Transition metal dichalcogenides (TMDs) provide promising alternatives to conventional semiconductors in advanced applications due to their unique optoelectronic properties. Typically, the bandgap of TMDs is in the range of visible light, which makes them candidates for use in photovoltaic cells. The purpose of our research is to characterize how photoexcited charges move and lose energy through recombination in 2D TMDs. Time-resolved photoluminescence spectroscopy was used to map the properties of a WSe2 monolayer grown on a sapphire substrate over a 6.3 μm2 area. Fitting a differential diffusion equation to the data provided insight into the effectiveness of radiative/non-radiative recombination, electron traps, and diffusion in the spread of electrons in the material. We found that while trap-assisted recombination has a moderate effect on the evolution of carrier densities over time, but band-to-band recombination has a 34 times larger effect initially, which decreases to 3.3 times when the carrier density reaches a minimum. The rate of diffusion decreases as the density of charge carriers decreases.