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Title: Mixing and deformation of alluvial bed surfaces in rivers

Topic Area: A2.1a.2 Sediment Processes

Objective: a. Produce a numerical algorithm to simulate the long-term mixing process that occurs at the bed surface of alluvial rivers. This includes both the armoring process that occurs with a sediment deficit and the mixing process that occurs with equilibrium transport and with a sediment surplus. b. Formulate an algorithm to predict bed form type, length, height and speed.

Problem: Existing methodologies for calculation of sediment transport do not allow for changes in the bed-material gradation with discharge. Sediment transport calculations are frequently based on bed-material samples collected at low flow and the bed gradation is assumed to remain the same at higher flows. However, during the course of flood events, the bed-gradation changes as finer sediment sizes are selectively removed from the bed surface or the coarse surface layer is destroyed. When the bed surface gradation changes so does the sediment transport and the surface bed form. Using bed-gradations collected at low flow can led to significant errors in the estimation of sediment transport, sediment yield, and channel forming discharge.

Benefits: The particle-sorting algorithm to be formulated in this work unit will be especially useful; to planning level studies where elaborate numerical models are not feasible and simple tools such as the SAM hydraulic design package are used to evaluate sedimentation issues. A reliable hydraulic sorting and armoring algorithm is also essential for proper simulation of sedimentation processes in numerical models. Knowledge of the occurrence and geometry of bed forms in alluvial rivers is necessary when formulating hydraulic sorting algorithms in numerical sedimentation models and when calculating hydraulic roughness. Products from this work unit are directly applicable to needs 15,18,30,42,43,69,70,71,72 and 86 in the RSM field needs appendix.

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: The research will provide an algorithm that predicts the composition and characteristics of an alluvial bed for a variety of flow conditions. It is hypothesized that bed response can be determined from the characteristics of the alluvial bed material collected under a specific set of field conditions and

the variation of flow parameters with discharge. Algorithms will be developed for 1) sand bed streams, where bed forms and hydraulic mixing are expected to be the most significant alluvial processes, 2) sand and gravel bed streams, where surface layer formation and destruction are expected to be the most significant processes, and 3) gravel-boulder bed streams, where hydraulic roughness and critical shear stress are expected to be the most significant characteristics. Work items will develop knowledge to produce and test these hypotheses. Guidelines for collection of bed-material samples will be developed in conjunction with other federal agencies through the Federal Interagency Sedimentation Project (FISP). This information will be published in an interagency report and in Corps Engineering Manuals. Available river and flume data on armoring, hydraulic sorting and bed forms will be collected. Additional field data will be collected from gaged stream sites where bed material gradation varies with discharge. Methods for prediction of bed form occurrence and geometry will be evaluated based on prototype data collected. Relationships between hydraulic and sediment parameters will be evaluated to find regression relationships for variable bed-material gradation. In conjunction with the empirical approach, an analytical methodology will be formulated to simulate the armoring, hydraulic sorting, and bed form formation processes. This analytical method will be suitable for incorporation into existing and future numerical sedimentation models. The SAM program will be enhanced to include sediment continuity, which will allow bed gradation changes with time during a hydrograph calculation. Test cases will be evaluated. A report detailing the alluvial processes and providing guidelines for solution of practical problems will be prepared.

Products:
Primary Products from this work will be knowledge of armoring and bed form processes and algorithms to be incorporated in the SAM hydraulic design package used in preliminary sedimentation studies and in the formulation of multi-dimensional numerical models in Task Area B.

Product	Scheduled
1. TN: Interagency guidelines for bed material sampling	4Q FY02
2. TN: “Prediction of bed form processes in alluvial rivers”	4Q FY02
3. JP: “Guidelines for bed-material sampling”	2Q FY03
4. TN: Algorithm for predicting bed form geometry and speed	4Q FY03
5. TN: Regression equations for bed-gradation change with discharge	4Q FY03
6. TN: Hydraulic sorting and armoring algorithm for reach analysis	2Q FY04
7. Modified SAM to handle particle-sorting	4Q FY04
8. Draft Guidelines for EM 1110-2-4000.	4Q FY04