



Responses of coastal dunes to the tropical cyclone along the west coast of Korea

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Coastal dunes are highly evaluated as a natural defense against a predicted sea level rise triggered by global warming. They help stabilize the coastal landscape and protect the hinterland through dynamic interaction with sand beaches. During the tropical cyclones, dune erosion generally occurs because of storm surges, while dune recovery may naturally follow after the event. However, the erosion and recovery of dunes are highly variable with the condition of beach-dune systems including gradients of foreshore and front slope of the dune, sediment supply, vegetation, wind activity, and human interferences. Typhoon Kompasu, a tropical cyclone, passed through the Korean Peninsula from September 1 to 2 in 2010. It caused a rise in water in association with the storm, wave run-ups, and heavy rains in coastal areas. Coastal dunes along the west coast of Korea were damaged during the storm. We evaluated the extent of the damage on 52 coastal dunes in Chungnam and Jeonbuk provinces after this extreme weather event. We graded the erosion in terms of dune profile and vegetation into four categories: major (9.6%), moderate (11.5%), minor (40.4%), and no damaged (38.5%). Major damaged dunes were characterized by steep scarps or cliffs higher than two meters with pine trees fallen after the storm. However, no damaged and minor damaged dunes had a low gradient of front slope with herbaceous vegetation covers such as Gramineae and Cyperaceae. Sohwang dunefield, a monitoring site in Chungnam province, showed processes and responses of coastal dunes to the impact of the storm, with meteorological condition records during the cyclonic period. During the typhoon, strong winds (mean velocity > 10 m/s, up to 18 m/s) lasted for three hours. The tide level got much higher (up to 0.6 m) than predicted, and rainfalls were also increased. Dune erosion occurred differently with slope gradient according to previous conditions; Steep slopes were more severely damaged than gentle slopes. Dune crests with a steep slope ($> 40^\circ$) formed by the previous erosion retreated by around 2 m and got lowered by 0.3 m compared with its status before. Dunes with comparatively a gentle slope ($6\text{--}7^\circ$) were also eroded, and about 0.5 meter-high scarps were created. Given the observation during the period of Typhoon Kompasu, it is likely that the impacts and responses of coastal dunes to the extreme storms are mainly related with the initial conditions including morphology and vegetation. In addition, anthropogenic factors such as tourism, construction, and development along the coastline may affect the extent of damage induced by the storm.