TECHNICAL COMMUNICATION

Field Measurement of Microtopography[1]

Stephen P. Leatherman

Department of Geography
University of Maryland
College Park, MD 20742, USA

ABSTRACT

LEATHERMAN, S.P., 1987. Field measurement of microtopography. *Journal of Coastal Research*, 3(2), 233-235. Charlottesville, ISSN 0749-0208.

The microtopography profiler (MTP) has been constructed to allow precise measurement of surface features such as ripple marks or off-road vehicle tire tracks in beach sand. The design is simple, construction cost is minimal, and the reliability of collected information is high.

ADDITIONAL INDEX WORDS: *Surface profiler, microtopography measurement.*

INTRODUCTION

Geomorphologists often need a simply-operated device to make field measurements of microtopographic surfaces. A number of different designs for varying purposes have been utilized to date. For instance, ROBINSON (1976) and TRUDGILL *et al.* (1981) used microerosion meters to determine the erosion rate of rock surfaces. These triangular-shaped metal objects are much too heavy to be utilized in loosely compacted, unconsolidated beach sand.

TOY (1983) developed a micro-elevation instrument to overcome the probleas of using *in-situ* erosion pins to measure soil erosion. This instrument, along with the one developed by CURTIS and COLE (1972) for determining soil loss from surface-mined lands are similar to the familiarly known carpenter's contour gauge. It consists of a frame holding 150 sliding brazing rods, which when in contact with the ground surface provide an accurate representation of its form.

Falling-rod type devices, which were developed independently, are similar in design and operation to the underwater ripple marker profiler of NEWTON (1968). In this case 0.3 meter long aluminum knitting needles with small plastic feet were held by a frame for release by a diver on the ocean floor. The frame was then tightened, after the line of pins had faithfully traced out the bedform, and returned to the beach for measurement of ripple configuration.

DESIGN AND OPERATION

The microtopography profiler (MTP) was developed to measure the amount of direct sand displacement resulting from off-road vehicles (ORVs) traveling along the beach (Figure 1). This instrument consists of a wooden frame with four adjustable legs. Suspended within the frame is a 1.2 meter long row of 0.6 cm diameter light-weight plastic rods of equal length. Loosening a retaining clamp allows the rigid rods to gradually descend to the surface while maintaining their single line posture. The lower end rests on the surface, and the upper end of the rods exactly duplicates the surface profile.

After the ORV experimental impact site was selected (*e.g.,* foreshore, berm, backshore or dune face), and the environnental variables were measured (*e.g.,* slope angle, sand compaction and moisture), testing began by driving the vehicle through the test site once at a designated speed. To determine the amount of sand displacement, the mic-

[1] *The research project which led to the development of this device was funded by the U.S. National Park Service, Boston, MA. 86009 received 3 February 1986; accepted in revision 24 March 1986.*

rotopography profiler was set up perpendicular to the track, and the rods were lowered to the surface. The profile of the upper end of the rods (duplicating the actual surface profile) was then traced onto a long sheet of paper (Figure 2). The MTP was then removed, and the vehicle was then driven through the same track twice for a total of three passes. The MTP was set up again at the same relative location to determine the exact surface profile. This procedure was repeated after 5, 10, 15, 20, 25, 30, 40, and 50 or more passes through the same track.

The MTP data for each test were returned to the laboratory for analysis of surface profile changes resulting from vehicle impacting. Each impact profile had the original beach slope superimposed on it, and measurements of departure from this datum were made with a planimeter (Figure 3). Three primary measurements were taken for each profile: area of the track (area below the original surface, in which the tire passed) and areas of the

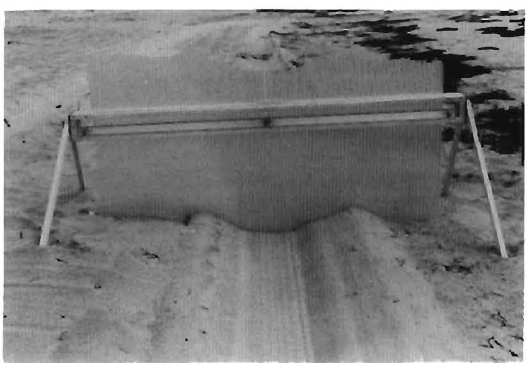

Figure 1. Microtopography profiler is set up perpendicular to the vehicle tire track with the upslope legs resting on a temporary benchmark established on the beach face.

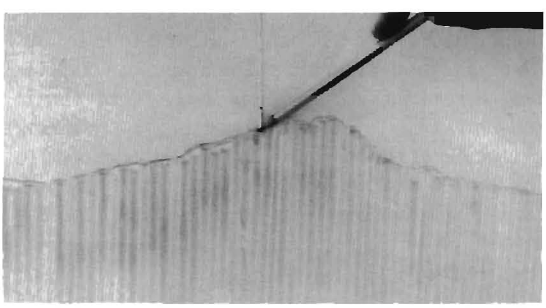

Figure 2. A tracing board is fitted to the back of the MTP frame so that the upper outline of the pins exactly duplicates the sand surface at a 0.6 cm sampling interval. The distance between the bottom of the tracing board and the temporary benchmark on the sand surface is measured so that all the profiles can be superimposed through time and with impacting to determine volumetric changes in sand disturbance per unit length of tire track.

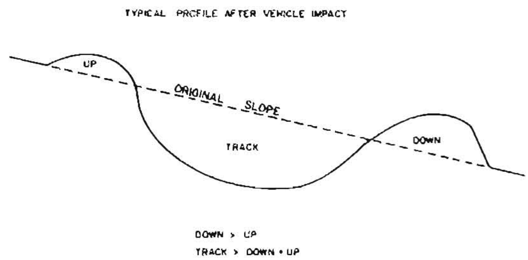

Figure 3. Typical profile after vehicle impact is shown.

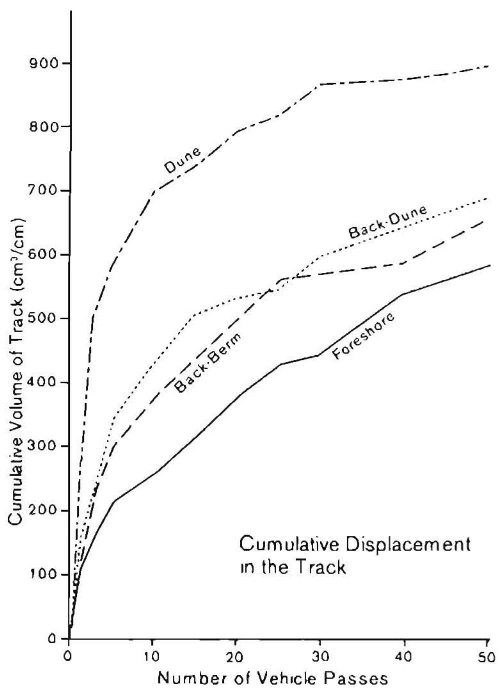

Figure 4. Four environments (unvegetated dune toe, beach backshore near the dune, beach berm, and beach foreshore) were experimentally impacted, and the amount of sand displacement following a specified number of vehicle passes was measured by the microtopography profiler (MTP).

downslope and upslope mounds (ridges of sand displaced by the moving tire). From these measurements, net downslope movement (downslope-upslope) and net disruption (track—(downslope+upslope)) were calculated. For example, the MTP data clearly showed a differential amount of sand displacement for each environment (Figure 4). The statistical analysis of these data sets and results of this study are given elsewhere (ANDERS and LEATHERMAN, 1981).

Reliability of the microtopography profiler was tested by making repeated measurements of the same tire track by removing and re-establishing the instrument at the same location without any impacting between set-ups. Tests indicated that the MTP yielded two to three millimeters of measurement replicability while obtaining undisturbed site data. Measurement accuracy depended upon sand compaction, which can be quite loosely positioned in the shear-produced mounds to either side of the vehicle tire track. TOY (1983) reported precision of one millimeter for hillslope soil profiles, and a similar range of measurement replicability could be expected for this instrument on firm ground.

CONCLUSIONS

This inexpensive and simply-operated device can be employed whenever the microtopography of an irregular surface is to be obtained under field conditions. Although the microtopography profiler was designed to determine the amount of beach sand displaced by a vehicle, it could be employed in a range of geomorphologic settings (*e.g.,* gully development on nonvegetated slopes, sand ripples on desert dunes, lichen growth on lava beds) where highly accurate measurements, singly or over time, are required.

ACKNOWLEDGMENTS

The MTP was designed with the help of and utilized in the field by Mr. Fred Anders and Dr. Allan T. Williams.

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☐ RESUMEN ☐

El perfilador microtopográfico (MTP) ha sido construido para proporcionar medidas precisas de superficies como ripples o huellas de vehiculos en playas de arena. El diseño es simple, el coste de construcción minimo y la información obtenida es altamente aceptable.--*Miguel A. Losada, Universidad de Santander, Santander, Spain*

☐ ZUSAMMENFASSUNG ☐

Das Mikrotopographie-Profilgerät (MTP) wurde gebaut, um präzise Messung solcher Oberflächenmerkmale wie Kräuselungen oder Reifenspuren der Fahrzeuge zu lassen. Der Bauplan des Geräts ist einfach, die Baukosten sind niedrig, und die Zuverlässigkeit der mit diesem Gerät gesammelten Information ist sehr hoch.--*Stephen A. Murdock, CERF, Charlottesville, Virginia, USA*