



Remote Sensing Metrics

India Mining Project Princeton University



RS
Metrics

Objectives

- **Princeton University is interested in measuring growth, activity and change at selected mines and mining regions to better determine how the amount of legal and illegal mining increases or decreases as a result of various overhauls of the royalty regime for certain minerals. Official mining data published by the Indian government is lacking.**
- **Illegal mining is rampant throughout the industry, including (1) mines that are undetected in official documents (rare, limited mostly to surface grading for gold in particular areas) and (2) mines where the extent of the mine and surface mining has not been approved (bauxite, iron, manganese, coal).**
- **Locations of interest are 18 states in India listed on page 4 of this proposal.**
- **Primary timeframes of interest are surrounding government interventions including major overhauls of the royalty regime in 2005, 2007 and 2009 for certain minerals, and another overhaul in 2011.**
- **While the initial project will be a one-time historical analysis, Princeton University will continue to monitor new regulation bills in India coming up over the next few years, and RS Metrics can track the impact of those bills quarterly, annually, or as needed.**

Approach

- **RS Metrics has already identified several bauxite, iron, coal, and manganese mining sites in India located within the 18 states of interest, and will work with Princeton University to develop a complete list of locations.**
- **Historical satellite imagery is available for most of these locations. Please see attached spreadsheet for available imagery.**
- **Using historical satellite imagery analysis from 2004 to 2014, RS Metrics will measure activity, change and growth over time for selected mines and mining regions within these 18 states:**
 - Each satellite image measures mining site areas, trucks & other site activity.
 - Focus is on growth of mine areas surrounding 2005, 2008, 2011, and 2014 for selected mines, and monitoring mining areas to detect whether any of the mines there are operating illegally.
 - Measurements for individual mine observations are tracked individually, and also combined into a statistical sample to measure overall growth over time.
- **Reports include:**
 - Trends in activity for each mine and the combined sample, showing monthly, quarterly, and year-over-year growth in mining site areas, trucks & other site activity.
 - All data with date and time stamps for each mine observation for further analysis.

Sample Mine Locations in the 18 Indian States of Interest

Mine Types By State

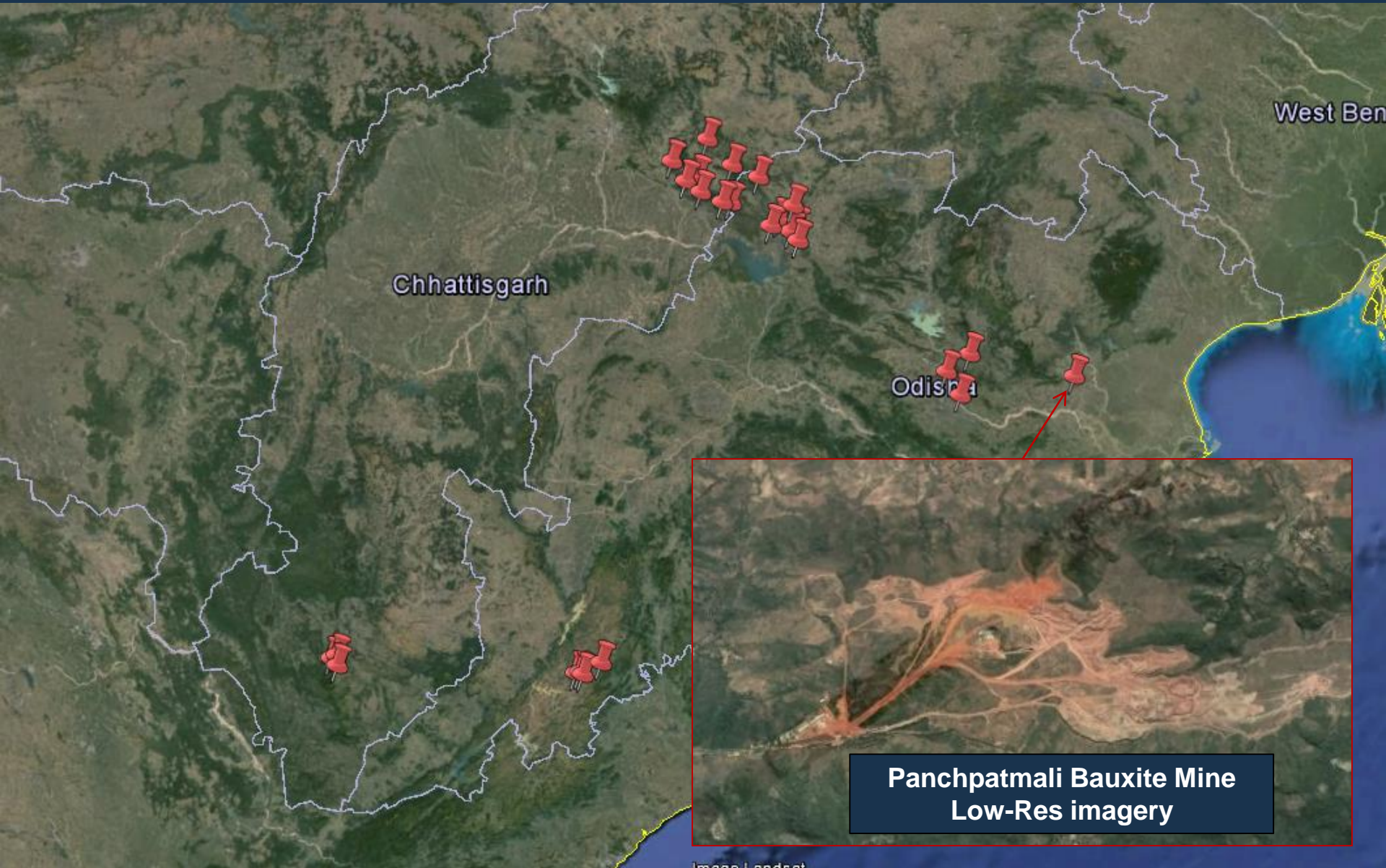
State	Bauxite	Iron	Coal	Manganese
Assam			5	
Andhra Pradesh		4		32
Chhattisgarh	4	11	55	
Goa	2	49		2
Gujarat	27			1
Jharkhand	14	17	173	3
Karnataka	1	61		19
Madhya Pradesh	26	4	74	25
Maharashtra	4	18	51	15
Orissa	3	49	23	40
Rajasthan				1
Tamil Nadu	3			
Uttar Pradesh	4		4	
Jammu and Kashmir			4	
West Bengal			101	
Meghalaya			1	
Total	88	213	491	138

The Red Pins represent a small portion of mines located in these states. We will work with you to identify and confirm the full list of mines for analysis.

Arabian Sea

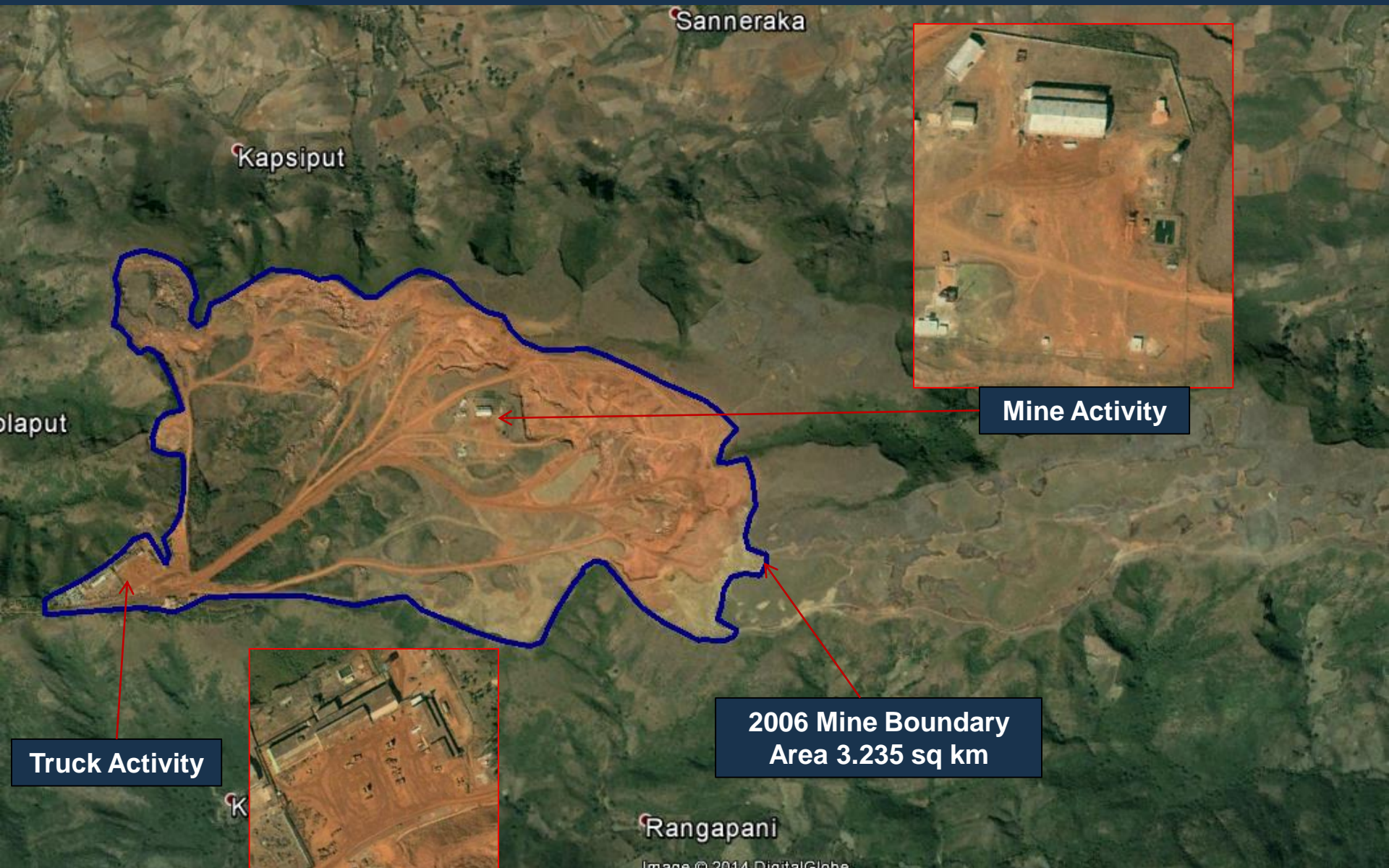
Odisha / Chhattisgarh, India (1 of 3)

Overview of Sample Locations



Panchpatmali Bauxite Mine, Odisha, India (2 of 3)

1/3/2008



Truck Activity

Mine Activity

2006 Mine Boundary
Area 3.235 sq km

Panchpatmali Bauxite Mine, Odisha, India (3 of 3)

11/23/2011



Madhya Pradesh / Jharkhand, India (1 of 3)

Overview of Sample Locations



Umdaur Mine, Madhya Pradesh, India (2 of 3)

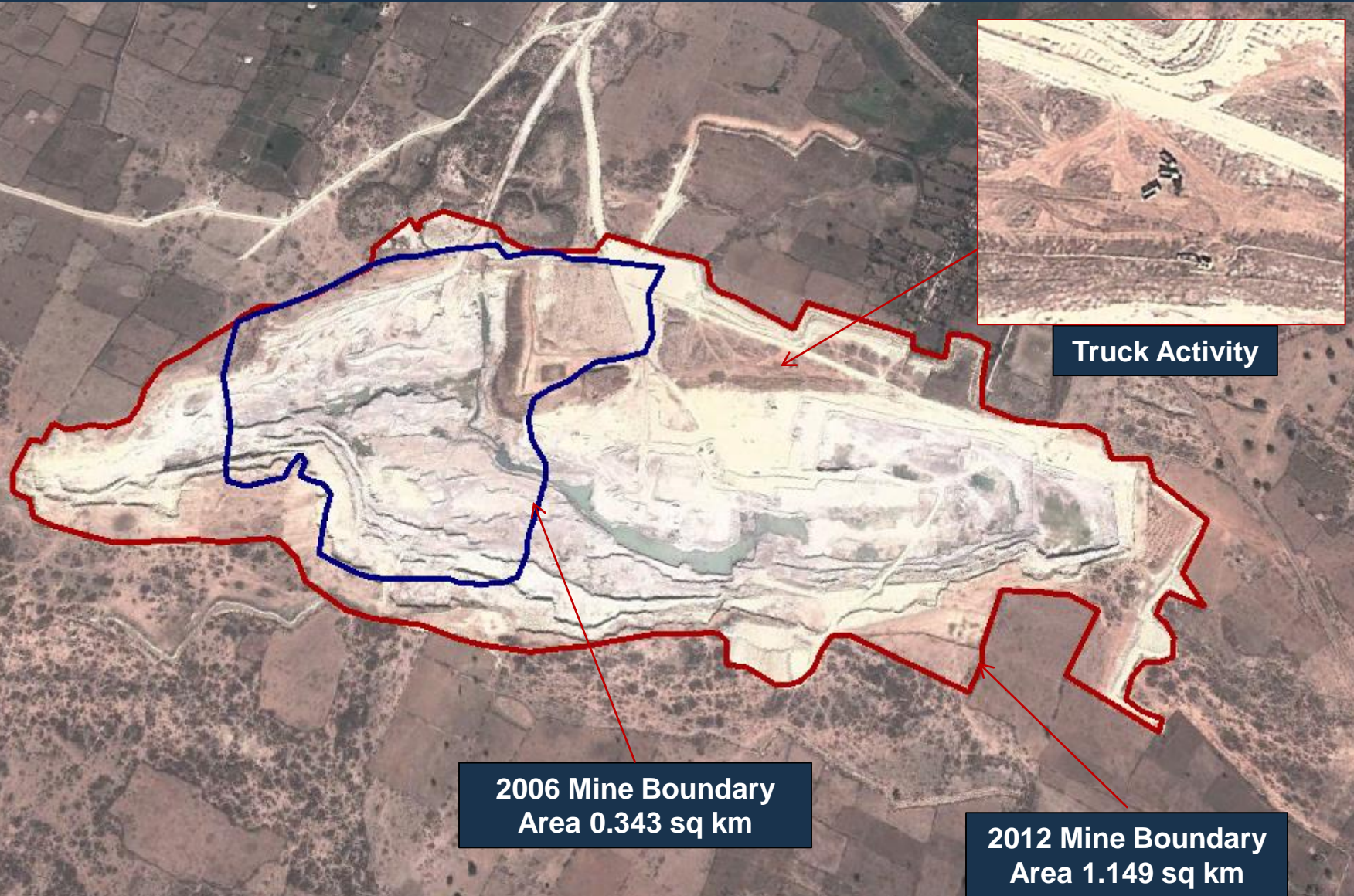
2/25/2006



**2006 Mine Boundary
Area 0.34 sq km**

Umdaur Mine, Madhya Pradesh, India (2 of 3)

2/19/2012

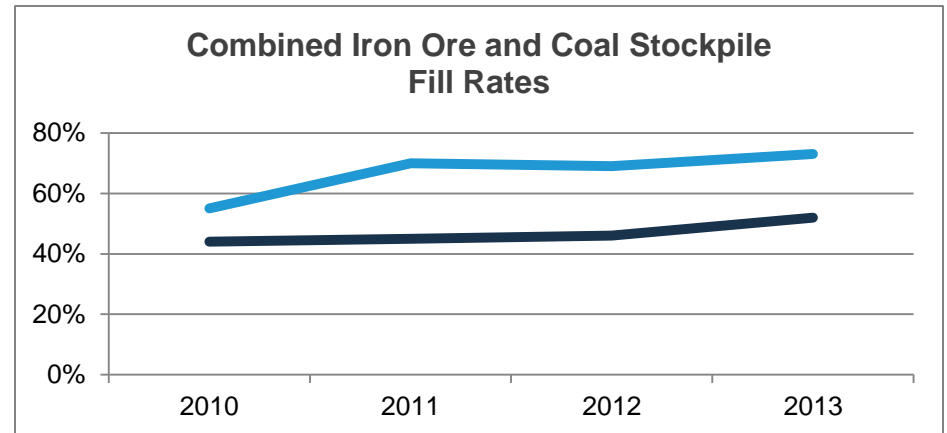
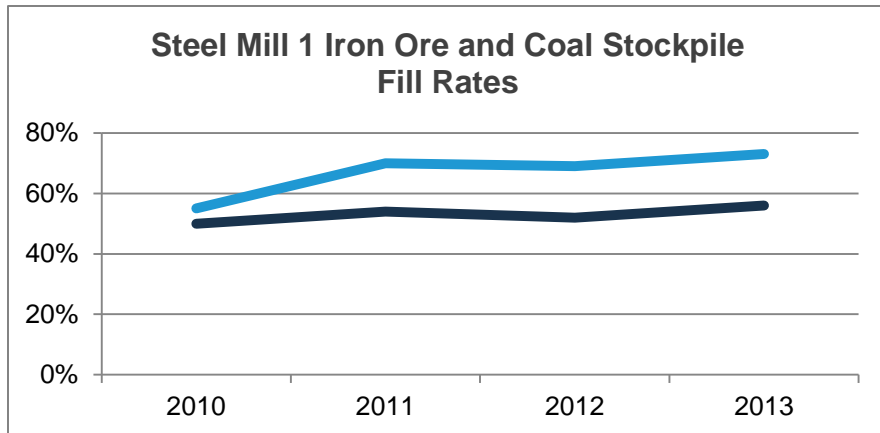


Monthly Reports Include Trends for Each Mine Over Time, and Combined Growth for the Sample

Example summary results for two mines. Actual monthly reports will have data for all sites collected in the sample.

Location	Metric	2010	2011	2012	2013
Mine 1	Iron Ore Stockpile	50%	54%	52%	56%
	Coal Stockpile	55%	70%	69%	73%
Mine 2	Iron Ore Stockpile	34%	31%	37%	46%
	Coal Stockpile	51%	68%	67%	70%
TOTAL	Iron Ore Stockpiles	44%	45%	46%	52%
TOTAL	Coal Stockpiles	53%	67%	66%	71%

Charts show trends for each site and all sites combined.



Timing and Investment

- **Upon your approval, we will begin historical analysis covering the selected India mines and mining regions over the selected timeframes.**
- **Historical reports will require time to deliver due to the large number of observations to process. We can deliver the go-forward reports much faster because they will include smaller numbers of observations collected over each 2-week period.**
- **With your approval in the next week, we are targeting delivery of historical data and results by the end of April.**
- **Professional fees for the historical analysis as described will be a total of \$30,000. For projects of this type we customarily invoice for all professional fees at project kick-off.**

Summary and Next Steps

- **Confirm all mine locations within each state and identify which specific mines and mining regions for analysis.**
- **Discuss options for imagery analysis (what to track), frequency of observations, frequency of report delivery, and data formats.**
- **Discuss ideas for using historical imagery to show changes before/after specific date periods.**

Contact us for more information

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