Ecological and Geomorphological Changes After Artificial Disturbance in a Coastal Dune

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Abstract

The Sindu coastal dune, located in western Korea, has been studied intensively by many researchers. The studies assume that the system shows an equilibrium state. In this era of rapid climate change, however, it is anticipated that the frequency and magnitude of disturbance events can increase. Therefore, it is questionable whether our current understanding of Sindu is still applicable in a non-equilibrium state we may encounter.

In this study, we take advantage of an unusual event, in which an extensive foredune area (ca. 1.2ha) at Sindu was completely dev egetated and flattened. The situation can mimic the occurrence of a large-scale washover event driven by a high-magnitude storm surge. The purpose of our research is to show ecological and geomorphological changes over one year after this disturbance.

The results indicated that geomorphological changes were closely related to seasonal wind and vegetation cover. In winter with strong wind, the disturbed area with no vegetation showed high erosion. Together, these eroded sands were deposited in the dune slack with high vegetation cover. In summer and fall when plant species established, vegetation cover of the disturbed area was negatively related to erosion rate. In terms of ecological changes, the plant species composition of the disturbed foredune was diversified over time and became more similar to that of the undisturbed foredune.

One year was definitely a short time to identify the full process of recovery. Geomorphological resilience of Sindu only led to the microscale pattern formation and could not make foredune-like hummock in a year. However, changes in plant species composition of the disturbed area clearly showed the trajectory to the undisturbed system, which indicates that the coastal system has the resilience to the disturbance.

Study Site

Sindu coastal dune, with 120 survey points

THE Disturbance & Study Design

Oct 2019

1.2ha of the foredune area was completely dev egetated and flattened

11 times of geomorphological survey
5 times of vegetation survey
2 times of soil properties survey in one year

spatially heterogeneous
spatially heterogeneous
habitat conditions
habitat conditions

Ecological Changes

Five times of vegetation survey
three areas of interest
(disturbed foredune, undisturbed dune slack and undisturbed foredune)

PERMANOVA
(p-values for statistically different spp composition and R² for degrees of difference)

- There were almost no significant changes in plant spp composition of undisturbed foredune/dune slack over time. (few arrows for the blues and the yellows)
- Great changes in plant species composition were observed in the disturbed foredune. (lots of arrows for the reds)
- Plant species composition of the disturbed foredune became similar to that of the undisturbed foredune. (grey line graph decreases through time)

Geomorphological Changes

high erosion – erosion – geomorphological equilibrium – deposition – high deposition

[Dec 2019 ~ April 2020] with a strong northwesterly wind
- Disturbed foredune, with no vegetation, showed high erosion.
- These eroded sands were deposited in undisturbed dune slack with high vegetation cover.
- An (artificial) disturbance may increase the geomorphological dynamics of a coastal dune

[May 2020 ~ Oct 2020] with random wind pattern
- Only small erosion and deposition occurred due to increased vegetation cover of the disturbed foredune.
- In the disturbed foredune, survey points with high vegetation cover showed a low erosion rate because of the biogeomorphic protection induced by vegetation (partial spearman’s rho = 0.343 / p-value < 0.05 / controlling distance to the coastline)

Tentative Conclusion

One year was a short time for landforms to regenerate. However, changes in plant species composition clearly showed that the coastal system has the resilience to the disturbances!

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