Impact of remote sensing characteristics for biodiversity monitoring

A case study of Southern Myanmar mangroves

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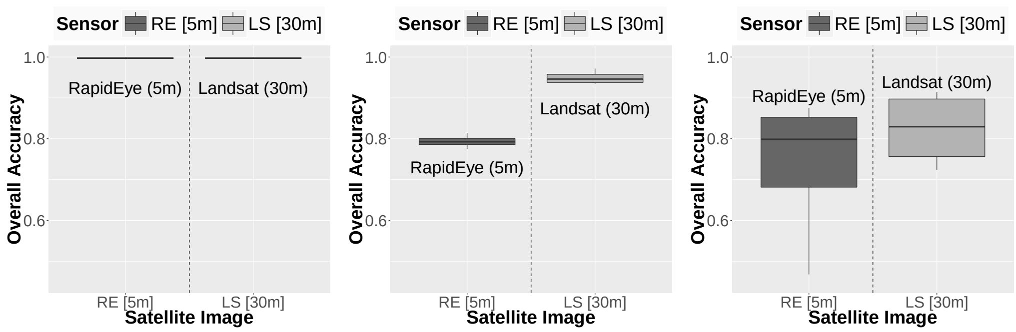
Results

1 Sensor Comparison

Overall accuracies obtained within all three classification schemes were utilized to investigate whether high-resolution RapidEye data leads to higher classification accuracies than medium-resolution Landsat 8 data in the context of mangrove mapping in Southern Myanmar. Only the two original datasets with their initial spatial and spectral capabilities were used for the pure sensor comparison. Therefore, no aggregated RapidEye imagery as well as no additional predictor layers were incorporated into the analysis. Hence, RapidEye satellite imagery with a spatial resolution of 5 meters and 5 spectral bands was compared with the Landsat 8 mosaic having a spatial resolution of 30 meters and featuring 8 spectral bands. In order to make sure that resulting trends were not only caused by the behavior of a specific model, performance statistics obtained from all four classification algorithms were utilized.



(a) *Classification Scheme 1* (b) *Classification Scheme 2* (c) *Classification Scheme 3*

Figure 1: Comparison of overall classification accuracies derived from RapidEye imagery with a spatial resolution of 5 meters (darkgrey) and Landsat 8 imagery (lightgrey) with a spatial resolution of 30 meters. Classification accuracies obtained from all four model algorithms were used for box plotting.(a) *Classification Scheme 1:* Discrimination between land cover classes 'Water', 'Non-Vegetated' and 'Vegetation'; (b) *Classification Scheme 2:* Discrimination between land cover classes 'Mangrove vegetation' and 'Terrestrial vegetation'; (c) *Classification Scheme 3:* Discrimination between land cover classes 'Intact to slightly degraded mangroves', 'Degraded mangroves', 'Heavily degraded mangroves' and 'Nipa'

The pure sensor comparison shows that both sensors lead to highly accurate classification results when discriminating between the simple land cover classes 'Water', 'Non-Vegetated' and 'Vegetation' (Fig. 16). All mean overall accuracy values are ranging between ~99 and 100 % with negligible variability (Tab. 3.1).

Table 1: Comparison of mean overall accuracies and standard deviations for RapidEye (5 m) and Landsat 8 (30 m). Recorded values are rounded to three decimal places.

	Classification 1		**Classification 2**		**Classification 3**	
	RapidEye	*Landsat 8*	*RapidEye*	*Landsat 8*	*RapidEye*	*Landsat 8*
Mean overall accuracy	0.997	0.997	0.794	0.949	0.735	0.824
Standard Deviation	0.002	0.002	0.016	0.017	0.186	0.093

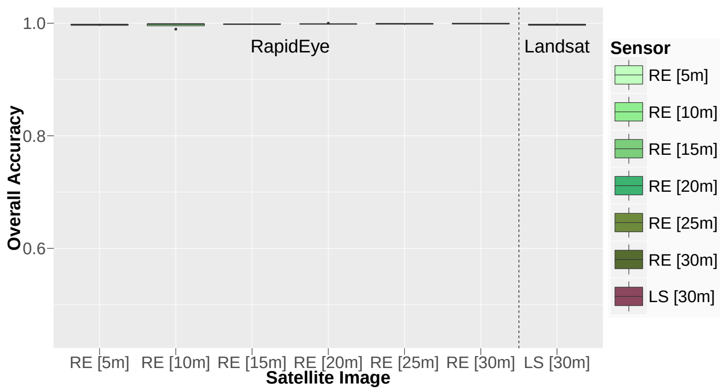
A fairly different pattern is observed when comparing accuracy values ob-

tained within the second classification scheme which discriminates between the land cover classes 'Mangrove vegetation' and 'Terrestrial vegetation'. Although variability is still quite low with regard to both sensors, Landsat 8 derived classifications exhibit considerably higher accuracy values than land cover classifications based on RapidEye imagery. Whereas the RapidEye derived mean overall accuracy is ~79 %, Landsat derived land cover maps achieve an explicitly higher mean overall accuracy of ~95 % (Tab. 3.1).
Referring to results received within the third classification scheme, a strong increase in variability is found with respect to both sensors. The mean overall accuracy value obtained from Landsat 8 imagery strongly decreased when compared to results received within the second classification scheme to ~82 %. However, Landsat 8 derived land cover maps were still more accurate than RapidEye based classifications which achieved a mean overall accuracy of ~74 %. High-resolution RapidEye data therefore leads to more variable and also less accurate classification results than medium-resolution Landsat 8 imagery when discriminating between the land cover classes 'Intact to slightly degraded mangroves', 'Degraded mangroves', 'Heavily degraded mangroves' and 'Nipa' (Tab. 3.1).
In summary, both sensors perform nearly equally when discriminating between very distinct land cover classes in the first classification scheme. However, medium-resolution Landsat 8 based classifications lead to more accurate classification results than land cover classifications derived from high-resolution RapidEye imagery within the second and third classification scheme. It is investigated in the following paragraph, whether this resulting pattern is attributable to the different spatial resolution of both sensor types.

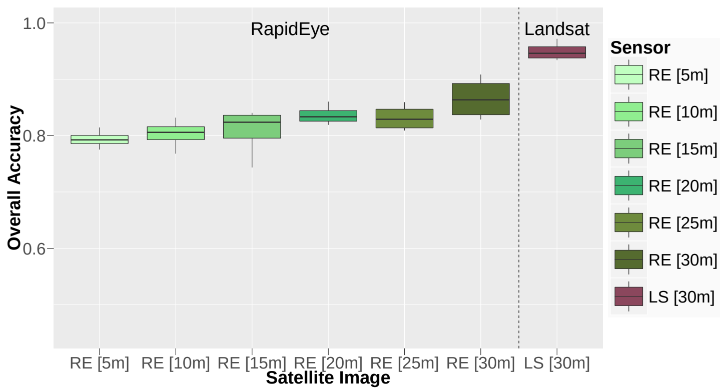
2 Spatial Resolution

To test whether the different spatial resolution of both sensors is responsible for their unequal performance, aggregated RapidEye data with spatial resolutions of 10, 15, 20, 25 and 30 meters is compared to the Landsat 8 mosaic. Consistently, performance statistics obtained from all four classification models are utilized to make sure that resulting trends are not only induced by the behavior of a specific algorithm. Furthermore, only the initial spectral composition of each sensor is taken into consideration for the following comparison of different spatial resolutions. Therefore, RapidEye images are comprised of 5 spectral bands whereas Landsat 8 imagery consists of 8 spectral bands. The comparative analysis can show with regard to the first classification scheme, that very high overall accuracies of ~99 to 100 % are

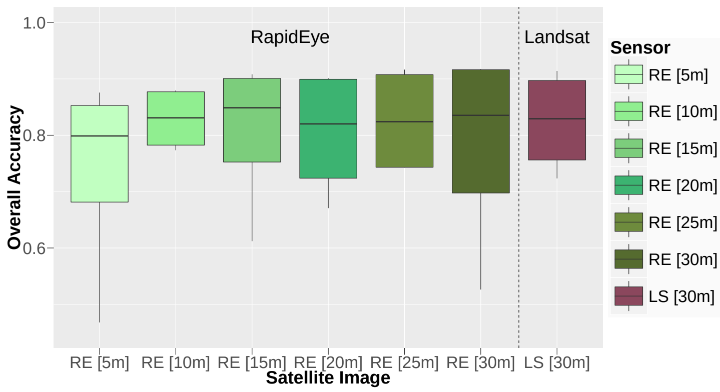
achieved when discriminating between the basic land cover classes ‘Water’, ‘Non-Vegetated’ and ‘Vegetation’ for each sensor and spatial resolution (Fig. 17). However, the mean overall accuracies slightly increase and the variability slightly decreases with coarser spatial resolutions of RapidEye data (Tab. 3.2). Classification results based on the RapidEye mosaic with a spatial resolution of 10 meters seem to be slightly exceptional by featuring the lowest mean overall accuracy value as well as the highest variability.
Analysing results of the second classification scheme, which is discriminating between mangrove and terrestrial vegetation, a considerable increase of overall accuracy values with lower spatial resolutions of RapidEye images is observed (Fig. 17). Whereas RapidEye data with a spatial resolution of 5 meters leads to a mean overall accuracy of ~79 %, aggregated RapidEye data with a spatial resolution of 30 meters leads to overall accuracies of ~87 %. Moreover, the comparison of RapidEye and Landsat 8 data each with a spatial resolution of 30 meters reveals, that – despite featuring the same spatial resolution – Landsat 8 imagery still leads to a considerably higher mean overall accuracy of ~95 % than RapidEye data (~87 %) when discriminating between mangrove and terrestrial vegetation (Tab. 3.2). Therefore, Landsat derived land cover predictions are clearly more accurate than RapidEye derived results, even when both datasets have exactly the same spatial resolution.
Regarding results obtained within the third classification scheme, a slightly increasing trend of overall accuracy values with lower spatial resolutions of RapidEye data is observed. However, highly increased variability of recorded accuracy values complicates the identification of a distinct trends. The most accurate classification results could be derived from the RapidEye dataset featuring a spatial resolution of 10 meters leading to the highest mean overall accuracy (~83 %) and lowest variability. Comparing Landsat and RapidEye imagery each with a spatial resolution of 30 meters, RapidEye data leads again to more variable and less accurate classification results when discriminating between the four different mangrove land cover classes. Leading to mean overall accuracy values of ~78 % (RapidEye) and ~82 % (Landsat), differences between both datasets are less pronounced than within the second classification scheme (Tab. 3.2).



(a) *Classification Scheme 1*



(b) *Classification Scheme 2*



(c) *Classification Scheme 3*

Figure 2: Overall accuracies derived from the original RapidEye image as well as aggregated RapidEye images with a spatial resolution of 10, 15, 20, 25 and 30 meters are compared with the Landsat 8 mosaic having a spatial resolution of 30 meters. Boxplots referring to RapidEye imagery are displayed in green colors, whereas Landsat derived overall accuracies are displayed using violet. Classification accuracies obtained from all four classification models were used for box plotting. (a) *Classification Scheme 1:* Discrimination between land cover classes 'Water', 'Non-Vegetated' and 'Vegetation'; (b) *Classification Scheme 2:* Discrimination between land cover classes 'Mangrove vegetation' and 'Terrestrial vegetation'; (c) *Classification Scheme 3:* Discrimination between land cover classes 'Intact to slightly degraded mangroves', 'Degraded mangroves', 'Heavily degraded mangroves' and 'Nipa'

Table 2: Mean overall accuracies and standard deviations for RapidEye images with spatial resolutions of 5, 10, 15, 20, 25 and 30 meters and Landsat 8 imagery with a spatial resolution of 30 meters respectively. Recorded values are rounded to three decimal places.

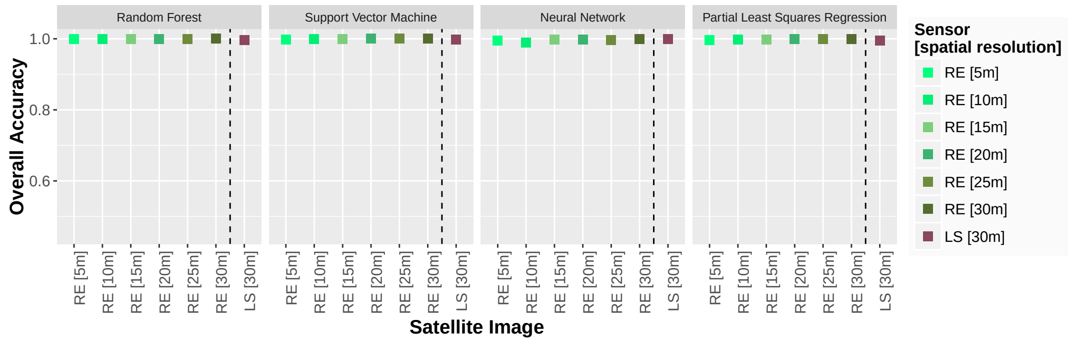
	Classification 1		**Classification 2**		**Classification 3**	
	RapidEye	*Landsat 8*	*RapidEye*	*Landsat 8*	*RapidEye*	*Landsat 8*
Mean overall accuracy	0.997 (5 m)	0.997	0.794 (5 m)	0.949	0.735 (5 m)	0.824
	0.996 (10 m)		0.803 (10 m)		0.829 (10 m)	
	0.999 (15 m)		0.808 (15 m)		0.804 (15 m)	
	0.999 (20 m)		0.837 (20 m)		0.803 (20 m)	
	0.999 (25 m)		0.832 (25 m)		0.827 (25 m)	
	0.999 (30 m)		0.866 (30 m)		0.779 (30 m)	
Standard Deviation	0.002 (5 m)	0.002	0.016 (5 m)	0.017	0.186 (5 m)	0.093
	0.005 (10 m)		0.027 (10 m)		0.057 (10 m)	
	0.001 (15 m)		0.045 (15 m)		0.137 (15 m)	
	0.001 (20 m)		0.018 (20 m)		0.116 (20 m)	
	0.001 (25 m)		0.024 (25 m)		0.097 (25 m)	
	0.001 (30 m)		0.038 (30 m)		0.185 (30 m)	

In summary, the overall pattern as observed already in section 3.1 is reoccurring with slight modifications. Although RapidEye imagery was aggregated to lower spatial resolutions of 10, 15, 20, 25 and 30 meters, both sensors lead to highly accurate results when conducting land cover classifications discriminating between very distinct land cover classes as e.g. water or vegetation. However, Landsat derived classification results are considerably more accurate when performing classifications distinguishing between mangrove and terrestrial vegetation. Both sensors lead to less accurate and more variable results when conducting classifications, which discriminate between different mangrove classes.

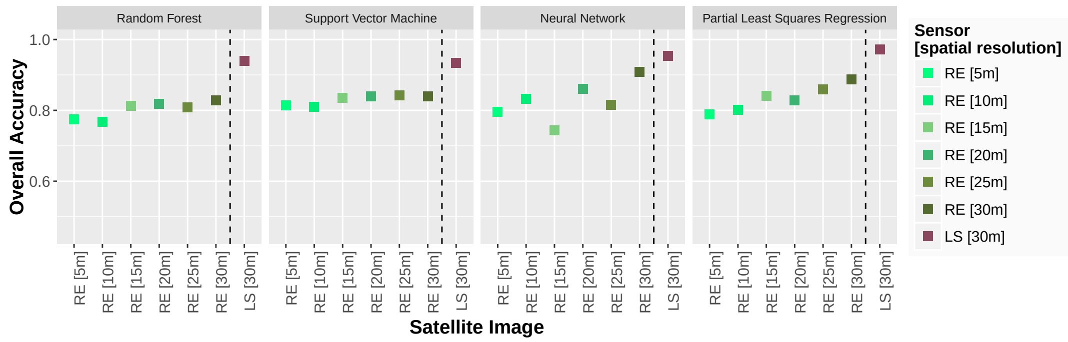
Particularly results obtained within the second classification scheme show, that it is not only the spatial resolution which is responsible for the different performance of the RapidEye and Landsat 8 sensor. In order to test whether these discrepancies are caused by the sensors' different spectral capabilities, both datasets are compared again by utilizing four different predictor layer combinations. However, the best performing model was selected primarily for each of the three classification schemes to make sure that observed differences are actually caused by the variations in predictor combinations and are not merely an effect of variable model performances.

3 Model Comparison

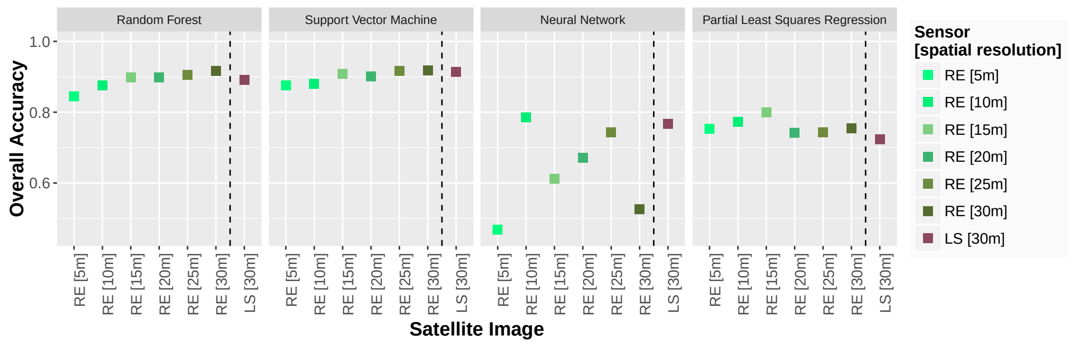
The comparison of the four selected classification models RF, SVM, NNET and PLS reveals some well discernible differences in model performance. However, referring to performance statistics obtained within the first classification scheme, all models perform on a similarly high level and lead to consistently high overall accuracy values between ~99 and 100 % (Fig. 18). Small differences in mean overall accuracy values and the standard deviations are negligible (Tab. 3.3). Despite very small differences, the SVM model can be identified as the best performing classification algorithm due to its slightly higher mean overall accuracy and lower variability. It is therefore applied for the comparison of different predictors within the first classification scheme.
Investigating overall accuracy patterns derived from the second classification scheme, which distinguishes between mangrove and terrestrial vegetation, a considerably different pattern is observed (Fig. 19). On the one hand, the three models RF, SVM and PLS lead to similar overall accuracy patterns. RapidEye derived overall accuracies increase relatively steady with lower spatial resolution and the Landsat 8 derived classification always leads to the most accurate land cover prediction. On the other hand, the NNET model exhibits a considerably higher variability of overall accuracy values (Tab. 3.3). Therefore, it does not lead to the uniform increase of overall accuracy with lower spatial resolution which is observed when applying the other models. However, Landsat 8 derived classifications still lead to the most accurate land cover predictions. Taking mean overall accuracy values and standard deviations into account, the PLS model is identified as the best performing algorithm. It is therefore used for the comparison of different predictor combinations within the second classification scheme. Comparing model performances with respect to the third classification scheme, it is revealed that the application of the RF and SVM classifiers lead to explicitly higher classification accuracies than the utilization of NNET and PLS algorithms (Fig. 18). As already observed within the second classification scheme, the NNET model exhibits the lowest mean overall accuracy as well as the highest variability. The SVM classifier was identified as best performing model with respect to the discrimination between the four mangrove land cover classes. It is therefore used for the comparison of different predictor combinations within the third classification scheme.



(a) *Classification Scheme 1*



(b) *Classification Scheme 2*



(c) *Classification Scheme 3*

Figure 3: Comparison of four selected models: RF, SVM, NNET and PLS. Classification accuracies are derived from RapidEye images with spatial resolutions of 5, 10, 15, 20, 25 and 30 meters and the Landsat mosaic having a spatial resolution of 30 meters. RapidEye imagery is displayed as green coloured squares, Landsat imagery by a violet square. (a) *Classification Scheme 1:* Discrimination between land cover classes ‘Water’, ‘Non-Vegetated’ and ‘Vegetation’; (b) *Classification Scheme 2:* Discrimination between land cover classes ‘Mangrove vegetation’ and ‘Terrestrial vegetation’; (c) *Classification Scheme 3:* Discrimination between land cover classes ‘Intact to slightly degraded mangroves’, ‘Degraded mangroves’, ‘Heavily degraded mangroves’ and ‘Nipa’

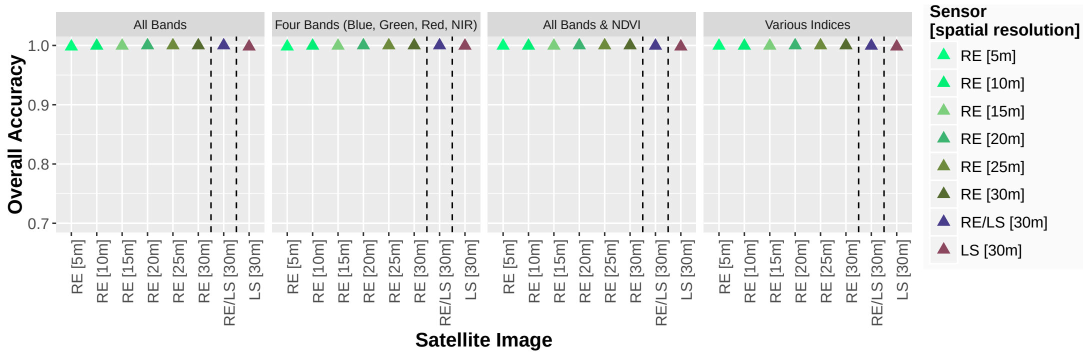
Table 3: Comparison of the four selected classification models. Mean overall accuracies and standard deviations are reported for each individual classification scheme. Most suitable models for the individual classification schemes are indicated by bold face. Recorded values are rounded to three decimal places.

	Random Forest	**Support Vector Machine**	**Neural Network**	**Partial Least Squares Regression**
Classification 1				
Mean	0.999	**0.999**	0.997	0.998
SD	0.001	**0.001**	0.003	0.001
Classification 2				
Mean	0.837	0.856	0.861	**0.874**
SD	0.067	0.050	0.081	**0.060**
Classification 3				
Mean	0.894	**0.901**	0.650	0.752
SD	0.025	**0.017**	0.114	0.025

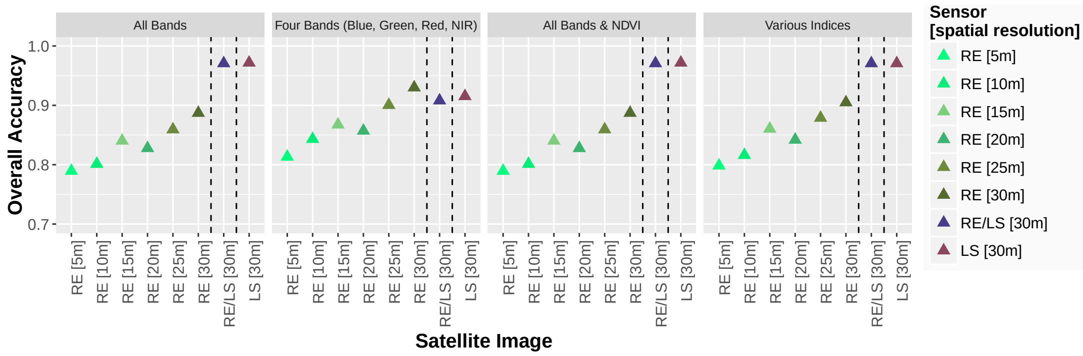
In order to investigate whether differences in sensor performance can be explained by the sensors' different spectral capabilities, classifications based on varying predictor combinations are comparatively analysed in the following paragraph. Previously identified best performing models are applied within the different classification schemes.

4 Predictor Comparison

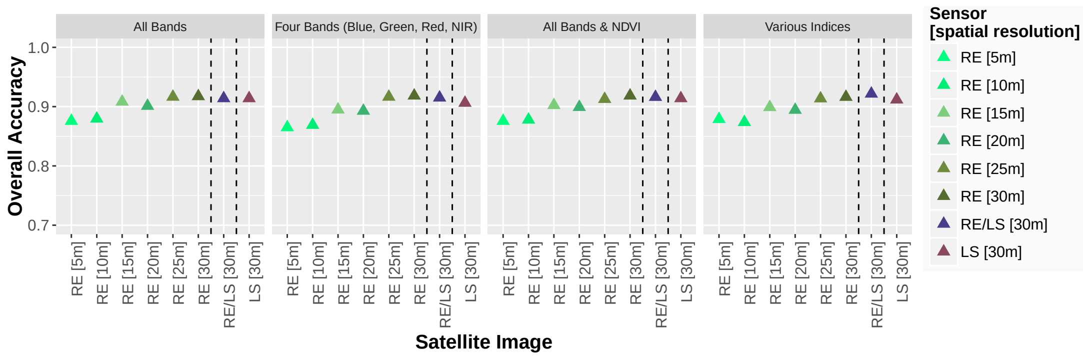
The following four predictor combinations are utilized to test the influence of predictor layer characteristics on classification accuracies. First, the original spectral band compositions of both sensors are used as predictor layers. This is five spectral bands with respect to RapidEye imagery (Blue, Green, Red, Red Edge, NIR) and 8 spectral bands with regard to Landsat 8 imagery (Coastal aerosol, Blue, Green, Red, NIR, SWIR 1, SWIR 2, Cirrus). Second, spectral bands are reduced to only those bands which are a common characteristic of both sensors. These are the Blue, Green, Red and NIR bands. Third, original spectral band compositions of both sensors are used in combination with the most frequently used vegetation index NDVI. Last, initial RapidEye and Landsat 8 band compositions are complemented with several commonly applied vegetation indices (NDVI, RVI, SAVI) and a moisture index (NDWI). Furthermore, to investigate whether the data fusion of both image types can further increase classification results, a fused RapidEye and Landsat 8 dataset is included in the analysis as well.



(a) *Classification Scheme 1:Based on the SVM classifier*



(b) *Classification Scheme 2:Based on the PLS classifier*



(c) *Classification Scheme 3: Based on the SVM classifier*

Figure 4: Comparison of four different predictor combinations: 'All bands', 'Four bands', 'All bands + NDVI' and 'All bands + various indices'. Classification accuracies are derived from RapidEye images with spatial resolutions of 5, 10, 15, 20, 25 and 30 meters and the Landsat mosaic having a spatial resolution of 30 meters. RapidEye imagery is displayed as green coloured triangles, Landsat imagery by a violet triangle. The fused RapidEye and Landsat 8 dataset is indicated by a darkblue triangle. (a) *Classification Scheme 1:* Discrimination between land cover classes 'Water', 'Non-Vegetated' and 'Vegetation'; (b) *Classification Scheme 2:* Discrimination between land cover classes 'Mangrove vegetation' and 'Terrestrial vegetation'; (c) *Classification Scheme 3:* Discrimination between land cover classes 'Intact to slightly degraded mangroves', 'Degraded mangroves', 'Heavily degraded mangroves' and 'Nipa'

Regarding results obtained within the first classification scheme, it is observed that very high classification accuracies are achieved with respect to both sensors independently of the four different predictor combinations (Fig. 19 a). However, it is noticeable that the Landsat 8 derived overall accuracy value is highest when using only four bands.

Table 4: Overall accuracy values derived from different predictor combinations (RapidEye and Landsat 8 imagery). Overall accuracy values are listed only for RapidEye and Landsat images having a spatial resolution of 30 meters, since these images were identified in section 3.1 as leading to the most accurate classification results. Recorded values are rounded to three decimal places.

	All bands	**Four bands**	**All bands + NDVI**	**All bands + various indices**
	Overall accuracy	*Overall accuracy*	*Overall accuracy*	*Overall accuracy*
Classification 1				
RapidEye (30m)	1	1	1	1
Landsat (30m)	0.998	0.999	0.998	0.998
Classification 2				
RapidEye (30m)	0.887	0.930	0.887	0.905
Landsat (30m)	0.973	0.915	0.972	0.971
Classification 3				
RapidEye (30m)	0.917	0.919	0.919	0.916
Landsat (30m)	0.914	0.906	0.914	0.912

The results obtained within the second classification scheme reveal, that RapidEye derived classification accuracies increase with lower spatial resolution – irrespective of number and characteristics of the predictor layers. It can furthermore be observed that the fused dataset leads to very similar classification results than Landsat 8 imagery. Concerning the three predictor combinations ‘All bands’, ‘All bands + NDVI’ and ‘All bands + various indices’, Landsat derived classifications as well as classifications based on the fused dataset lead to considerably higher overall accuracy values than RapidEye derived land cover predictions. Strikingly, this is not the case when considering the ‘Four bands’ predictor combination: when Landsat 8 imagery is reduced to only four spectral bands – omitting coastal aerosol, SWIR 1, SWIR 2 and cirrus bands – classification results based on the Landsat 8 mosaic and the fused dataset are considerably less accurate. Exhibiting an overall accuracy value of ~93 %, RapidEye derived classifications even outperform Landsat 8 based classifications (~91,5 %) when applying only four bands (Tab. 3.4). Therefore, the enhanced spectral capability of the

Landsat 8 sensor is identified as being responsible for its better performance compared to the RapidEye sensor. In contrast to Landsat 8 derived classifications, RapidEye based classification accuracies increase when the number of spectral bands is reduced to four (Fig. 19 b). This pattern shows, that the inclusion of RapidEye's Red Edge band deteriorates the accurate discrimination of mangrove and terrestrial vegetation. Including the NDVI as predictor layer does not increase classification accuracies. However, the inclusion of several vegetation indices and a moisture index slightly improves classification accuracies, but only with respect to RapidEye imagery.
Fewer differences between the performance of both sensors are observed when considering results obtained within the third classification scheme which discriminates between different mangrove classes (Fig. 19). RapidEye derived classification accuracies increase again with lower resolution, independent of the utilized predictor combination. However, accuracy discrepancies between the RapidEye image with a spatial resolution of 5 meters (~87 %) and the image having a resolution of 30 meters (~91,5 %) are alleviated. Moreover, the distinct superiority of Landsat 8 imagery compared to RapidEye images, as observed within the second classification scheme, cannot be detected anymore. RapidEye images with a spatial resolution of 30 meters rather lead to slightly higher overall accuracy values of (~92 %) than the Landsat 8 mosaic (~91 %) (Tab. 3.4). In contrast to the second classification scheme, RapidEye derived classification accuracies do not increase when utilizing only four spectral bands. Excluding the Red Edge band from the classification procedure rather leads to slightly less accurate results. The lowest Landsat 8 derived accuracy value is achieved when using only four bands and removing coastal aerosol, SWIR 1, SWIR 2 and cirrus bands. The addition of further vegetation and moisture indices does not improve classification accuracies when compared to the 'All bands' predictor combination.

5 Land Cover Maps and their Variability

In the following section, most and least accurate land cover maps are presented with respect to each individual classification scheme. Moreover, results obtained from raster entropy calculations are used to identify areas featuring specifically high variability.

Classification Scheme 1

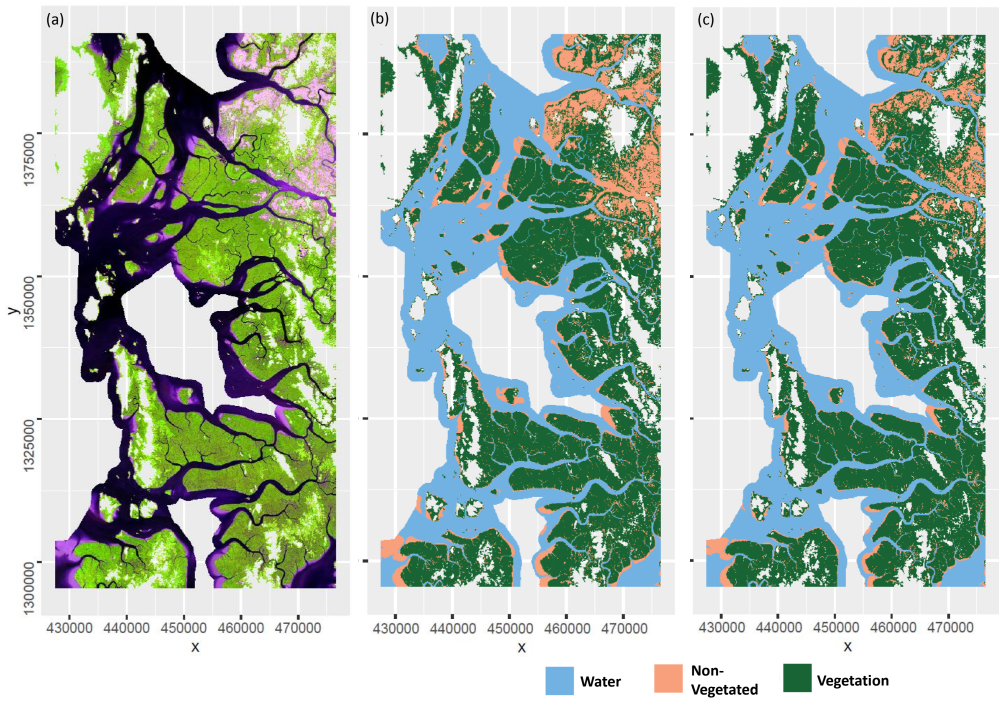


Figure 5: Most and least accurate land cover map obtained within the first classification scheme. (a) RapidEye imagery with a spatial resolution of 30 meters *(4,5,3)*. (b) Most accurate land cover map with an overall accuracy of 1 based on RapidEye imagery with a spatial resolution of 30 meters, all bands and the SVM model. (c) Least accurate land cover map with an overall accuracy of 0.989 based on RapidEye imagery with a spatial resolution of 10 meters, all bands and the NNET model.

Visual differences between the most and least accurate land cover map obtained within the first classification scheme are hardly recognizable (Fig. 20).

However, the land cover class 'Non-vegetated' seems to be slightly underrepresented on the land cover map derived from the least accurate classification using RapidEye imagery with a spatial resolution of 10 meters and the NNET model (Fig. 20c).

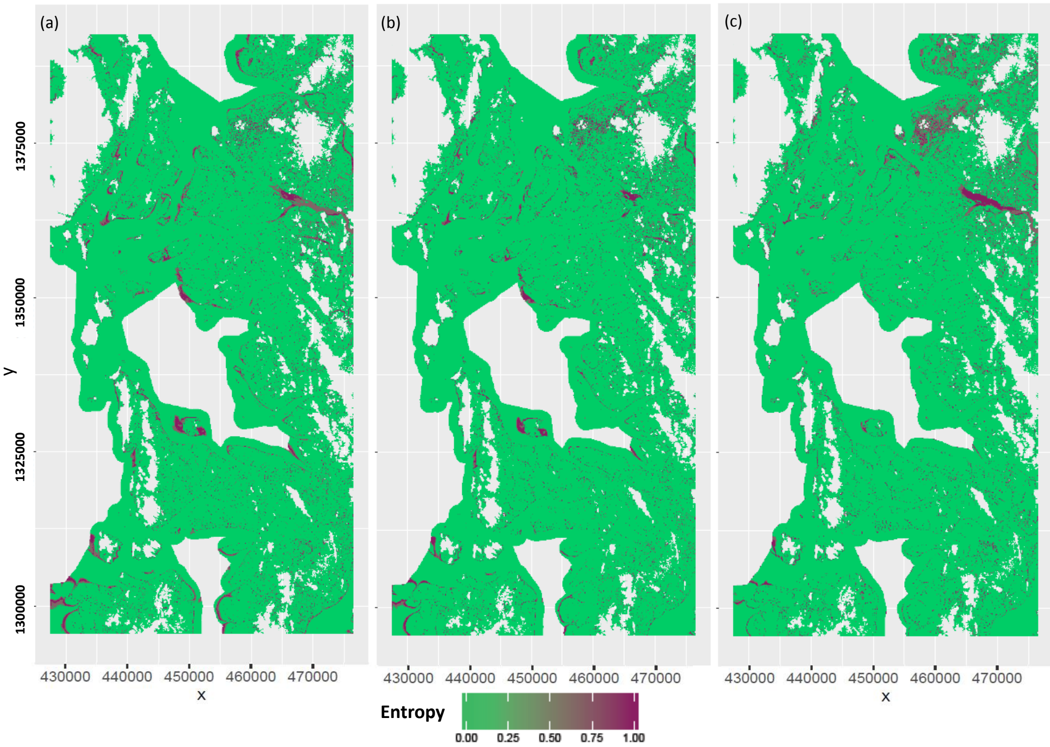


Figure 6: Raster Entropy of classification results obtained within the first classification scheme. Areas with low variability are indicated by green colours, areas with high variability are displayed in dark red. (a) Raster entropy of classification results derived from RapidEye imagery with a spatial resolution of 5 meters. (b) Raster entropy of classification results derived from RapidEye imagery with a spatial resolution of 30 meters. (c) Raster entropy of classification results derived from Landsat imagery with a spatial resolution of 30 meters.

The visual evaluation of the raster entropy calculations shows, that very high classification variability can be observed especially in areas which are mudflats, shallow waters or occasionally flooded areas. Relatively high variability is found in built-up areas as well (e.g. around Myeik). Altogether, variations between the different land cover maps are very low with regard to both sensor types and different spatial resolutions (Fig. 21).

Classification Scheme 2

Highly pronounced differences are identified when comparing land cover maps with highest and lowest overall accuracy values generated within the second classification scheme (Fig. 22). The thematic map based on Landsat 8 imagery shows relatively well-defined borders between the two relevant land cover classes 'Mangrove vegetation' and 'Terrestrial vegetation'. In contrast, the least accurate thematic map based on RapidEye imagery with a spatial resolution of 15 meters portrays rather ambiguous boundaries and a high degree of the so called salt-and-pepper effect.

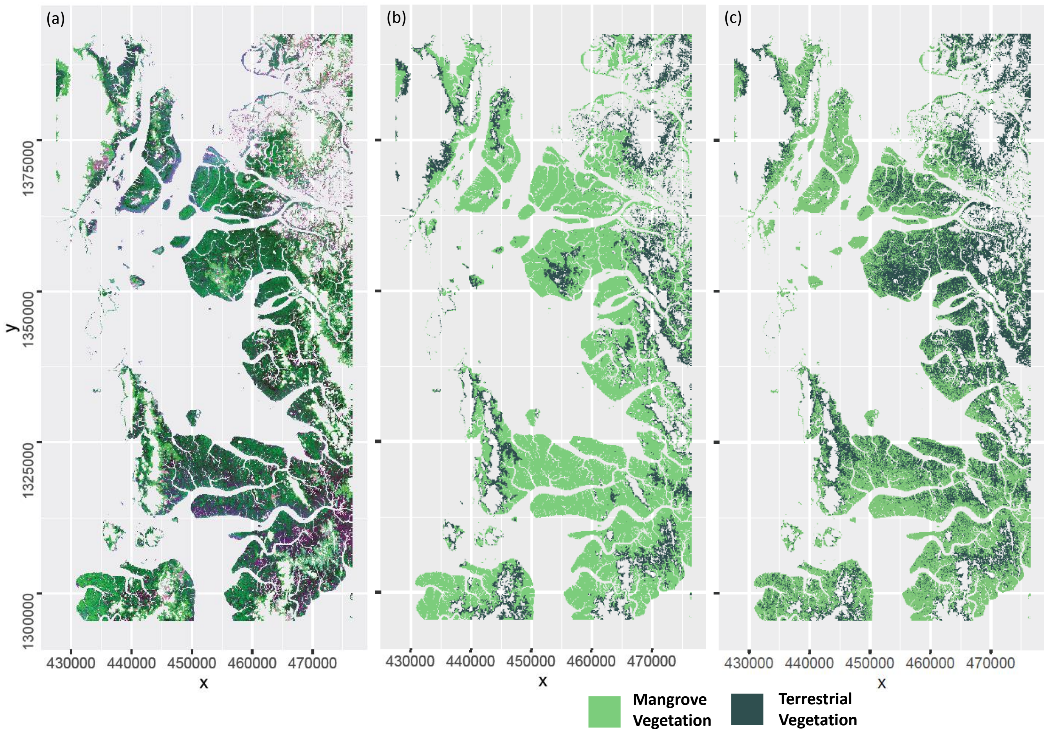


Figure 7: Most and least accurate land cover map obtained within the second classification scheme discriminating between 'Mangrove Vegetation' and 'Terrestrial Vegetation'. (a) Landsat 8 imagery with a spatial resolution of 30 meters *(6,5,4)*. (b) Most accurate land cover map with an overall accuracy of 0.972 based on Landsat 8 imagery with a spatial resolution of 30 meters, all bands and the PLS model. (c) Least accurate land cover map with an overall accuracy of 0.743 based on RapidEye imagery with a spatial resolution of 15 meters, all bands and the NNET model.

The visual evaluation of results obtained from raster entropy calculations shows, that differences in classification variability between the two sensors and varying spatial resolutions are more pronounced within the second classification scheme (Fig. 23). Areas of high variability are distributed relatively equally throughout the whole study area when considering classifications based on RapidEye imagery. In contrast, areas with high variability are more concentrated when taking classifications based on Landsat 8 imagery into account. A decrease of variability with coarser spatial resolution can be observed when visually comparing raster entropy results derived from RapidEye imagery with 5 and 30 meter spatial resolution. The dispersion of variability through the whole study area is most pronounced in the raster entropy result derived from RapidEye imagery with a spatial resolution of 5 meters. However, classifiction variability is relatively low regarding all three remote sensing data types.

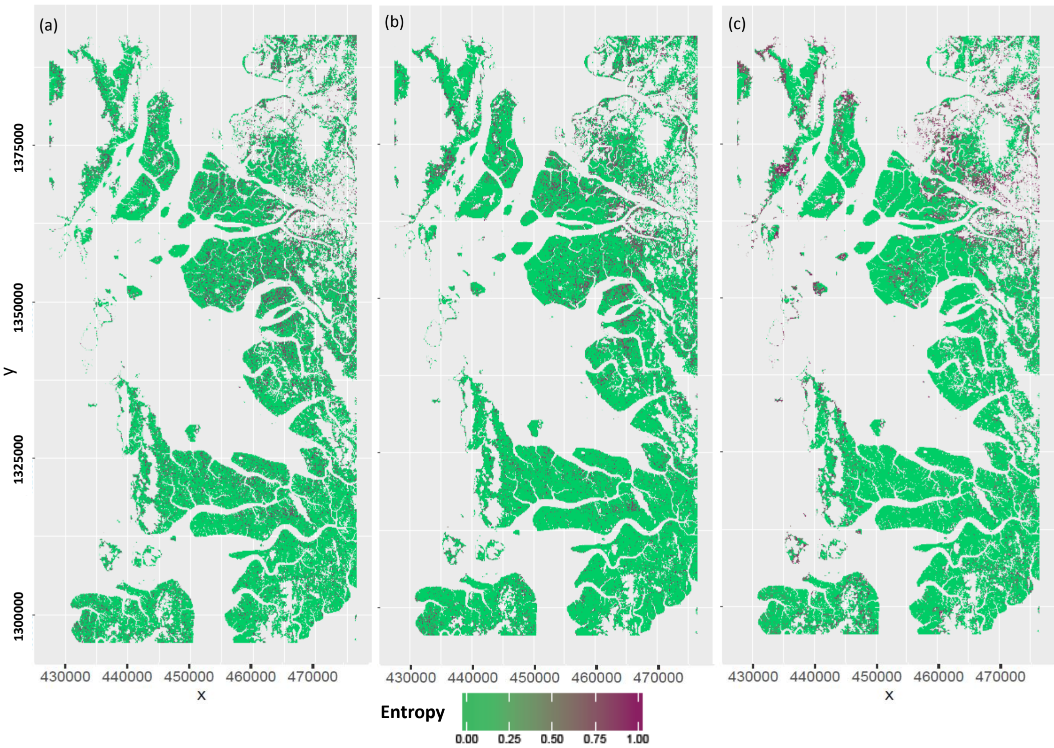


Figure 8: Raster Entropy of classification results obtained within the second classification scheme. Areas with low variability are indicated by green colours, areas with high variability are displayed in dark red. (a) Raster entropy of classification results derived from RapidEye imagery with a spatial resolution of 5 meters. (b) Raster entropy of classification results derived from RapidEye imagery with a spatial resolution of 30 meters. (c) Raster entropy of classification results derived from Landsat imagery with a spatial resolution of 30 meters.

Classification Scheme 3

Highly pronounced differences between most and least accurate mangrove maps can be observed when considering thematic land cover maps generated within the third classification scheme (Fig. 24). Whereas all four previously defined mangrove classes are well presented in the land cover map based on the fused RapidEye and Landsat 8 dataset, only three of these mangrove classes are portrayed in the least accurate map derived from RapidEye imagery with a spatial resolution of 5 meters. The mangrove class 'ipa' is completely omitted by the least accurate classification. Moreover, the amount of pixels classified as 'Intact to slightly degraded' mangroves is so low, that they can hardly be identified by means of visual inspection.

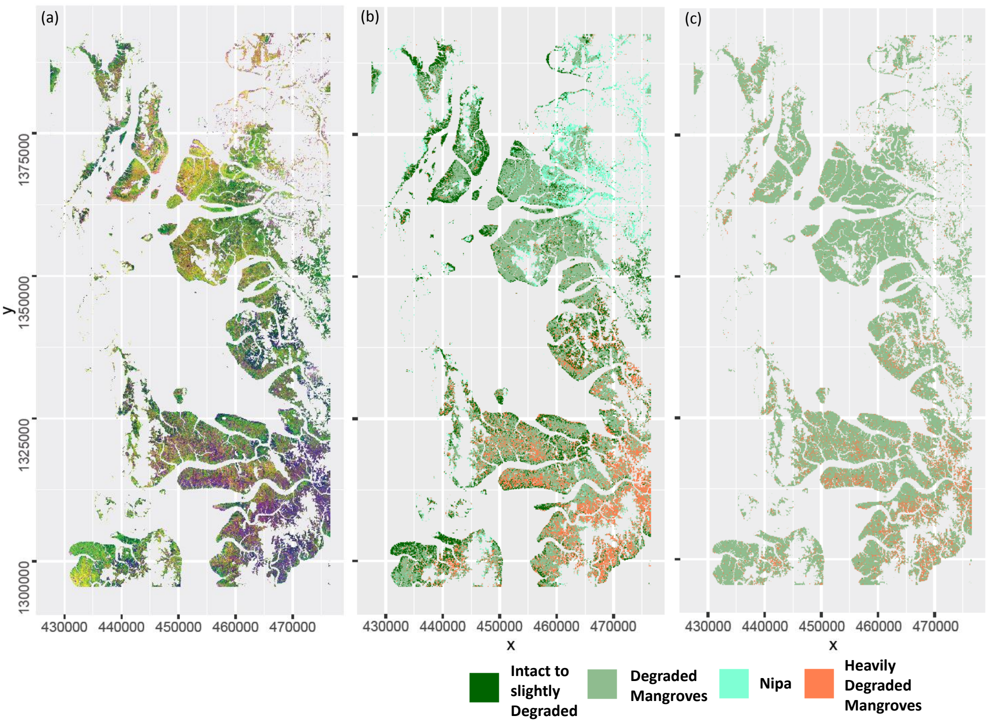


Figure 9: Most and least accurate land cover map obtained within the third classification scheme discriminating between 'Mangrove Vegetation' and 'Terrestrial Vegetation'. (a) RapidEye imagery with a spatial resolution of 30 meters *(4,5,3)*. (b) Most accurate land cover map with an overall accuracy of 0.924 based on fused RapidEye and Landsat 8 imagery with a spatial resolution of 30 meters, all bands and the RF model. (c) Least accurate land cover map with an overall accuracy of 0.468 based on RapidEye imagery with a spatial resolution of 5 meters, all bands and the NNET model.

Evaluating results obtained from raster entropy calculations, distinct variability differences can be observed. Variations in land cover class predictions based on RapidEye imagery with a spatial resolution of 5 meters occur evenly distributed throughout the whole study area. In contrast, variability of Landsat 8 based classifications is rather aggregated in certain areas – especially along edges of land cover classes (Fig. 25). Variability in classifications based on RapidEye imagery with a spatial resolution of 30 meters can be described as an intermediate stage between the two other datasets.
Comparing raster entropy results of these three remotely sensed data types, it is observed that variability in land cover predictions decreases with lower spatial resolution. Moreover, highest classification variations can be observed within the third classification scheme. These findings are therefore consistent with the results presented in sections 3.1 – 3.4.

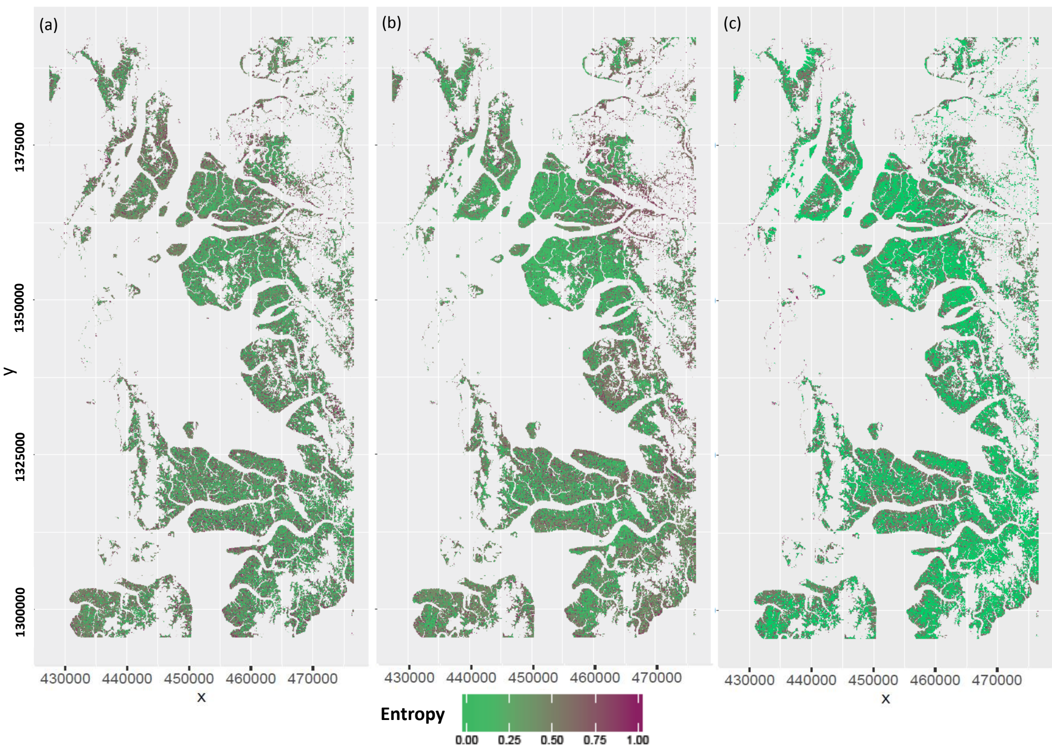


Figure 10: Raster Entropy of classification results obtained within the third classification scheme. Areas with low variability are indicated by green colours, areas with high variability are displayed in dark red. (a) Raster entropy of classification results derived from RapidEye imagery with a spatial resolution of 5 meters. (b) Raster entropy of classification results derived from RapidEye imagery with a spatial resolution of 30 meters. (c) Raster entropy of classification results derived from Landsat imagery with a spatial resolution of 30 meters.