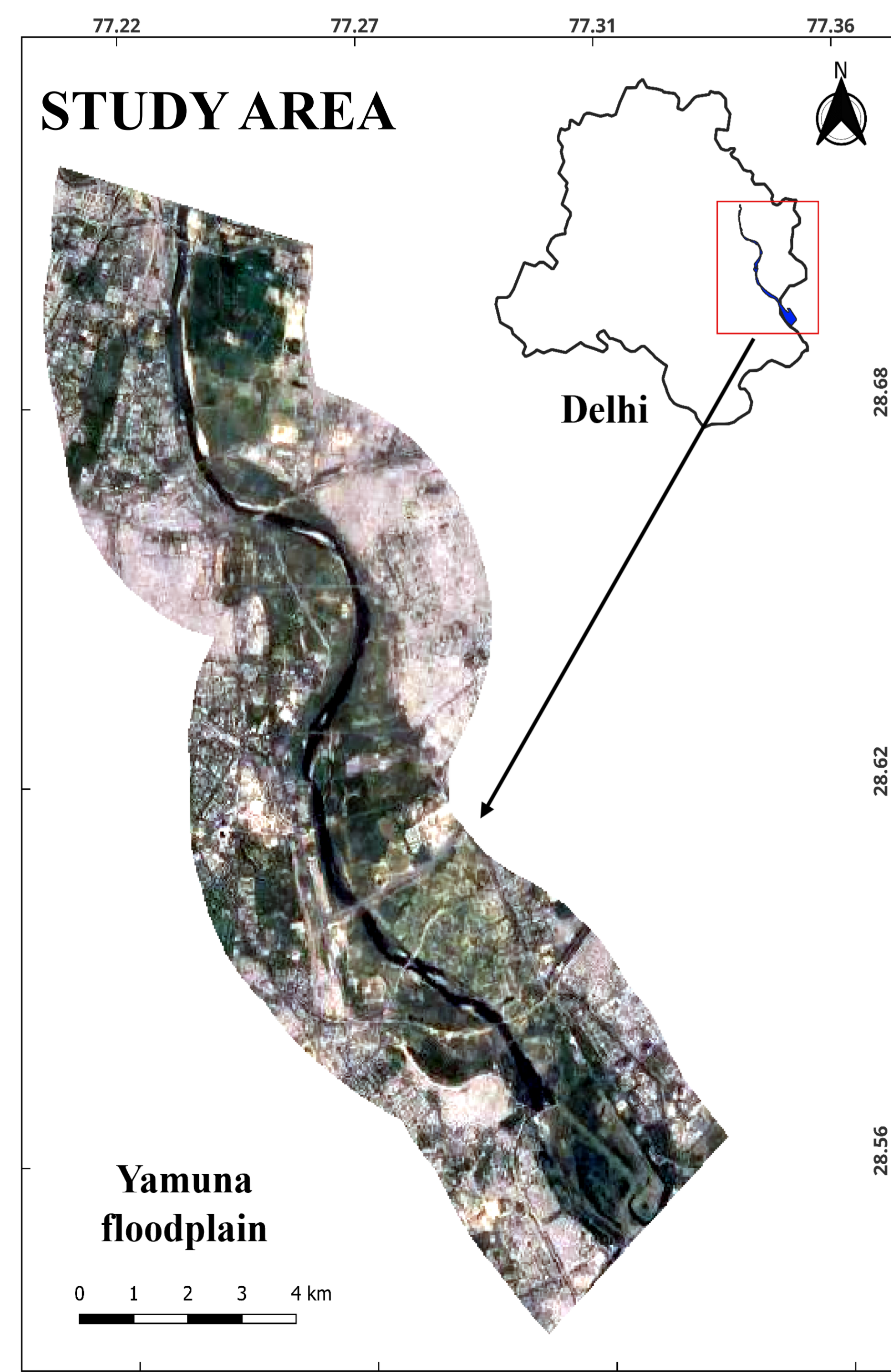
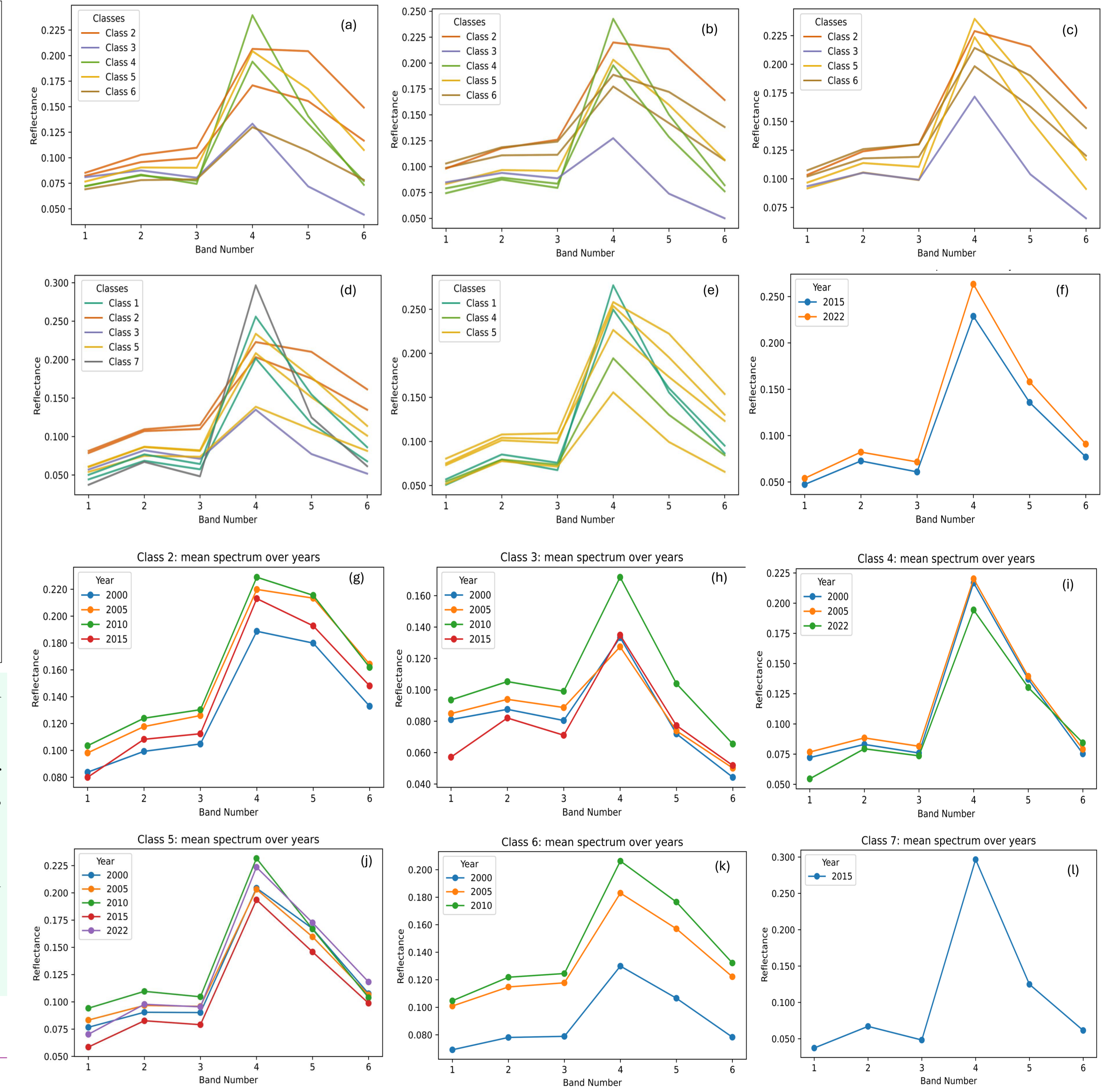
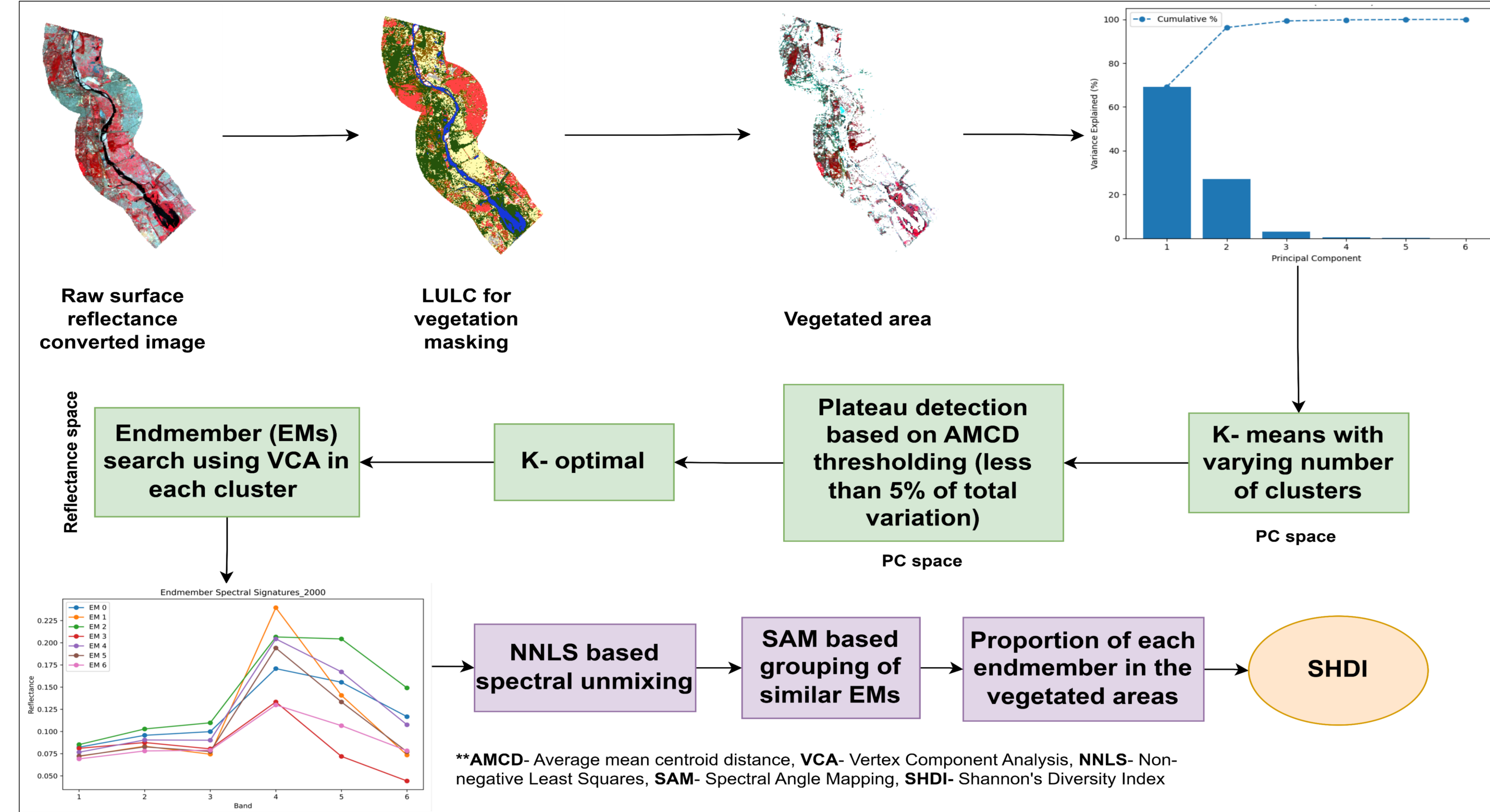


INTRODUCTION

The diversity and integrity of riparian forests form the basis for indicating their physical health in various landscape health studies. Moderate spatial resolution satellites often tend to have their limitations in quantifying the floral biodiversity. Thus, we have assimilated the roots of spectral variation hypothesis (Madonsela et al., 2021; Rocchini et al., 2004) with the present remote sensing and clustering based frameworks to determine the structural vegetation diversity. It is important to note that the obtained diversity does not provide the species-level composition but rather quantifies the structural diversity using pixel level heterogeneity that can be used in landscape ecology-based studies.

FRAMEWORK



ANALYSIS

Mean centroid distance d_k , given as: $d_k = \frac{1}{n_k} \sum_{n=1}^{n_k} |z_n - \mu_k|$

here, $\mu_k = \frac{1}{n_k} \sum_{n=1}^{n_k} z_n$

where, μ_k is the centroid of cluster k , z_n is the feature vector for pixel or data point n in PC space and n_k is the number of data point in cluster k .

AMCD for any K number of clusters is given as: $d_{AMC_K} = \frac{1}{K} \sum_{k=1}^K d_k$

Optimal (K^*) is when the AMCD change drops below 5% of its total change between $K=2$ and K_{max} . We assume one EM per cluster and determine it using Vertex Component Analysis (VCA).

VCA determines the most extreme spectra in the multi-dimensional simplex space assuming them to be the pure pixels. A tolerance of 0.01 is provided to merge the similar endmembers, if any. Mathematically, the linear unmixing model is $y_n = \sum_{i=1}^M p_{i,n} e_i + \varepsilon_n$

It represents any pixel in the given scene, where, y_n is the reflectance vector of pixel n , $p_{i,n}$ is the proportion of EM e_i for pixel n , ε_n is the noise and M is the total number of endmembers. It is optimized for the required proportions using NNLS subjected to constraints $p_{i,n} \geq 0 \forall i, n$ and $\sum_{i=1}^M p_{i,n} = 1 \forall n$.

We determine the structural diversity based on the proportion of the area covered by each EM in the whole forest scene. SHDI is used as the indicator of the diversity as: $H = -\sum_{m=1}^M p_m \ln(p_m)$

where, H is the Shannon's diversity index, p_m is the proportion of EM (m) based on the area occupied by it in the scene.

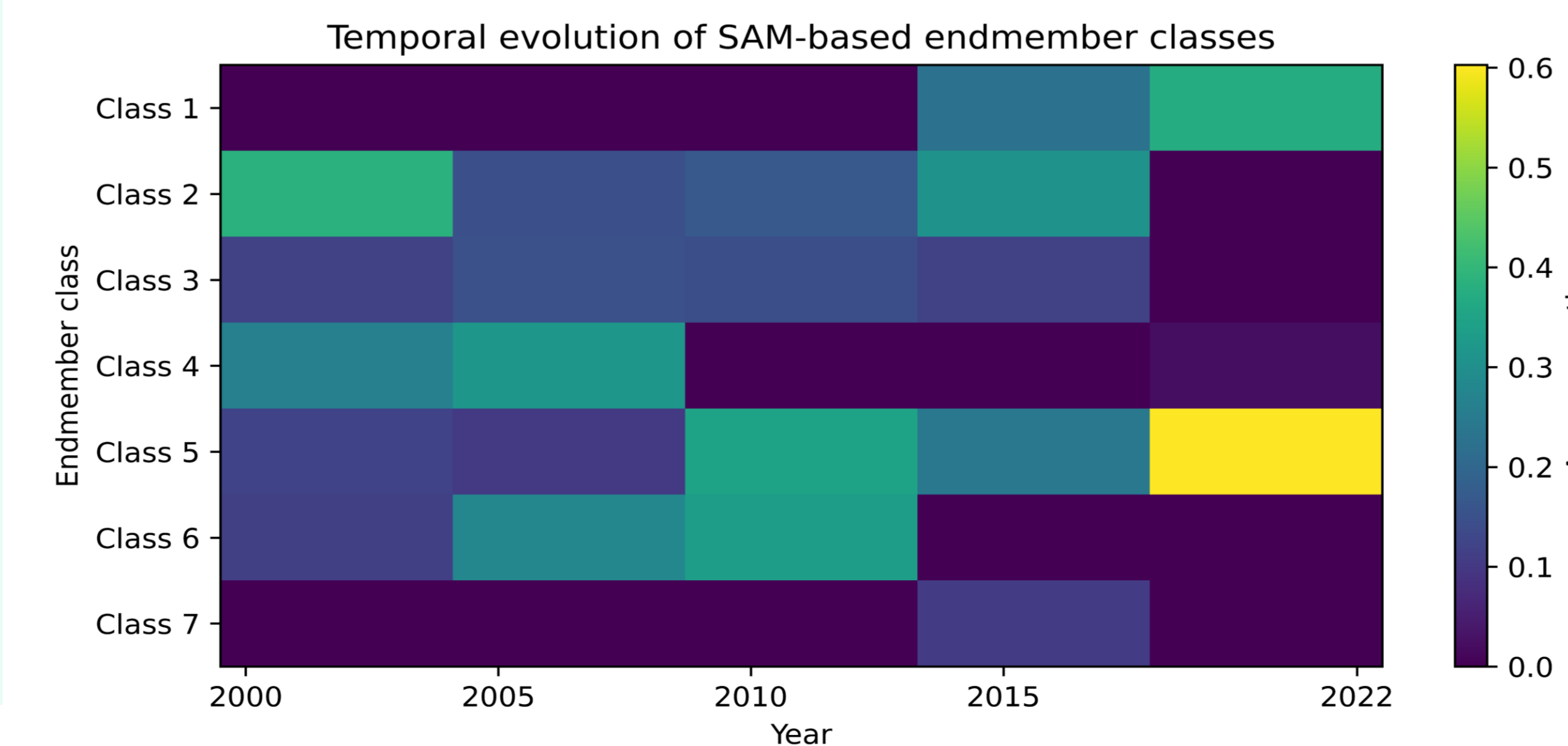
Again, using Spectral Angle Mapping (SAM), we have identified groups of similar EMs within and across multiple years by picking the closest spectra. This enables us to understand how EMs of similar type behave temporally.

If θ_1 and θ_2 are the angle between two spectral vectors r_1 and r_2 , then the spectral angle θ between these two vectors are given as:

$$\cos(\theta_2 - \theta_1) = \frac{\vec{r}_1 \cdot \vec{r}_2}{\|\vec{r}_1\| \|\vec{r}_2\|} \text{ and } \theta = \cos^{-1} \frac{\vec{r}_1 \cdot \vec{r}_2}{\|\vec{r}_1\| \|\vec{r}_2\|}$$

RESULTS

Year	2000	2005	2010	2015	2022
SHDI	1.893	1.841	1.787	1.996	1.722



Endmember spectra of different classes for year (a) 2000, (b) 2005, (c) 2010, (d) 2015, (e) 2022 and class-based mean EM spectra over the years. Band number (1) Blue, (2) Green, (3) Red, (4) NIR, (5) SWIR 1, (6) SWIR 2.

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