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Space Technology for Climate Adaptation and Mitigation [1] (6A)

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# EARTH OBSERVATION TECHNOLOGIES FOR CLIMATE CHANGE ADAPTATION AND MONITORING: FUTURE PROJECTIONS FROM DECADAL TRENDS

**Abstract**

Space-borne earth observation (EO) platforms have significantly expanded in the past decade, and high resolution, high frequency data sets from a variety of sensors including earth imagery from optical sensors and topography and moisture from radars are freely or increasingly cost-effectively available. These trends provide new capabilities for decision making related to climate change mitigation and adaptation efforts including early-warning of intense weather events, landslides, floods, and impacts on critical infrastructure such as of transportation, energy, and water. Here, we show key types of decisions, related to climate change mitigation, that are informed by EO datasets, and the associated EO technologies that generate those datasets. Next, an empirical and quantitative characterization of advancement in several of those key technologies is presented using comprehensive data sourced from licensed data sets, as well as technology project portals published by NASA and ESA. Some selected results include spacecraft mass (which serves as a proxy of cost), resolution of optical imagers, synthetic aperture radars, LIDARs, instrument data rates, on-board data processing and storage, ground processing, and data assimilation technologies. Our recent results have shown that launch mass of earth observation spacecraft exhibits strong variation since 2010, with a shift towards smaller spacecraft. The median mass of launched spacecraft for EO per decade between 1959-2020 shows a parabolic trend, where starting from 2000 kg in 1959-1970 median mass peaked at 6300 kg in 1981-1990 and has since consistently declined. The median mass of a launched spacecraft was 5 kg in 2011-2020 largely due to proliferation of cubesats. The spatial resolution in meters of optical imagers annually decreased (with a statistically significant trend verified by the Mann-Kendall trend test) representing higher resolution capabilities over time. Projection of current trends to 2030 showed a resolution of 6 cm for optical imagers for scientific and commercial imagers for which resolution information is publicly provided. Additionally, empirical analysis of data rates for imagers showed an increase by a factor of 10,000 in 45 years. Additional analysis of on-board data storage and processing and ground station architectures and processing technologies is provided. Overall, the quantitative characterization presented in this work can help in technology road-mapping for data analytics and decision services that are increasingly emerging, and for informing expectations regarding future capabilities and associated implications for monitoring and decisions and can help in guiding investments.