GIC/AIT – JAXA MINI PROJECT ON FOREST FIRE 2007-2008

Vietnam

Forest Fire Risk Zone Mapping by using Remote sensing and GIS

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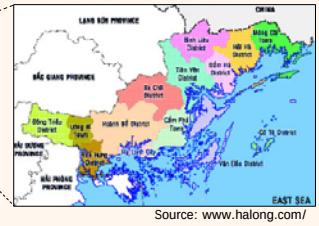
Provincial Administrative Map of Vietnam

Study area

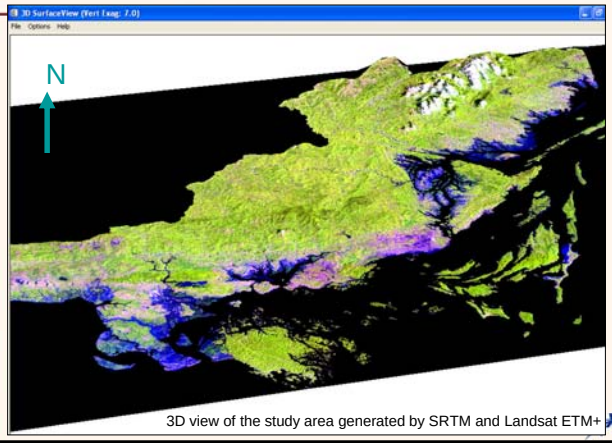


Source: www.halong.com/

Study area: Quang Ninh province

- Location: 20.72 to 21.66 degree North and 106.43 to 108.09 degree East.
- Area: 5,900 km^2
- Population: 1,000,000
- Dry season: November to March (high possibility of forest fire occurrence)

3D view of the study area



3D view of the study area generated by SRTM and Landsat ETM+

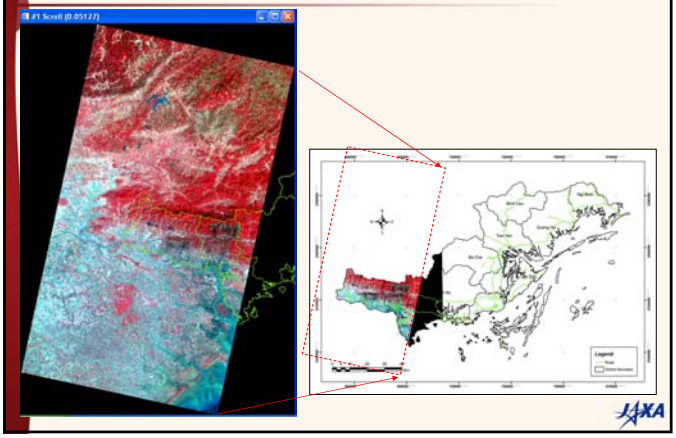
Objectives

1. To investigate the forest fire occurrence in the study area using Remote sensing, GIS data and Ground Truth information
2. To compare the hotspot from ground truth survey and MODIS Fire Product for validation
3. To generate forest fire risk zone map
4. To find the relationship of forest fire occurrence with the social aspect in term of human activities for better understanding and decision making.

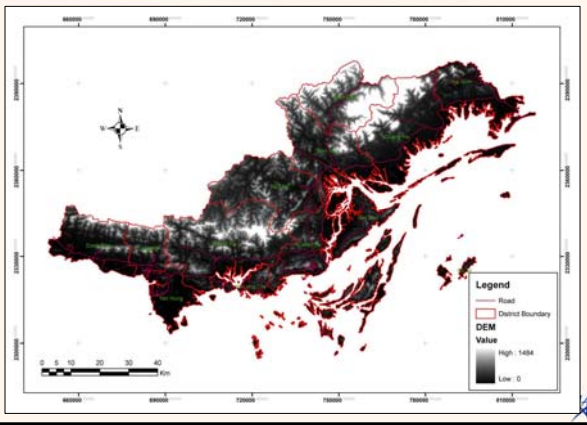
Available Data

1. ALOS AVNIR (2 scenes) – JAXA (Jan 29, 2007)
2. Landsat ETM+ *(Source: GLCF, University of Maryland)*, 2000
3. Forest map *(scale 1:1000.000; Source: FPD), 2005*
4. Road network *(scale 1:50.000; Source: MONRE), 2002*
5. Settlement points *(scale 1:50.000; Source: MONRE), 2002*
6. DEM-SRTM 90m *(Source: GLCF, University of Maryland)*
7. MODIS Fire product (MOD14) *(1km resolution; Source: GIC-AIT).*
8. *Ground Truth from the field survey (see Slide No.17)*

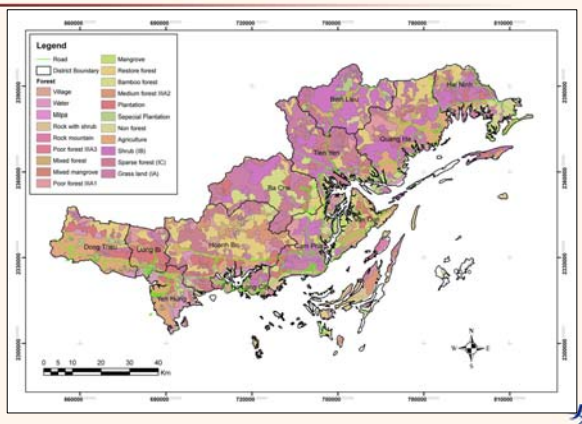
ALOS/AVNIR-2



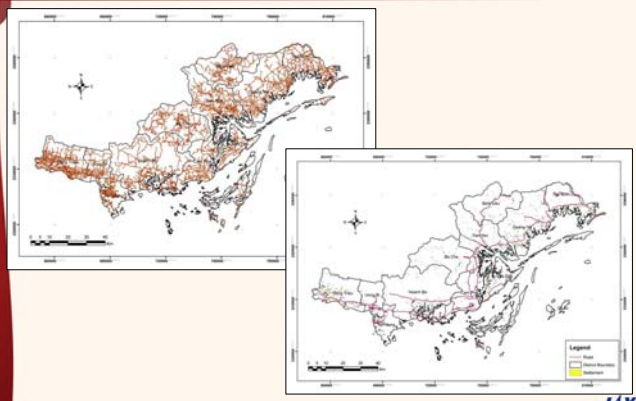
DEM SRTM (90m)



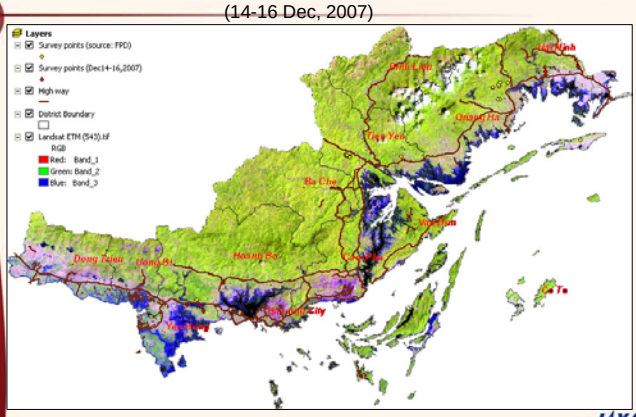
Forest map 2005



Road network and Settlement



Field Survey (shown by red and yellow points)
(14-16 Dec, 2007)



Field Survey
(14-16 Dec, 2007)

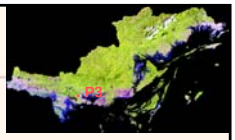
Example of surveyed points

Point 1:
- LC type : Pine Trees, Landscape type: Hilly
- Location: Hoanh Bo dist, Quang Ninh province
- GPS Lat/Lon: N 20° 59' 53.5", E 106° 55' 49.8"
- Burning area: 6.0 ha
- Burning date/time: 2007-09-21 10:00

Descriptions:
We have found that there were trees cutting in the forest, after the forest was burn. The forest fire at this place was recorded on Sept 21, 2007 at 10:00. Nearby to this burning place, there is some agricultural area, like the pineapple. In this area, the type of the forest is pine forest. The activity of the people in this area is to burn, cut and sell.

Field Survey
(14-16 Dec, 2007)

Example of surveyed points



Point 3:
- LC type: Bush and Pine trees
- Location: Hoanh Bo dist, Quang Ninh province
- GPS Lat/Lon: N 20° 59'45.3", E 106° 54' 13.3"
- Burning area: 6.7 ha
- Burning date/time: 2007-02-xx

Descriptions:
The Pine forest was planted by the villagers to have the resin. After collecting the resin, the Pine forest was burn by other people. The characteristic of the burning is from the ground, but not from the top (not canopy burning). This forest fire happens every year. This area is the area of Pine Trees Plantation.

Field Survey
(14-16 Dec, 2007)

Example of surveyed points

Point 10:
- LC type: Bush and Pine trees
- Location: MongCai dist, Quang Ninh province, VN
- GPS Lat/Lon: N 21.54065, E 107.84463
- Burning area: 50 ha
- Burning date/time: 2007-11-27

Descriptions:
This area was burn on the Nov 27, 2007 with the burning area is about 50 hectares. The landcover type is bush and pine trees. At the time record the photo, the pine was recovering itself.

Field Survey - Summary

- Ground Truth information:
  1. 10 of burning points were collected in the field survey
  2. 20 points were obtained from local forest department
- Possible reasons of forest fire in the study:
  1. The illegal activities of timber, wood and other forest products exploitation…and the forest fire happened.
  2. The benefit conflict from forest resources of stakeholder may be the result of forest fire, they deliberate to burn the forest to harm other
  3. To burn shrub, grass land for cultivation.

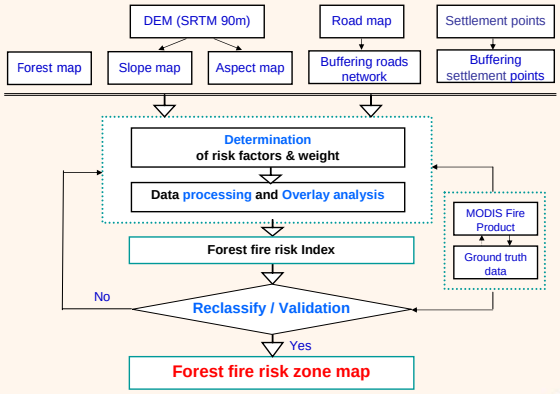
These reasons show the relationship of the forest fire occurrence with the human activities in the study area.

Methodology

Main ideas:

- Comparison of the ground truth with the MODIS detected hotspots
- Allocation of the ground truth and MODIS detected hotspots to physical & social parameters in the study area
- Weight Overlay Analysis (WOA) as tool for fire risk area analysis

Methodology - Flowchart



Comparison of the ground truth with the MODIS detected hotspots

1. GROUND TRUTH OBTAINED FROM FIELD SURVEY

Ground Truth					MODIS					Distance	Burn area	
Point Name	Date	Time	lat	long	lat	long	Date	Time	Fire conf.	(km)	Ha	Km2
P1	21/09/2007	10:00	21	106.93	20.99	106.92	21/09/2007	03:43	96	1.5	6	0.06
P2	13/05/2007	n/a	21	106.95	n/a	n/a	n/a	n/a	n/a		30.5	0.305
P3	xx/02/2007	n/a	20.99	106.94	20.99	106.92	8/2/2007	06:04	81	2	n/a	n/a
P4	5/12/2007		21	106.9	n/a	n/a	n/a	n/a	n/a		6.7	0.067
P5	12/1/2007		21.56	107.93	n/a	n/a	n/a	n/a	n/a		28.1	0.281
P6	30/01/2007	18:00	21.35	107.33	21.35	107.45	30/01/2007	06:22	93	9.2	3	0.03
P7	29/01/2007	n/a	21.35	107.33	21.36	107.34	30/01/2007	06:10	76	1.4	30	0.3
P8	27/11/2007	n/a	21.56	107.84	21.56	107.8	27/11/2007	23:39	24	1.3	40	0.4
P9	27/11/2007	n/a	21.55	107.84	21.55	107.83	27/11/2007	23:39	69	1.5	14	0.14
P10	27/11/2007	n/a	21.541	107.845	21.54	107.84	27/11/2007	23:39	92	0.5	50	0.5

2. GROUND TRUTH OBTAINED FROM FOREST PROTECTION DEPARTMENT (FPD)

Ground Truth					MODIS					Distance	Burn area	
Point Name	Date	Time	lat	long	lat	long	Date	Time	Fire conf.	(km)	Ha	Km2
N1	08/01/2006	n/a	21.48371	107.72521	n/a	n/a	n/a	n/a	n/a			
N2	09/01/2006	n/a	21.48256	107.71947	n/a	n/a	n/a	n/a	n/a			
N3	11/01/2006	n/a	21.52389	107.72567	n/a	n/a	n/a	n/a	n/a			
N4	17/05/2006	n/a	21.52311	107.7464	n/a	n/a	n/a	n/a	n/a			
N5	15/10/2006	n/a	21.51403	107.72483	n/a	n/a	n/a	n/a	n/a			
N6	30/10/2006	n/a	21.51071	107.70759	n/a	n/a	n/a	n/a	n/a			
N7	30/12/2006	n/a	n/a	n/a	21.7	107.25	29/12/2006	06:10	94	n/a	4	0.04
N8	17/12/2006		21.5135	107.70829	n/a	n/a	n/a	n/a	n/a			
N9	30/12/2006	n/a	21.34893	107.46587	21.37	107.23	29/12/2006	06:10	76	24.6	2.9	0.029
N10	30/12/2006	n/a	21.35549	107.32044	21.37	107.23	29/12/2006	06:10	76	9.5	2.4	0.024
N11	29/01/2007	n/a	21.35299	107.32138	n/a	n/a	n/a	n/a	n/a			
N12	29/01/2007	n/a	21.35167	107.3248	n/a	n/a	n/a	n/a	n/a			
N13	29/01/2007	n/a	21.35105	107.32786	n/a	n/a	n/a	n/a	n/a			
N14	29/01/2007	n/a	21.35028	107.33164	n/a	n/a	n/a	n/a	n/a			
N15	29/01/2007	n/a	21.34823	107.33232	n/a	n/a	n/a	n/a	n/a			
N16	30/01/2007	n/a	21.34823	107.33232	21.35	107.42	28/01/2007	06:22	93	9.1	2	0.02
N17	30/01/2007	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a			
N18	18/04/2007		21.51864	107.72264	n/a	n/a	n/a	n/a	n/a			
N19	09/02/2007		21.381	107.9335	n/a	n/a	n/a	n/a	n/a			
N20	22/09/2007		21.00656	106.93026	n/a	n/a	n/a	n/a	n/a			

NO DATA

Comparison of the ground truth with the MODIS detected hotspots

Data Source	Total points	Matched points
Field survey (Dec 14-16, 2007)	10	7
Forest Protection Department	14	3
Total	24	10

Some difficulties for the collected data

- Local department collected the burning data using simple way without GPS
- Some burning locations could be taken by mistake
- Some small burning area, maybe MODIS MOD14 can not detected

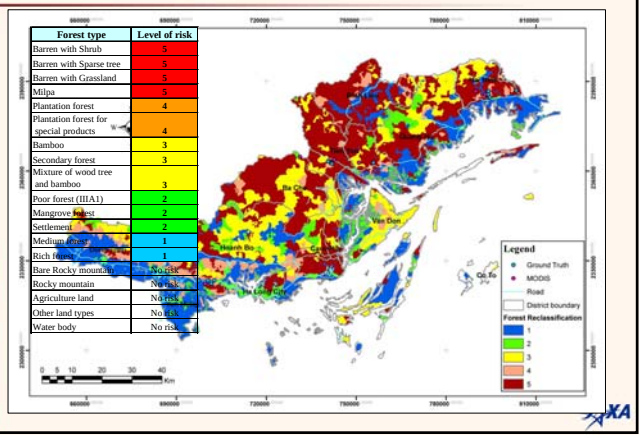
10 points collected from field survey and 3 points from the local department were matched on MODIS Product. Therefore, these points could be used to validate and allocate to the **input components** of model

Allocate the matched hotspots of ground truth and MOD14 to input components

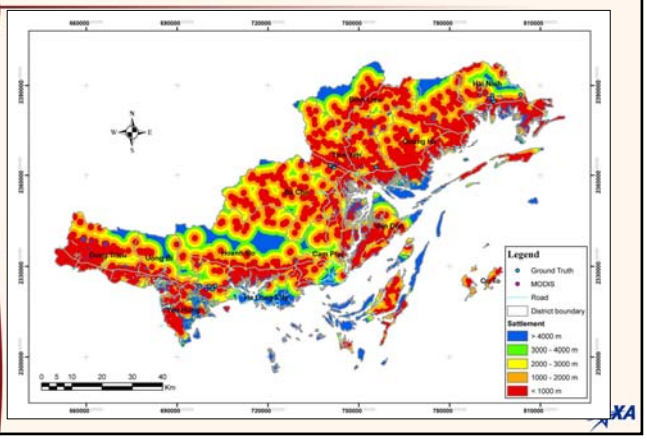
Point No	Lat	Lon	Forest	Settlement (m)	Road (m)	Slope (degree)	Aspect
1	21.00	106.93	Pine	< 1000	< 200	>35	SW
2	21.00	106.95	Pine	< 1000	< 200	> 35	SW
3	20.99	106.94	Shrub	< 1000	< 200	> 35	NE
4	21.00	106.90	Pine	1000 – 2000	< 200	> 35	SW
5	21.56	107.93	Plantation	2000 – 3000	< 200	> 35	NE
6	21.35	107.33	Plantation	< 1000	< 200	> 35	SW
7	21.35	107.33	Plantation	< 1000	< 200	> 35	SW
8	21.56	107.84	Plantation	2000 – 3000	< 200	10 – 25	SE or NW
9	21.55	107.84	Plantation	1000 – 2000	< 200	25 – 35	NE
10	21.54	107.84	Plantation	< 1000	< 200	10 – 25	SW
11	21.34	107.46	Shrub	< 1000	< 200	10 – 25	SW
12	21.35	107.32	Shub	< 1000	200 – 400	10 – 25	SE or NW
13	21.34	107.33	Shrub	1000 – 2000	< 200	> 35	SW

NE = NorthEast, SW = SouthWest, SE or NW = SouthEast or NorthWest

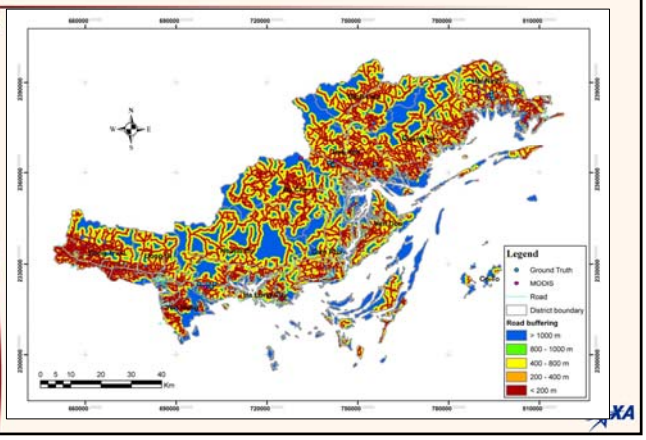
Methodology - Forest Re-classification map



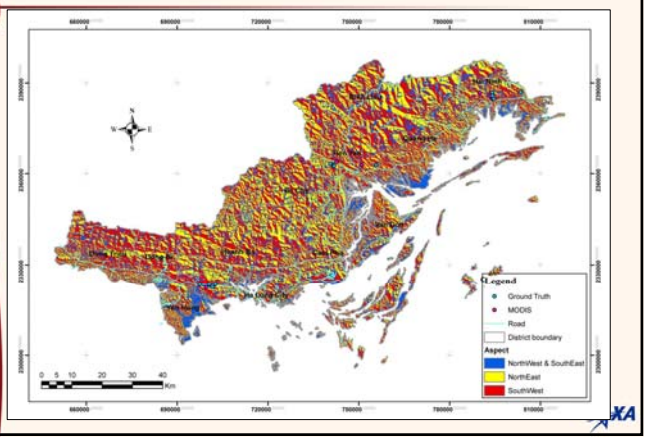
Methodology - Buffering settlement points



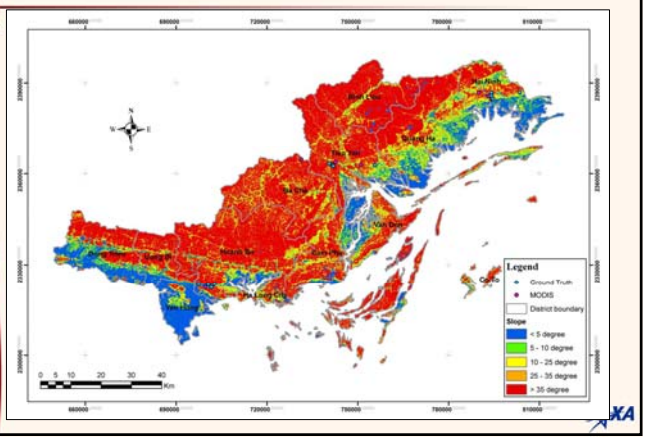
Methodology - Road buffering network



Methodology - Aspect map



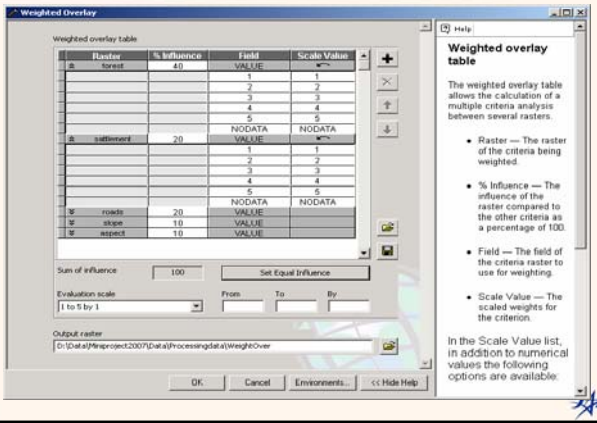
Methodology - Slope map



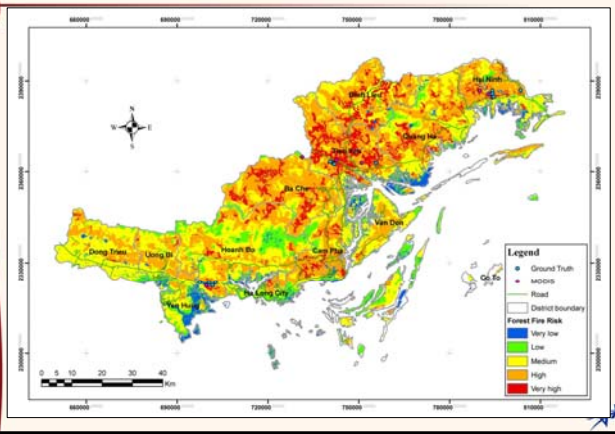
Methodology - Evaluation of Susceptibility Coefficients

Causal Factors	Weight	Class	Factors	Fire Rating classes
Forest	0.40	level 5	5.00	Very high
		level 4	4.00	High
		level 3	3.00	Medium
		level 2	2.00	Low
		level 1	1.00	Very low
Settlements	0.20	<1000 m	5.00	Very high
		1000-2000 m	4.00	High
		2000-3000 m	3.00	Medium
		3000-4000 m	2.00	Low
		>4000 m	1.00	Very low
Roads	0.20	<200 m	5.00	Very high
		200-400 m	4.00	High
		400-800 m	3.00	Medium
		800-1000 m	2.00	Low
		>1000 m	1.00	Very Low
Slope	0.10	> 35 degree	5.00	Very high
		25-35 degree	4.00	High
		10-25 degree	3.00	Medium
		5-10 degree	2.00	Low
		< 5 degree	1.00	Very low
Aspect	0.10	SouthWest	5.00	Very high
		NorthEast	3.00	Medium
		NorthWest and SouthEast	1.00	Very low

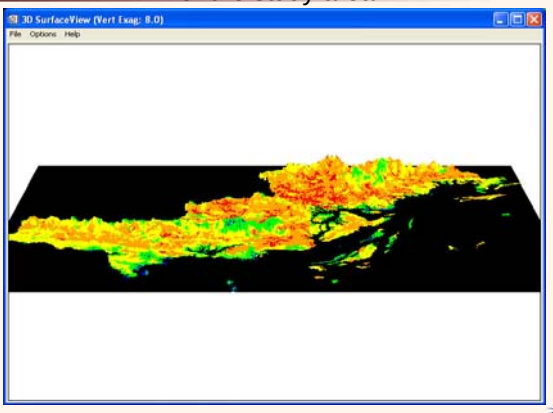
Methodology - Weighted Overlay Analysis



Result: Forest Fire Risk Zone Mapping

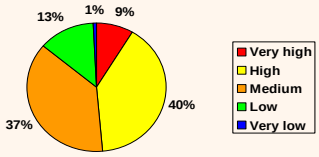


Result: 3D View of the Risk fire map for the study area



Result: Statistical Summary

Risk level	No. of hotspots	Percent (%)	Area (%)
Very high	8.00	61.53	8.69
High	3.00	23.07	39.99
Medium	2.00	15.40	37.41
Low	0.00	0.00	13.06
Very low	0.00	0.00	0.85
Total	13.00	100.00	100.00



Conclusions

- The forest fire occurrence in the study area were investigated using RS&GIS with ground truth information **(Obj.1)**
- During the data analysis, the data from both sources (MOD14 vs. ground truth) were compared **(Obj. 2)**
- Based on the information from the above two sections, The forest fire risk zone mapping has been generated by probabilistic method using Weighted Overlay Analysis as a tool **(Obj. 3)**
- In addition to the obtained forest fire risk map, burning points locations are logically distributed, which can be seen in the result that most of hotspots are located in the high and very high risk zones.
- During the field survey, the relationship of the forest fire occurrence with the human activities in the study area were identified **(Obj. 4)**

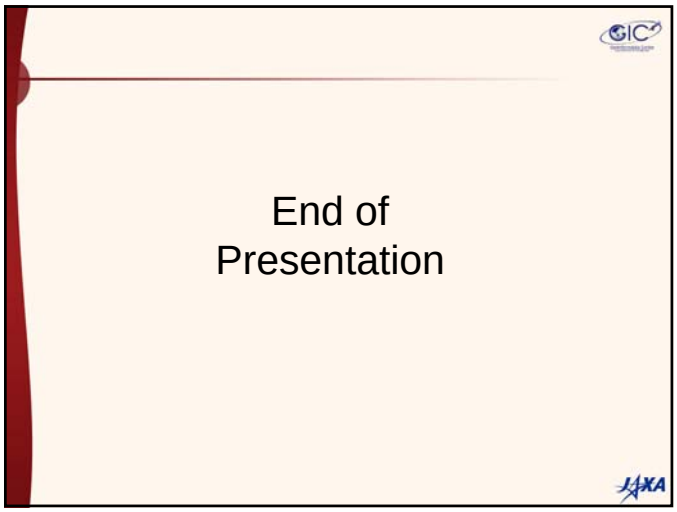
Conclusions

Limitations and difficulties:

1. Ground truth information obtained from the local department are not precise.
2. Different format of baseline data recorded by the local department which is time consuming to re-arrange to be input data for the analysis.
3. ALOS/AVNIR-2 data are not available for the whole province.

Future Plan

- In order to improve the result, the high-resolution data of ALOS/PRISM will be applied in the next step for generating better DEM.
- The application of ALOS/PRISM and ALOS/AVNIR-2 using sharpening technique will improve the hotspot detection during the visual interpretation.
- The result can be improved by having more casual factors which related to:
  + Social activities (number of population in the village, population careers, etc.) and
  + Weather conditions (air temperature, humidity, rainfall, wind directions/speed, etc.)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Presentation