

# The Science and Art of Cat Modeling – A Case Study of Thailand Flood

**Adityam (Adi) Krovvidi**  
Head of Impact Forecasting Asia Pacific

17<sup>TH</sup> EAST ASIAN ACTUARIAL CONFERENCE  
15-18 October 2013, Singapore

Picture source: US Marine Corps



## Agenda

---

1. Introduction
2. Hazard Model
3. Industry Exposure and Claims
4. Vulnerability Model
5. Financial Model
6. Uncertainties



Impact Forecasting

1



## Agenda

1. Introduction
2. Hazard Model
3. Industry Exposure and Claims
4. Vulnerability Model
5. Financial Model
6. Uncertainties



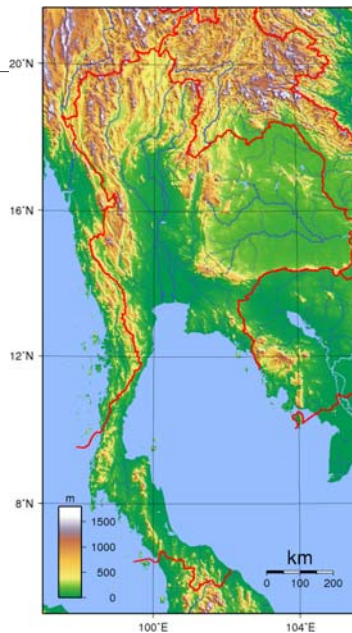
Impact Forecasting

2

**AON** BENFIELD

## Introduction – Model Overview

- No flood risk model before 2011 floods
- The new model helps RI placements and underwriting
- Fully probabilistic nationwide model for insurance market
  - Full range of Insured loss estimates
  - Quantification of uncertainty
  - Implemented on ELEMENTS 8 platform
- LoBs: Industrial, Commercial, Residential
- Coverages
  - Industrial: Building, Machinery & Equipment, Furniture & Fittings, Stock and BI
  - Commercial: Building, Contents and BI
  - Residential: Building and Contents
- Geocoding levels
  - Province or *changwat* (76)
  - District or *amphoe* (927)
  - Subdistrict or *tambon* (7255)
  - Grid cell 90m x 90m
  - Industrial estate (59)
- Incorporates learning from field studies
  - Conducted in Dec 2011 and August 2012



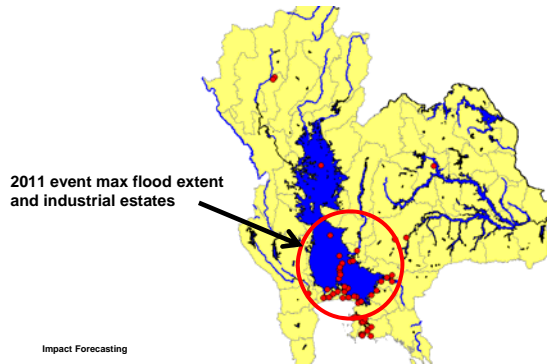
Impact Forecasting

3

**AON** BENFIELD

## Introduction – The Setting

- Thailand is 513,000 sq km and population is 64 mi
- Chao Phraya catchment is 159,000 sq km (31% of Thailand)
  - Bigger than Switzerland and Austria combined
- Eastern Thailand drains into Mekong river system
- 7<sup>th</sup> most flood prone country; never had major insurance loss
- Industrial sector 38.6% of GDP, largely export oriented
- Most industrial estates are in lower CP basin
  - Flat terrain with >100 km wide flood plain



## Introduction – Challenges to Model Flood

Good quality DTM

Detailed riverflow data

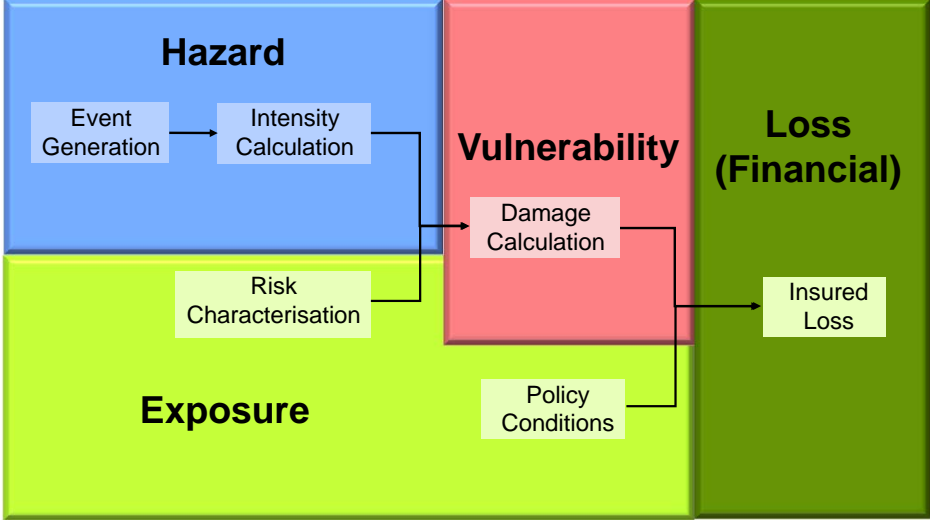
Flood defences

Human factors

Industry exposure and loss data

Local published research

Introduction – Cat Modeling Framework



Agenda

- 1. Introduction
- 2. **Hazard Model**
- 3. Industry Exposure and Claims
- 4. Vulnerability Model
- 5. Financial Model
- 6. Uncertainties



## Hazard Model

- Digital Terrain Model (DTM) – SRTM 90m
- Modeled river network: 1189 segments; 25,615 km long
- Hazard maps from JBA
  - 2D hydrodynamic modeling
  - Return periods: 5, 10, 20, 50, 100, 250 & 1500 yrs
- 10,000 stochastic events
  - Simulated from historical flow data of 139 gauge sites
  - One flood occurrence per year



Modeled river network

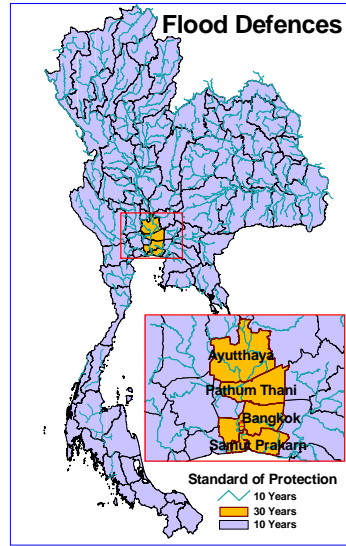
<Hazard map 250yr

## Hazard Model – Existing Flood Defences

- Significant impact on lower return period losses and AAL
- No publicly available info on standard of protection
- Relied on past studies and field observations
- Standard of Protection taken:
  - 10yr for all river segments
  - 30 yr for four provinces
  - 10 yr for rest of the provinces



Impact Forecasting Source: Panya Consultants



## Hazard Model – New Flood Defences

- Model provides an option to account for new flood protection measures
- RCC flood walls around 7 industrial estates damaged last year
- Few individual factories protected by concrete perimeter flood wall
- Data collected from field surveys
- Address information is needed to take benefit



Impact Forecasting

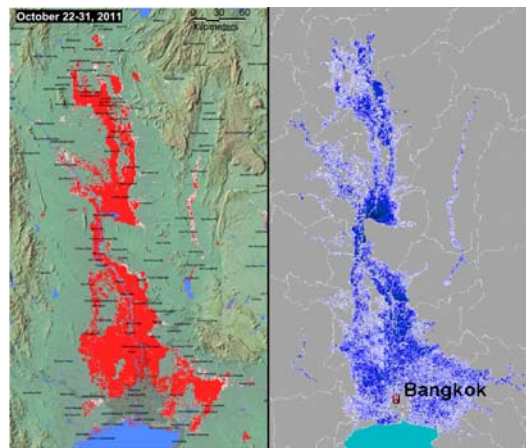
Flood defences: before and after 2011 flood

10

**AON** BENFIELD

## Hazard Model – Validation

- 2011 event is reconstructed in the model
- Modeled event is based on the observed riverflow data at various gauge sites
- Flood extents are generated by interpolating hazard maps



Source: Dartmouth Flood Observatory

Impact Forecasting

11

**AON** BENFIELD

## Agenda

1. Introduction
2. Hazard Model
- 3. Industry Exposure and Claims**
4. Vulnerability Model
5. Financial Model
6. Uncertainties



Impact Forecasting

12

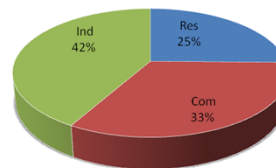
**AON** BENFIELD

## Industry Exposure and Claims Data

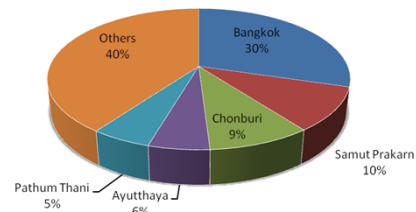
- Necessary for calibration and validation
- Thai market leader - Advantage Aon
- Industry exposure data (2011)
  - Covers 60% marketshare
  - Scaled to 100% = THB 8.2 tr (USD 265 bi)
  - Data by client by lob by province by coverage
  - Used in 2011 event as-if analysis and validation
- Loss adjuster reports from 2011 event
  - 100's of reports covering industrial, commercial and residential risks
  - Used in calibration of damage functions
- Claims data of 2011 event
  - 30+ treaty portfolios
  - Used in calibration of model

### Industry Exposure

THB 8.2 tr (USD 265 bn)



### Industry Exposure



Impact Forecasting

13

**AON** BENFIELD

## Agenda

1. Introduction
2. Hazard Model
3. Industry Exposure and Claims
- 4. Vulnerability Model**
5. Financial Model
6. Uncertainties



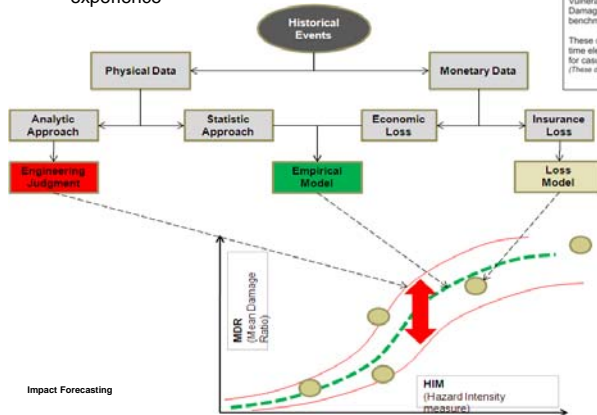
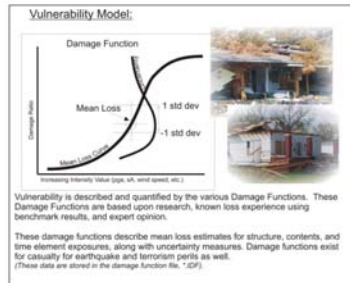
Impact Forecasting

14

**AON** BENFIELD

## Vulnerability Model – General Approach

- Challenging in this part of the world
  - No major research in South East Asia
- Detailed insurance loss data necessary
  - Thai flood provided unique opportunity
- Aon Benfield invested in an internal research project
  - An approach making best use of local and international experience



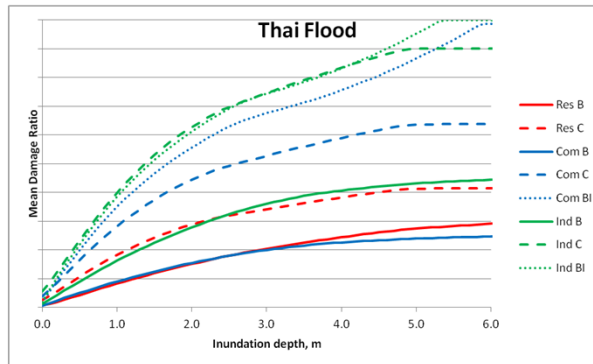
15

**AON** BENFIELD



## Vulnerability Model – Damage Functions

- Empirical curves from international studies
  - 4 EU and 4 Asian considered
  - Several damage functions integrated
- International DF are calibrated to get Thai DF
  - 2011 event loss adjuster reports used
  - Thai curves follow the same shape as intl.



Impact Forecasting

16

**AON** BENFIELD

## Agenda

1. Introduction
2. Hazard Model
3. Industry Exposure and Claims
4. Vulnerability Model
- 5. Financial Model**
6. Uncertainties



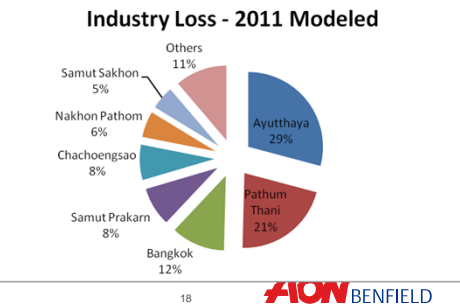
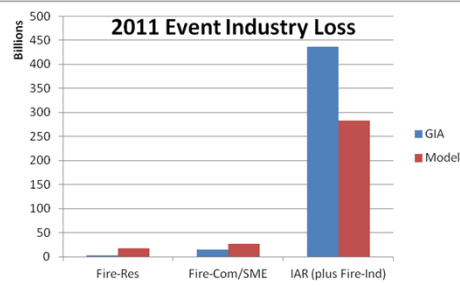
Impact Forecasting

17

**AON** BENFIELD

## Financial Model – Industry Loss Validation

- Model is validated against 2011 event
- Reported total industry loss from Office of Insurance Commission (OIC) is THB 482 bn (USD 15.5 bn)
  - General Insurance Association (GIA) reported USD 14.6 bn excluding BI loss
- Modeled loss is THB 351 bn (USD 11.3 bn) i.e. 73% of industry loss experience
- Why underestimation?
  - Part of the 2011 loss was man-made
    - Remember Katrina hurricane, dikes failure and underestimation by models
  - Thailand is prepared now!
- Industry loss geographic distribution
  - All provinces above 5% share are shown in chart

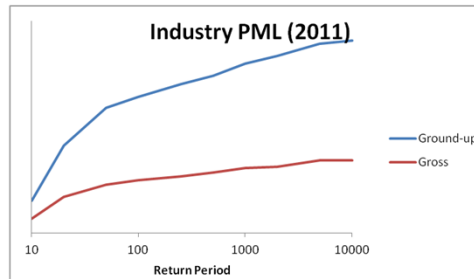


Impact Forecasting

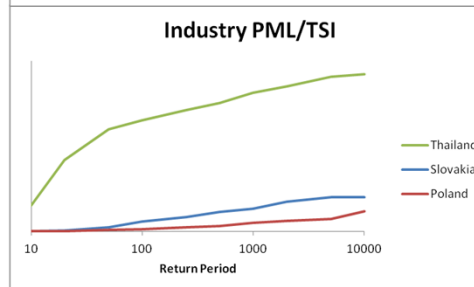
18

AON BENFIELD

## Financial Model – PML Results



- Ground-up corresponds to fire TSI
- Gross corresponds to flood exposure
  - 10% sub limit applied for flood



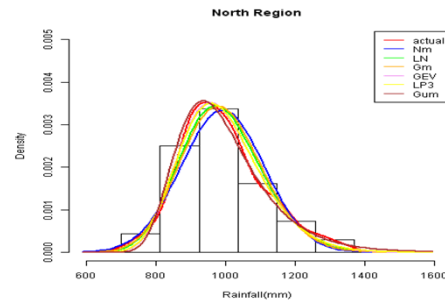
Impact Forecasting

19

AON BENFIELD

## What is the return period of 2011 event?

- Depends a lot on the:
  - event definition,
  - location, and
  - method
- Some idea based on the present work
  - Meteorological
    - Record monsoon rainfall of 1328mm since 1951 in northern region
    - 52 yrs by Gumbel distribution
  - Hydrological
    - Record riverflow by volume since 1956 at gauge station C2
    - 77 yrs by average of select distributions
  - Insurance loss
    - 150 - 250 yrs
    - Very sensitive to the modeled 2011 loss

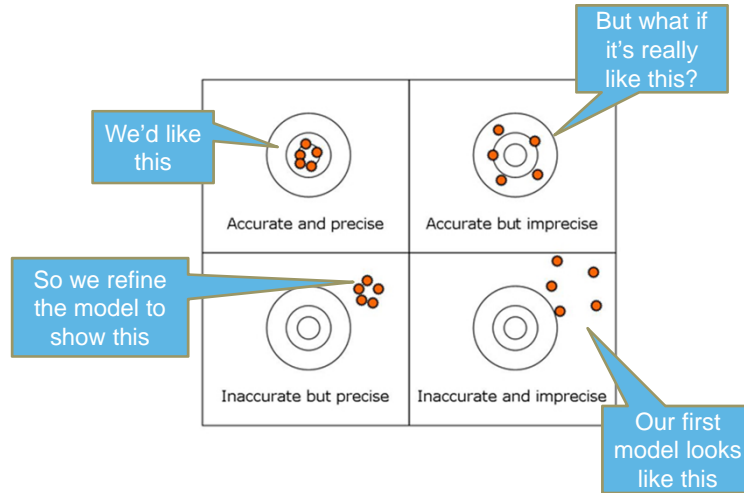


## Agenda

1. Introduction
2. Hazard Model
3. Industry Exposure and Claims
4. Vulnerability Model
5. Financial Model
6. **Uncertainties**



## Delusional Certitude

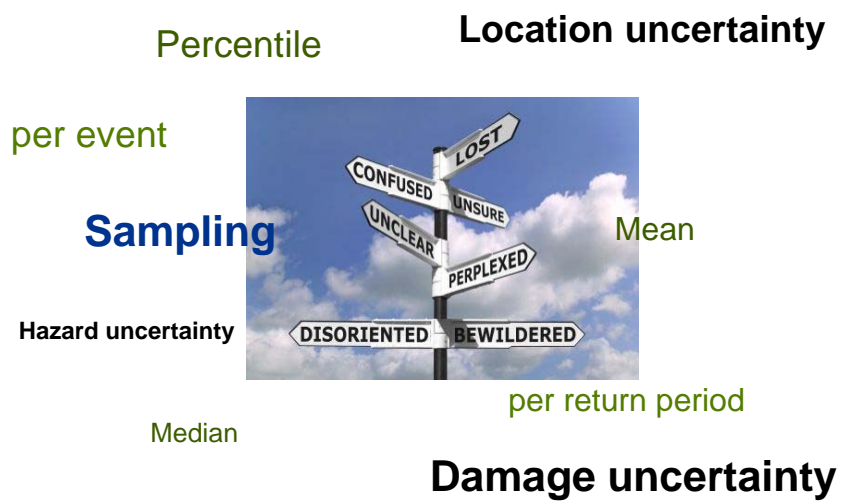


Impact Forecasting

Source: Peter Taylor, "Realizing the Value of Uncertainty"  
Aon Benfield Hazards Conference, Gold Coast, Australia, 2013 22

**AON** BENFIELD

## Model Uncertainties



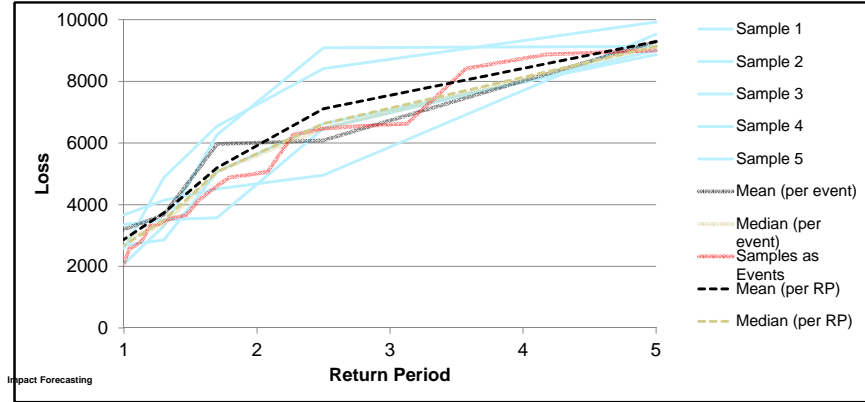
Impact Forecasting

23

**AON** BENFIELD

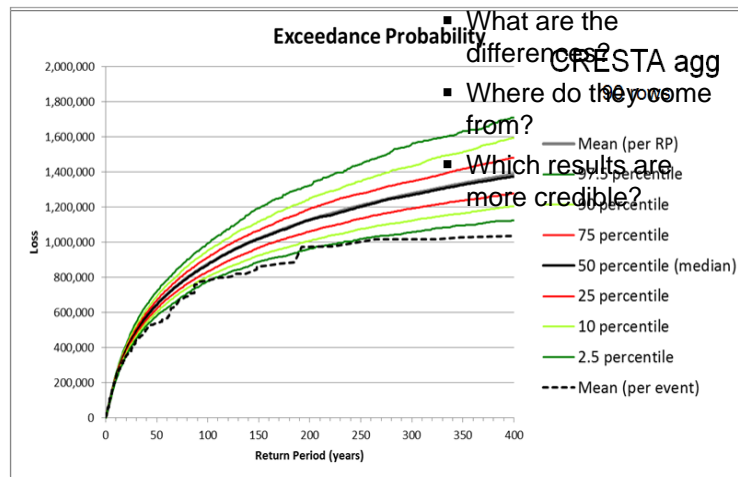
## Quantifying Uncertainty

Return period	Mean (per event)	Median (per event)	Samples as events	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Mean (per RP)	Median (per RP)
5.0	9292	9134	9006	8871	9528	9923	9006	9134	9420	8679
2.5	6086	6474	6474	6627	4958	8416	6474	9089	8417	8236
1.7	5965	5069	4606	5069	4514	6546	3580	6267	6025	6305
1.3	3672	3356	3465	2855	4142	4881	3509	3305	5089	4373
1.0	3197	2855	2083	2678	3670	2578	3356	2083	2384	3187



## Accuracy and Uncertainty

### QUESTIONS



- What are the differences?
- Where do they come from?
- Which results are more credible?

## Model Implementation – ELEMENTS 8

- Features
  - Loss calculation platform to run all Impact Forecasting models
  - Developed internally by a team of 20+ programmers
  - Client-Server and parallel computing architecture
  - Open, transparent, flexible and easy-to-use platform
  - Distributed to Aon Benfield catastrophe analysts
  - Licensed to insurers and reinsurers

## ELEMENTS



The screenshot displays the ELEMENTS software interface. The main window shows a portfolio management view for 'LONNB403'. It includes a line graph titled 'Report for LONNB403 - 10, 10, 10, PROVINCE - PROVINCE, 219' and a data table below it. The table has columns for 'Period', '01', '02', '03', and '10'. The data table shows values for various periods, with the last row showing a total of 176,128,493.

Period	01	02	03	10
10/1/2010	432,111,111	432,111,111	432,111,111	432,111,111
10/2/2010	432,111,111	432,111,111	432,111,111	432,111,111
10/3/2010	387,774,748	387,774,748	387,774,748	387,774,748
10/4/2010	387,774,748	387,774,748	387,774,748	387,774,748
10/5/2010	333,438,325	333,438,325	333,438,325	333,438,325
10/6/2010	333,438,325	333,438,325	333,438,325	333,438,325
10/7/2010	333,438,325	333,438,325	333,438,325	333,438,325
10/8/2010	333,438,325	333,438,325	333,438,325	333,438,325
10/9/2010	333,438,325	333,438,325	333,438,325	333,438,325
10/10/2010	333,438,325	333,438,325	333,438,325	333,438,325
10/11/2010	333,438,325	333,438,325	333,438,325	333,438,325
10/12/2010	333,438,325	333,438,325	333,438,325	333,438,325
10/13/2010	333,438,325	333,438,325	333,438,325	333,438,325
10/14/2010	333,438,325	333,438,325	333,438,325	333,438,325
10/15/2010	333,438,325	333,438,325	333,438,325	333,438,325
10/16/2010	333,438,325	333,438,325	333,438,325	333,438,325
10/17/2010	333,438,325	333,438,325	333,438,325	333,438,325
10/18/2010	333,438,325	333,438,325	333,438,325	333,438,325
10/19/2010	333,438,325	333,438,325	333,438,325	333,438,325
10/20/2010	333,438,325	333,438,325	333,438,325	333,438,325
10/21/2010	333,438,325	333,438,325	333,438,325	333,438,325
10/22/2010	333,438,325	333,438,325	333,438,325	333,438,325
10/23/2010	333,438,325	333,438,325	333,438,325	333,438,325
10/24/2010	333,438,325	333,438,325	333,438,325	333,438,325
10/25/2010	333,438,325	333,438,325	333,438,325	333,438,325
10/26/2010	333,438,325	333,438,325	333,438,325	333,438,325
10/27/2010	333,438,325	333,438,325	333,438,325	333,438,325
10/28/2010	333,438,325	333,438,325	333,438,325	333,438,325
10/29/2010	333,438,325	333,438,325	333,438,325	333,438,325
10/30/2010	333,438,325	333,438,325	333,438,325	333,438,325
10/31/2010	333,438,325	333,438,325	333,438,325	333,438,325
10/31/2010	176,128,493	176,128,493	176,128,493	176,128,493

26



## Questions

[adityam.krovvidi@aonbenfield.com](mailto:adityam.krovvidi@aonbenfield.com)

+65.6239.7651 (work)





THANK YOU