**Motivation**

LPIS has to be up to date as possible, to correctly quantify the eligible / ineligible area in each LPIS parcel. The LPIS quality assessment is often done by interactive computer-aided photo-interpretations by domain experts as well as by field visits.

To address the need for an automated LPIS quality check, we propose an automated anomaly detection method based on land cover identification, using SOM based spectral clustering (Tasdemir, 2011).

We use RapidEye imagery due to its spatial resolution and its daily overpass capability which enable acquiring annual imagery encompassing a whole country.

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**Automated LPIS assessment**

D-dimensional image (5-band RapidEye imagery)

**Determine data representatives using an SOM**

Self-organizing map (Unsupervised learning) (D-dimensional neurons)

Spectral clustering with CONN similarity (Tasdemir, 2011)

Extracted artificial areas (ineligible)

Calculate Pantex measure (Pesaresi et al. 2010)

**Extracted K clusters (K is pre-set to 30)**

Current LPIS (white: eligible)

Eligibility mask from clustering

LPIS control mask

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**Self-Organizing Maps (SOMs)**

- **adaptive vector quantizer**: learns the optimal placement of prototypes, for best approximation of the unknown pdf, from the data nonlinear topology preserving mapping from n-dimensional input space to a low-dimensional lattice

**Formation of basic Kohonen SOM:**

1. **Competition**
   - Select an input pattern \( x(i) \in M \subseteq \mathbb{R}^p \) randomly. The neural unit with most similar prototype \( y(j) \in \mathbb{R}^q \) wins the competition.
   - \( i(x) = \arg \min_{j} \| y(j) - x(i) \| \), \( j = 1, \ldots, N \)

2. **Cooperation**
   - Winning neuron \( i(x) \) activates its neighborhood, according to a neighborhood function \( h_r(i) \).

3. **Adaptation of prototypes in the neighborhood**
   - \( w_{j}(t+1) = w_{j}(t) + \alpha(t) h_r(i) (x(i) - w_{j}(t)) \)

**Spectral Clustering (Ng et al. 2002)**

Let \( X = \{ x_1, x_2, \ldots, x_n \} \) be the set of \( n \) points to be clustered, \( G = (V, S) \) be a weighted, undirected graph.

The degree of each node, \( d(v) \), is represented by a diagonal degree matrix \( D \), with

\[ d_i = \sum_j s(i,j) \]

Ng et al. [2] define a normalized Laplacian matrix, \( L_{norm} \), as

\[ L_{norm} = D^{-1/2}SD^{-1/2} \]

1. Calculate \( n \) similarity matrix \( S \) (eq. 1), diagonal degree matrix \( D \) (eq. 2), and \( L_{norm} \) (eq. 3)

2. Find the \( k \) eigenvectors \( \{ e_1, e_2, \ldots, e_k \} \) of \( L_{norm} \), associated with the \( k \) highest eigenvalues \( \{ \lambda_1, \lambda_2, \ldots, \lambda_k \} \)

3. Construct the \( n \times k \) matrix \( E = [e_1 e_2 \ldots e_k] \) and obtain \( n \times k \) matrix \( U \) by normalizing the rows of \( E \) to have norm 1, i.e.

\[ u_{ik} = \frac{e_i}{\sqrt{\sum_k e_i^2}} \]

4. Cluster the \( n \) rows of \( U \) with the \( k \)-means algorithm into \( k \) clusters.

**Conclusion**

The proposed automated method utilizes both the SOM properties and the advantages of spectral clustering, owing to its spectral partitioning of the data representatives obtained by the SOM using a local density-based similarity.

In addition, a textural measure (pantex) accurately detects artificial surfaces that necessitate spatial information for their true discrimination.

\[ \rightarrow A \text{ successful tool for fast and accurate LPIS control.} \]

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**References**

3. K. Tasdemir and C. Wirnhardt (2011), "Neural network based clustering for agriculture management", To Appear in EURASIP Journal on Advances in Signal Processing, Special Issue on Neural Networks for Interpretation of Remotely Sensed Data, invited paper.