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# EOCap4Africa

## 10 Validation / Accuracy Assessment



INES Ruhengeri  
Institute of Applied Sciences



# Learning objectives

Understand the principles and importance of accuracy assessment in spatial analysis.

Differentiate between various accuracy metrics and their applications.

Implement accuracy assessment techniques using QGIS and R.

Critically evaluate classification results and understand sources of errors.

# Accuracy assessments



## Why assess accuracy?

- Ensures reliability and credibility of spatial data analyses
- Identifies and quantifies errors in classification outputs

## Common Applications

- Land cover classification
- Change detection studies
- Environmental monitoring

# Accuracy assessments



Can answer the following questions:

- What is the overall accuracy of the classification map?
- What is the accuracy of single classes in the classification map?
- Which classes are misclassified and confused with each other?

# Understanding classification errors

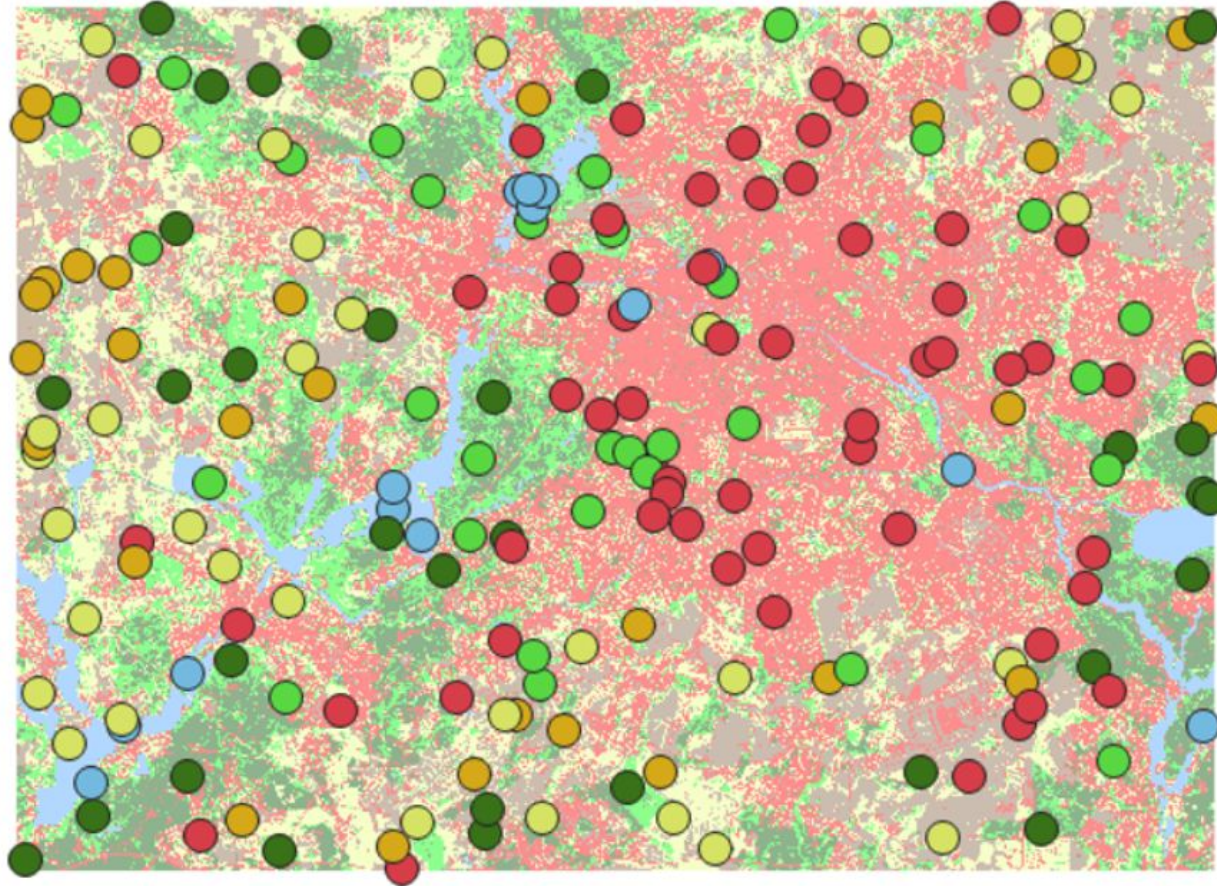
## Sources of errors

- Data quality issues (e.g., sensor errors, atmospheric conditions).
- Mislabeling in training data
- Algorithm limitations

## Impacts of errors

- Misinterpretation of spatial phenomena
- Erroneous decision-making based on flawed data

# Validation data



## Validation data

Point samples with class labels representing the 'reality' for the following land cover classes:

- Urban (built-up and non built-up)
- Grass & Crops
- Broadleaf trees
- Coniferous trees
- Soil (incl. harvested cropland)
- Water

(Humboldt Universität zu Berlin n.d.)

# Validation data collection



## Collection methods

- Field surveys and in-situ measurements.
- High-resolution imagery interpretation
- Existing reliable datasets

## Sampling techniques

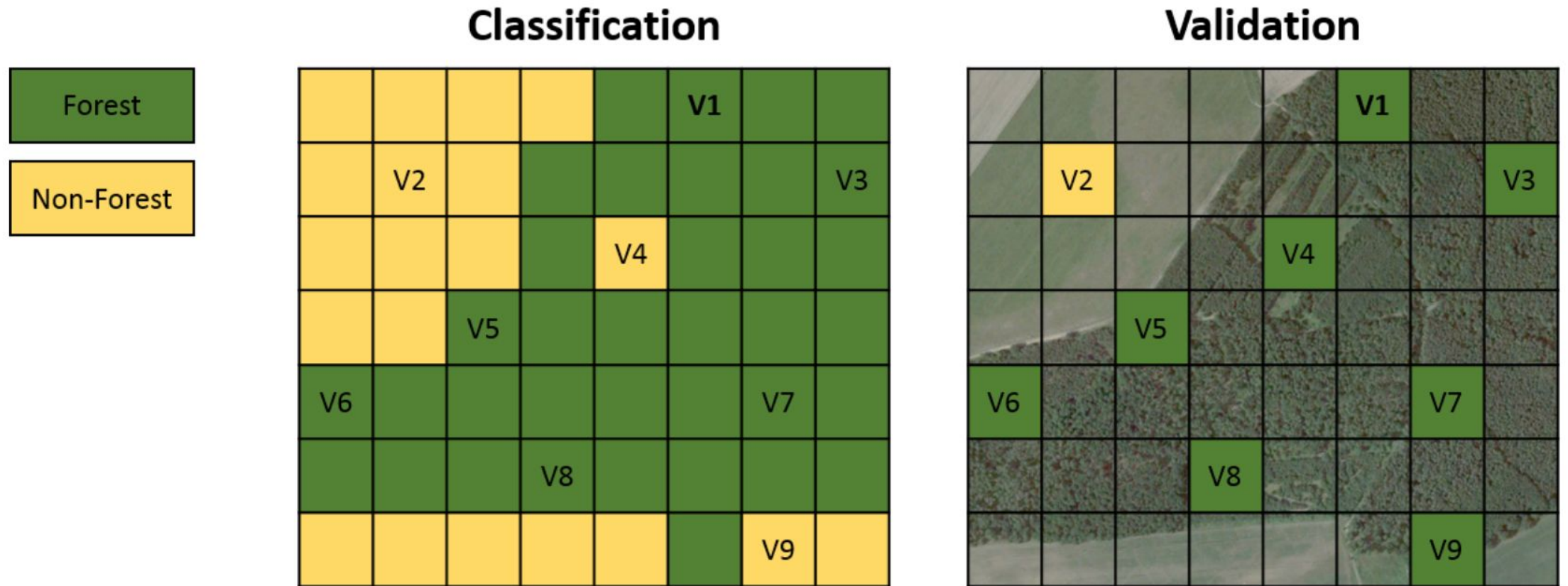
- Random sampling
- Stratified random sampling
- Systematic sampling





# Validation method: Confusion matrix

Provides a detailed breakdown of classification performance, for example:



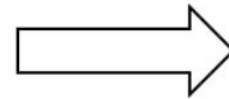
(Humboldt Universität zu Berlin n.d.)



# Validation method: Confusion matrix

- The table that compares predicted classifications to actual classes
- Rows represent actual classes
- Columns represent predicted classes
- Diagonal elements indicate correct classifications; off-diagonal elements indicate misclassifications

	V1	V2	V3	V4	V5	V6	V7	V8	V9
Classification	Green	Yellow	Green	Yellow	Green	Green	Green	Green	Yellow
Validation	Green	Yellow	Green	Green	Green	Green	Green	Green	Green
Correct / False	✓	✓	✓	✗	✓	✓	✓	✓	✗



		Validation		
		Forest	Non-For.	Sum
Class.	Forest	6	0	6
	Non-For.	2	1	3
	Sum	8	1	9

(Humboldt Universität zu Berlin n.d.)

# Accuracy metrics derived from confusion matrix

## Overall accuracy

- Proportion of correctly classified instances out of the total instances

		Validation		
		Forest	Non-For.	Sum
Class.	Forest	6	0	6
	Non-For.	2	1	3
Sum		8	1	9

$$OA = \frac{6 + 1}{9} = 0.78 = 78\%$$

### Overall Accuracy (OA)

$$OA = \frac{\text{Number of correctly classified samples}}{\text{Number of samples}}$$

(Humboldt Universität zu Berlin n.d.)

# Accuracy metrics derived from confusion matrix

## Producer's accuracy (recall):

- Likelihood that a given land cover of an area on the ground is classified as such

		Validation				
		Forest	Non-For.	Sum	UA	Com. Err.
Class.	Forest	6	0	6	100%	0%
	Non-For.	2	1	3	33%	67%
	Sum	8	1	9		
	PA	75%	100%			
	Om. Err.	25%	0%			

### Producer's Accuracy (PA) of class $c$

$$PA_c = \frac{\text{Number of correctly classified samples of } c}{\text{Sum of samples with true label of } c}$$

### Omission error (Om. Err.) of class $c$

$$Om. Err._c = 100\% - PA_c$$

$$PA_{\text{Forest}} = \frac{6}{8} = 0.75 = 75\%$$

$$Om. Err._{\text{Forest}} = 100\% - 75\% = 25\%$$

(Humboldt Universität zu Berlin n.d.)

# Accuracy metrics derived from confusion matrix

## User's accuracy (precision):

- Probability that a pixel classified into a given category actually represents that category on the ground

		Validation				
		Forest	Non-For.	Sum	UA	Com. Err.
Class.	Forest	6	0	6	100%	0%
	Non-For.	2	1	3	33%	67%
	Sum	8	1	9		

### User's Accuracy (UA) of class $c$

$$UA_c = \frac{\text{Number of correctly classified samples of } c}{\text{Sum of samples classified as } c}$$

### Commission error (Com. Err.) of class $c$

$$\text{Com. Err.}_c = 100\% - UA_c$$

$$UA_{\text{Forest}} = \frac{6}{6} = 1 = 100\%$$

$$\text{Com.Err.}_{\text{Forest}} = 100\% - 100\% = 0\%$$

(Humboldt Universität zu Berlin n.d.)

# Task

Fill out the table using the formulas on the slides before:

Classification	Wetland	Savanna	Urban	Agriculture	Water	Sum	UA [%]	Com.Err. [%]
Wetland	12	3	0	0	1	16	75%	25
Savanna	2	28	1	3	0	34	82.3	17.7
Urban	0	0	15	2	0	17	88.23	11.77
Agriculture	0	2	4	21	0	27	77.77	22.22
Water	0	0	0	0	10	10	100	0
Sum	14	33	20	26	11	104		
PA [%]	85.7	85	75	81	91			
Om. Err. [%]								

# Task



Complete an accuracy assessment in R and in QGIS using the land cover classification from lecture 9d



# Summary & key takeaways

Accuracy assessment verifies how well your classification matches reality

The **confusion matrix** is the main tool to evaluate classification performance

Key metrics: **Overall Accuracy**, **User's Accuracy**, **Producer's Accuracy**, and related error rates

QGIS (SCP plugin) and R (caret, terra) both support practical and reproducible accuracy checks

Reliable results depend on **good validation data** and thoughtful sampling design

# Sources



Humboldt-Universität zu Berlin. (n.d.). 9. *Accuracy assessment*. Retrieved March 31, 2025, from [https://pages.cms.hu-berlin.de/EOL/geo\\_rs/S09\\_Accuracy\\_assessment.html](https://pages.cms.hu-berlin.de/EOL/geo_rs/S09_Accuracy_assessment.html)

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# Thank you for your attention!

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