 *THE LIGHT BLUE AREA IS DEEP WATER.*
493 01:20:18:01 01:20:19:29 *THE DARK BLUE-- SHALLOW WATER,*
494 01:20:20:01 01:20:23:21 *WHICH CORRESPONDS TO SEDIMENT BUILD-UP.*
495 01:20:23:23 01:20:26:20 *AS THE MODEL GOES FROM LOW DISCHARGE LEVELS*
496 01:20:26:22 01:20:29:19 *TO HIGH DISCHARGE LEVELS AND BACK TO LOW AGAIN,*
497 01:20:29:21 01:20:32:02 *THE DARK BLUE AREA GROWS IN SIZE*
498 01:20:32:04 01:20:33:20 *INDICATING THAT SEDIMENT IS MOVING IN*
499 01:20:33:22 01:20:36:21 *CAUSING THE DEEP WATER CHANNEL TO NARROW.*
500 01:20:40:11 01:20:42:10 *POTENTIAL SOLUTIONS TO THE PROBLEM*
501 01:20:42:12 01:20:43:19 *AT RED EYE CROSSING*
502 01:20:43:21 01:20:46:03 *ARE TESTED ON THE COMPUTER.*

503 01:20:47:27 01:20:50:05 *THE CONSTRUCTION*
OF WALLS OR DIKES
504 01:20:50:07 01:20:51:22 *WITHIN THE CHANNEL*
505 01:20:51:24 01:20:53:08 *IS FACTORED*
INTO THE PROGRAM.
506 01:20:53:10 01:20:54:24 *ACCORDING TO THE COMPUTER,*
507 01:20:54:26 01:20:57:27 *DIKES HELP TO ELIMINATE*
THE POINT BARS.
508 01:21:00:00 01:21:02:26 *EVENTUALLY, DIKES WILL BE*
BUILT AND TESTED
509 01:21:02:28 01:21:05:25 *ON THE PHYSICAL MODEL*
TO CHECK THEIR EFFECTS
510 01:21:05:27 01:21:07:10 *ON SEDIMENT TRANSPORT.*
511 01:21:07:12 01:21:08:25 THE WAY DIKES FUNCTION
512 01:21:08:27 01:21:11:12 AS FAR
AS OPENING A CHANNEL
513 01:21:11:14 01:21:14:11 AND MAKING IT
WIDE ENOUGH
AND DEEP ENOUGH,
514 01:21:14:13 01:21:16:09 IS THEY ACTUALLY
TAKE THE CHANNEL
515 01:21:16:11 01:21:18:11 THAT HAS
A RELATIVELY
WIDE WIDTH
516 01:21:18:13 01:21:20:11 FROM TOP BANK
TO TOP BANK,
517 01:21:20:13 01:21:22:23 AND IT CONTRACTS
IT NORMALLY
ON ONE SIDE
518 01:21:22:25 01:21:25:22 AND MAKES IT
A LITTLE BIT
NARROWER.
519 01:21:25:24 01:21:28:07 WHAT THAT DOES
IS MOTHER NATURE
520 01:21:28:09 01:21:30:06 AND THE RIVER
ITSELF SAYS,
521 01:21:30:08 01:21:34:08 I NEED TO HAVE
SO MUCH AREA
AVAILABLE TO ME.
522 01:21:34:10 01:21:36:11 WHEN YOU PINCH
IN THE SIDES,
523 01:21:36:13 01:21:39:11 THE ONLY THING
THAT CAN HAPPEN
IS THE BED SCOUR.
524 01:21:39:13 01:21:42:10 YOU WANT TO MAKE SURE
THE BED SCOUR'S ENOUGH,
525 01:21:42:12 01:21:44:12 THAT THE CHANNEL
IS WIDE ENOUGH
526 01:21:44:14 01:21:46:12 AND DEEP ENOUGH
YEAR AROUND,
527 01:21:46:14 01:21:48:26 BE IT HIGH WATER
OR LOW WATER.
528 01:21:48:28 01:21:51:25 ALSO, YOU DON'T WANT TO
PINCH IT DOWN TOO MUCH
529 01:21:51:27 01:21:54:11 THAT ALL OF A SUDDEN
THE VELOCITIES

530 01:21:54:13 01:21:56:18 START GETTING
HIGH GOING THROUGH
THAT DIKE FIELD,
531 01:21:56:20 01:21:59:16 AND THEN
IT BECOMES A PROBLEM
TO NAVIGATION, ALSO.
532 01:22:01:00 01:22:03:24 *DIKES SEEM TO BE*
THE MOST EFFECTIVE WAY
533 01:22:03:26 01:22:06:10 *TO REDUCE THE NEED*
FOR DREDGING
534 01:22:06:12 01:22:09:01 *AND KEEP*
THE CHANNEL OPEN.
535 01:22:09:03 01:22:11:24 *BUT BEFORE THEY ARE INSTALLED*
AT RED EYE CROSSING,
536 01:22:11:26 01:22:13:09 *THE ENGINEERS*
WANT TO DETERMINE
537 01:22:13:11 01:22:15:24 *HOW THE DIKES*
WILL AFFECT THE PEOPLE
538 01:22:15:26 01:22:17:25 *WHO ACTUALLY*
USE THE CHANNEL--
539 01:22:17:27 01:22:20:26 *THE SHIP*
AND TOWBOAT PILOTS.
540 01:22:20:28 01:22:22:24 *THE PILOTS*
OF THE MISSISSIPPI RIVER
541 01:22:22:26 01:22:25:09 *HAVE BEEN PART*
OF THE REGION'S LORE
542 01:22:25:11 01:22:26:18 *FOR MANY YEARS.*
543 01:22:26:20 01:22:28:18 *THEY KNOW*
THE RIVER BETTER
544 01:22:28:20 01:22:30:28 *THAN ANYONE ELSE*
POSSIBLY COULD.
545 01:22:31:00 01:22:34:08 *GUIDING A SHIP OR BOAT*
DOWN THE MISSISSIPPI
546 01:22:34:10 01:22:36:25 *MEANS FAR MORE*
THAN SIMPLY MEMORIZING
547 01:22:36:27 01:22:39:25 *A ROUTE FROM POINT "A"*
TO POINT "B."
548 01:22:39:27 01:22:42:26 *FOR THE MIGHTY MISSISSIPPI*
IS A DYNAMIC SYSTEM,
549 01:22:42:28 01:22:45:09 *ALWAYS SHIFTING*
AND CHURNING.
550 01:22:45:11 01:22:47:09 *AS MARK TWAIN*
SO KNOWINGLY WROTE
551 01:22:47:11 01:22:49:10 *IN LIFE*
ON THE MISSISSIPPI--
552 01:22:49:12 01:22:53:11 *"TWO THINGS SEEM PRETTY*
APPARENT TO ME.
553 01:22:53:13 01:22:55:24 *"ONE WAS, THAT IN ORDER*
TO BE A PILOT,
554 01:22:55:26 01:22:57:24 *"A MAN HAD TO LEARN MORE*
555 01:22:57:26 01:22:59:20 *"THAN ANY MAN OUGHT*
TO BE ALLOWED TO KNOW,
556 01:22:59:22 01:23:03:02 *"AND THE OTHER WAS*
THAT HE MUST LEARN IT
557 01:23:03:04 01:23:05:27 *"ALL OVER AGAIN*
IN A DIFFERENT WAY

558 01:23:05:29 01:23:07:27 *EVERY 24 HOURS."*
559 01:23:09:12 01:23:13:08 *THE WES FACILITY INCLUDES*
A SHIP/TOW SIMULATOR
560 01:23:13:10 01:23:16:08 *WHICH FUNCTIONS MUCH LIKE*
A FLIGHT SIMULATOR.
561 01:23:16:10 01:23:18:07 *HERE, THE NAVIGATING*
INSTRUMENTATION
562 01:23:18:09 01:23:22:27 *CAN BE CONFIGURED FOR EITHER*
A TOWBOAT OR A SHIP.
563 01:23:22:29 01:23:25:23 *THE SCREEN IS*
AN ACCURATE REPRESENTATION
564 01:23:25:25 01:23:28:23 *OF THE VIEW*
FROM THE PILOT HOUSE.
565 01:23:28:25 01:23:30:23 *MANY PILOTS ARE BROUGHT*
566 01:23:30:25 01:23:33:22 *TO THE WATERWAYS*
EXPERIMENT STATION
DURING THE STUDY.
567 01:23:33:24 01:23:35:22 *EACH SPENDS*
A WEEK REPEATEDLY
568 01:23:35:24 01:23:39:21 *STEERING UP AND DOWN*
THE COMPUTER-SIMULATED COURSE
569 01:23:39:23 01:23:41:21 *OF RED EYE CROSSING.*
570 01:23:44:16 01:23:47:14 *THE PROPOSED DIKES ARE FACTORED*
INTO THE SIMULATION.
571 01:23:47:16 01:23:50:13 *EVERY RUN DOWN THE CROSSING*
IS DIFFERENT.
572 01:23:50:15 01:23:52:21 *THE COMPUTER CHANGES*
MANY PARAMETERS,
573 01:23:52:23 01:23:54:07 *SUCH AS RIVER DISCHARGE,*
574 01:23:54:09 01:23:57:21 *THE NUMBER AND PLACEMENT*
OF PASSING SHIPS,
575 01:23:57:23 01:23:59:17 *AND CHANNEL DEPTH.*
576 01:23:59:19 01:24:02:25 *AS THE PILOT WENDS*
HIS WAY DOWN RED EYE,
577 01:24:02:27 01:24:06:16 *THE COMPUTER RECORDS*
THE EXACT COURSE OF EACH RUN,
578 01:24:06:18 01:24:08:16 *THE TIME FROM START*
TO FINISH,
579 01:24:08:18 01:24:10:22 *AND WHETHER OR NOT*
THERE WERE ANY COLLISIONS
580 01:24:10:24 01:24:12:20 *OR OTHER SAFETY PROBLEMS*
ALONG THE WAY.
581 01:24:12:22 01:24:15:20 *ALTHOUGH DIKES SEEM TO BE*
A PROMISING SOLUTION,
582 01:24:15:22 01:24:17:21 *THE ARMY CORP STUDY*
INDICATES
583 01:24:17:23 01:24:21:05 *THAT THEY MIGHT CREATE*
SOME NAVIGATIONAL PROBLEMS.
584 01:24:21:07 01:24:23:05 *SO THE INVESTIGATION*
CONTINUES.
585 01:24:23:07 01:24:25:20 *AND THE MIGHTY RIVER*
REMAINS UNSHACKLED
586 01:24:25:22 01:24:29:10 *AS IT FLOWS THROUGH*
RED EYE CROSSING.
587 01:24:31:06 01:24:33:04 *THE POWER OF RUNNING WATER*
588 01:24:33:06 01:24:35:21 *EXTENDS FAR BEYOND*

THE MISSISSIPPI.

589 01:24:35:23 01:24:37:20 *INDEED, IT IS*
THE DOMINANT FORCE

590 01:24:37:22 01:24:40:05 *SHAPING EARTH'S LANDSCAPE.*

591 01:24:44:06 01:24:47:19 THE COMBINED DISCHARGE
OF ALL THE RIVERS ON EARTH

592 01:24:47:21 01:24:50:06 IS ONLY 1/10,000th
OF ONE PERCENT

593 01:24:50:08 01:24:53:05 OF ALL OF THE WATER
ON THIS PLANET,

594 01:24:53:07 01:24:55:21 BUT FEW GEOLOGIC PROCESSES
HAVE EXERTED

595 01:24:55:23 01:24:58:20 A GREATER INFLUENCE
ON HUMAN HISTORY
AND CIVILIZATION.

596 01:24:58:22 01:25:01:04 MANY OF THE WORLD'S
GREAT CITIES

597 01:25:01:06 01:25:04:02 WERE FIRST ESTABLISHED
AS RIVERSIDE SETTLEMENTS,

598 01:25:04:04 01:25:06:18 AND THROUGHOUT THEIR HISTORY
THESE CITIES HAVE DEPENDED

599 01:25:06:20 01:25:09:03 ON THE RIVER FOR FOOD,
A WATER SUPPLY,

600 01:25:09:05 01:25:11:08 AND AN AVENUE
OF TRANSPORT AND TRADE.

601 01:25:11:10 01:25:13:09 BUT LIKE ALL
NATURAL SYSTEMS,

602 01:25:13:11 01:25:16:10 RIVERS UNDERGO RELATIVELY
RARE BUT EXTREME EVENTS.

603 01:25:16:12 01:25:18:10 RIVER FLOODING
IS A THREAT

604 01:25:18:12 01:25:20:18 TO NEARLY EVERY
NATION ON EARTH.

605 01:25:20:20 01:25:22:03 IN THE UNITED STATES,

606 01:25:22:05 01:25:24:03 FLOODS EXACT
THE GREATEST TOLL

607 01:25:24:05 01:25:25:18 OF ANY GEOLOGIC HAZARD,

608 01:25:25:20 01:25:28:19 CAUSING BILLIONS OF DOLLARS
IN PROPERTY DAMAGE

609 01:25:28:21 01:25:31:19 AND KILLING
ABOUT 100 PEOPLE EVERY YEAR.

610 01:25:31:21 01:25:34:18 AND THIS LOSS
IS MODEST WHEN COMPARED

611 01:25:34:20 01:25:36:17 TO THE DESTRUCTION
IN COUNTRIES

612 01:25:36:19 01:25:38:17 WITH PRIMITIVE
FLOOD CONTROL SYSTEMS,

613 01:25:38:19 01:25:40:17 OR THE DEVASTATION
IN PREINDUSTRIAL SOCIETIES

614 01:25:40:19 01:25:43:08 WHICH WERE VISITED
BY FLOODS WITHOUT WARNING.

615 01:25:43:10 01:25:44:23 LIKE MOST NATURAL SYSTEMS,

616 01:25:44:25 01:25:47:10 RIVERS CHANGE AND EVOLVE
THROUGH TIME

617 01:25:47:12 01:25:50:24 IN RESPONSE TO A VARIETY
OF GEOLOGIC FACTORS

618 01:25:50:26 01:25:52:09 THAT ARE
THEMSELVES CHANGING.
619 01:25:52:11 01:25:54:09 FACTORS SUCH AS
REGIONAL CLIMATE,
620 01:25:54:11 01:25:56:18 HILL SLOPE,
TECTONIC ACTIVITY,
621 01:25:56:20 01:25:59:19 VEGETATION, AND
THE BEDROCK COMPOSITION
622 01:25:59:21 01:26:01:16 OF THE EARTH'S CRUST.
623 01:26:01:18 01:26:03:17 SO THE BEHAVIOR OF RIVERS
624 01:26:03:19 01:26:07:02 IS CONTROLLED
BY PHYSICAL LAWS
AND GEOLOGIC PROCESSES
625 01:26:07:04 01:26:09:25 THAT CAN BE OBSERVED
AND UNDERSTOOD.
626 01:26:09:27 01:26:12:16 RIVERS DO MUCH MORE
THAN DRAIN WATER
627 01:26:12:18 01:26:15:15 FROM THE LAND AND CARRY
SEDIMENT TO THE SEA.
628 01:26:15:17 01:26:17:16 THE EVOLUTION OF A RIVER
629 01:26:17:18 01:26:19:02 EXERTS A POWERFUL INFLUENCE
630 01:26:19:04 01:26:21:01 ON THE SURFACE
OF THE EARTH.
631 01:26:21:03 01:26:23:16 IN FACT, MUCH OF THE
CONTINENTAL LANDSCAPE,
632 01:26:23:18 01:26:25:16 ESPECIALLY THOSE AREAS
WHERE PEOPLE LIVE,
633 01:26:25:18 01:26:29:02 WAS FORMED BY THE POWER
OF RUNNING WATER.
634 01:26:29:04 01:26:32:01 CAPTIONING PERFORMED BY
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INSTITUTE, INC.
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