



Know the Earth...Show the Way

Image Quality Evaluation of QuickBird Super Resolution and Revisit of IKONOS

Civil And Commercial Application Project (CCAP)

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High Spatial Resolution Commercial Imagery Workshop

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► Study Objectives

- Determine the National Imagery Interpretability Rating Scale (NIIRS) for:
 1. Space Imaging IKONOS Revisit
 2. DigitalGlobe QuickBird Super Resolution

► Evaluation Process

- Prepare plan
- Define variables
- Collect materials
- Develop evaluation capabilities
- Perform pilot evaluation
- Perform evaluation
- Analyze data
- Prepare briefing
- Publish brief



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IKONOS Revisit

► Background

- IQ&U assessed IKONOS pan imagery in the fall of 2000
 - 46 chips from 24 images
 - Average GSD: 0.93 meters (36.6 inches)
 - Average NIIRS 4.65
- Data was re-analyzed because new outlier procedures had been established
 - Two IAs were removed as outliers that were not removed in the previous analysis
 - Average NIIRS under this new analysis is 4.49 ± 0.19 (95% confidence)
 - Confidence bounds assumes IAs are random effects as opposed to fixed effects

► Objective of Revisit

- To re-assess the quality of IKONOS imagery to determine if there had been a change over time

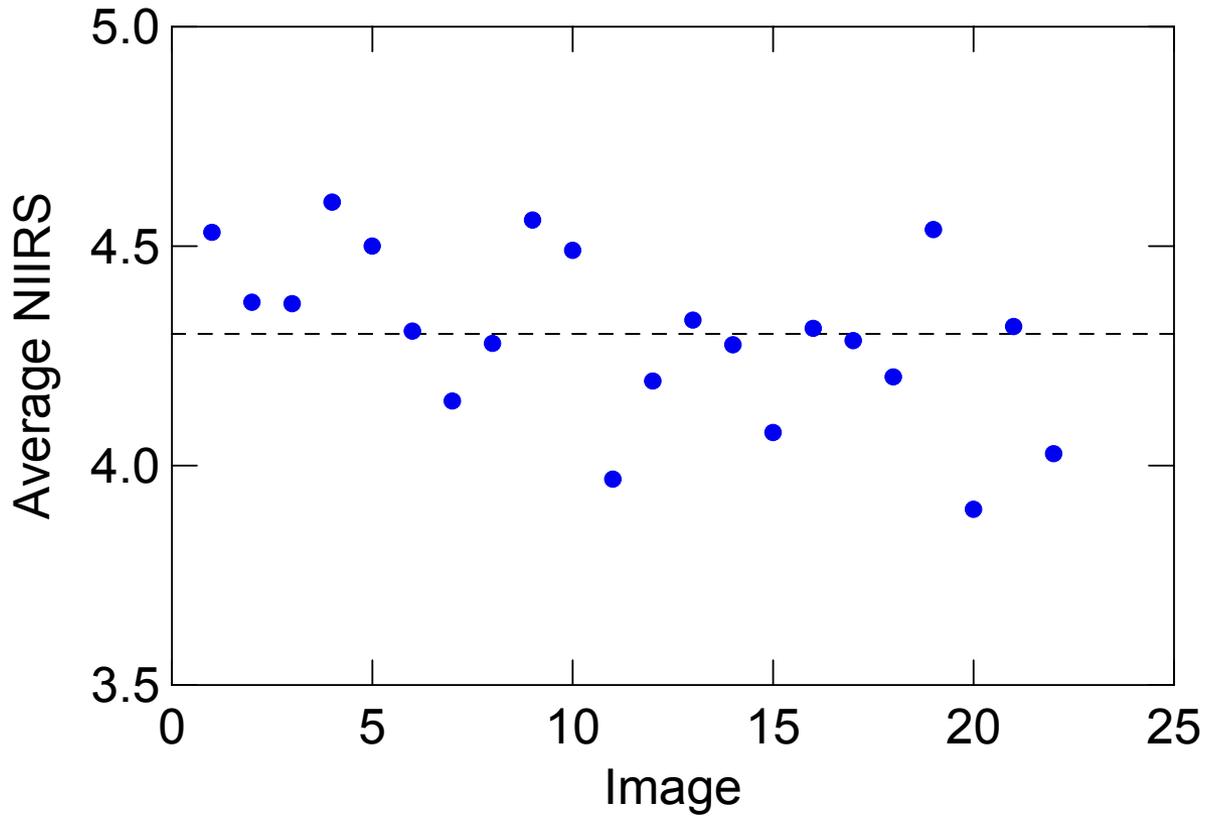
► Experimental Design

- 10 Imagery Analysts
- 22 Images
 - One to five sub-scenes extracted from each image
 - Total of 68 chips
 - GSD from 0.82 (best) to 0.995 meters (32 to 39 inches)
 - Average GSD = 0.89
 - Various OBs (A, C, G, I, N)
- Absolute NIIRS Ratings

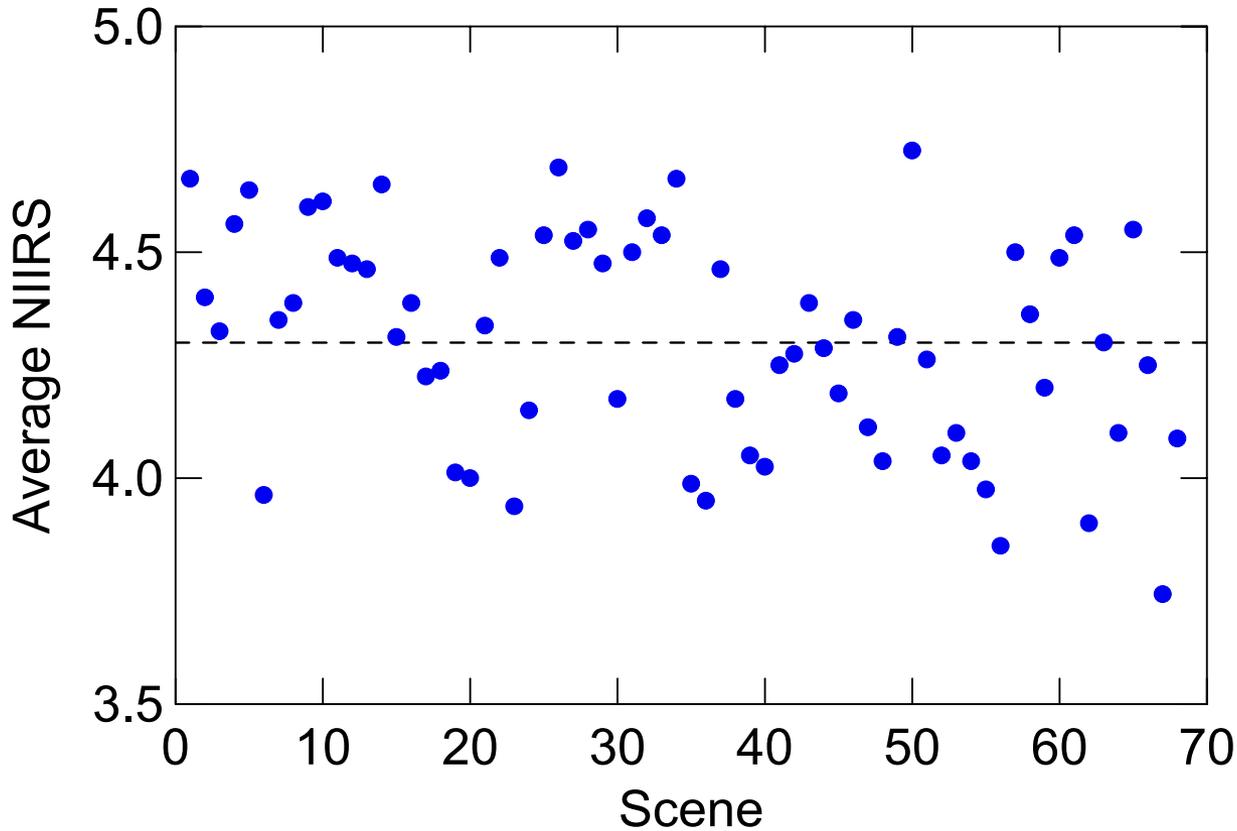
► Outlier Analysis

- Calculated Bias and RMSE for each IA
 - Remove IAs that exceed thresholds
- Examine individual ratings to identify possible outliers
- Results
 - Two IAs removed from the analysis and one additional rating was identified as an outlier and also removed from the analysis

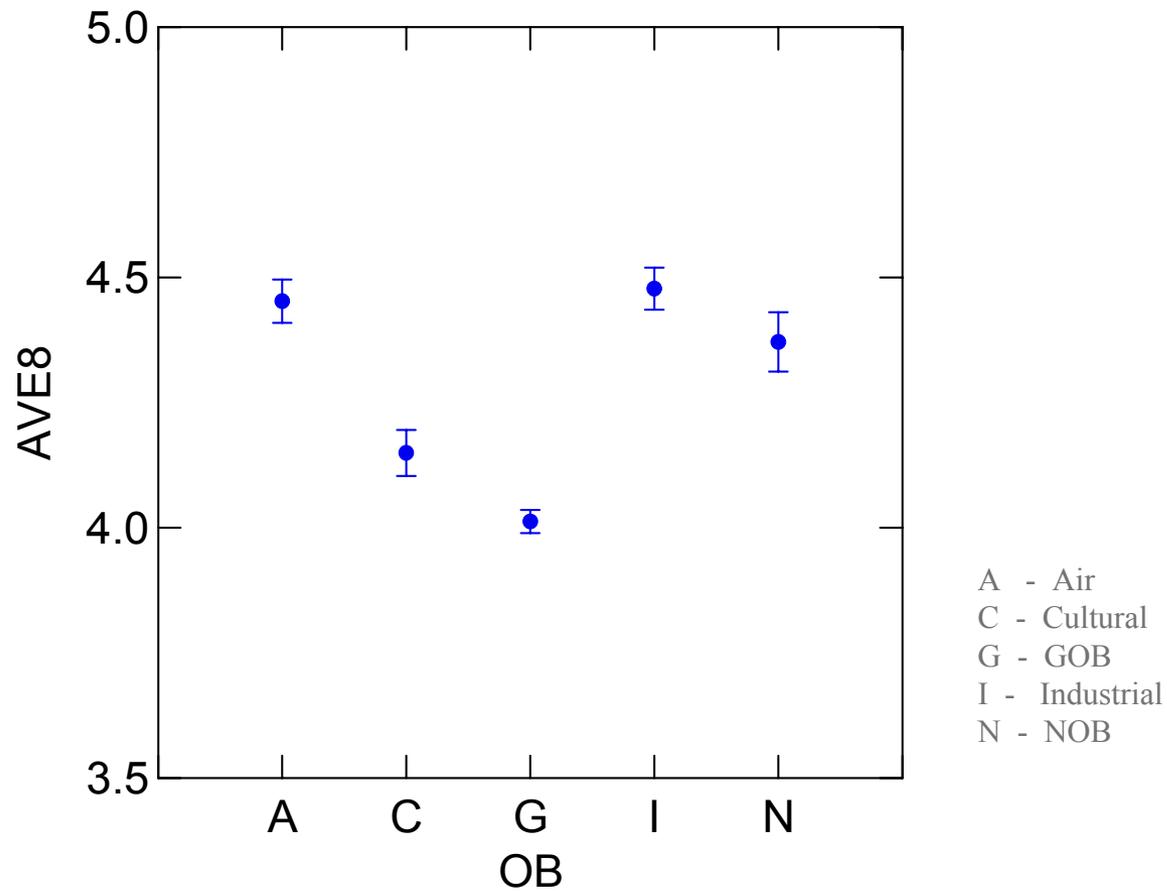
► Average NIIRS by Image Scene n=22



► Average NIIRS for Image Chips n=68



► Average NIIRS by OB



► Comparison with Previous Evaluation

- Average NIIRS
 - 1st Evaluation (2000): 4.49 ± 0.187
 - 2nd Evaluation (2003): 4.30 ± 0.155
- Difference not significant at the 0.05 level

► Conclusions

- While average NIIRS rating was smaller than previous evaluation, difference not statistically significant
- Conclude that IKONOS panchromatic image quality has not changed between 2001 and 2003



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QuickBird Super Resolution

► Purpose of Evaluation

- DigitalGlobe developed an algorithm for processing a Super Resolution imagery product
- NGA Commercial Imagery Office requested NGA IQ&U evaluate the Super Resolution product

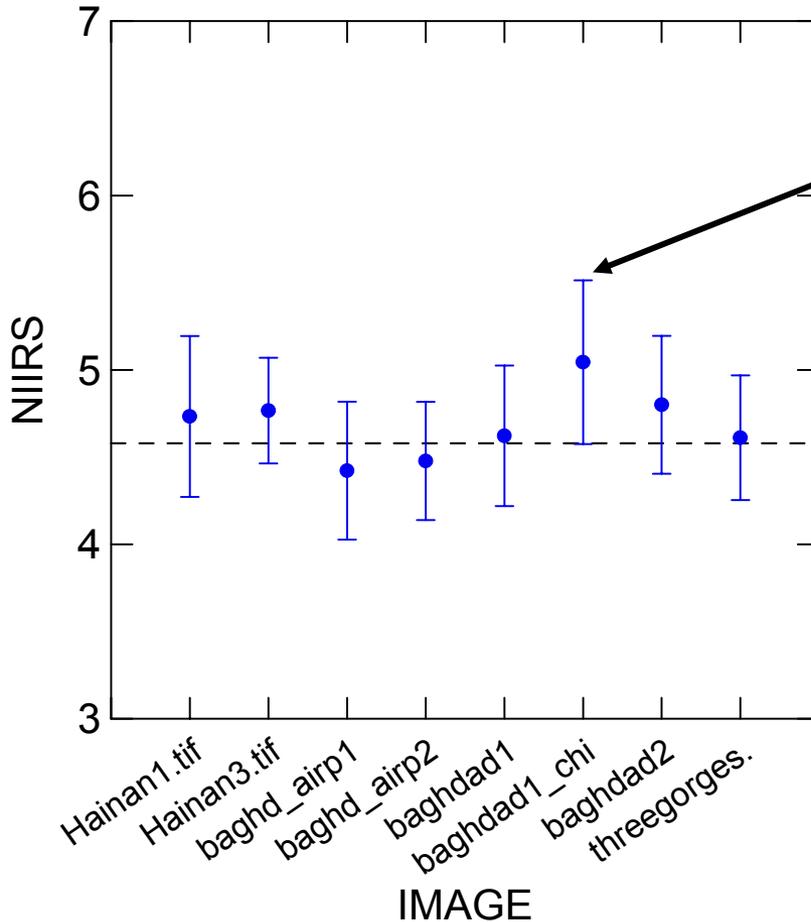
► Background of Original QuickBird Evaluation

- 10 Imagery Analysts (IAs)
- 53 Images
 - 28 Pan (Basic 1B)
 - 10 MSI (Basic 1B)
 - 15 Pan Sharpened MSI (Standard 2A)
 - One to five sub-scenes extracted from each image
- Total of 213 chips
- All images at near-nadir collection geometry
 - Pan and Pan-Sharpended: GSD between 0.62 and 0.7 meters (24.4 – 27.6 inches)
 - MSI: GSD = 2.54 meters (100 inches)

► Super Resolution Experimental Design

- 9 IAs
- 8 scenes re-processed two ways
 - Original
 - Super Resolution
- Each IA
 - Absolute NIIRS rated the regular scenes
 - Delta NIIRS rated the original against the Super Resolution product

► Average Absolute NIIRS by Image (IA #4 removed from analysis)



2 standard deviations

Average NIIRS = 4.57 (\pm 0.10)

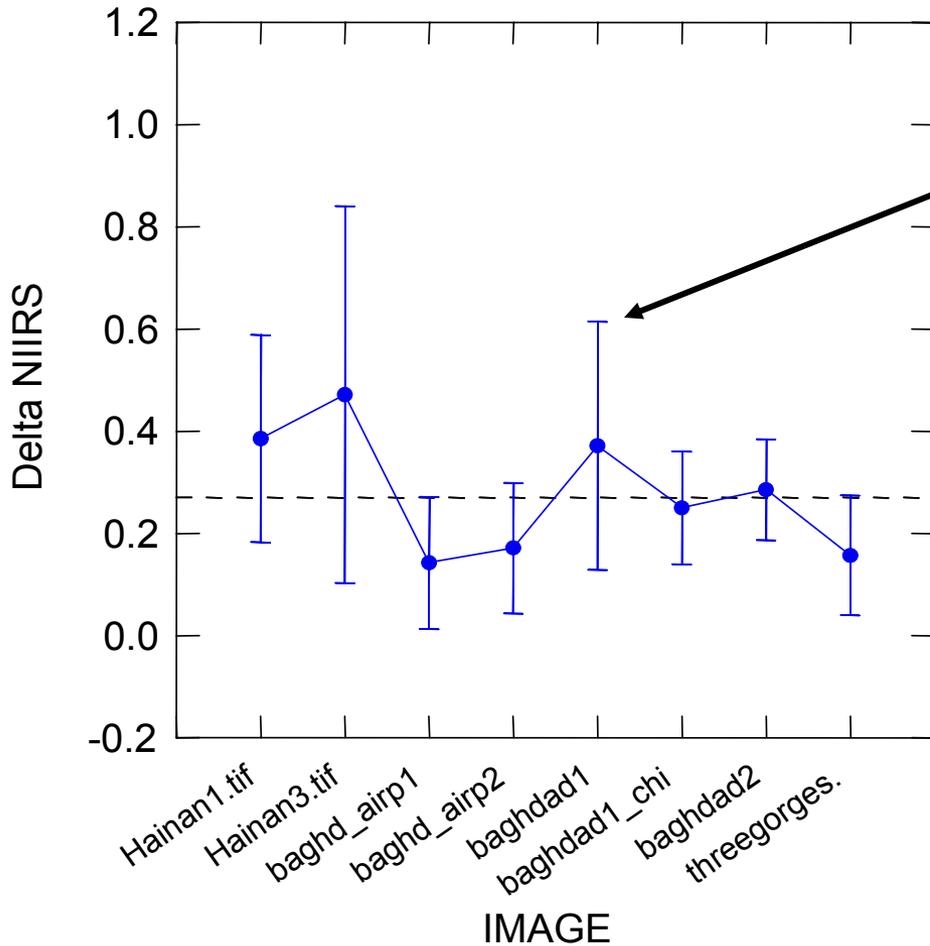
95% confidence interval for the Average is \pm 0.10 NIIRS

► Outlier Analysis

Absolute NIIRS

- IA NIIRS ratings examined for outliers by
 - Correlation analysis
 - Bias
 - Needs to be less than 0.45 in absolute value
 - RMSE
 - Needs to be less than 0.75
- Based upon this analysis, IA #4 responses were identified as being different from the remaining IAs and these data were removed from the analysis

► Delta NIIRS by Image (IAs #6 and #8 removed)

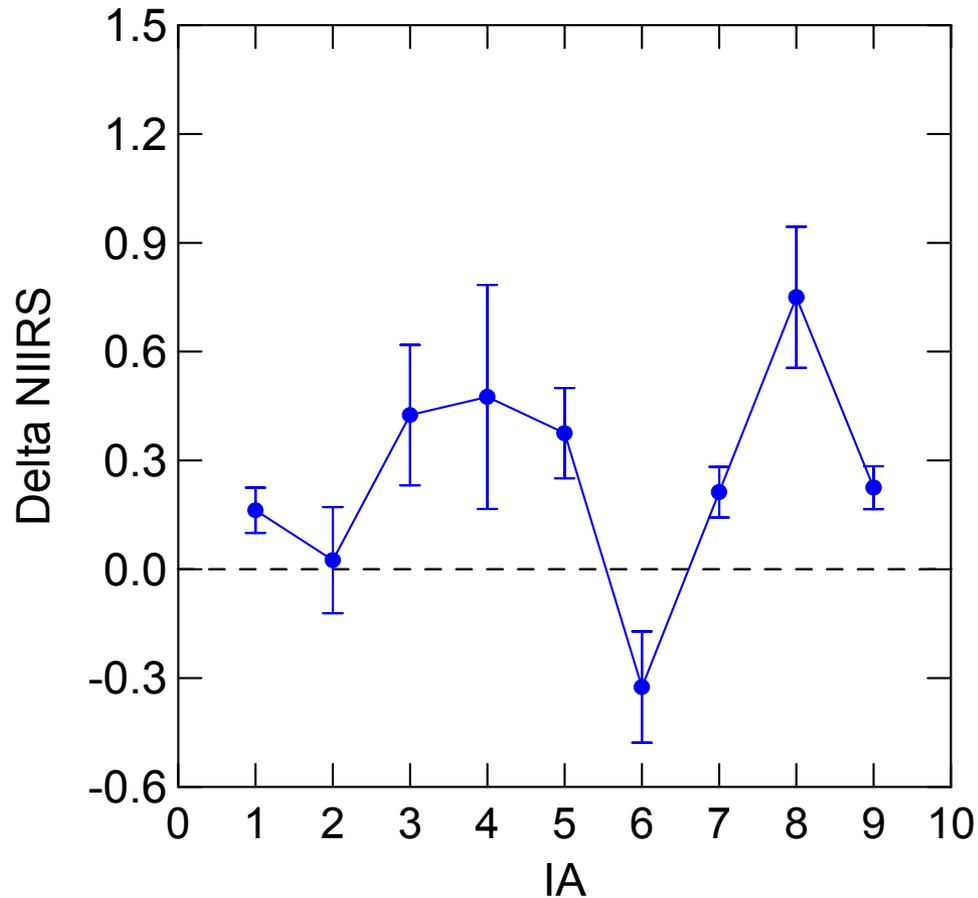


2 standard deviations

Average Delta NIIRS = 0.27 ± 0.063

95% confidence interval for the Average is ± 0.063 NIIRS

► Average Delta NIIRS by IA (IAs #6 and #8 removed)



IA #6 is only IA to not prefer the super resolution image

► Outlier Analysis

Delta NIIRS

- IA Delta NIIRS ratings examined for outliers by:
 - Average Delta NIIRS
 - Correlation analysis
 - Bias (No threshold established)
 - RMSE (No threshold established)
- Based upon this analysis, IAs #6 and #8 responses were identified as being different from the remaining IAs and these data were removed from the analysis

► Conclusions

- All but one IA preferred the Super Resolution product when compared to the original product
- Average Delta NIIRS improvement (after outlier analysis) was 0.27
- Average Delta NIIRS is statistically different from zero at the 0.01 level of significance

► QB Super Resolution

Three Gorges



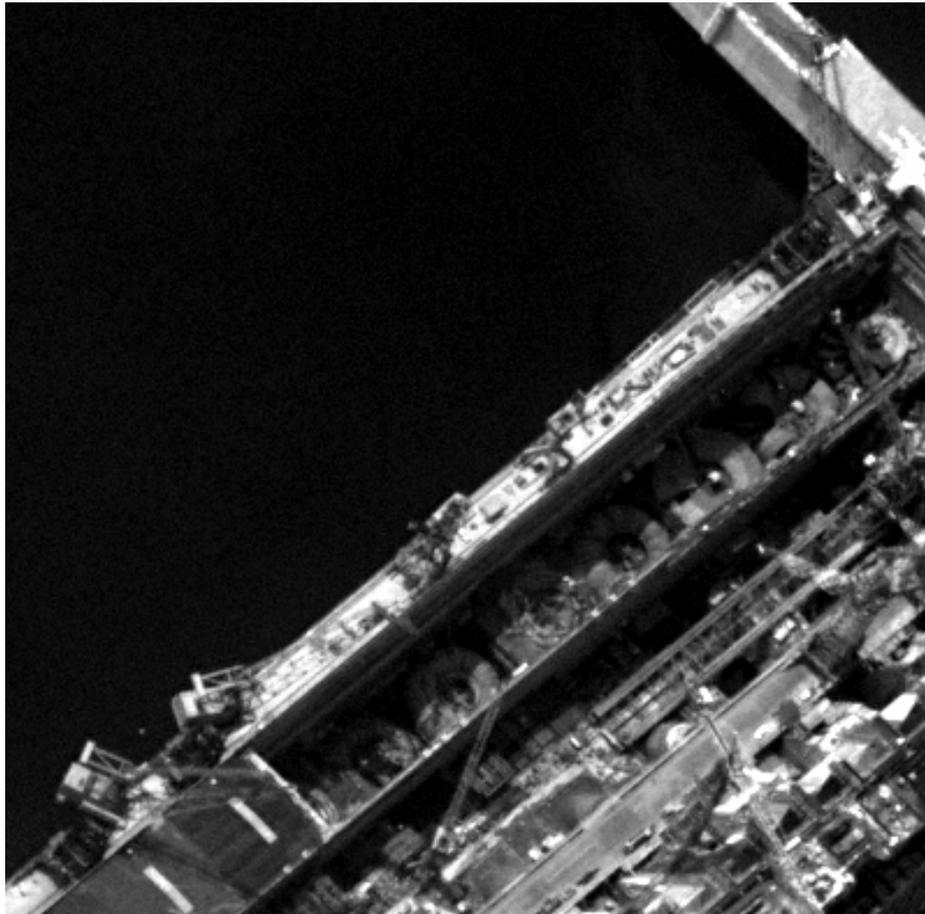
Standard Product



Super Resolution Product

► QB Super Resolution

Three Gorges



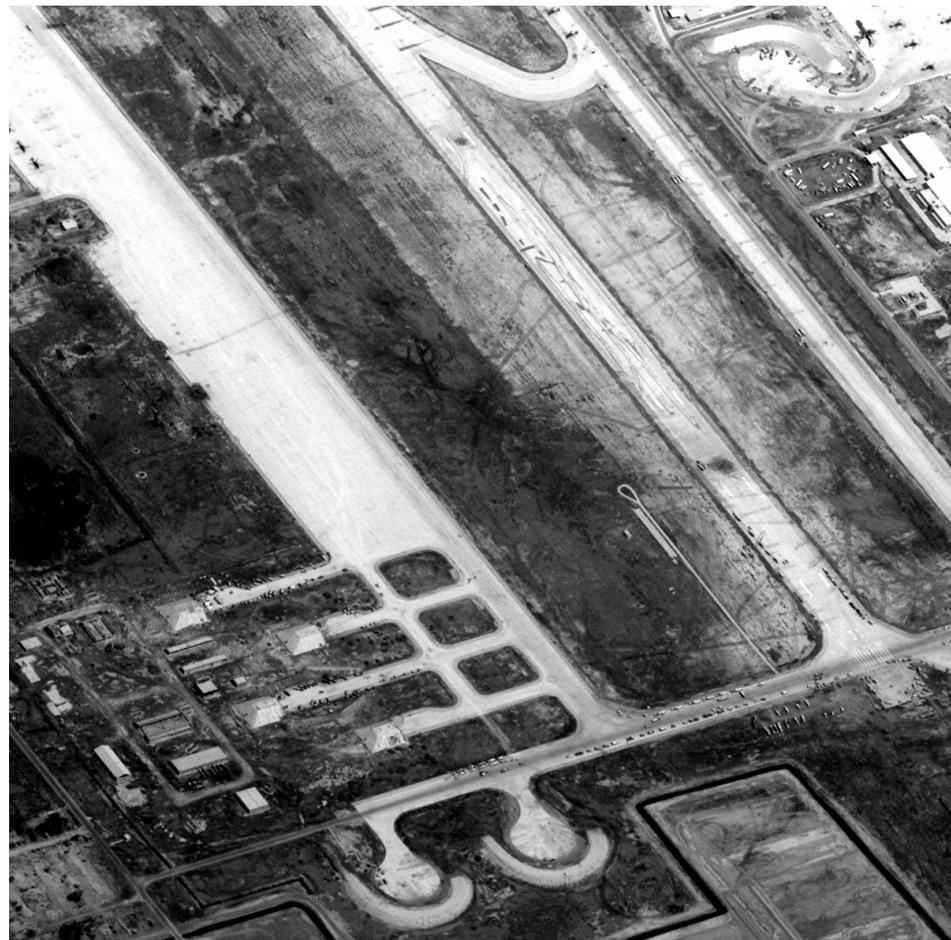
Standard Product



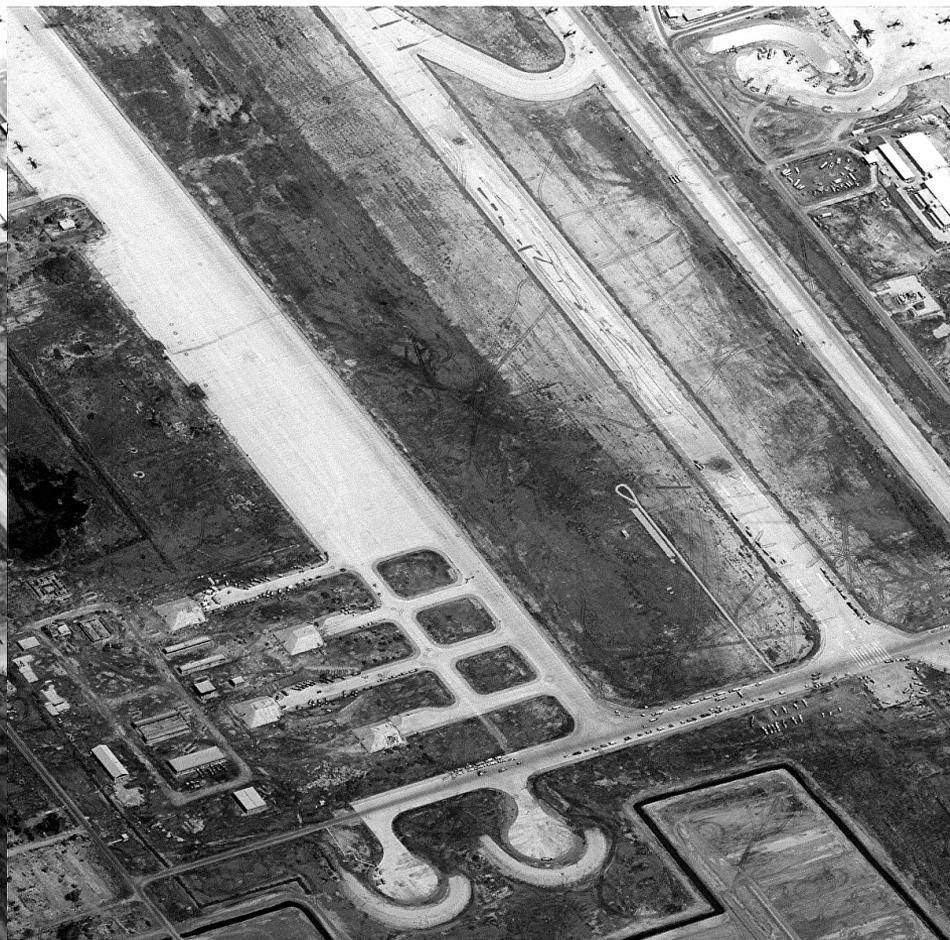
Super Resolution Product

► QB Super Resolution

Baghdad Airport1



Original Product



Super Resolution Product

► QB Super Resolution

Baghdad Airport1



Original Product



Super Resolution Product

► QB Super Resolution

Hainan1



Original Product



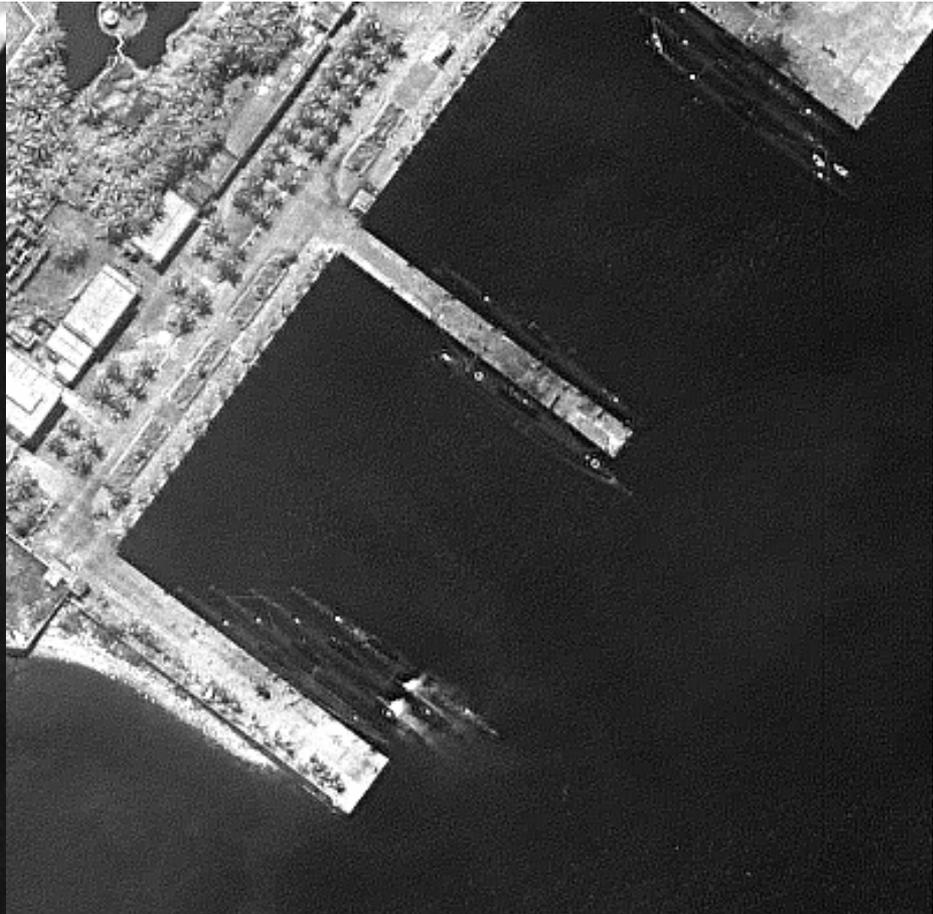
Super Resolution Product

► QB Super Resolution

Hainan1



Original Product



Super Resolution Product

▶ CCAP Team

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- Additional Support
 - Image Quality & Utility Branch (AEAI)
 - Leigh Harrington, Statistician (AEAI)
 - Community IAs

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