Harmonic functions of random walks in a semigroup via ladder heights.

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We investigate harmonic functions and the convergence of the sequence of ratios $(\P(\tau_\vartheta > n)/\P_e(\tau_\vartheta > n))$ for a random walk on a countable group killed up on the time τ_ϑ of the first exit from some semi-group with an identity element e. Several results of classical renewal theory for one dimensional random walk killed at the first exit from the positive half-line are extended to a multi-dimensional setting. For this purpose, an analogue of the ladder height process and the corresponding renewal function V are introduced. The results are applied to multidimensional random walks $(t))$ killed upon the times of first exit from a convex cone. Our approach combines large deviation estimates and an extension of Choquet-Deny theory.