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Title: Sand Transport During High-Energy Storm Events

Topic Area: A2.1a, Sediment Processes, Non-Cohesive

Objective: Provide improved parameterizations of surf and swash zone sediment transport processes for integration into multidimensional numerical models. Provide improved estimators of net and gross transport for integration into regional-scale models. Provide information on the accuracy of storm-driven longshore transport estimators, for use in assessing risk and uncertainty in regional-scale, long-term predictions. Expand the number and quality of benchmark data sets available for sand transport model development, evaluation and validation.

Problem: Any reliable models or methods to predict movement of sand through a regional coastal system must properly treat the process of sand transport along the coastline. Past studies suggest that annual net (magnitude and direction) and gross sand transport rates within littoral systems are in large part defined by the extreme storm events that occur during the year. The numbers of events and their severity, in terms of wave and current conditions they produce, exert great control over longshore transport rates and regional system response. Tools such as CASCADE must be able to accurately simulate the alongshore movement of sand, and its interaction with and interception by inlet systems, to most reliably address RSM issues. Emerging information from ongoing studies being conducted in CHL's Large-Scale Sediment Transport Facility (LSTF), and past laboratory studies by Kamphuis, all done in low-energy laboratory environments, cast some doubt on the accuracy of the CERC formula which is commonly used to compute longshore sand transport rates. Results from LSTF studies completed thus far suggest the CERC formula over-predicts by a factor ranging from 3 to 6. Studies by Kamphuis also found the CERC formula substantially over-predicted transport rates. On the other hand, data that were recently collected at the CHL Field Research Facility with the Sensor Insertion System (SIS) suggest that computed rates seem to agree with the CERC formula. The SIS measurements did not capture transport in the very nearshore zone and swash zone. Laboratory experiments done in the LSTF and by Bodge and Dean, suggest that transport in the swash zone may comprise 20-30%, possibly more, of the total being transported along the beach. If true, then computed rates based on the SIS measurements may be 20-30% low, or more, which suggests that the CERC formula may in fact under-predict LST rates for high-energy events. Considerable uncertainty remains concerning accuracy of the CERC formula, and other methods used to estimate the longshore transport rate.

Benefits: The proposed research will provide valuable information for understanding and quantifying longshore transport rates under storm conditions, including the swash zone, which will lead to improved numerical models, and

provide information for assessing the uncertainty associated with simulations of regional scale processes and predictions of system response. This addresses needs 3, 15, 18, 79, 84, 85, 86, 87, 89, and 99 in the RSMP field needs appendix. All will contribute to more informed and improved regional sediment management decision-making.
This work produces new tools and methods for the USACE and nation. It is an integral part of the Regional Sediment Management Research Program, and thus contributes primarily to support of the USACE's navigation, flood/storm damage reduction, and environmental protection and quality missions. It supports all 8 Civil Works strategic goals and 7 of 9 Listening Session objectives identified by HQUSACE as R&D priorities. With companion work units, it employs active technology transfer and insertion.

Work Description: In light of the fact that longshore transport in the swash zone is potentially a significant percentage of the sand that is moved alongshore, the fact that swash processes are poorly understood, and in light of the difficulties of measuring processes in this shallow high-energy domain, a workshop involving investigators who have studied swash processes, and developers and appliers of measurement sensors and techniques that potentially have use in the swash zone, will be convened. Based on workshop discussions and recommendations, a plan for measuring swash transport at the Field Research Facility will be developed. We expect this plan will utilize some of the promising video techniques being developed by researchers at the Naval Research Laboratory and applied in the LSTF studies to measure swash hydrodynamics, as well as sensors for measuring sediment concentration and water surface/depth in the swash bore region. Physical traps and obstructions to create impoundment are also candidate methods for quantifying sand transport. We expect partnering with researchers at other universities and agencies will occur as well, and will add to the monitoring and instrumentation scheme. The SIS, with improvements designed to more accurately identify the position of the sand bottom and better measure the vertical variation of concentration and velocity near the bed, and the swash measurement system, will be deployed during a series of high-energy storm events spanning two winter seasons. Data from the storm events will be analyzed to estimate both the total longshore transport rates for different wind-wave, swell, and beach conditions, and the distribution of longshore transport from the swash zone to the offshore limit of the FRF research pier. Results of this effort have implications on engineering and design studies, and RSM decision-making. Results from the field will be integrated into the LSTF calibrations. In cooperation with Dr. Brad Johnson, algorithms relating swash transport to incident wave conditions, and other relevant forcing, will be sought and developed in a follow-on work unit.

Products and Schedule

Primary products will consist of improved knowledge of high energy littoral zone sediment transport and data for algorithm and model validation, contributing to program Products A1.2.3, "Impact of large storms and floods," and A2.1.3, "Algorithms quantifying transport of sediment during extreme events."

Product	Schedule
TN: Workshop – Measurement of Swash Zone Processes	Q2/02
JP – Observations of Longshore Sand Transport During Storms	Q3/03
TN – Longshore Transport During Storms	Q4/03
TR – Field Experiments of Surf and Swash Zone Transport: Vol. 1	Q4/03
JP – Cross-shore Distribution of Storm-Induced Longshore Transport	Q3/04
TR – Field Experiments of Surf and Swash Zone Transport: Vol. 2	Q3/04
TN – Cross-shore Distribution of Longshore Transport	Q4/04