# MERGING LANDSAT TM IMAGES AND AIRBORNE PHOTOGRAPHS FOR MONITORING OF OPEN-CAST MINE AREA

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Fig. 1.

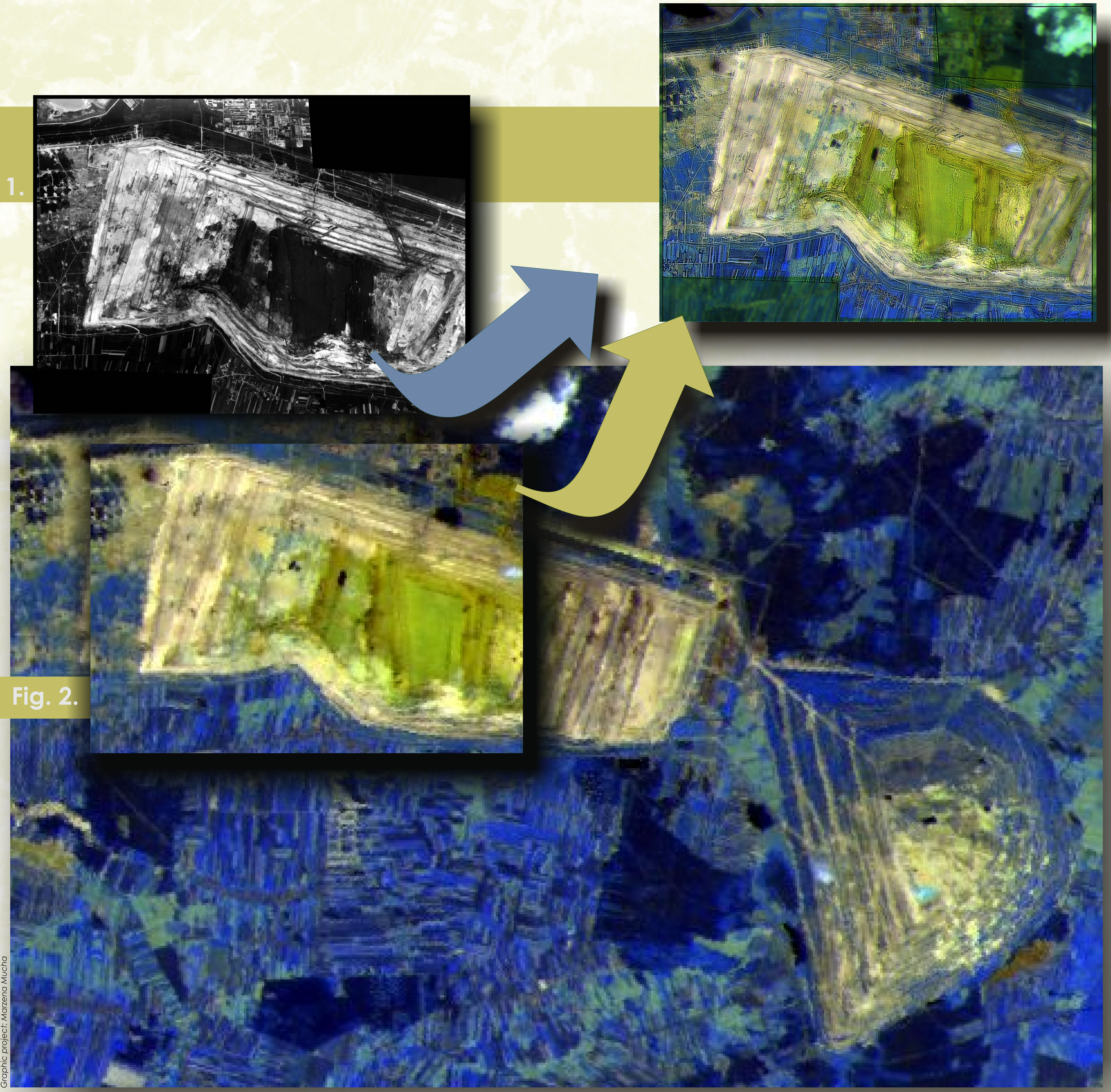


Fig. 2.

Graphic project: Marzena Mucha

## Problem definition

Merging of the multispectral Landsat TM (30 m spatial resolution, vide Fig. 2.) and digital airborne photographs (2 m spatial resolution, vide Fig. 1.)
of the largest lignite open pit mine in Poland might produce a usefull data for:

- geological features discrimination;
- inventory of mining operation;
- reclamation activity registration.

## Metodology

Preprocessing (creating data sets):

- image registration;
- resampling of the multispectral data;
- atmospheric effect removing;
- digital mask of open-pit mine area.

Merging methods:

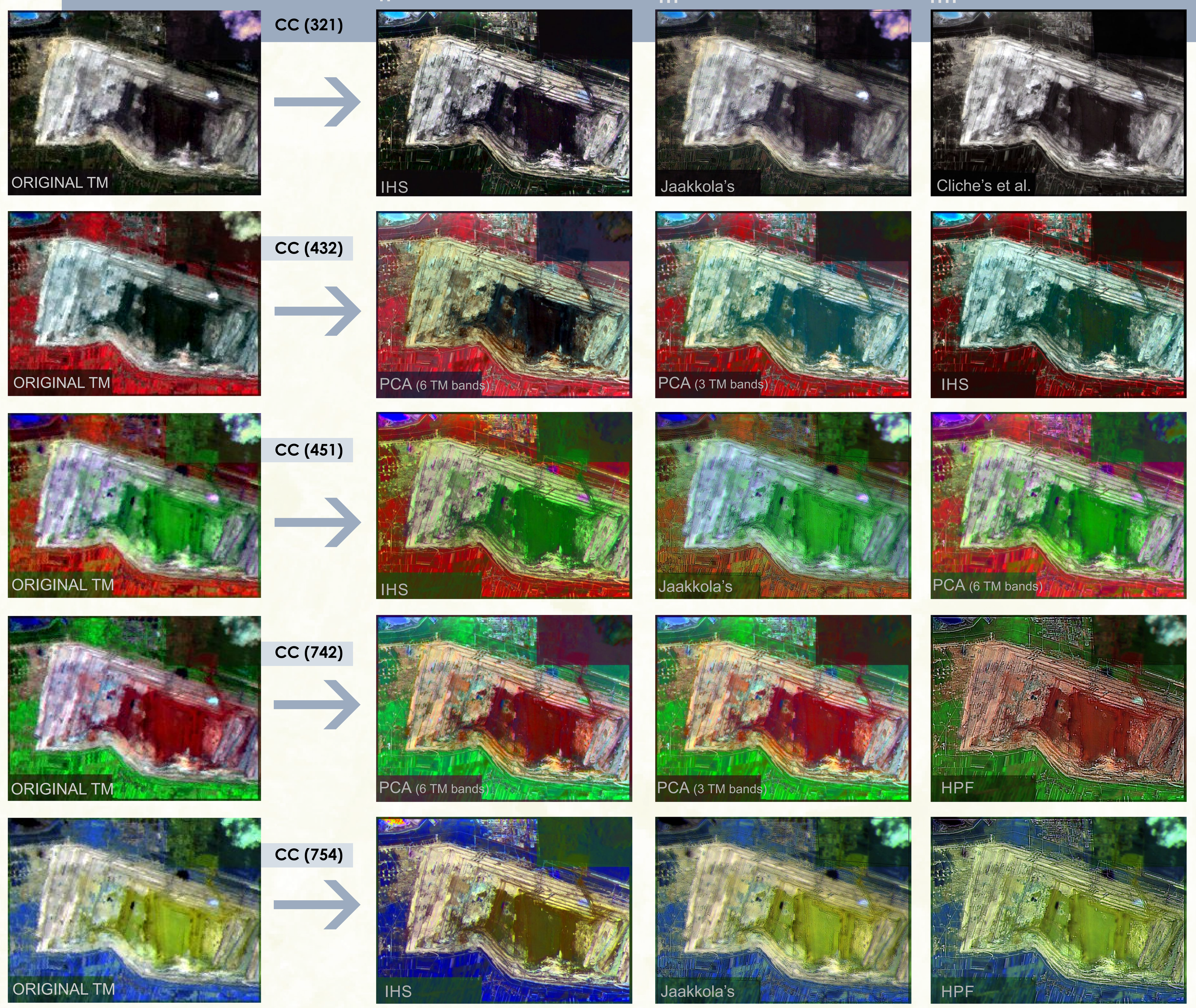
- IHS (Intensity, Hue, Saturation);
- HPF (High Pass Filter);
- PCA (Principal Component Analysis);
- The Brovey transform;
- Clische's et al. method;
- Jaakkola's method.

## Evaluation criteria

Visual interpretation
Statistical analysis methods:

- Optimum Index Factor (OIF);
- Determinant - analysis method (DET);
- Relative Average Spectral Error (RASE);
- Correlation analysis.

## V i s u a l   r a n k i n g




The ranks of merging methods based on the visual comparison of the IHS and PCA methods, are the best for TM (754), TM (432) and TM (742) bands combination (vide plate and Table 1.)

Table 1. Result of visual interpretation (the ranks 1-6)

| Method | Composit | | | | | |
|---|---|---|---|---|---|---|
| | CC 321 | CC 431 | CC 432 | CC 451 | CC 742 | CC 754 |
| PCA - 6 bands | 4 | 6+ | 6+ | 5 | 6 | 5 |
| PCA - 3 bands | 4 | 5 | 5 | 5 | 6- | 5 |
| IHS | 6 | 6 | 5 | 6 | 5 | 6+ |
| HPF | 2 | 5 | 4 | 5 | 5 | 5 |
| Cliche's et al | 4 | 4 | 3 | 4 | 5 | 4 |
| Jaakkola's | 5 | 5 | 4 | 5 | 4 | 6 |
| Brovey's - 6 bands | 2 | 3 | 3 | 2 | 3 | 2 |
| Brovey's - 3 bands | 1 | 4 | 4 | 2 | 2 | 3 |

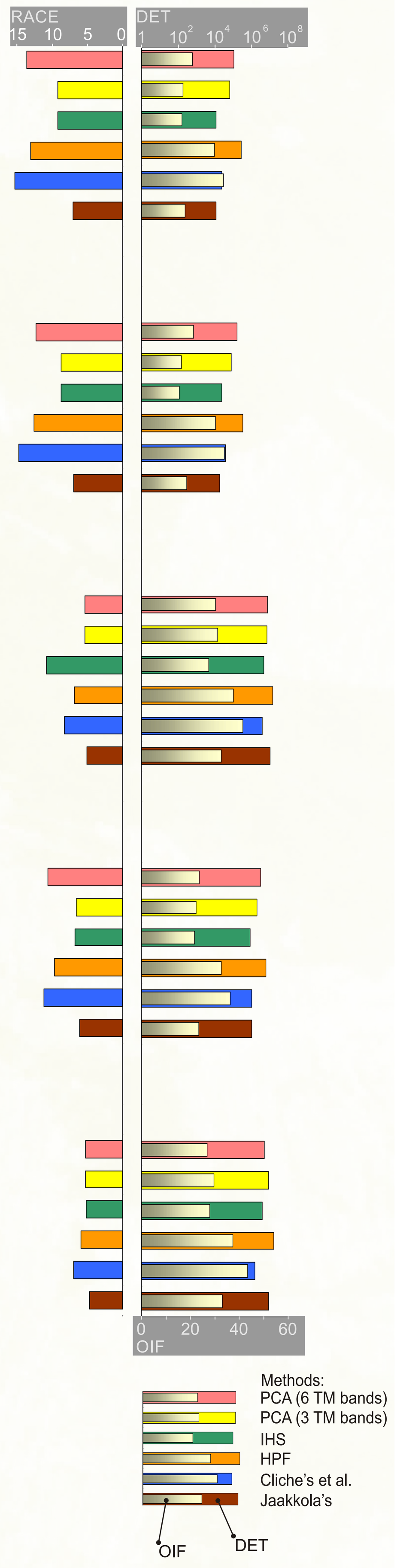
The mining infrastructure elements machines, transportation facility, buildings etc. are clearly, visible and recognisable on the fusion products.

The Jaakkola's and Cliche's et al. methods became the best to preserve the multispectral content of the original Landsat TM bands (vide Table 2.).

Table 2. Corelation between4 TMx bands (original) and nTMx bands (after merging)

| Method | Composit | nTM1 | nTM2 | nTM3 | nTM4 | nTM5 | nTM7 |
|---|---|---|---|---|---|---|---|
| PCA - 6 bands | all | 0.716 | 0.573 | 0.721 | 0.829 | 0.848 | 0.737 |
| PCA - 3 bands | 321 | 0.753 | 0.587 | 0.780 | | | |
| | 431 | 0.687 | | 0.711 | 0.781 | | |
| | 432 | | 0.749 | 0.723 | 0.814 | | |
| | 451 | 0.657 | | | 0.740 | 0.813 | |
| | 742 | | 0.584 | | 0.817 | | 0.817 |
| | 754 | | | | 0.822 | 0.582 | 0.470 |
| IHS | 321 | 0.703 | 0.738 | 0.720 | | | |
| | 431 | 0.720 | | 0.735 | 0.717 | | |
| | 432 | | 0.749 | 0.722 | 0.703 | | |
| | 451 | | 0.845 | | 0.823 | | 0.535 |
| | 742 | 0.856 | | | 0.868 | 0.421 | |
| | 754 | | | | 0.875 | 0.429 | 0.598 |
| HPF | all | 0.580 | 0.493 | 0.622 | 0.602 | 0.688 | 0.567 |
| Cliche's et al | all | 0.865 | 0.877 | 0.876 | 0.866 | 0.599 | 0.712 |
| Jaakkola's | all | 0.909 | 0.918 | 0.912 | 0.904 | 0.700 | 0.758 |

The HPF, IHS and PCA methods distort more or less the spectral characteristic of the satellite TM data depending on the particular band combinations (vide Table




Statistically (OIF, DET and RASE factor) high ranks
for Landsat TM (541),
TM (754) were obtained

**The spatial resolution limitations in the Landsat TM data might be effectively reduced by the merging with digital high-resolution aerial photographs.**