By Rusty Walker and Alison Paul

"Lot for lot, we have seen some terrible sights," reports Terry Moore of the Division of Coastal Management in the N.C. Department of Environment and Natural Resources. "Some people can step out of their back door and almost step off a cliff where before there was a gradual slope to the water. Tons of soil went into the river," Moore says of his post-storm evaluations.

"We were lucky," says Stan Riggs, professor of geology at ECU. "As bad as it was, we were lucky."

Riggs and Moore both point to the supersaturated conditions of the shoreline soils created by rains before, during, between, and after Hurricanes Dennis and Floyd. According to Riggs, when Floyd hit with two feet of water in two days over Eastern Carolina, the flood stage on the Tar River was approaching 24 feet, the previous record level.

So how were we lucky? Because Floyd was a south to north moving storm and the winds were well below hurricane force inland.

"The storms that dump the most water on us have been the ones that moved from east to west because the Tar River drainage basin is elongate in this direction. If Floyd had moved this way, we would have gotten much more water in the drainage basin. With the saturated soil conditions, root systems were weak. Hurricane force winds would have been devastating to both the vegetated and unvegetated shorelines," Riggs said.

That's how we were lucky, even if it doesn't feel that way.

A curious fact Riggs uncovered in the data is that the three storms of 1955 (Connie, Diane, and Ione) may have dumped as much rain on Eastern North Carolina as Dennis and Floyd. But there wasn't as much flood ing. Part of the reason was that the storms were spaced further apart in time. But a contributing factor may also be the tremendous development in the area since the mid-50s. Impermeable areas like shopping malls and parking lots have increased orders of magnitude along with subdivisions and networks of ditches that rapidly direct storm runoff into streams nature designed to receive the runoff at a much slower pace.

"Planners and governments now have a taste of how bad things could be with the worst case combination of several back-to-back storms coming in from the east with high winds that slow down or stall over us," Riggs said.

Larry Crowder, a researcher at the Duke Marine Lab, pointed out to the Pamlico-Tar River Foundation advisory board Wednesday night that most climatologists now seem to believe "we are in another hurricane cycle" and can probably expect more years with multiple storm events. Riggs agrees.

Scientists, regulatory agencies, economic developers and others will continue their study of storm impacts on everything from water quality to fishing and motel occupancy. State and local governments can expect a whole series of recommendations and requests for funding for studies to restrict rebuilding and new building along shorelines and in the Boddie plains.

But right now, the DENR field people are still in the evaluation stage and concentrating on working with property owners that have been hurt.

"A lot of the hardest hit properties in Floyd had weathered the other recent storms. They were feeling good before Floyd. Everybody seemed to agree that you want to buy and build on the highest waterfront property you can get. But the hardest hit shorelines this time were the ones on high banks and bluffs. It's left property owners exploring all kinds of shoreline stabilization techniques, not just bulk heading. They're looking at back fill with sloping to the water and even terracing. They want ways to reclaim the land they've lost," Moore said.

"We had virtually no erosion with Fran...but with Bonnie, we had significant erosion which was magnified by Dennis and Floyd...We lost about 50 feet of shoreline, and a lot of trees," said Dr. Kelley Wallace of Down Shore Road.
The most inland shoreline type is that
ochreous area where swamp forests end
and the river begins. Bold cypress trees
can survive in the rising tide and act as
temporary erosion shields.

Low banks are composed of sand and
drift and have a relief of less than 1.5 m
above mean water level. These make
up 60 percent of the shoreline.

High banks are a result of erosion
against high upland areas. Clay banks,
which are more prevalent on the south
side of the Panhandle, are hard and tight
and erode slower than sandy banks.

High banks have sandy beaches that
extend into the Panhandle.

The Tar-Panhandle has eroded south
ward over time, leaving the low banks
on the northside of the river. The high
banks on the southside make up 35 per-
cent of Panhandle shoreline and the low
banks constitute 19 percent of the
shore.

High bluffs are composed of
Plaquemine sands and clays that
make up 25 percent of shoreline.

The remnant is that of a barrier island
chain which was a former outer banks that
drew several hundred thousand.

The high shoreline is the match, which
is the most common at 62 percent, but
least developed of the three. Fossiliferous
clay banks are the most common, and
clays feeding on small beaches can be
found in this area.

Shoreline characteristics play a sig-
nificant role in determining the effects
of sea level rise and storms have the
shoreline in any given area.

There include oceanfront homes, geor-
geny, bulk height and type of soil, vege-
tation type and amount, shoreline shape,
and orientation to wind and waves.

Human activity

A growing factor influencing erosion
is the activity of people - everything
from shoreline development such as
clearing and bulkheading for housing to
wave action from boating. Bulk-
headings has localized effects. It removes
beaches and inhibits erosion in the
immediate area and may enhance its
effect on nearby property. No quantita-
tive study has been made on the relative
significance of these human activities
on shoreline erosion. In the mid-term,
bulkheading of ever increasing amounts of shoreline prevents the natural
inland migration of valuable mudflats with significant ecological
consequences so sea level continues to
rise. It is expected, however, that with
the apparent return of major hurricane
activity on the Atlantic coast, the need
to better understand the human factor
will grow.

In the long term -
the next millennium, for example

No matter what we do, scientific and
common sense tells us, the Atlantic is
the sea - ultimate 500 ft. gulfs. It will
do what will the ultimate gulf do, it
climat" makes it do. The second

second section on Page 1C is the need
evaluation of all the factors
discussed, including soil and other
characteristics to predict where the
Panhandle shoreline will be at the
beginning of the next millennium. In 1978 when the map was first
made, Drs. Riggs and Bell concluded it
represented the shoreline in about a
thousand years. Riggs has been work-
ing with the data since that time and
has recently revised his projections so
that the map, he now believes, could be a
representative of conditions throughout
the map in 100 to 500 years.

A "single category 5 hurricane or se-
imals could produce the con-
ditions predicted for the outer banks on
the map in "10 to much less time," Riggs
explained.

He will soon be publishing a new
series of maps and data on the coastal
system based on his recent work.

### Shoreline Systems of the Panhandle

<table>
<thead>
<tr>
<th>Type</th>
<th>Low Bank</th>
<th>Medium Bank</th>
<th>High Bank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Eroded</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Rate (m/yr)</td>
<td>0.65</td>
<td>0.85</td>
<td>1.3</td>
</tr>
</tbody>
</table>

### Special Natural Shoreline Features

- Cypress Field (5)
- Marl Pond (2)
- Sand-Arroyo (3)

### Shoreline Status

- Contiguous Bank
- Climate Effects
- - Storm Surge
- Beach Modification

- Bulksheads (245)

---

The setting

North Carolina's coastal plain, including
marshes, swamps, and swamps and
parochially, are the result of the Atlantic
ocean moving inland and scoured
between Raleigh and points west (off.
As the ocean "transgressed" and
"regressed," it eroded soils from the
mountains and Piedmont to produce the
coastal plain. When the sea covered the
coast plain, minerals such as calcium
(i.e., calcium carbonate) precipitated out
of ocean water and helped to build the
land. It is not cycling topped and
recycled into the plains surface.

The cycling was in response to ice
sheets that alternated with warming
periods many times during the Pleis-
tocene Epoch, roughly two million to
100,000 years ago.

At the height of the last ice age,
18,000 years ago, the

---

Shoreline (see chart)

- There are six basic types of shore
  lines in the Panhandle and lower Tar
  river systems. The shoreline and erosi-
  on rates of each are summarized on the
  accompanying table. A brief description
  follows,