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EOCap4Africa

9 Raster Analysis

d) Land Cover Classification Practical



INES Ruhengeri
Institute of Applied Sciences



Learning objectives



Understand how to create high-quality training data for classification

Learn best practices for selecting representative training samples

Apply training data to classify land cover using a random forest model

Training data



Training data is the foundation of supervised classification

- The quality of training data directly impacts classification accuracy
- Poor training data can lead to misclassification and unreliable results
- Training data should be well-distributed, balanced, and spectrally distinct

Training data



Characteristics of good training data

- **Representative** – Covers all land cover classes in the study area
- **Balanced** – Avoid class imbalances by ensuring roughly equal sample sizes
- **Spatially Distributed** – Spread across different locations to account for variability
- **Spectrally Pure** – Use homogeneous areas to avoid mixed pixels
- **Independent Validation Set** – Keep separate data for accuracy assessment



R for random forest classification

- **Better model control** – Allows fine-tuning of hyperparameters (e.g., number of trees, depth, feature selection)
- **Faster processing** – More efficient for large datasets compared to QGIS
- **Advanced accuracy metrics** – Generates confusion matrices, feature importance scores, and cross-validation
- **Better performance tracking** – Can visualize classification accuracy and analyze errors
- **Seamless integration with GIS** – Results can be exported back into QGIS for visualization and further spatial analysis

QGIS can run Random Forest, but it has **limited customization** and may struggle with **large datasets**

Task



Create your own LCC!

As an example, we are investigating wetlands in Rwanda

1. Create your own training data in QGIS
2. Run a Random Forest Model in RStudio
3. Visualise your results in RStudio or QGIS

Interpretation of models



Output of the random forest model -> but what does this mean?

Confusion matrix:

	agriculture	forest	urban	water	wetlands	class.error
agriculture	79	2	6	5	0	0.14130435
forest	1	148	0	5	0	0.03896104
urban	17	2	11	20	1	0.78431373
water	6	1	2	648	2	0.01669196
wetlands	3	4	1	28	8	0.81818182



Interpretation of models

Actual → Predicted	agriculture	forest	urban	water	wetlands	class.error
agriculture	79	2	6	5	0	14.1% misclassified
forest	1	148	0	5	0	3.9% misclassified
urban	17	2	11	20	1	78.4% misclassified
water	6	1	2	648	2	1.7% misclassified
wetlands	3	4	1	28	8	81.8% misclassified

Interpretation of models



Good performances

- Water (97.8% accuracy) – The model is classifying water very well, with only 1.7% error
- Forest (96.1% accuracy) – Also good, with only 3.9% misclassified cases

Bad performances

- Urban (only 11/51 correct, 78.4% error) – The model struggles to distinguish urban areas, misclassifying them as agriculture and water
- Wetlands (only 8/44 correct, 81.8% error) – The worst class! Wetlands are being confused with water (28 cases)



Interpretation of models

1. Not enough training data for certain classes

- Urban and wetlands have very high misclassification rates
- They likely have too few training samples or are too similar to other classes (e.g., wetlands vs. water)
- Increase the number of training points for urban and wetlands

2. Overlapping spectral signatures

- Wetlands and water are confused because they likely have similar spectral reflectance
- Urban areas are confused with agriculture and water, which may indicate that urban pixels include mixed land cover types
- Try adding more spectral bands to improve separability



Interpretation of models

3. Class imbalance

- Water (648 cases) dominates the dataset, while urban (11 cases) and wetlands (8 cases) are underrepresented
- The Random Forest model will naturally be biased toward classes with more data
- Balance the dataset by using equal numbers of training samples per class

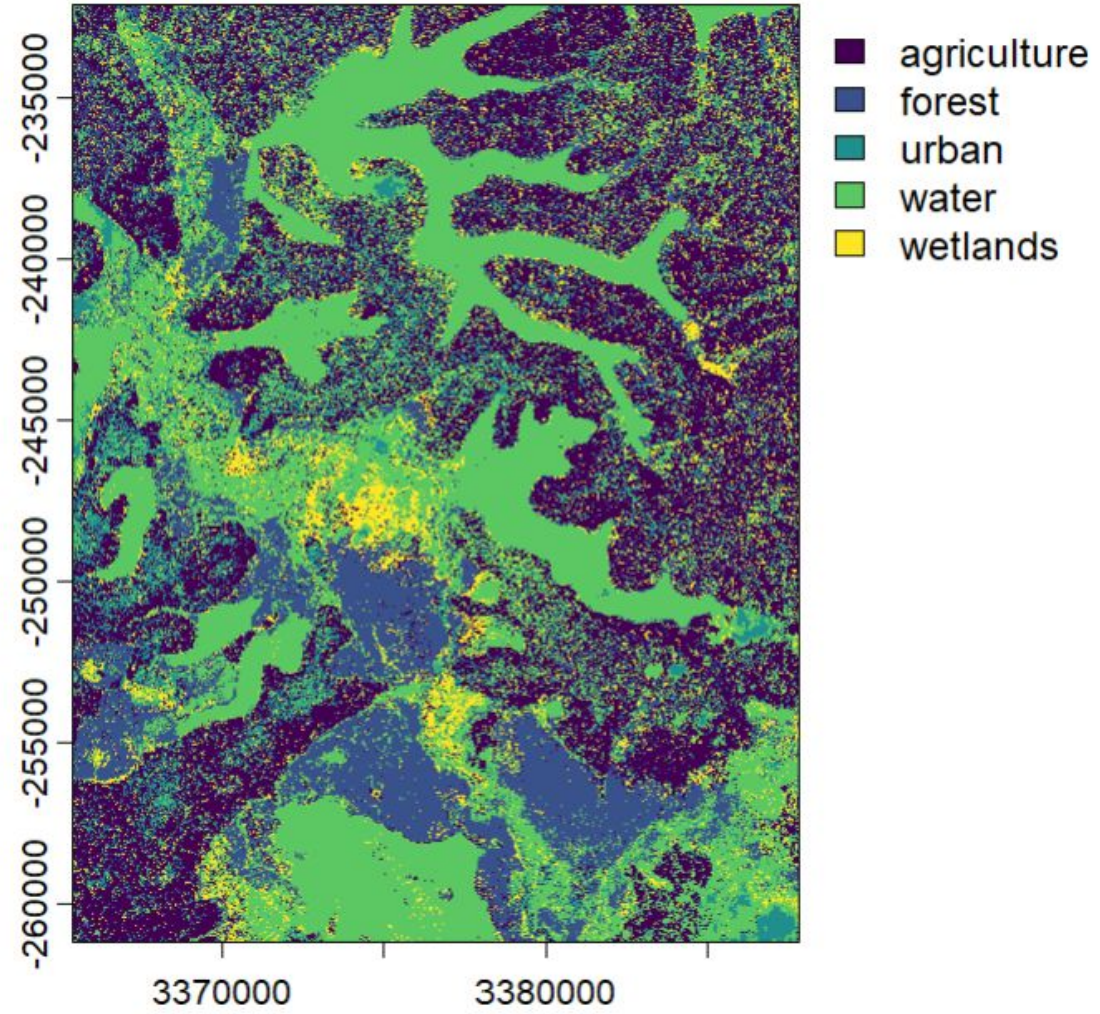
4. Feature selection

- The features (raster bands) used for training might not be sufficiently different for urban, wetlands, and water
- Add additional data like:
 - Vegetation indices (NDVI, NDBI) to separate vegetation and built-up areas
 - Texture analysis to distinguish urban areas from natural ones

Results



Random Forest Land Cover Classification





Summary & key takeaways

Good training data is essential for accurate land cover classification

Training samples must be **well-distributed, balanced, and spectrally pure**

QGIS can be used to **create training data, train the model and run the prediction**

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Thank you for your attention!

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