In this study, the self-assembly of surface nanoclusters on 10-20-nm-thick Co$_{50}$Pd$_{50}$ (Co-Pd) alloy thin films deposited on the Al$_2$O$_3$(0001) substrate was systematically investigated. When the Co-Pd alloy films were stored in an ambient environment, small nanodots gradually gathered to form large nanoclusters. Approximately 30 days after growth, a nanocluster array formed with an average lateral size of 100 ± 20 nm and average height of 10 ± 3 nm. After 100 days, the average lateral size and average height had increased to 140 ± 20 and 25 ± 5 nm, respectively. Cross-sectional investigation through transmission electron microscopy coupled with energy dispersive spectroscopy showed that the nanoclusters were mostly composed of Co oxide. A uniform Pd-rich underlayer had been maintained underneath the self-assembled Co-oxide nanoclusters. With the formation of a Co-oxide nanocluster array, the magnetic easy axis of the Co-Pd film gradually altered its direction from the pristine perpendicular to in-plane direction. The hydrogenation-induced spin-reorientation transition was also suppressed with the evolution of the surface Co-oxide nanoclusters.