ASSESSMENT OF RADIOMETRIC RESOLUTION IMPACT ON REMOTE SENSING DATA CLASSIFICATION ACCURACY

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1. Abstract

Improved sensor characteristics are generally assumed to increase the potential accuracy of image classification and information extraction from remote sensing imagery. However, the **increase in data volume** caused by these improvements raise challenges associated with the selection, **storage, and processing** of this data, and with the cost-effective and timely analysis of the remote sensing datasets. Previous research has extensively assessed the relevance and impact of spatial, spectral and temporal resolution of satellite data on classification accuracy, but little attention has been given to the impact of radiometric resolution. This study focuses on the **role of radiometric resolution on classification accuracy** of remote sensing data through different classification experiments over three different sites. The **experiments** were carried out using fine and low scale radiometric resolution images **classified through a bagging classification tree**. The classification experiments addressed different aspects of the classification road map, including among others, **binary and multiclass classification** schemes, spectrally and **spatially enhanced images**, as well as **pixel and objects as units** of the classification. In addition, the impact of image radiometric resolution on **computational time** and the **information content** in fine- and low-resolution images was also explored. While in certain cases, higher radiometric resolution has led to up to 8% higher classification accuracies compared to lower resolution radiometric data, other results indicate that **higher radiometric resolution does not necessarily imply improved classification accuracy**. Also, classification accuracy of **spectral indices** and **texture** bands is not related so much to the radiometric resolution of the original remote sensing images but rather to their own radiometric resolution. Overall, the results of this study suggest that **data selection and classification need not always adhere to the highest possible radiometric resolution**.

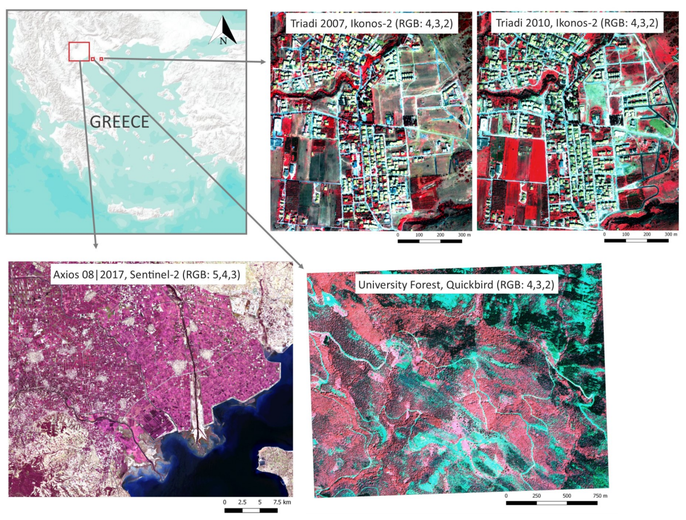
2. Introduction

Radiometric resolution impact on image classification accuracy		
Compared resolution	**Study**	**Accuracy improvement**
6bits – 8bits	Tucker, 1980	2-3%
8bits – 11bits	Legleiter et. al., 2002	0,8-2,1%
8bits – 12bits	Platt & Goetz, 2004	6%
7bits – 12bits	Rama Rao et al., 2007	3%
8bits – 12bits – 16bits	Pope & Rees, 2014	0%

Radiometric resolution impact on image information content		
Compared resolution	**Study**	**Information improvement**
6bits – 8bits	Bernstein et. al., 1984	1-2 bits/pixel
6bits – 8bits	Malila, 1985	0-1.8 bits/pixel
7bits – 12bits	Rama Rao et al., 2006	1-2%
8bits – 12bits – 16bits	Alonso et. al., 2017	0%
12bits – 14bits	Orych et. al., 2014	1%

- **Radiometric resolution:** number of bit depth divisions, associated also with the sensitivity of the sensor to incoming reflectance.
- **From 6 bits** (Landsat MSS sensors) up **to 14 bits** (KOMPSAT 3 satellite sensor), over the years.
- Existing studies dealing with radiometric resolution are implemented in a specific site and a **single variable** of interest (i.e., LAI or fractional vegetation or single land use/land cover classification).

3. Objective



The three study sites

- We **attempt to expand previous research** on the impact of radiometric resolution.
- **Experiments** in **3 different landscapes:** peri-urban (Ikonos -2), forest (Quickbird) and agricultural (Sentinel-2).

- Impact on classification accuracy:

a) binary (**ES1**) and multiclass classification (**ES2**)

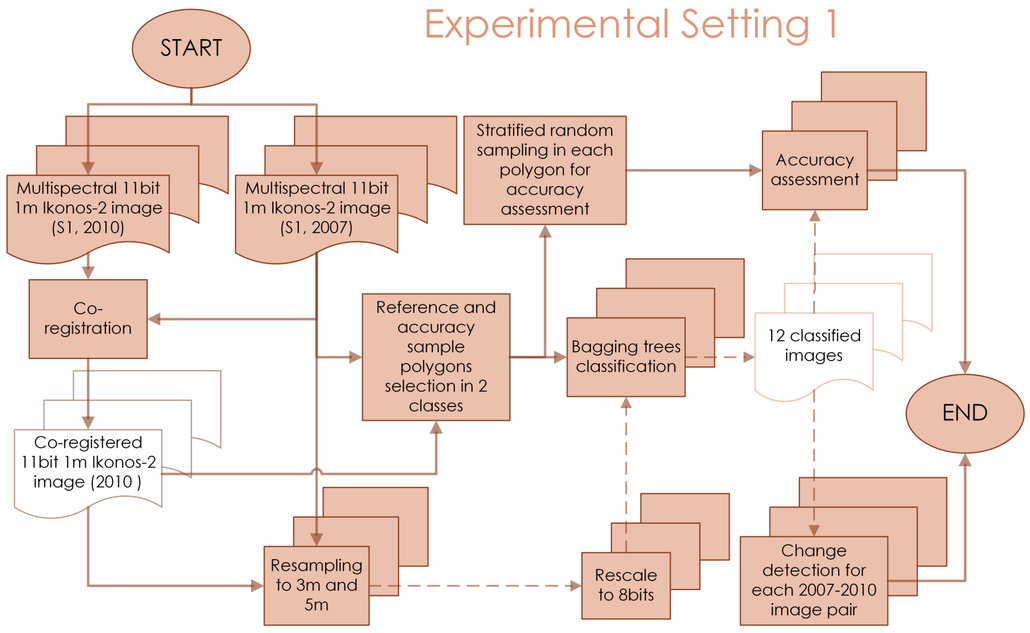
b) bi-temporal change detection (**ES1**)

c) texture-based classification (**ES2**)

d) per-field multiseasonal classification using original and synthetic bands (spectral indices) (**ES3**)

- Impact on information content: entropy (**Initial data**)
- Impact on computational time (**All ES**)

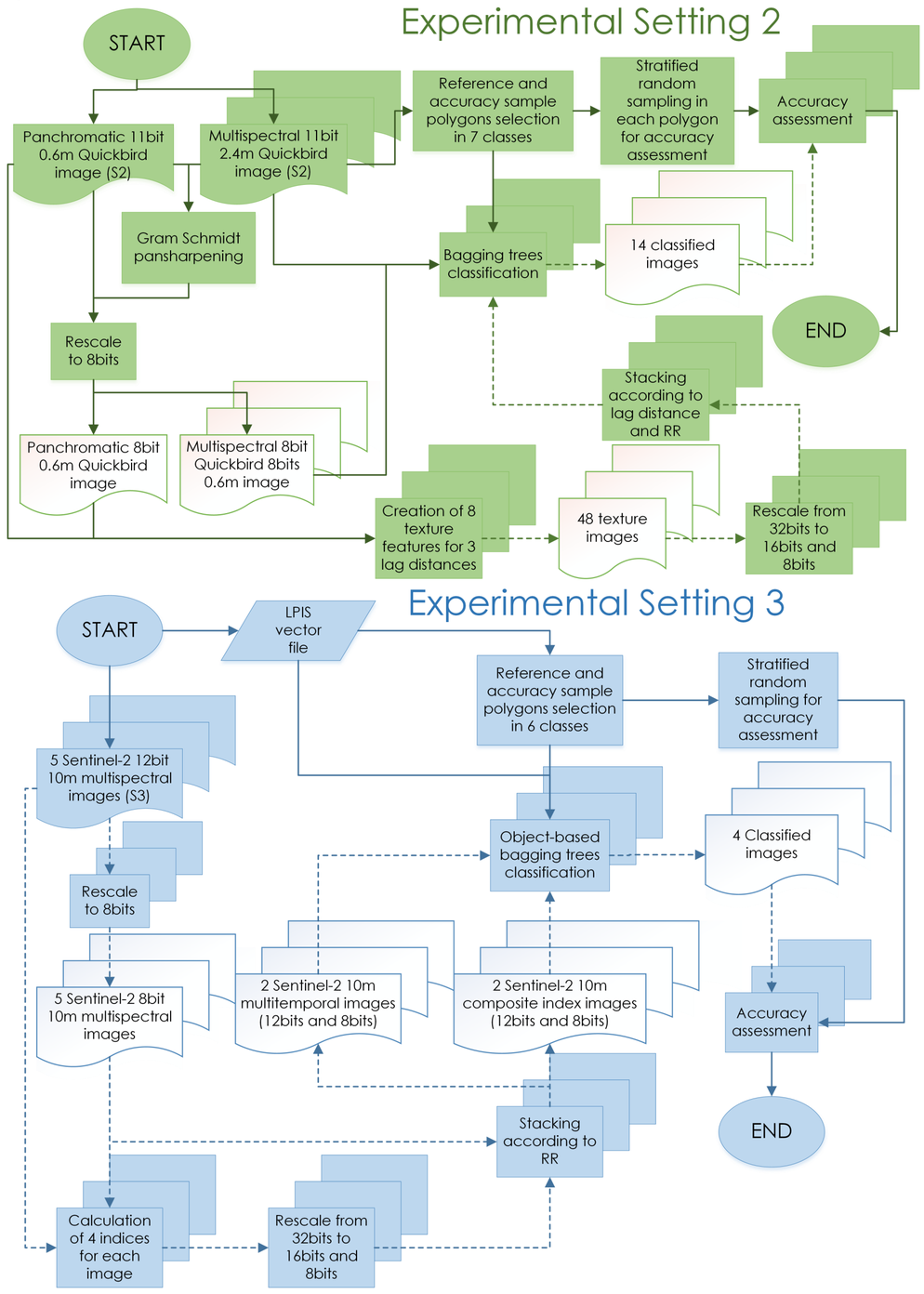
4. Methods



- Rescale from original bits to 8bits.
- Texture and multispectral index images were also rescaled.
- Bagging trees classification (BTC).

Accuracy assessment:

- Out-of-bag error from BCT.
- Independent validation polygons along with "Kappa hat" (Khat) statistics.



5. Results

Differences in classification accuracies (based on the Khat statistic):

- Multispectral binary classification (ES1): **0%-8%**
- Change detection (ES1): **1%-4%**
- Multispectral pixel-based multiclass classification (ES2): **1%**
- Texture classification (ES2): **3%-8%**
- Multispectral multiseasonal object -based classification (ES3): **0%**
- Multiseasonal indices object-based classification (ES3): **1%**

Entropy: differences that did not exceed **0.02 bits/pixel**

6. Discussion

- Results are consistent with other studies (see introduction section).
- Classification maps derived from higher radiometric resolution data were less affected by salt and pepper noise.
- In texture classifications, results are marginally affected by radiometric resolution change texture window size being more important than radiometric resolution.
- Spectral indices are barely affected by the radiometric resolution of the images from which they derive. This can be also observed in Singh et al. , 2001.
- Lower radiometric resolution data can be used safely in object-based classification.

7. Conclusions

- Low impact of radiometric resolution in classification accuracy.
- No significant effect on BTC computational times.
- Negligible difference in image information content.

Lower radiometric resolution is not always at the expense of classification accuracy.

Future research:

⇒ **interrelations** between radiometric and other types of **resolutions**.

⇒ **impact of the classification algorithm** used in the classification accuracy of various radiometric resolution images.

Major References

Rama Rao, N.; Garg, P.K.; Ghosh, S.K. Evaluation of radiometric resolution on land use/land cover mapping in an agricultural area. *Int. J. Remote Sens.* 2007, 28, 443–450, doi:10.1080/01431160600733181.

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Pope, A.; Rees, W.G. Impact of spatial, spectral, and radiometric properties of multispectral imagers on glacier surface classification. *Remote Sens. Environ.* 2014, 141, 1–13, doi:10.1016/j.rse.2013.08.028.