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Analysis of changes in shoreline locations along the Shizuoka and Shimizu coast since the Meiji period

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Many researchers have analyzed changes in shoreline locations due to coastal erosion in relation to human activities, using topographic maps and aerial photographs. In such studies using topographic maps, errors due to paper sheet expansion and contraction were problematic. In studies using aerial photographs, errors due to the central projection and inclination of the axis of the camera can be reduced by geometric correction using GIS. This study aims to analyze temporal and spatial changes in shoreline locations since the Meiji period, using geometrically corrected topographic maps and aerial photographs, as well as a high-resolution digital elevation model (DEM). We selected the Shizuoka and Shimizu coast in Shizuoka Prefecture as the study area. It is known that the extraction of a large amount of gravel from the bed of the Abe River in the 1950s and 1960s reduced sediment discharge, causing coastal erosion. Later breakwaters were built along the coast to reduce erosion, which also affected shoreline locations. Therefore, this area is suitable for studying human-induced shoreline changes.

We scanned topographic maps and aerial photographs and corrected them geometrically, using the base map information distributed by the Geospatial Information Authority of Japan (GSI). Then vector data of shorelines were obtained by tracing lines shown in the corrected images of the topographic maps and aerial photographs. We also obtained shoreline data from the DEM which corresponds to the high-tide level. We set 13 baselines almost parallel to the shoreline, and survey lines perpendicular to the baseline at an interval of 25 m. Then the distance between the baseline and the shoreline along a survey line was measured to quantify changes in shoreline locations. The results were presented in maps and graphs to visually and quantitatively understand shoreline changes.

The detected changes of the shoreline locations and their controlling factors can be summarized as follows. Until 1953, when the influence of human activities was small, significant forwarding migration of shorelines had occurred particularly at the tip Miho Peninsula, and at the outlet of the Abe River. In these areas, sediment deposition had been very active. On the other hand, shorelines in other areas changed intricately and the balance between erosion and deposition had not always be constant even before the influence of human activities became strong. From 1953 to 1976, significant coastal erosion occurred at the outlet of the Abe River and south of the Udo Hills, caused by the extraction of a large amount of gravel from the bed of the Abe River. On the other hand, around the Miho Peninsula, the situation was very similar to that before 1953, in that shorelines changed intricately. This is because the influence of gravel extraction in the Abe River had not reached there until 1976. From 1976 to 2009, shorelines have moved forward at the outlet of the Abe River and south of the Udo Hills, because the supply of sediment from the Abe River has recovered gradually. However, shorelines moved back in some parts of the other areas, because the effect of increased sediment supply from the Abe River had not reached these areas. In addition, shorelines changed to form tongues or saws due to artificial construction. In summary, this study using various data sources and GIS allowed us to discuss details of shoreline changes related to both natural processes and human activities.

Keywords: GIS, coastal erosion, changes in shoreline locations, topographic maps, aerial photographs, human activities