Characterization of Water Movement in Poor Drainage Riding Ground using GPR

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Horse riding grounds are designed to enhance both drainage and water retention abilities at the same time. To achieve such conflicting objectives, a 6.5 cm thick plastic mat which consists with a series of holes and dents was bed 15-20 cm below the surface. In addition, this mat not only increases the stability of the riding ground, but also reduces loads to horse limbs. There are usually gravels and/or sands below the plastic mat so that excess of water can be readily removed. At the horse riding ground of Tokyo University of Agriculture & Technology (TUAT), however, areas with poor drainage have been observed especially where horses frequently used for running and practice equestrian skills. At poor drainage areas, it is almost impossible to ride horses after rainfall. Although, pipes have been placed under the plastic mat and more holes have been made for under-drain, the cause of poor drainage still remains unknown. In this study, we conducted infiltration experiments both at poor drainage (PD) and good drainage (GD) locations within the TUAT horse riding ground. The surface GPR (Pulse EKKO Pro 250 MHz) was then used to monitor infiltration processes without disturbing the soil layers.

Interpretation of profiling and CMP data obtained prior to the infiltration test agrees well with soil layer structures. After applying 10 mm of water both at PD and GD, a series of time-lapse GPR profiling data were obtained. CMP measurements were also conducted at the end of each infiltration test. The profiling data set from GD shows that water infiltrates through the plastic mat to the deeper layer. On the other hand, at PD, infiltrated water remains around the plastic mat and does not clearly move toward the deeper layer. In addition, the RMS velocity obtained at GD was reduced after the infiltration test due to increase in water contents for the entire profile. However, the RMS velocity at PD was almost invariant after the infiltration test, suggesting that water does not infiltrate into the deeper layer. This study shows that, as the GPR allows non-destructive measurements of the near surface environment, the GPR survey is a useful tool to detect locations where poor drainage actually occurs.