Abstract: Providing a best linear unbiased predictor (BLUP) is always a challenge for a non-repetitive, irregularly spaced, spatial data. The estimation process as well as prediction involves inverting an $n \times n$ covariance matrix, which computationally requires $O(n^3)$. Studies showed the potential observed process covariance matrix can be decomposed into two additive matrix components, measurement error and an underlying process which can be non-stationary. The non-stationary component is often assumed to be fixed but low rank. This assumption allows us to write the underlying process as a linear combination of fixed numbers of spatial random effects, known as fixed rank kriging (FRK). The benefit of smaller rank has been used to improve the computation time as $O(nr^2)$, where $r$ is the rank of the low rank covariance matrix. In this work we generalize FRK, by rewriting the underlying process as a linear combination of $n$ random effects, although only a few among these are actually responsible to quantify the covariance structure. Further, FRK considers the covariance matrix of the random effect can be represented as product of $r \times r$ Cholesky decomposition. The generalization leads us to a $n \times n$ Cholesky decomposition and use a group-wise penalized likelihood where each row of the lower triangular matrix is penalized. More precisely, we present a two-step approach using group LASSO type shrinkage estimation technique for estimating the rank of the covariance matrix and finally the matrix
itself. We investigate our findings over a set of simulation study and finally apply to a rainfall data obtained on Colorado, US.