Aquaculture and Coastal Habitats Report No. 3

A Baseline Mapping of Aquaculture and Coastal Habitats in Myanmar

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Introduction

On behalf of the Gordon and Betty Moore Foundation, Clark Labs has been engaged in a series of projects to map aquaculture and coastal habitats. This report summarizes the procedures used and the results of a baseline mapping of Myanmar for 2014. For information on the broader objectives of the program, please refer to Eastman et al., (2015). Although a total of 33 classes of land cover were mapped, the focus was primarily on pond aquaculture and mangroves.

Procedure

Myanmar was mapped using essentially the same procedure as was used for the baseline mapping of Vietnam, Cambodia and Thailand (see Eastman et al., 2015). The coastal zone was defined in the same manner (essentially 10 km either side of the coast with extensions inland for areas less than 5 m in elevation). The input data were Landsat 8 images for 2014, upscaled to 15 m resolution using pan sharpening for the visible bands. Figure 1 shows the Landsat scene footprints and the coastal zone.

A total of 33 land cover classes were mapping (Figure 2). This was essentially the same classification scheme used for Vietnam, Cambodia and Thailand, with two additions – a "Transitional/Bare" class and a "Freshwater Aquaculture" class. The former is associated with drainage schemes whereby shallow coastal waters are reclaimed for agriculture, while the latter accommodates a very extensive network of freshwater aquaculture ponds to the west of Yangon.

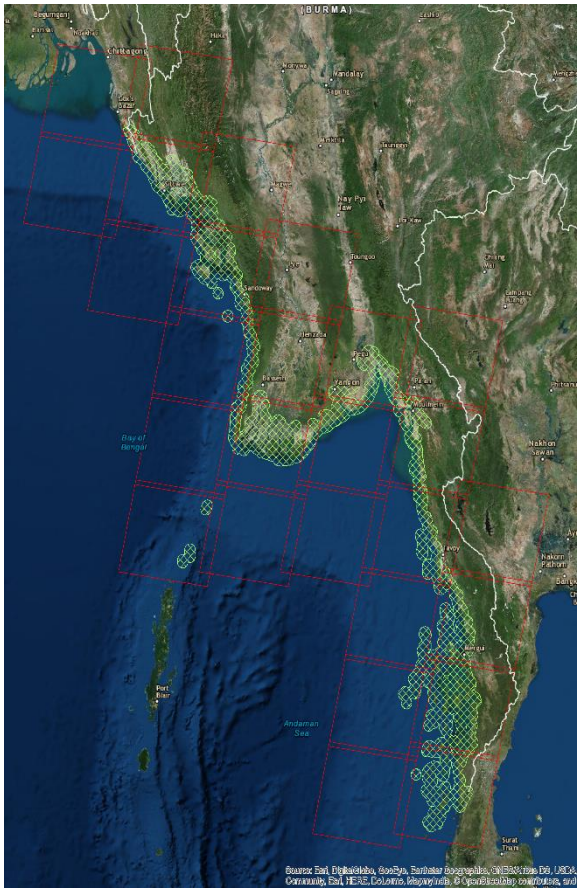

Figure 1 The coastal zone of Myanmar (cross-hatched) with the Landsat scene footprints.

Figure 3 The classification scheme

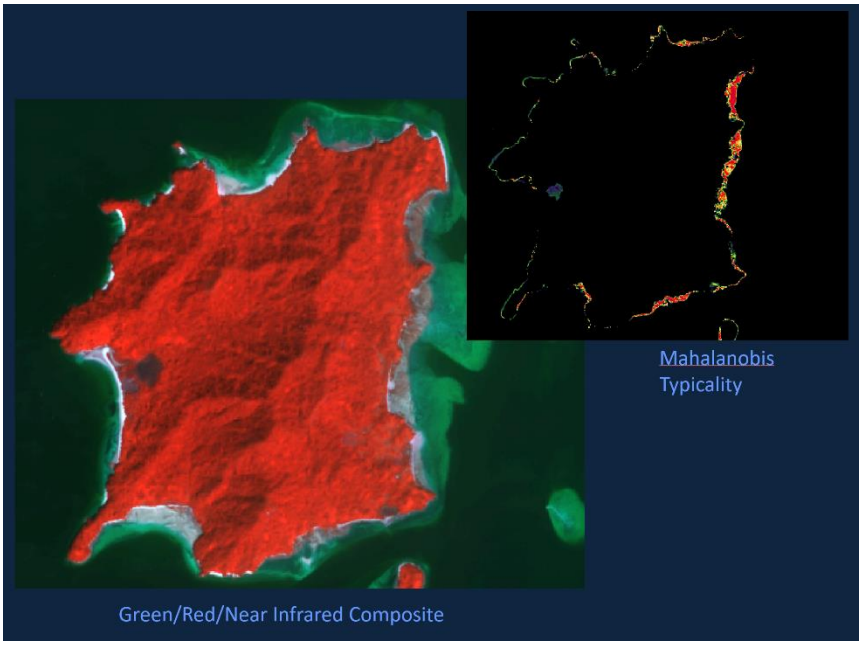

Figure 2 An illustration of the Mahalanobis Typicality output (in this case for the mapping of coral)

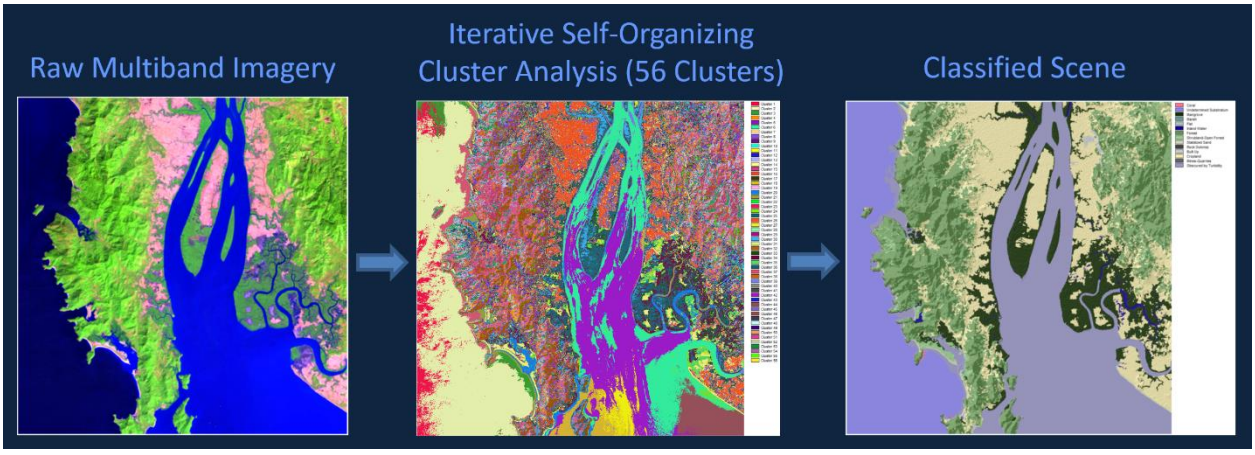

Figure 4 An illustration of the ISOCLUST procedure

Classification of the imagery was handled differently for marine and land classes. For marine classes a supervised procedure known as a Mahalanobis classifier (Foody, 1992) was used. Within each image, the analyst delineates polygons around some examples of specific classes. The Mahalanobis classifier then computes a probability image known as a *typicality* that indicates for each pixel how typical it is of the class it was trained on. Figure 3 illustrates the output. This would then be thresholded to yield a hardened class. This is the only classifier that is capable of mapping a single class at a time.

For land classes, a different approach was used. The ISOCLUST procedure in TerrSet was used (Eastman, 2014). ISOCLUST is an iterative hybrid supervised/unsupervised classifier. In the first stage it uses a histogram peak technique to yield a large set of clusters in the spectral response patterns of pixels. It then presents to the analyst a histogram of the relative frequency of occurrence of each cluster. The analysis then looks for significant breaks in the histogram to decide on the number of clusters to keep. Typically this was a large number – around 50-100. The procedure then calculates the mean reflectance of each cluster as well as the variance and covariance between bands. This is then submitted to a Maximum Likelihood classifier, which redefines the cluster. This calculation of cluster statistics and reclassification is repeated 3 times. The end result is a large number of well-defined clusters. The analyst then inspects the original imagery to label the identity of each cluster. The clusters are subsequently reclassified into the final scheme. Figure 4 illustrates this process.

Accuracy Assessment

After all scenes were classified and the results mosaicked, an accuracy assessment was undertaken in the same manner as for Vietnam, Cambodia and Thailand (Eastman et al., 2015). In total, 3600 points were randomly located, with 2/3 falling within 2.6 km from the coast and 1/3 falling farther inland up to the limits of the coastal zone. These points were located using Google Earth and independently interpreted to compare with the mapped categories. The standard that was set in Vietnam, Cambodia and Thailand was 85% accuracy for primary categories (mangrove, integrated mangrove-shrimp and pond aquaculture) and 70% for other categories. Table 1 indicates the results as an error matrix while Table 2 summarizes the Producer's, User's and Overall accuracy. Producer's accuracy measures the degree to which the map correctly captures what is in the environment (i.e., its completeness). User's accuracy indicates the reliability of the information as mapped. Overall accuracy is simply the average of the two. As there was so little pond aquaculture, only 9 of the 3600 points fell on pond aquaculture and all were correctly mapped. For mangroves, the overall accuracy was 96%, with 95% of points that were truly mangrove being correctly mapped (producer's accuracy) and 97% of points mapped as mangrove being truly mangrove (user's accuracy). All categories met the project standards in overall accuracy.

Table 1 Error matrix associated with the accuracy assessment

		Truth																	User's
		Pond Aq	Fresh Aq	Mangrove	Marsh	Flat	Inl. Water	Forest	Shrub	Un. Sand	St. Sand	Outcrop	Trans/Bare	Salt	BuiltUp	Cropland	Clouds		Accuracy
	Mapped	11	16	31	33	34	36	41	42	51	52	53	54	61	62	63	71	Total	
Pond Aquaculture	11	9																9	100.00%
Fresh Water Aquaculture	16		12															12	100.00%
Mangrove	31			548			1	3	2				5			5		566	96.82%
Marsh	33				8				2									10	80.00%
Flat	34			1		108	1						3			2		115	93.91%
Inland Water	36			3			139						3		1	3		149	93.29%
Forest	41			10				742	12	1			4		1	29		799	92.87%
Shrubland and Open Forest	42			1			1	4	61							2		69	88.41%
Sand/Unconsolidated	51			1						30					1	1		33	90.91%
Stabilized Sand	52										1							1	100.00%
Rock Outcrop	53							1				3						4	75.00%
Transitional/Bare	54			2		1	3	1	1				105			1		114	92.11%
Sea Salt Production	61													7		1		8	87.50%
Built Up	62								2						47	2		51	92.16%
Cropland	63		1	9	1	1	9	42	17	4			7		16	1553		1660	93.55%
Obscured by Clouds/Smoke	71																1	1	100.00%
	Total	100.00%	92.31%	95.30%	88.89%	98.18%	90.26%	93.57%	62.89%	85.71%	100.00%	100.00%	82.68%	100.00%	71.21%	100.00%	100.00%	3600	
	Producers																		
	Accuracy	100.00%	92.31%	95.30%	88.89%	98.18%	90.32%	93.57%	62.89%	85.71%	100.00%	100.00%	82.58%	100.00%	71.21%	97.06%	100.00%		93.72%

Table 2 Summary of Producer's, User's and Overall Accuracy

	Producer's	User's	Overall
Pond Aquaculture	100.00%	100.00%	100.00%
Fresh Water Aquaculture	92.31%	100.00%	96.15%
Mangrove	95.30%	96.82%	96.06%
Marsh	88.89%	80.00%	84.45%
Flat	98.18%	93.91%	96.05%
Inland Water	90.26%	93.29%	91.77%
Forest	93.57%	92.87%	93.22%
Shrubland and Open Forest	62.89%	88.41%	75.65%
Sand/Unconsolidated	85.71%	90.91%	88.31%
Stabilized Sand	100.00%	100.00%	100.00%
Rock Outcrop	100.00%	75.00%	87.50%
Transitional/Bare	82.68%	92.11%	87.39%
Sea Salt Production	100.00%	87.50%	93.75%
Built Up	71.21%	92.16%	81.68%
Cropland	100.00%	93.55%	96.78%
Obscured by Clouds/Smoke	100.00%	100.00%	100.00%

Area Statistics

Table 3 summarizes the area of mangrove and pond aquaculture (excluding freshwater aquaculture) by region/state. In total, 130.57 km^2 of pond aquaculture was found in Myanmar in 2014, with most of that being extensive aquaculture in northern Rakhine state. More intensive pond aquaculture was restricted to Kyauktan near Yangon (with a mix of shrimp and crabs), and just north and east of Nwe Saung (shrimp) on the coast of Pathein District and near Myeik (crab) in Tanintharyi. Some remnant operations also exist along the heavily cyclone damaged coast of Ayeyarwadi, and appear to be mostly shrimp with extensive cultivation. Country-wide, 6000.56 km^2 of mangrove were found, with the bulk occurring in Tanintharyi, followed by Rakhine.

Table 3 Area of Pond Aquaculture and Mangrove by Subdivision in Myanmar 2014

Subdivision	Pond Aquaculture	Mangrove
Ayeyarwady Region	4.02	1533.88
Bago Region	0.00	11.23
Kayin State	0.00	0.00
Mon State	0.96	164.40
Rakhine State	83.16	1577.03
Tanintharyi Region	5.16	2685.73
Yangon Region	37.27	28.24
Myanmar Total	130.57	6000.50

References

Eastman, J.R., (2014) TerrSet Geospatial Monitoring and Modeling System (Worcester, MA: Clark University).

Eastman, J.R., Crema, S.C., Sangermano, F., Cunningham, S., Xiao, X., Zhou, Z., Hu, P., Johnson, C., Arakwiye, B., and Crone, N., (2015) "Aquaculture and Coastal Habitats Report No. 1: A Baseline Mapping of Aquaculture and Coastal Habitats in Thailand, Cambodia and Vietnam", (Clark Labs, Worcester, MA).

Foody, G.M., Campbell, N.A., Trodd, N.M., and Wood, T.F., (1992) Derivation and Applications of Probabilistic Measures of Class Membership from the Maximum Likelihood Classification, Photogrammetric Engineering and Remote Sensing, 58, 9, 1335-1341.