Time-lapse movies of migrating bedforms

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Abstract
Observing bedform migration is useful for two purposes: (1) measuring rates of bedload transport, and (2) learning how bedforms operate. Time-lapse imagery allows visualization of bedform behavior that can not be recognized in individual images. Two techniques have been developed for making time-lapse movies that display such information about bedform migration.

Techniques for recording time-lapse movies
In a laboratory flume, ripple migration was recorded by high-resolution video, using light planes projected on the bed. An algorithm was developed to convert x, y, and illumination plane in the video image to x, y, and z in space. This system was used to record ripple migration over a 16-hour interval. In the field, a rotating side-scan sonar (Rubin et al., 1983) was deployed on a tripod and used to record migration of sand waves within a radius of a few tens of meters. The sonar images were recorded approximately every two minutes, over durations as long as 18 hours. The time-lapse image sequences collected by video and sonar are processed and then displayed as QuickTime movies.

Determining bedload transport rates from bedform migration
Bedform migration can be converted to bedload transport following the approach used by Simons et al. (1965). Bedload transport (volume of sediment transported per unit width and time) is approximated by the bedform migration speed multiplied by one-half the bedform height. In the Colorado River, bedload transport rate was found to be a small fraction (approximately 5%) of the total transport.

Observed bedform behavior
In the 10 movies to be shown at this symposium, bedforms display the following behavior:
(1) Downstream bedforms are coupled to those upstream; changes in upstream bedforms cause changes in the next bedform downstream.
(2) Bedforms change in size through time, in response to changing flow strength.
(3) Superimposed bedforms increase in size while migrating from trough to crest of the main bedforms. Some superimposed bedforms merge at the main crest, others migrate down the lee side.
(4) Some fields of bedforms display a pronounced lateral variability in migration speed and transport rate.
(5) Fields of starved bedforms are easily recognized by reappearance of individual cobbles in the bedform troughs.
(6) Many bedforms display indications of obliquity to flow, such as scour pits and lee-side spurs that migrate obliquely to the main bedform crests.

References:
Rubin, D.M., McCulloch, D.S., and Hill, H.R., 1983. Sea-floor-mounted rotating side-scan sonar for making time-lapse sonographs. *Continental Shelf Research*. **v. 1**, p. 295-301.

Simons, D.B., Richardson, E.V., and Nordin, C.F., Jr., 1965. Bedload equations for ripples and dunes. *U.S. Geological Survey Professional Paper*. **462-H**, 9 p.