Regional Sediment Management
In the
US Army Engineer District, Mobile

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Abstract

Historically, the US Army Corps of Engineers (USACE) has managed navigation and beach restoration on a project-by-project basis rather than managing the coastal system that encompasses the individual projects. This approach to project management, and therefore sediment management, may adversely impact up-drift and downdrift beaches and/or adjacent projects. For example, when sand is removed from navigation channels and placed in upland or offshore disposal sites, it will not return to the littoral system. Consequently, the supply of sand to downdrift beaches is reduced resulting in increased potential for erosion. To address this issue, the USACE implemented a Regional Sediment Management (RSM) Demonstration program in the USACE Mobile District (CESAM). The purpose of the program was to evaluate the benefits of managing sediments as a regional scale resource, and therefore manage projects on a regional basis. The concept of RSM resulted from the 67th meeting of the USACE Coastal Engineering Research Board (CERB) held in May 1998.

Since the initiation of the CESAM RSM demonstration in 1999, the National RSM Program was initiated in 2000, nine additional demonstrations have been initiated in USACE Districts, and the US Army Engineer Research and Development Center (ERDC) initiated the RSM Research and Development program in 2002. The CESAM RSM demonstration was completed in 2002. This paper discusses the RSM demonstration program and the CESAM efforts to implement regional sediment management practices through improved project and sediment management.

Introduction

In September 2002, the US Army Engineer District, Mobile (CESAM) completed a 3-year demonstration program to evaluate implementation of the Regional Sediment Management (RSM) philosophy within the US Army Corps of Engineers (USACE). CESAM is now in the process of implementing RSM into everyday practice. The purpose of RSM is to change the focus from project specific management to taking a regional approach to project management. Therefore, sediments would be managed as a regional scale resource rather than a localized project resource. Goals and objectives of the RSM demonstration program defined by the Coastal Engineering Research Board (CERB) include:

Goals:

- Maximize beneficial use of sediments
- Minimize environmental impacts
- Optimize Expenditures

Objectives:

- Implement regional sediment management practices
- Improve economic performance by linking projects
- Develop new engineering techniques to optimize/conserve sand
- Identify bureaucratic obstacles to regional sediment management
- Manage in concert with the environment

The CESAM RSM demonstration region extends approximately 600-kilometers from the St. Marks River, FL (eastern boundary of CESAM), to the Pearl River, MS (western boundary of CESAM) and includes the Mississippi barrier islands, Figure 1. The domain includes 3-states (Florida, Alabama, and Mississippi), 13-coastal counties, and 4-congressional districts. The region is divided into eleven sub-regions based on geography or geology and/or sediment transport patterns. The sub-regions in the Florida Panhandle are coincident with the sub-regions defined by the Florida Department of Environmental Protection (FLDEP).

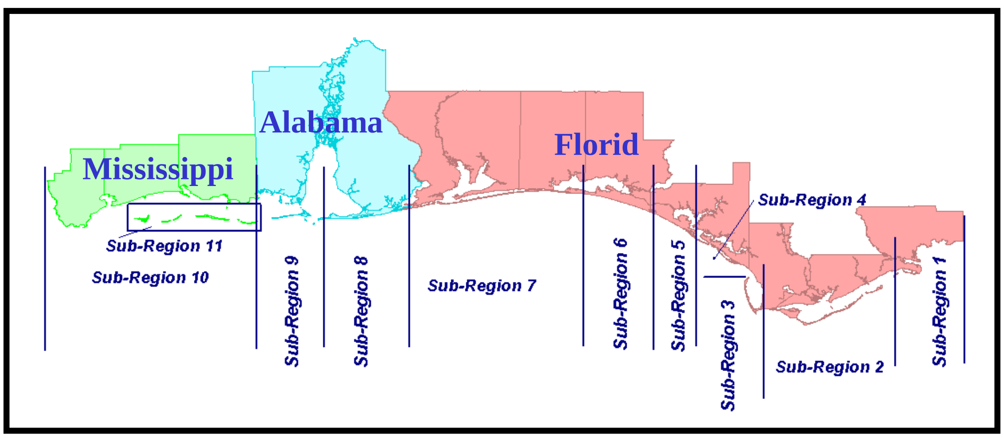

Figure 1. Northern Gulf of Mexico Regional Sediment Management domain

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RSM Activities

The RSM program included several ongoing activities as shown in Figure 2. The over arching activity is to change present practices to improve the management of sediment throughout the region. The key activities to a successful program are development of a regional sediment budget and coordination with Federal, State, and Local agencies. Other activities include gathering information and data collection, application of numerical models, development and implementation of a data management and Geographic Information System (GIS), and identifying research and development needs for improving or developing tools for implementing RSM. The program must be active in publicizing efforts through available avenues such as the Internet, public meetings and workshops, conferences, and etc.

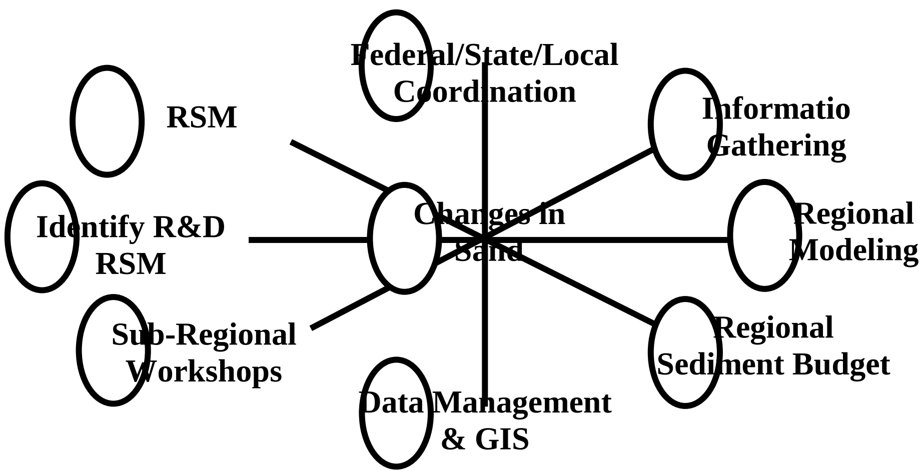

Figure 2. Regional Sediment Management program activities

Because the regional sediment budget is the only means to comprehensively understand the coastal processes and sediment transport on a regional scale, development of the sediment budget was the initial program activity. A sediment budget quantifies, to the extent possible, sediment sources, sinks, and transport rates at the project level and/or throughout the region. The sediment budget also provides an understanding of the coastal processes and sediment transport patterns and pathways over the region.

RSM can only be successful if coordination and communication are maintained with the agencies that have an interest in the RSM coastal domain. An RSM Technical Working Group (TWG) was established to involve those agencies and to provide guidance in developing and implementing the RSM program. TWG representation included Federal, State, and local governing agencies as well as academia in Florida and Alabama. Presently 20 agencies are represented on the TWG.

RSM Demonstration Initiatives

Through the TWG, RSM initiatives or projects were identified to improve sand management over the region. Because there are many projects with management issues, the initial focus was to identify and prioritize those projects with issues that could be addressed in a timely manner. This plan would provide rapid realization of regional management benefits. The experience gained from these initiatives would be applied to other projects in the region. Below are the primary program initiatives and status:

Mobile Pass. In 1999, about 3-MCY of dredged material from the Mobile bar channel was placed in the Sand Island Beneficial Use Area (SIBUA) located on the Mobile Pass ebb shoal. The purpose of this initiative is to investigate the sediment transport pathways in the vicinity of the ebb shoal. This activity will establish procedures, field techniques, and data analysis tools for future studies in the area.

Perdido Pass. Since 1971 over 5.2 MCY of dredged material from the Perdido Pass navigation channels was placed in six disposal sites in the Pass vicinity. Due to upland and/or nearshore placement, the sand is slow to return to the littoral system. Stockpiled material is mined for hurricane restoration. Sand bypassing further downdrift is a more efficient and effective use of the material. Private property issues and attaining easements and rights-of-way have hindered this effort.

Pensacola Harbor (Fort McRee). The USACE periodically dredges the GIWW in the Pensacola Pass vicinity. Some of the material is stockpiled on Fort McRee, a 40-acre diked upland site created on an island near the eastern end of Perdido Key. Use of the stockpiled sand for beach replenishment requires resolving issues such as sand ownership, funding sources, and determining a means to transport the material.

East Pass (Norriego Point). The East Pass Inlet Management Plan (IMP) recommends bypassing of 80,000 CY/YR by placing dredged material from the navigation channels into the nearshore zone or directly on the downdrift beaches. Presently, most of the material is placed on Norriego Point, a sand spit within the inlet, for stabilization. Implementation of this initiative requires stabilization of Norriego Point, obtaining easements, and may increase dredging costs.

St. Andrews Inlet (Gator Lake). Periodic maintenance dredging of the St. Andrews Inlet navigation project includes placement of about 39,000 CY/YR along the interior inlet shoreline fronting Gator Lake, an environmental sensitive freshwater habitat in endangerment of breaching. Stabilizing the Gator Lake shoreline would allow the beach quality sand to be bypassed to the downdrift beaches.

RSM Technical Program

The technical program goal was to apply and develop tools to allow CESAM to evaluate coastal processes and manage sediments at regional scales as well as project scales. To meet this goal, CESAM followed the process outlined in Figure 3. The process began by developing a preliminary sediment budget based on a thorough literature review. This initial sediment budget quantified the knowns and qualified the unknowns relative to sediment transport over the region. CESAM then developed a program to improve our knowledge through field data collection and application of numerical models. Information gained would provide data to refine the sediment budget. It was quickly realized that a data management and GIS tool would be necessary to manage and perform analysis of information and data over such a large region. The comprehensive suite of engineering tools improves our ability to assess coastal process on a regional scale (600-kilometers), manage and analyze data, evaluate sediment management practices and develop new procedures to improve sediment management, and evaluate impacts of modified sediment management practices.

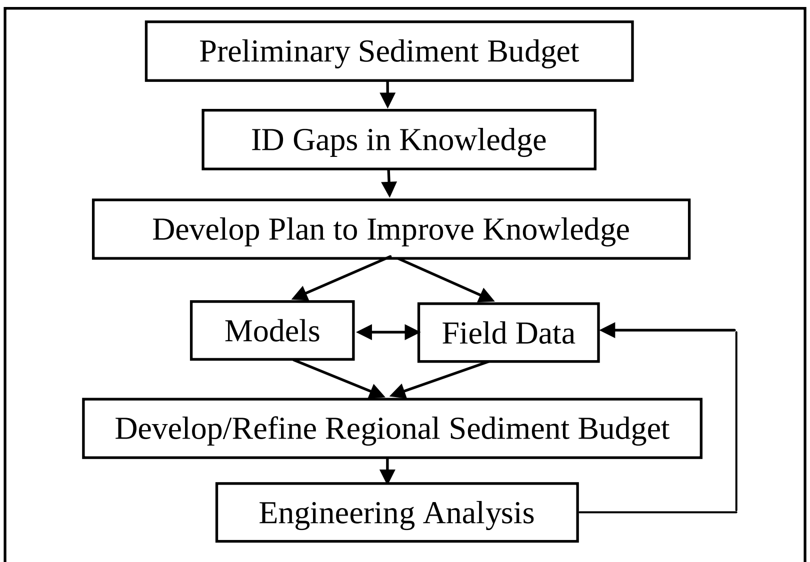

Figure 3. CESAM process to implement Regional Sediment Management

Regional Sediment Budget. A preliminary or conceptual regional sediment budget was created based on available historical information and utilizing the Sediment Budget Analysis System (SBAS) (Rosati and Kraus, 1999a), Figure 4. The preliminary regional sediment budget was the refined by utilizing a combination of regional and local-scale numerical models, regional and local-scale measuring techniques, the Sediment Budget Analysis System (SBAS), and a GIS. The purpose of the sediment budget was to quantify, to the extent possible, sediment sources, sinks, and transport rates throughout the region. The effort required gathering historic data and collecting new data from the District and RSM study partners. In parallel, numerical models were applied to develop sediment transport potentials over the region. The field data and model results were then combined in the GIS to calibrate the transport potentials with field measurements. Transport cells were created in SBAS at the project scale and integrated to the regional scale. This sediment budget provided the first regional context to develop engineering alternatives and assess potential regional impacts. It also identified where little, or no data existed prior to RSM, and these areas are the focus to improve our understanding of regional processes.

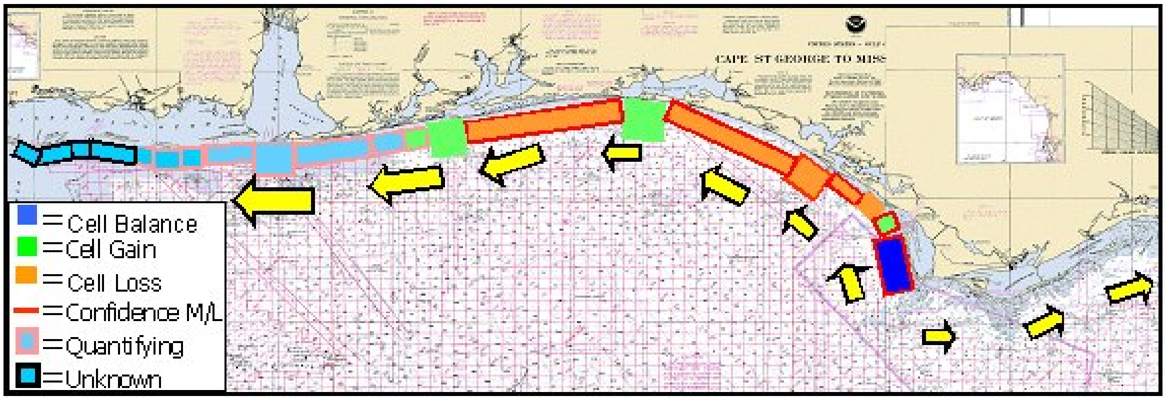

Figure 4. Conceptual regional sediment budget

Baseline Dataset. A baseline data set was developed to define the RSM existing 2000 conditions for the numerical models and the sediment budget. Because collection of required bathymetric, topographic, and aerial data over the entire region for a given year is not economically feasible, the regional baseline data set consists of a compilation of bathymetric and topographic data, beach profile, and aerial photography over a given time period. The regional baseline data set is based on 1998 and1999 aerial photography and the National Imagery and Mapping Agency (NIMA) digital nautical chart data. The NIMA data were augmented with surveys collected between 1997 and 2000: Scanning Hydrographic Operational Airborne Lidar System (SHOALS) (Guenther and Lillycrop, 2002) hydrographic and topographic surveys; CESAM conventional project surveys; FLDEP and CESAM beach profiles. The baseline was created through data manipulation using the SHOALS Toolbox (Wozencraft, et al 2002).

Numerical Models. To refine the sediment budget, CESAM coordinated with the US Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory to apply a suite of typically project level hydrodynamic models to the RSM region. The modeling efforts provided an understanding of the regional coastal processes including wave transformation, sediment transport, shoreline change, tidal circulation, and water-level fluctuations. The models were then focused at the sub-regional and project scales to refine the sediment budget and begin evaluation of project modifications to improve sediment management.

Wave Transformation. The Wave Information Study (WIS) (Hubertz and Brooks, 1989) 1976-1995 offshore hindcast data for the Gulf of Mexico were transformed over the shallow-water bathymetry to develop a nearshore breaking wave climate using the steady-state spectral wave model STWAVE (Smith et al, 1999). The grid system representing sub-regions 4-9 is show in Figure 5. The resulting breaking wave climate was used to develop potential longshore sediment transport rates discussed in the next section.

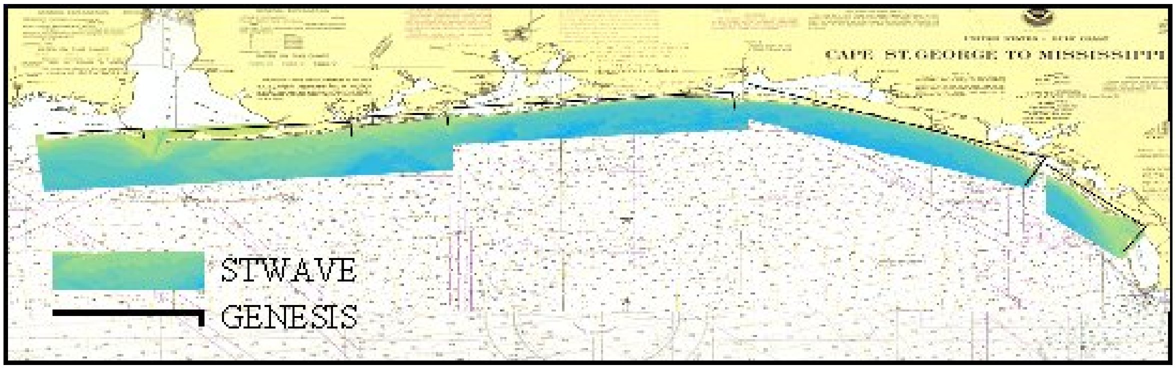

Figure 5. STWAVE and GENESIS grid systems

Longshore Sediment Transport and Shoreline Change. The GENEralized Model for SImulating Shoreline Change (GENESIS) (Hanson and Kraus, 1989) was utilized to develop potential net longshore sediment transport rates based on the breaking wave climate resulting from the STWAVE simulations. GENESIS was configured for the RSM sub-regions, and available historical shoreline position data and coastal processes information were applied to calibrate and verify the model. The GENESIS grid system developed for the RSM sub-regions 4-9 is shown in Figure 5. The resulting potential longshore sediment transport magnitudes and directions were imported to the RSM GIS and used in development of the regional sediment budget.

Water-level and Circulation. The two-dimensional ADvanced CIRCulation (ADCIRC) long-wave hydrodynamic model (Luettich et al, 1992) for simulating water surface fluctuations and tidal currents was applied over the RSM region. To ensure appropriate boundary conditions, the grid encompassed the entire Gulf of Mexico with refined resolution to resolve the RSM region and projects (Figure 6).

The ADCIRC model characterized tidal circulation patterns and water-level fluctuations both regionally and at project scales. The circulation magnitudes and patterns provided insight to understanding sediment transport patterns and pathways and erosion and accretion occurring along the shoreline and at project sites. The calibrated model will be used for future applications to develop and evaluate modifications to management practices and evaluate storm impacts to existing conditions.

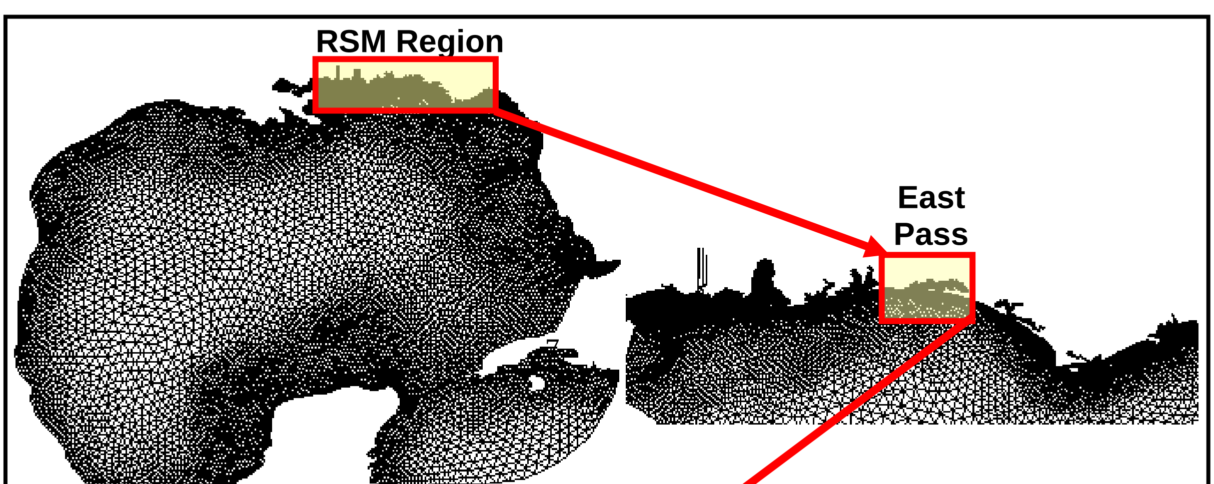

Figure 6. ADCIRC circulation model regional grid

Regional Geographic Information System. A regional GIS was developed to manage, analyze, share, and view historic and newly collected data, as well as numerical model results. These data will be crucial to evaluating potential O&M decisions affecting RSM. For example, information such as beach profiles, navigation project surveys, aerial photos and dredging records comprise the historic data for comparison with baseline data established in 2000. These data will be instrumental in calibrating and verifying the sediment budget. A key component of the RSM program is the partnering with State and local governments. To maximize the sharing of data and eliminate duplication, this GIS forms the backbone for standardizing formats and producing easily accessible information. The GIS also provides a means to maintain “institutional” knowledge over the region. RSM tools within the GIS are discussed in the following section.

Regional Sediment Budget. These data and analysis were compiled into a sediment budget using the Sediment Budget Analysis System for ArcView (SBAS-A) GIS extension (Dopsovic et al, 2002). The Spatial Data Branch of CESAM coded the SBAS-A GIS Extension to exactly match the stand-alone version created by the Coastal Inlets Research Program.

The regional sediment budget based on potential longshore sediment transport rates resulting from the numerical model effort is provided in Figure 7. Perhaps the most important information gained from the creation of the regional sediment budget is the identification of those areas where more data collection is required. For most of the region, except the inlets and shore protection projects, there is little or no data with which to make volumetric comparisons. In Figure 8, cells shown in red are those cells where insufficient data exist to make volumetric comparisons in order to balance those cells.

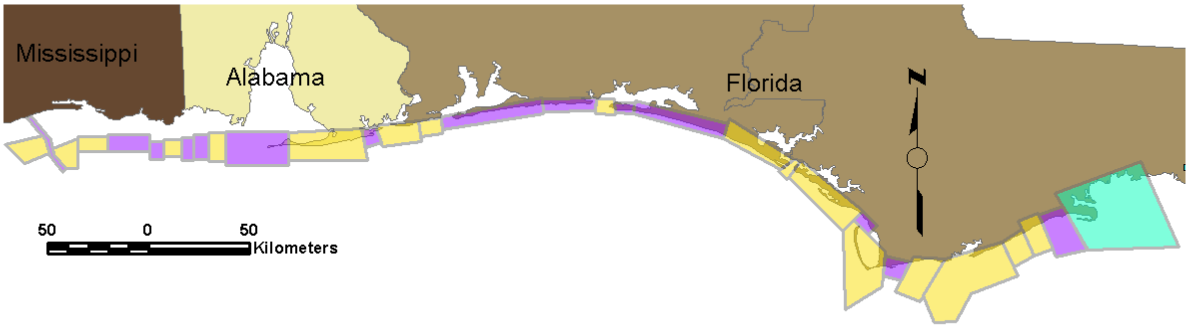

Figure 7. Results of transport rates applied to sediment budget cells. Purple indicates a gain of sediment. Yellow indicates a loss of sediment. Green means no gain or loss, or no data

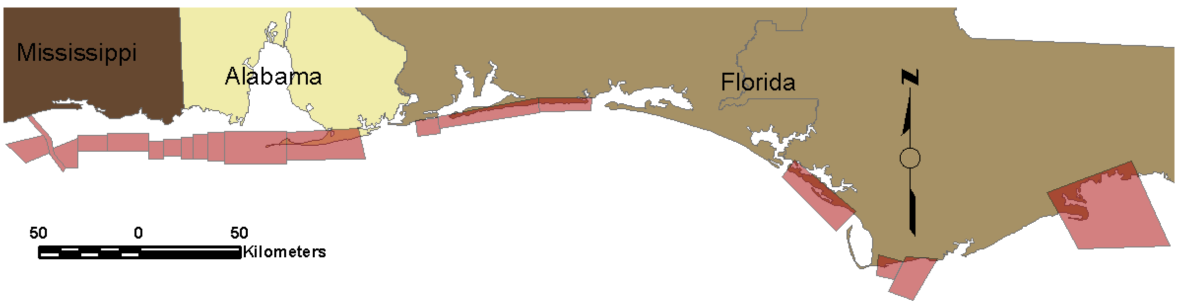

Figure 8. Sediment Budget cells with insufficient data for volume comparisons

Conclusions

The US Army Engineer District, Mobile (CESAM) has recently completed a three-year Regional Sediment Management (RSM) Demonstration program that was initiated in October 1999. Lessons learned from the CESAM RSM program are that successful implementation of RSM requires application of engineering tools appropriate for regional management and analysis, and effective coordination and communication with Federal, State, and local agencies with an interest in the RSM domain. Since the completion of the demonstration, a CESAM RSM Product Delivery Team has been established to ensure lessons learned and RSM principals and concepts are incorporated into District practice.

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