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Changes in trends of development of microtopography: effects of oil exploration and production in NorPatagonia, Argentina

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Oil exploration and production (E&P) create disturbances that may affect the geomorphological dynamic of the landscape. In particular, the construction of oil wells and seismic lines has an profound impact on soils and microtopography patterns. Regional geomorphological dynamics in NorPatagonia are controlled by ephemeral rivers associated to alluvial fans and playa lake deposits (“barreales”). Wind is involved in the transportation and deposition of sand and nutrients, which accumulate around vegetation and generate mounds or nebkhas. In order to evaluate the changes in trends of development of microtopography we compared the characteristics of mounds located inside 73 well locations with those in nearby natural areas (control sites). We performed an stratified random sampling, according to the geomorphological units at the local scale in the study area. We measured height (H), lenght (l) and width (w) of mounds, and calculated the horizontal component (L). We observed that H increases with the increase in L across all landforms (positive trend or growing phase) until a maximum H (equilibrium phase). From this value on, we detected a negative trend (degrading phase) as H decreases with an increase in L. Finally, there was an increase in the dispersion of data in both equilibrium and degrading phases, which could be explained by changes in geomorphologic dynamics within the oil wells. These results contribute to explain ecosystem regeneration and threshold variability during the post-disturbance process.

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Transformation of Earth's surface by humans

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Earth is moved and the landscape modified, commonly degraded, by many human activities. Mining, infrastructure expansion and urban development are obvious ones. Plowing moves huge amounts of earth and leads to accelerated erosion. Grazing and logging also increase erosion. Much of the eroded sediment ends up as colluvium on hillslopes and as alluvium in floodplains, thus subtly altering the shape of the land. The rest is carried away by streams and rivers.

As of ~2007, human activities had altered the shape of ~53% of Earth’s surface (Hooke et al., 2012). Most of these activities also had indirecteffects well beyond the area directly affected, so the full impact of land transformation was much larger than 53%. Both the direct and the indirect impacts compromise ecosystem services that are essential for human survival, some of which are irreplaceable.Thus, these changes may be the most significant component of Global Change for decades to come.

Continued degradation of agricultural land and expansion of urban land at the expense of prime agricultural land, together with our continuing disruption of crucial ecosystem services, are likely to limit Earth’s ability to provide an acceptable standard of living for even current populations. Indeed, we already appear to be in a state of overshoot. Overshoot is a situation in which a population exceeds the carrying capacity of the environment and, after a delay during which a storehouse of resources is consumed faster than they are replaced, the population crashes.This long-term sustainability issue is more serious than, but exacerbated by, climate change.

To restore sustainability we can: 1) reduce demand; 2) develop technological solutions; and 3) adopt measures that would first slow population growth and then reverse it. The first two are unlikely to solve the problem alone.

Reference: Hooke, R.LeB., Martín-Duque, J.F., and Pedraza, J. 2012. Land transformation by humans. *GSA Today*, 22(12): 4-10.