GEO-INFORMATICS FOR ESTIMATION YIELD LOSS OF RICE PRODUCTION AREAS CAUSING BY FLOODING IN LOWER YOM BASIN, THAILAND

Vicharn Amarakul[a] and Sirirat Sanyong[b]

[a] School of Liberal Arts, University of Phayao, Phayao 56000, Thailand

Tel: 66-54-466666 ext 1033 E-mail: v_amarakul@yahoo.com

[b] Faculty of Agriculture, Natural Resources and Environment,

Naresuan University, Phitsanulok 65000, Thailand

Tel: 66-55-962722 E-mail: siriratsy@nu.ac.th

Key words: Flooding Risk areas, Rice Growth Stages, Lower Yom basin, Rice Yield Damage

ABSTRACT

The flooding risk areas affected to the rice production from June to October had been studied in the Lower Yom Basin, Thailand. The satellite data since year 2002-2007 had been used for study, LANDSAT data for identification of rice growth stages, RADARSAT data for identification the expanding of flooding areas in each period. From the calculation, the damage of rice yield had correlation between flooding period and the 4 growth stages of rice. The 144 sampling from the field survey found that if the flooding period was more than 5 days while rice growth was in flowering stage would be the highest damage to the rice yield growth and showed as 72%. The rice yield damage was on harvesting stage, tillering stage and seedling stage had showed as 66%, 53% and 50%, respectively. If flooding occurred more than 10 days, the rice yield would be completely damage. In September 2006, from 179,901 hectare of the total paddy areas had been analyzed and classified as rice plantation areas 131,133 hectare which these areas had been classified that no risk flooding area was 89,887 hectare and risk flooding area rice causing of yield damage was 41,241 hectare or 31.45% of the rice plantation areas. Flooding situation in September 2006 effected to the rice yield damages in 4 growth stages of rice. The rice plantation area in flowering stage had been risk on the damage by flooding 26,927 hectare or 20.53% of the total rice plantation areas. The rice plantation areas in harvesting stage, tillering and seedling stage had been risk on the damage by flooding 10,206 3,152 and 961 hectare or 7.78% 2.41% and 2.30% of the total rice plantation areas, respectively.

1. INTRODUCTION

Rice is annually destroyed by seasonal flooding in South and Southeast Asia. In order to reduce the loss of rice production, an accurate assessment of flood-affected paddies is essential. Taking the 2001 monsoon flooding that hit the Lower Chi River Basin, northeastern Thailand, as a case study, we derived the flood depth over the large and inaccessible areas using a RADARSAT-[1] image acquired during the flooding peak and a 30-m Digital Elevation Model. Based on the elongation properties of rice, we used the critical water-depth of 80 cm to classify the flood-affected paddies into 'damaged' or 'non-damaged' paddies. (Waisursinghai and et al, 2008) The Foreign Agriculture Service (FAS) of the U.S. Department of Agriculture (USDA) began producing a series of geographic information system (GIS)-based maps of the damaged agricultural areas to accompany its commodity intelligence reports. Myanmar's major rice-producing areas, which have suffered saltwater flooding and heavy rainfall as a result of the cyclone. The sattelite imagery was combined with rice land-cover classification data from the Landsat satellite program. FAS used ArcGIS to perform spatial analysis and create maps of the damaged rice production regions of Myanmar. (ESRI, 2008)
Kafle and et al (2006) had studied to integrate flood simulation model and remote sensing (RS) data with the available topographic and socioeconomic data in a geographic information system (GIS) environment for flood hazard mapping of Bagmati River in Terai region. Hydrologic model in combination with digital elevation model (DEM) is useful in delineating the inundation area extent and estimating the flood depths in areas where images capturing the peak flood events are not available. FAO (1998) had reported the floods experience in the Loa PDR. Particularly in three consecutive years - 1994, 1995 and 1996 - the floods were large and disastrous. This flood pattern indicates that, on average, a flood occurs in Lao PDR every 1.4 years and a disastrous flood every six years. The 1994 flooding of the Mekong River and its tributaries damaged about 28 000 ha of cropped land, but the floods which occurred during August-September 1995 and 1996 were the worst since 1966. Both can be regarded as major disasters for the agricultural sector in Vientiane Prefecture and the provinces of Vientiane, Borikhanhxay, Khammouane, Savannakhet

and Champassak. According to Government of Lao (GOL) estimates, up to 87 300 ha were inundated in 1995 and an estimated 104 000 ha in 1996 causing the complete loss of up to 62 000 ha of paddy in 1995 and 76 000 ha in 1996.

2. MATERIAL AND DETHODS

2.1 Study area

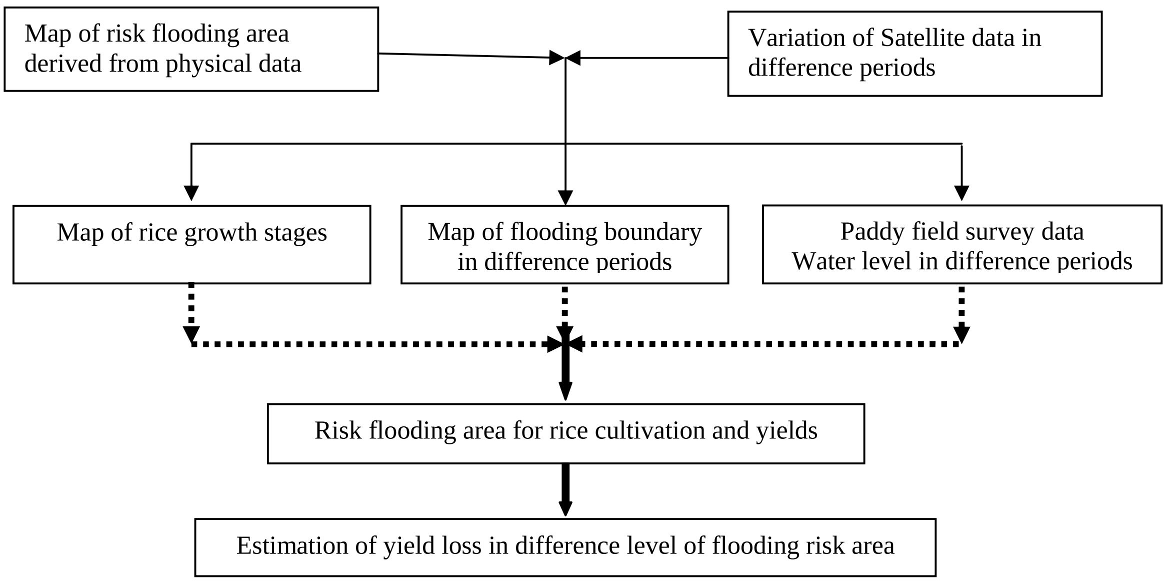
The study area located on the Lower Yom Basin. It covered some parts of Krongkrailad district which belong to Sukhothai province, some parts of Muang Phitsanulok and Bang Rakam districts which belong to Phitsanulok province, some parts of Wachirabarami, Pho Prathap Chang and Sam Ngam districts which belong to Phichit province.

2.2 Material

Landsat, SPOT and RADARSAT had been supported by Geo-Informatics and Space Technology Development Agency (Public Organization). The satellite data derived from the years 2002, 2004, 2006 and 2007, from June until October. Orthrophotograph had been supported by Land Development Department, Ministry of Agriculture and Cooperative.

2.3 Method

Flooding is the important factor in causing of damage on rice production areas in Lower Yom Basin. Therefore, this research had concerned on water levels, flooding period and growth stage of rice.



3. RESULTS

3.1 Risk analysis in Lower Yom Basin

The result of overlay the study area on Lower Yom Basin with risk flooding area map, it could be classified risk flooding area into 4 levels and the risk paddy field areas had shown at Table 1, Figure 1 and 2. The data from the field survey found that the period of flooding was the most effective to rice yield. One day flooding on rice in flowering stage was causing of the great damage to rice yield. Rice yield will be loss more than 50% if flooding had cover on the top of rice plants in every growth stages more than 5 days. Rice yield will be loss more than 80% if flooding had cover on the top of rice plants in every growth stages more than 7 days. The growth stage of rice had been classified from Landsat 5 which acquired on 14th June 2006 and 29th July 2006. Normalized Difference Vegetation Index (NDVI) had derived from the near-infrared light (band 4) and red light (band 3) which had been corrected and adjusted the light intensity value from 0-225. The new Normalized Difference Vegetation Index was corrected by the equation which showed in Table 2

Table 1 The area of risk paddy field to flooding in Lower Yom Basin

Levels	Items	Lower Yom Basin areas (ha)	Risk of flooding paddy field areas (ha)
1	No/less	110.08	92.48
2	Moderate	33,645.60	26,979.20
3	High	104,944.60	78,353.44
4	Highest	107,627.50	74,475.36
Total areas		246,327.78	179,900.48

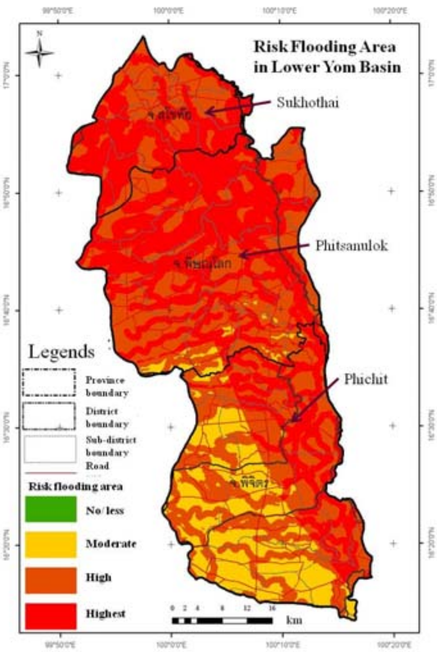


Figure 1 The highest risk flooding area on Lower Yom Basin

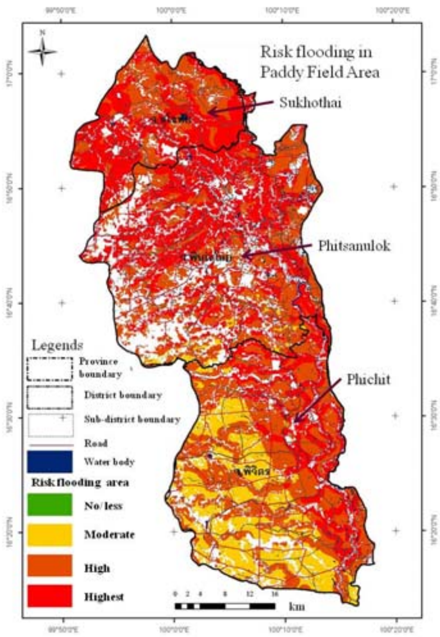


Figure 2 The moderate to highest risk flooding in paddy field located on Lower Yom Basin

Table 2 Data adjustment equation for the new Normalized Difference Vegetation Index

Satellite Data (D/M/Y)	Correction Equation for New NDVI	
	Band 3	Band 4
14/6/2550	Y = 4.250*X – 85.000	Y= 3.355*X – 181.130
29/7/2549	Y = 4.636*X – 92.727	Y= 3.228*X – 180.759
1/8/2550	Y = 2.525*X – 65.644	Y = 3.110*X – 230.122

Remark: X = data before adjustment Y = data after adjustment

3.2 Rice yield analysis causing of flooding

The paddy field area was classified in different of growth stages and overlay on flooding area in August and September. The results showed that flooding risk area in August was 15440.32 hectare. The 7,280.48 hectare of paddy field in tillering stage was on in risk of flooding. Paddy field area in flowering stage, harvesting stage and seedling stage were 4429.76 , 2460.16 and 1269.92 hectare, repectively, which all of them also cultivated on risk flooding area. (Figure 3 and 4) In case of flooding was more than 10 days, the rice yield will be loss more than 98.03%. Paddy field area in

September, there had opportunity to get flooding for 41246.72 hectare. Paddy field area in flowering stage, harvesting stage, tillering stage and seedling stage were 26927.20 10206.40 3152.32 and 960.80 hectare, respectively, had been cultivated on risk flooding area. If flooding was over the plants more than 10 days, the rice yield will be loss more than 98.03%. (Figure 5 and 6)

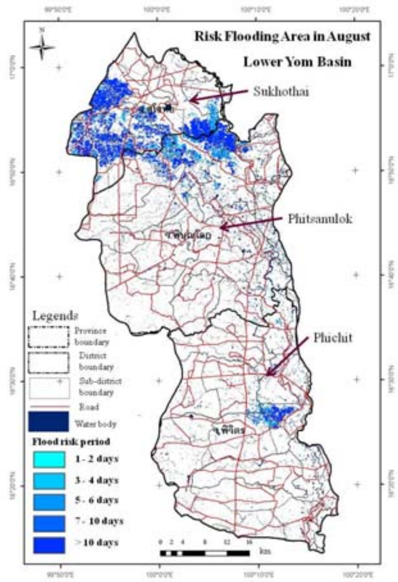


Figure 3 Flooding period in August at Phisanulok and Phichit provines, Lower Yom Basin

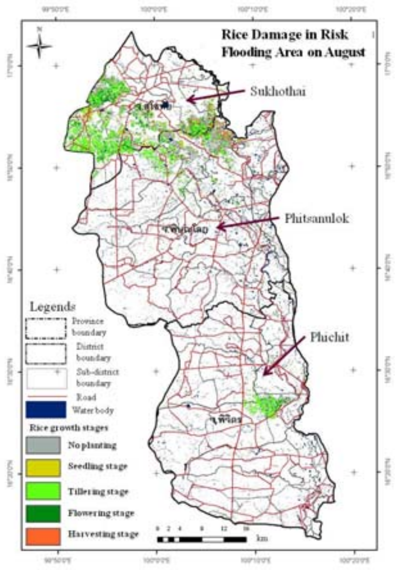


Figure 4 Growth stages of rice in August on risk flooding area

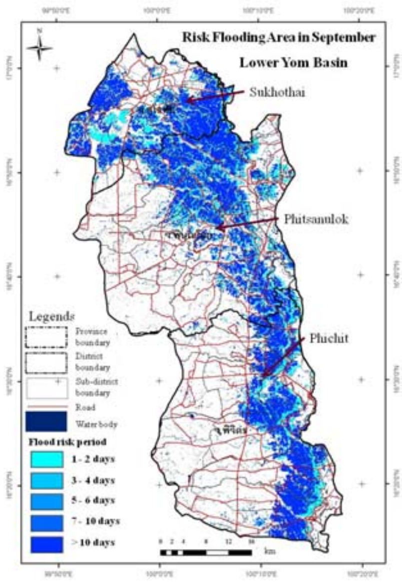


Figure 5 Flooding period in September at Phisanulok and Phichit provines, Lower Yom Basin

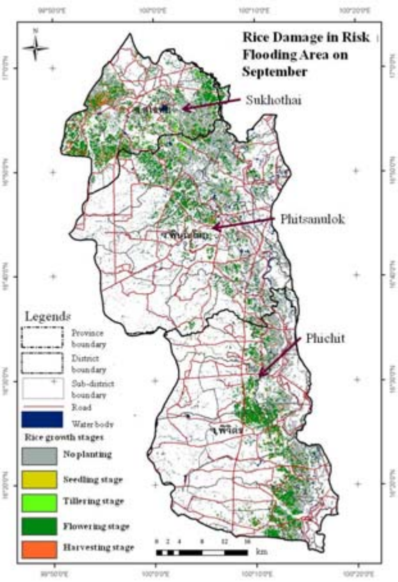


Figure 6 Growth stages of rice in September on risk flooding area

5. ACKNOWLEDGEMENT

We would to express the deeply thank to Geo-Informatics and Space Technology Development Agency (Public Organization) for supporting the research budget and satellites data (Landsat, SPOT and RADARSAT). And we would like to express the sincerely thank to Naresuan University for support research office and other facility.

6. REFERENCES

1. ESRI. 2008. USDA FAS Uses GIS, MODIS, and Landsat to Monitor Rice Production in Burma. Retrieved on July 2010 from http://landsat.gsfc.nasa.gov/news/news-archive/soc_0020.html
2. FAO. 1998. Flood management and mitigation in Mekong river basin. Retrieved on April 2011 from http://www.fao. org/docrep/004/ac146e/AC146E02.htm
3. Kafle, T.P., Hazarika, M.K., Shrestha, K.G., Prathumchai, K., and Samarakoon, L. 2006. Integration of remote sensing and GIS with flood simulation model for flood hazard mapping in the Bagmati river, Nepal. Retrieved on May 2010 from http://www.geoinfo.ait.asia/publications/PaperUMSCA2_Phuket.pdf
4. Waisursinghai, C. Aniya, M., Hirano, A., Sang-Arun, J and Sommut, W. 2008. Application of Remote Sensing and GIS for Improving Rice Production in Flood-prone Areas: A Case Study in Lower Chi-River Basin, Thailand. Japan Agricultural Research Quarterly. Japan. Retrieved on July 2010 from http://cat.inist.fr/?aModele=afficheN&cpsidt =20752673