In the Middle of the Storm.....

Just Where VIMS Scientists Plan to Be

Virginia's coastal residents well know how a hurricane's pounding waves and powerful currents can erode an entire beach or deposit a new sandbar. VIMS researchers are now working both at home and abroad to explore how the shape of the seafloor influences the storm-driven erosion and accumulation of marine sediment. Their findings will help improve the computer models used to help manage coastal resources and erosion.

The most recent phase in VIMS' on-going seafloor research began in February, when graduate student Art Trembanis traveled to New Zealand's North Island with technicians Bob Gammisch and Todd Nelson to deploy two instrumented tripods. During March, the trio returned to the island with VIMS Director Don Wright to retrieve the tripods and download the collected data.

The research, funded by the U.S. National Science Foundation, represents a major collaboration between VIMS and the National Institute of Water and Atmospheric Research (NIWA), its overseas partner in New Zealand. VIMS and NIWA formalized a General Cooperation Intention in 1998 to foster cooperation in education and research.

NIWA researchers Terry Hume and Mal Green deployed their own seafloor tripod during the most recent field season, bringing the total number of tripods in the study to three.

The New Zealand research builds on earlier studies along the U.S. East Coast, in which VIMS researchers partnered with colleagues at MIT, Woods Hole, and Scripps to study how currents erode, transport, and deposit marine sediments on the inner continental shelf. Research proposed by VIMS geologist Stephen Kuehl and colleagues would continue the work, tying it into the international collaborative effort of the MARGINS program (see article on page 6).

Results of these field studies are being used to help improve the computer models that scientists use to understand and predict erosion and accumulation of coastal sediments. The ultimate goal of the research, says Wright, is "to better model coastal erosion and the movement of sediment, pollutants, and other materials across the inner continental shelf."

Present-day computer models treat the seafloor as if it were consistently smooth or rippled or rocky. These relatively simple models have helped researchers better understand the major processes that control sediment motion and distribution, but they fail to realistically simulate the full complexity of the interplay between seafloor "roughness," bottom currents, and sediment transport.

"Models usually assume homogeneity of roughness," says Wright, "but along a coastline like we have in Virginia, homogeneity is the exception rather than the rule."

The roughness of Virginia's coastal seafloor is a product of the continuing rise in sea level since the end of the last Ice Age. As Virginia's coastline pushes slowly landward, it leaves behind a bumpy trail of relict oyster reefs, deep tidal channels, and marshy hummocks of peat.

VIMS' pod being retrieved by helicopter from New Zealand waters.

The team's study site in New Zealand's Tairua–Pauanui embayment provides a comparable environment, but on a smaller scale particularly conducive to fieldwork. Previous surveys using side-scan sonar showed that the floor of the 10-km-long bay comprises a discrete patchwork of small, sandy ripples; larger, gravelly ripples; and rocky outcrops.

In mid-February, a helicopter ferried the team's three tripods from a local rugby field to the bay, where the researchers anchored them in about 20 meters of water. Once switched on, the tripods' sensors began storing hourly readings in onboard solid-state memory.

The team scheduled their study during the Southern Hemisphere summer and early autumn to maximize the likelihood that a tropical cyclone might impact the site. "Storms are when everything happens on the shelf," says Wright. "Most sediment gets moved during storms, not fair weather."

And sure enough, nature complied. Tropical Cyclone Paula blew past New Zealand in early March, providing a unique opportunity for the team's tripods to record feedbacks between sediment behavior and seafloor roughness during the height of a storm.

In late March, the researchers retrieved the tripods and downloaded what Wright describes as "an exceptional data set." The team is now busy analyzing those data.

Each tripod used in the study stands about 2 meters tall and weighs about a ton. A host of D-cell batteries power its state-of-the-art sensors. The sensors use sound waves, light beams, pressure readings, and electromagnetic fields to measure current velocity, turbulence, and the concentration of sediments suspended in the water.

Unlike previous sensing techniques, many of the new sensors are non-intrusive. Thereby allowing the researchers to observe the behavior of the system free from any artificial influences introduced by the instruments themselves.

Sound sensors on the tripods include an Acoustic Doppler Velocimeter. The ADV focuses three sonic beams on a 1-centimeter cube located 15 centimeters from the sensor. By recording and analyzing how these intersecting beams reflect off particles in the water, the ADV can determine the speed and 3-dimensional motion of currents through that spot. Because the ADV emits 10 sonic pulses each second, it can resolve not only the average velocity of the local current, but its short-term variations as well. This is crucial for obtaining the type of high-resolution data that the team needs to understand the complex interplay between bottom roughness and sediment motion.

Another sound sensor is the Acoustic Doppler Current Profiler.

Continued on page 9

VIMS scientists preparing to dive during a recent research cruise in New Zealand. (L to R - Bob Gammisch, Don Wright and Wayne Reisner.)

Former Student Funds Scholarship

Kelly Johnson, first-year Masters student, in the Fisheries Genetic Lab.

Former VIMS student, Jamie Jackson, left marine science for computer science and a career with the highly successful Internet company YAHOO. She did not, however, forget the people she knew at VIMS nor their commitment to marine education. Last year, Jackson contacted Dr. John Milliman, former Dean of Graduate Studies, and told him she wanted to fund a scholarship to be established in his name. In the fall of 2000, Kelly Johnson became the first recipient of the Milliman Scholarship. Johnson, a master's student in the Department of Fisheries Science, graduated from North Dakota State University (NDSU). "I spent several summers doing field work in marine related areas and fell in love with marine science," she said. As part of her undergraduate study in zoology, she had an opportunity to begin work in genetics utilizing microsatellites and "allozymes." When Dr. Peg Mulvey, VIMS Dept. of Environmental Sciences, gave a seminar at NDSU Johnson became interested in the graduate education program at VIMS. After researching VIMS on the Internet, Johnson decided VIMS had both the graduate education and the strong genetics research opportunities she wanted. As a first year VIMS student, Johnson is taking the required core courses as well as planning her own research. "I love it here, " she says, "receiving this scholarship has enabled me to be in a premier education and research facility. It is quite challenging and exciting. And, I love the Virginia weather!"

Kelly is investigating the genetic relatedness of several species of shore fishes that occur in Bermuda and along the U.S. south Atlantic coast. Her results will increase our understanding of the population structure of widely distributed marine fishes, information that is necessary for effective management. In addition, the data will allow her to test various hypotheses regarding the temporal patterning of the colonization of Bermuda.

"As the cost of supporting students continues to rise, it is great to see private funds support for our academic program. I am most grateful to Ms. Jackson for her contribution—it is clearly making a big difference for one deserving student," said Dr. John Graves, Chair, Department of Fisheries Science and Johnson's major advisor.

Kauffman Aquaculture Center Campaign

Mr. and Mrs. John Kauffman have committed $500,000 as a challenge grant to construct an aquaculture facility on their property in Topping, Virginia. Their home and surrounding property and a supporting endowment was bequeathed to VIMS in 1997 to be used for marine education and research programs. VIMS will immediately begin a campaign to raise the $500,000 match needed to construct the facility.

Dr. Stan Allen, Director, Aquaculture Genetics and Breeding Technology Center (ABC) at VIMS explains that developing disease resistant strains of oysters offers the opportunity for a strategy of immense magnitude – genetic rehabilitation of oysters in the lower Chesapeake Bay. "Replacing oysters on a reconstructed reef is a multi-million dollar enterprise among various agencies in and around the Chesapeake Bay," says Allen. "Building reefs is one thing, seeding them with oysters capable of growing, reproducing and repopulating reefs and surrounding areas which will in turn grow and reproduce, is essential if restoration efforts are to be meaningful."

The facility, The Kauffman Aquaculture Center, will be used for research to advance the development of disease resistant oysters through technological innovation for aquaculture and restoration efforts. The Center will include laboratories to grow and study non-native and genetically enhanced native oysters in isolation. The techniques developed at the Center will have a wide array of application worldwide in shellfish and finfish aquaculture.

At the same time disease resistant stocks can be used for genetic rehabilitation, they can also serve as an agent of economic development. At present, wild oysters cannot survive to market size in sufficient quantities to warrant investment in oyster farming. Disease resistant strains provide an opportunity to redress this because they can withstand diseases for at least an extra six-month period. Continual improvements will extend this advantage. "Our progress in selection for disease resistance is hastened by new developments in ABC's molecular lab concerning oyster genomics and mapping important genes," said Allen.

"The Kauffman's support provides an opportunity to advance research that can have very significant long-term implications for both oyster culture and reef restoration efforts in Chesapeake Bay," said Dr. Gene Burreson, Director of Research and Advisory Service at VIMS.

Rendering of the proposed Kauffman Aquaculture Center in Middlesex County.

Middle of the Storm
continued from page 5

This sits atop the tripod and points upward. The ADCP measures the average current velocity in every 25-cm layer between the sensor and the water surface. It also measures turbulence, and the concentration of suspended particles.

Light sensors on each tripod operate on the same basic principle as the acoustic sensors, but emit and receive infrared light rather than sound waves. The team employs light sensors because they are much better than sound sensors at measuring the concentration and motion of very fine sediments such as mud and clay.

Pressure gauges on the tripods measures the depth of the overlying water column, and thus provide information on tides and wave height. This helps the researchers relate sediment motion to the daily tidal cycle or the passage of storms.

The final tool in the researchers toolbox is an electromagnetic sensor that provides back-up measurements of current velocity by detecting the motion of seawater, an electrolyte, past 4 electrodes protruding from its small spherical body.

Together with before and after surveys of the seafloor, these sensors provide a detailed 3-dimensional understanding of how seafloor roughness influences sediment motion, and vice versa. It is important to remember, notes Wright, that the interaction between seafloor and sediment goes both ways.

"Water turbulence is proportional to roughness," says Wright. Thus as a sediment-laden water current moves from a rough patch of seafloor to a smooth one, turbulence decreases, as does the amount of sediment the water can hold. Deposition of this sediment changes the seafloor's shape, which in turn alters the turbulence of water moving above and can result in further erosion or accumulation.

This type of complex feedback is exactly what the researchers are hoping the tripods they deployed in New Zealand will help them to better understand. These feedbacks can then be incorporated into computer models used right here at home.