

Training Sample Migration for Temporal Cropland Mapping in Central Asia

Aiman Batkalova, Pengyu Hao, Zhongxin Chen and Karl Morteo

Digital FAO and Agro-Informatics Division, Food and Agriculture Organization of the United Nations, 00153 Rome, Italy

NDVI time series sample migration improves regional cropland mapping accuracy

1. INTRODUCTION

- Accurate cropland mapping is essential for food security and land monitoring
- Central Asia faces limited ground data and high interannual variability
- Global products (e.g. ESA WorldCover, WorldCereal) may not always achieve high local accuracy

KEY IDEA

- Cross-year NDVI time series similarity enables reliable sample migration

ADVANTAGES:

- No additional field data required
- Scalable across years and regions
- Robust in data-scarce environments

2. STUDY AREA

- Regions: Kazakhstan (rainfed system), Uzbekistan (irrigated system)
- Data: Sentinel-2 and Landsat-8 NDVI time series
- 24 biweekly time steps
- Reference years: 2016 (UZ), 2022 (KZ)
- Target year: 2021

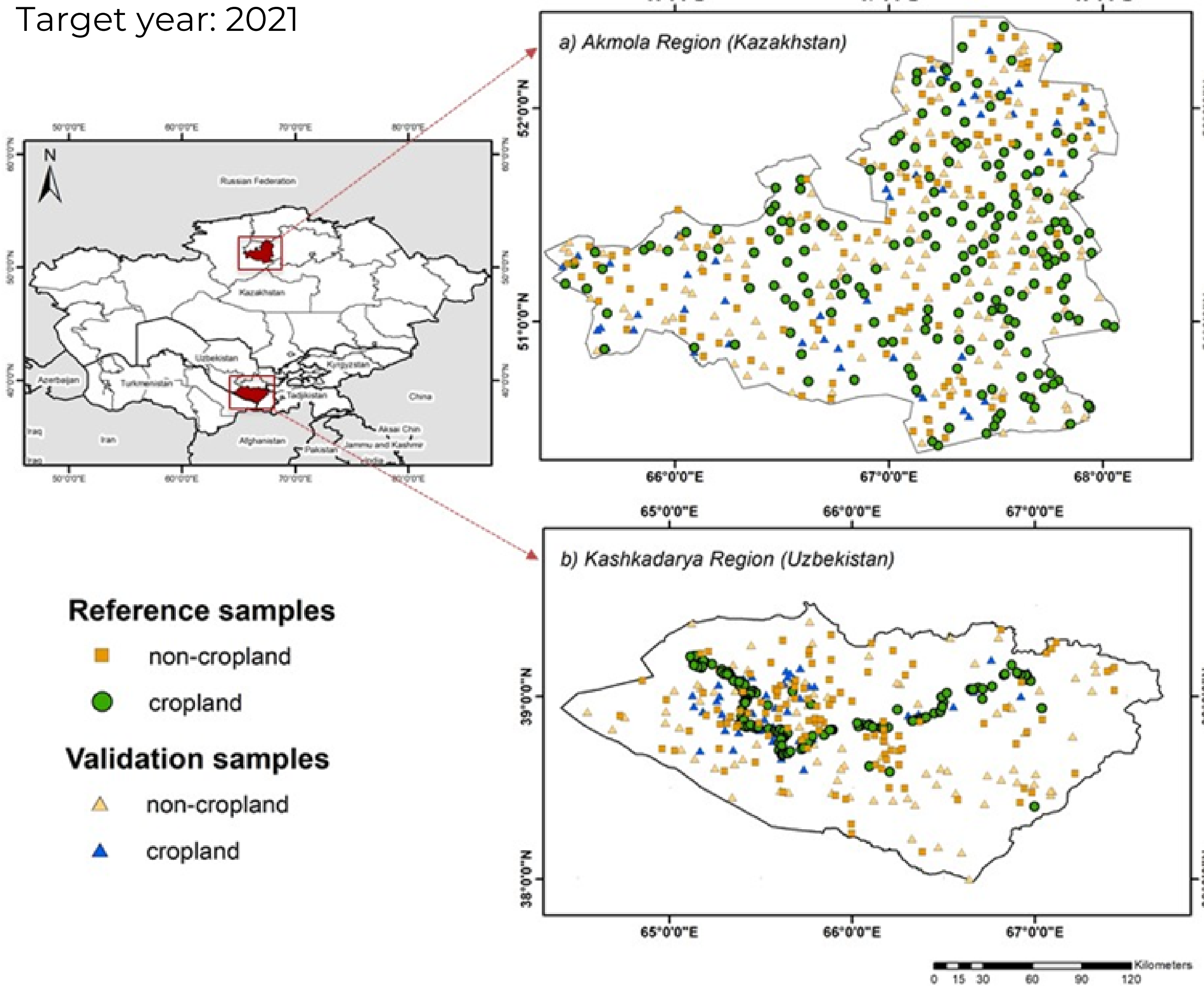
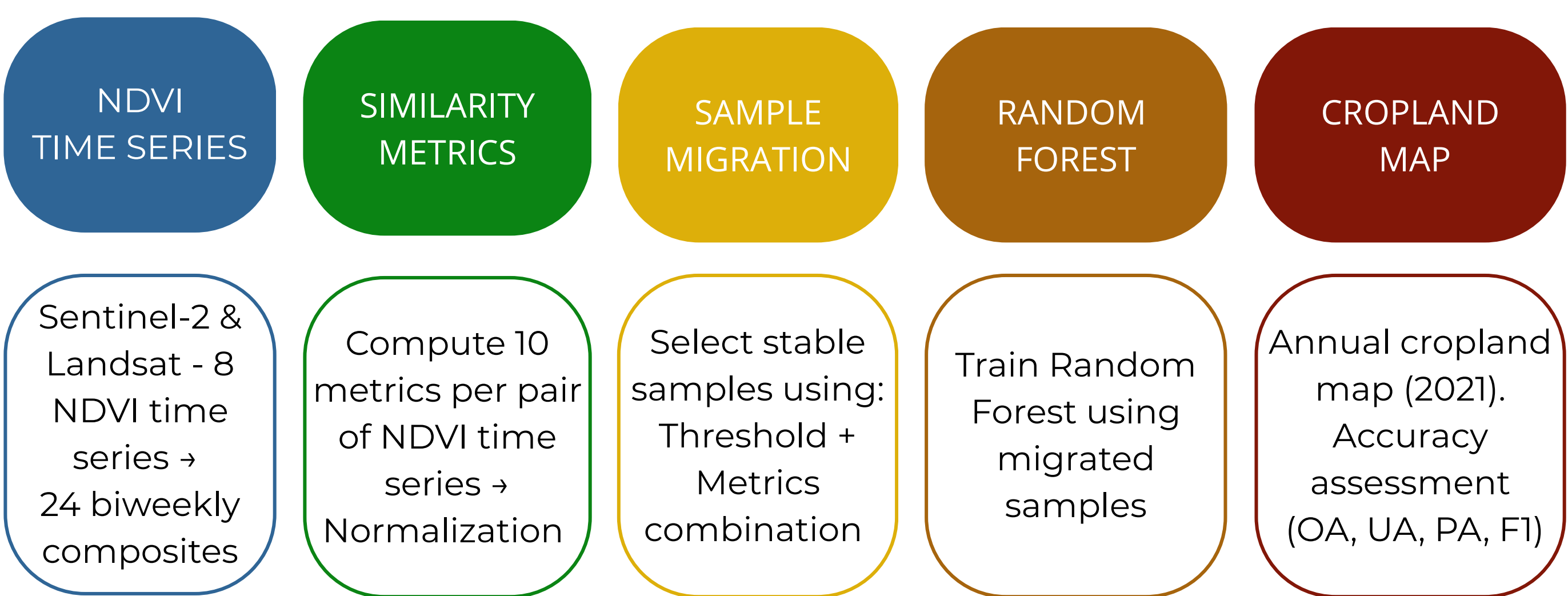


Figure 1. Distribution of cropland and non-cropland samples used for training (reference) and validation across two study regions: Akmola Region (Zharkain and Zhaksynsky districts), Kazakhstan, and (b) Kashkadarya Region, Uzbekistan.

3. METHODOLOGY



NDVI TIME SERIES

Similar temporal patterns between years enable reliable sample transfer

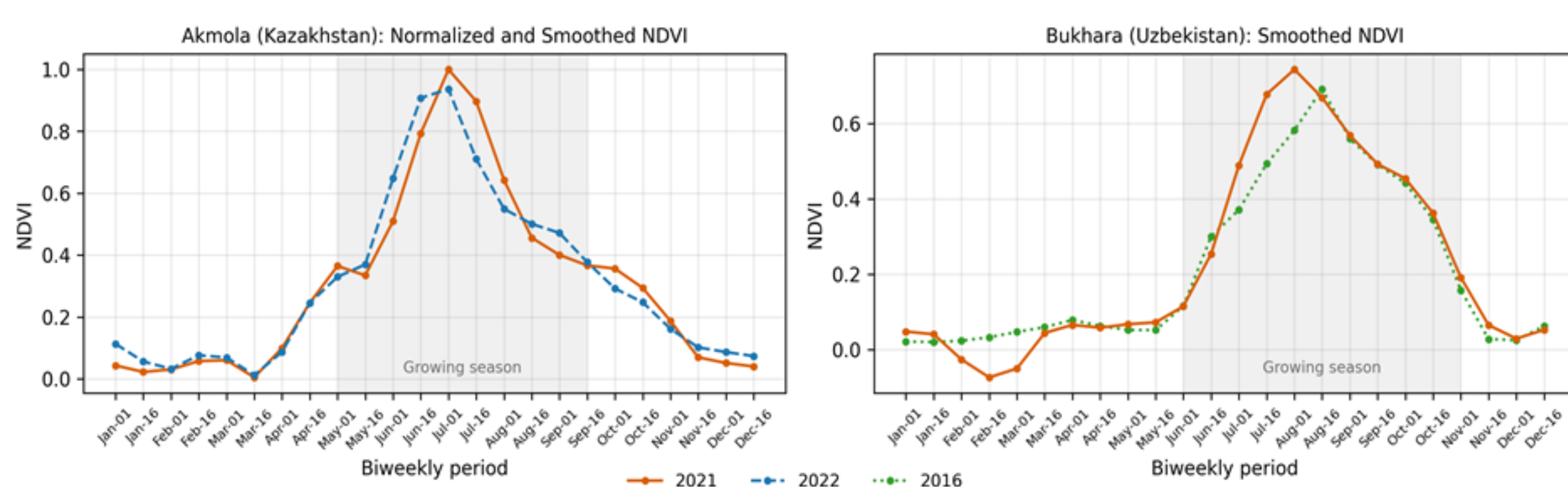


Figure 2. Biweekly NDVI trajectories for cropland sites in Akmola (Kazakhstan) and Bukhara (Uzbekistan) across representative years.

SIMILARITY METRICS

- | | | |
|--|--|--|
| Distance-based <ul style="list-style-type: none"> Euclidean Chebyshev Minkowski Cubic | Temporal Alignment <ul style="list-style-type: none"> DTW Spectral Angle Distance (SAD) | Correlation-based <ul style="list-style-type: none"> Pearson Spearman Kendall Tau Cosine similarity |
|--|--|--|

4. RESULTS

Metric Performance and Threshold Evaluation

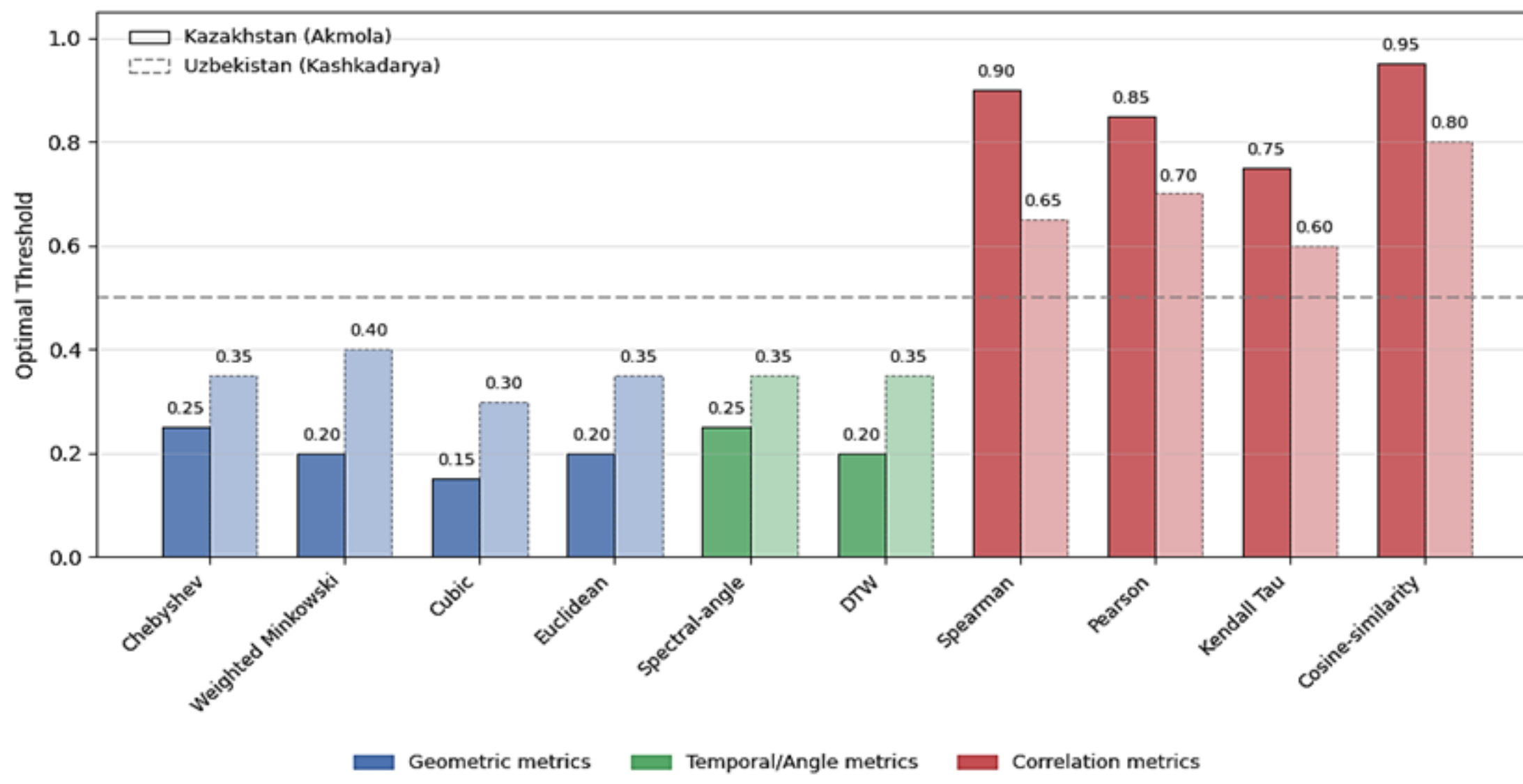


Figure 3. Optimal thresholds for NDVI similarity metrics in Kazakhstan (Akmola) and Uzbekistan (Kashkadarya).

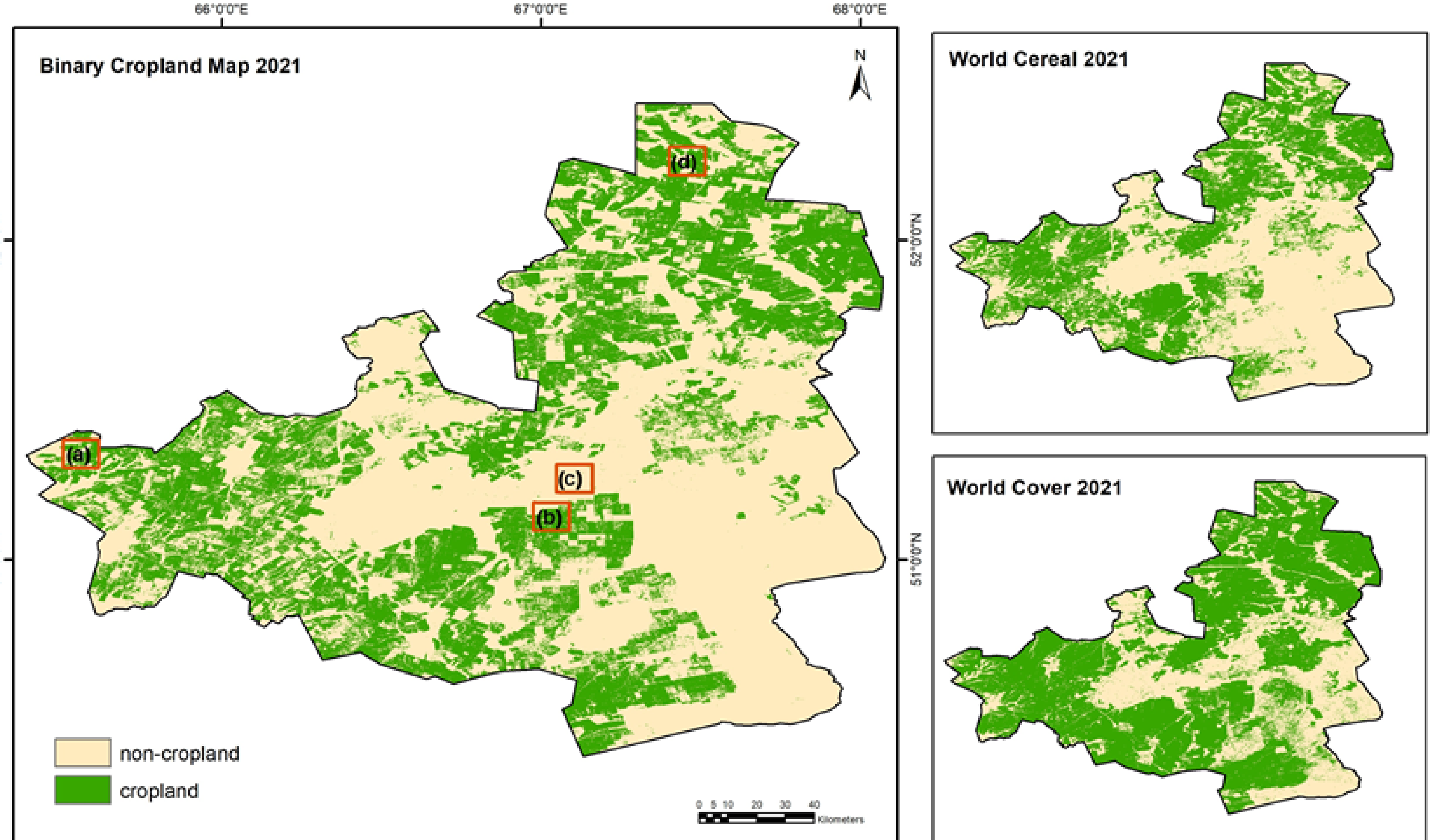
Kazakhstan (rainfed):

- Threshold (step = 0.05):
- 0.15–0.25 (distance & temporal)
 - 0.60–0.95 (correlation, normalized NDVI)
- Metric combination:
- Chebyshev + Cosine similarity

Uzbekistan (irrigated):

- Threshold (step = 0.05):
- 0.15–0.30 (distance)
 - 0.60–0.80 (correlation, raw NDVI)
- Metric combination:
- DTW + Cosine similarity

CROPLAND BINARY MAP



Kazakhstan (rainfed)
Overall Accuracy: **86%**
F1-score: **0.85**

Uzbekistan (irrigated)
Overall Accuracy: **95%**
F1-score: **0.93**

- Comparison with Global Products
- Outperforms ESA WorldCereal and WorldCover
- Improved boundary delineation
- Reduced misclassification in semi-arid regions

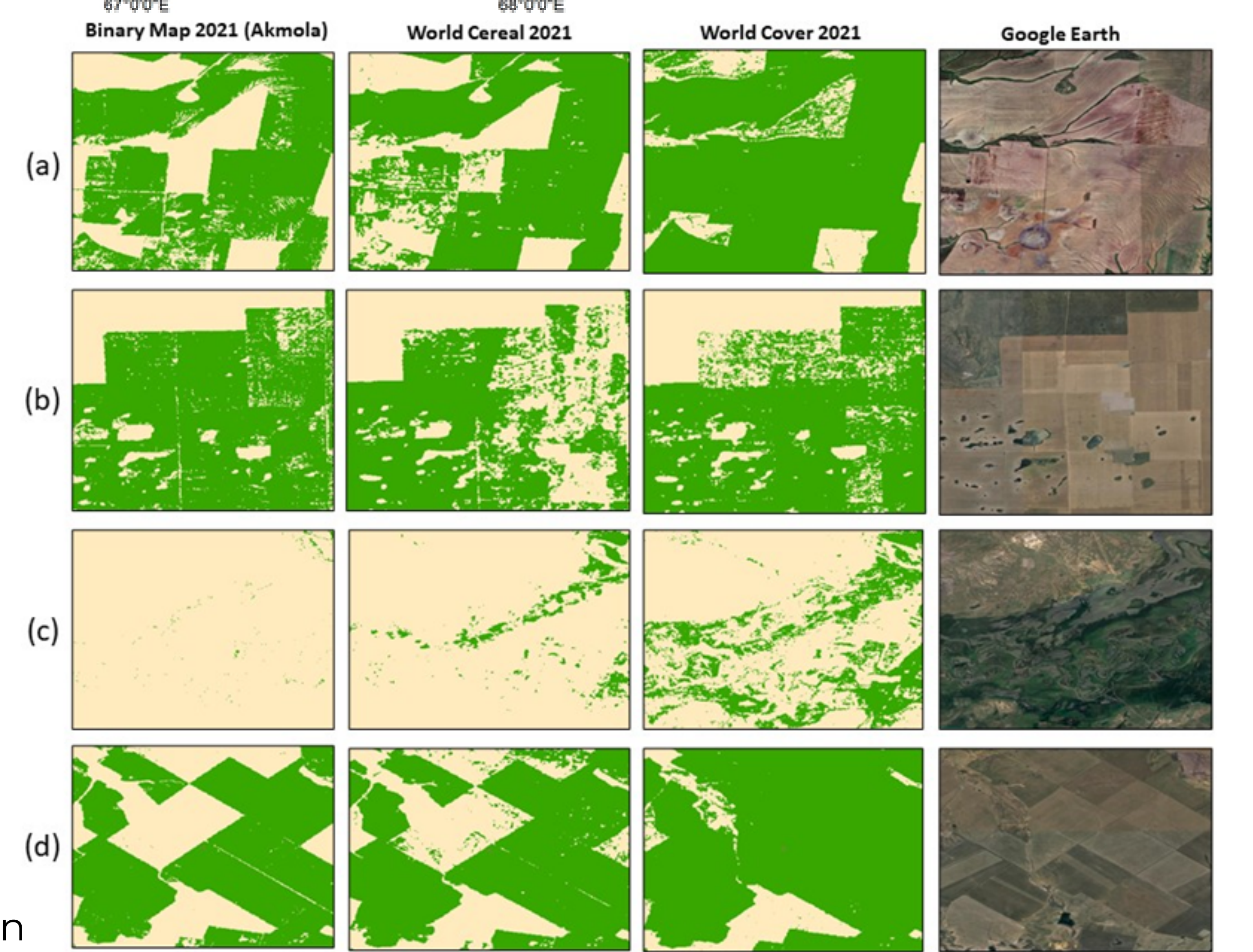


Figure 4. Binary cropland map for the Akmola Region (Kazakhstan) in 2021, compared with WorldCereal and WorldCover global products. Insets (a–d) show detailed views of typical land-use structures, including rainfed wheat cropland and steppe-cropland transitions, illustrating the improved parcel delineation achieved by the migration-based classification. Green areas represent cropland, while beige areas indicate non-cropland in all map panels.

5. CONCLUSION

- NDVI-based sample migration enables reliable cross-year model transfer
- Achieves high accuracy (86-95%) across different agro-climatic systems
- Improves spatial accuracy compared to global cropland products
- Supports scalable and cost-effective cropland monitoring
- Combining multiple similarity metrics improves robustness across regions



Scan to read the full paper

aiman.batkalova@fao.org,
pengyu.hao@fao.org



<https://doi.org/10.3390/land15010156>



Cross-year NDVI sample migration improves regional cropland mapping without the need for new field data