

Hanoi University of Mining and Geology (HUMG) and the International Society for Mine Surveying (ISM) organize the International Conference on Geo-Spatial Technologies and Earth Resources in Hanoi, Vietnam, from 5th to 6th October 2017 (GTER 2017). The conference is to mark the 50th anniversary of the Vietnam mine surveying education (1967-2017), the special event of Vietnamese mine surveyors.

The conference theme, "Geo-spatial Technologies and Earth Resources" is an invitation to researchers, academics and professionals to present their research results and exchange their new ideas and application experiences face-to-face. GTER 2017 is also an excellent opportunity for attendees to establish research or business relations and to find partners for future collaboration.

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The major topics announced for GTER 2017 are listed below:

- Geo-spatial technologies;
- Advance in mining and tunneling;
- Geological engineering;
- Environmental engineering.

The content of the proceedings book provides a broad overview of recent advances in the fields of geo-spatial technologies and earth resources for readers.

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# Geo-spatial Technologies and Earth Resources (GTER 2017)

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## Table of Contents

<b>GEO-SPATIAL TECHNOLOGIES</b>	1
<b>Evaluation of accuracy of handheld laser scanners</b> <i>Kshanovskaya Alina, Okhotin Anatoly</i>	3
<b>Classification of remote sensing imagery based on density and fuzzy c-means algorithm</b> <i>Trinh Le Hung, Mai Dinh Sinh</i>	9
<b>Taxi Trajectory Knowledge Mining Based on Oracle Big Data</b> <i>Chuanyong Li, Hong Fan, Jinghan Lei, Wu Du</i>	19
<b>Study of PM10 evaluation in atmosphere by Landsat 8 OLI and measurement data, experiment in Hanoi region, Vietnam</b> <i>Nguyen Nhu Hung, Tran Van Anh, Tran Phuong Ly, Doan Thi Nam Phuong</i>	27
<b>Application of Terrestrial Laser Scanning to rebuild cave: a case study at Son Doong cave in Vietnam</b> <i>Hoang Kim Quang, Nguyen Thi Thanh Binh, Vuong Trong Kha, Nguyen Minh Phong, Vo Ngoc Dung, Nguyen Dang Vu, Nguyen Hoang, Tran Viet Dung, Dinh Cong Hoa, Vu Thi Minh Huyen</i>	35
<b>Winter-wheat growth monitoring based on UAV multi-spectral remote sensing</b> <i>Liu Chang-hua, Ma Wen-yu, Chen Zhi-chao, Zhou Lan, Lu Jun-jun, Yue Xue-zhi, Fang Zheng, Wang Zhe, Miao Yu-xin</i>	41
<b>Classification of cross-flowed forests in national park of Ca Mau Cape with VNREDSat-1 satellite</b> <i>Pham Viet Hong, Tran Anh Tuan, Nguyen Thi Anh Nguyet</i>	47
<b>Application of remote sensing and GIS to assess the desertification sensitivity for coastal areas of Binh Thuan</b> <i>Nguyen Ngoc Tuyen, Vo Ngoc Ngan Nga</i>	53
<b>Using the NDVI difference to classify dipterocarp forest in Savannakhet Province, Lao PDR</b> <i>Virany Sengtianthr, Nguyen Ngoc Thach, Le Thi Khanh Hoa, Pham Xuan Canh</i>	61
<b>Solution for reduction of effects of some factors on accuracy of staking out axis to working platforms in construction of skyscraper</b> <i>Nguyen Quang Thang, Vu Thai Ha, Diem Cong Trang</i>	67
<b>Development of a new IOS-based geospatial application in smartphone for assisting fieldwork in geoscience</b> <i>Trung Tran Chuyen, Nguyen Truong Xuan, Nguyen Thi Mai Dung, Tran Mai Huong, Bui Tien Dieu, Dau Thanh Binh, Doan Thi Thu</i>	75
<b>Exploring existing spatial patterns of diarrhea and proposing new health unit using GIS in district Vehari, Punjab Pakistan</b> <i>Waseem Akram, Adeel Ahmad, Muhammad Asif Javed, Abdul Raoof</i>	83
<b>Evaluation of the accuracy of measuring technique using single CORS station technology for establishing the large scale Cadstral map</b> <i>Pham Cong Khai, Nguyen Quoc Long, Tran Trong Xuan, Tran Ngoc Quan, Tran Viet Dung</i>	91
<b>Change of mean dynamic topography on East Sea using satellite altimetry data</b> <i>Nguyen Van Sang, Nguyen Van Lam</i>	99

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Surface deformation analysis in a shallow mining area in conditions of thick unconsolidated layers and thin bedrock <i>Zengzeng Lian, Fengyuan Wei, Hebing Zhang</i>	103
Inundation extent and flooded maps of vegetation in Cuu Long River delta using multi-temporal sentinel-1 data <i>Nguyen Van Khanh, Tran Xuan Truong, Vu Xuan Cuong, Hoa Thi Luong, Van Tung Pham, Tran Thi Ha Phuong, Nguyen Thi Vinh, Nguyen Thi Tham</i>	109
Initial assessment of impact of underground coal mining on the Khe Cham screening plant <i>Pham Van Chung, Cao Xuan Cuong, Nguyen Quoc Long, Pham Ngoc Huy</i>	119
Detection of the urban area expansion using SPOT-5 and Sentinel-2 data: a case study in Ho Chi Minh city, Vietnam <i>Nguyen Van Trung</i>	127
Considerations for using ground based survey monitoring systems in open pit mining <i>Neil Ashcroft, Henri Prevost</i>	133
Main factors influencing accuracy of terrestrial 3D laser scanning <i>Ngo Sy Cuong, Tran Xuan Truong</i>	143
Making volumes of 3D object from the faces <i>Lien Ngo Thi, Duong Tran Thuy</i>	151
GPS/GLONASS mixed data processing <i>Vy Quoc Hai, Bui Thi Hong Tham</i>	159
The development and study of the volume calculation surveying technology in covered storehouses and conveyors <i>Veronika Valeryevna Gridneva, Semen Olegovich Gridnev</i>	167
Reality and solutions for overcoming soil erosion in Huong Khe district, Ha Tinh province in period of 2009 - 2015 <i>Pham Thi Ha, Nguyen Van Trung</i>	173
30 years monitoring spatial - temporal dynamics of agricultural drought in the central highlands using Landsat data <i>Ngo Thi Dinh, Nguyen Thi Thu Ha, Nguyen Thien Phuong Thao, Nguyen Thuy Linh</i>	181
Orientation of underground mine levels using a laser scanning system <i>S. O. Gridnev</i>	189
Accuracy assessment of UAV photogrammetry for mapping mangrove forest: case study in Xuan Thuy national park, Vietnam <i>Tong Si Son, Nguyen Vu Giang, Vu Phan Long, Le Quang Toan, Tong Thi Huyen Ai, Vu Huu Long, Pham Viet Hoa, Le Van Canh, Vu Tien Dien, Vu Van Chat</i>	197
Assessing the role of average value multiply by area of ellipse with the positional error of points in reliability assessment of coordinate control network <i>Le Ngoc Giang, Truong Quang Hieu</i>	205
Establishment of 3D terrain model for Thanh Liem - Ha Nam area using Arcscene <i>Nguyen Thi Thu Huong, Nguyen Van Hai</i>	209
Analyzing stability and recommending measures to ensure stable status of the Cao Son pit slopes <i>Pustovoitova T. K., Kieu Kim Truc, Nguyen Quoc Long</i>	217

<b>Application of geographic information system (GIS) and remote sensing (RS) in road monitoring: a case study in Hoa Binh city and environs, Vietnam</b> <i>Ha Thi Hang, Bui Duy Quynh, Luong Ngoc Dung, Khuc Thanh Dong, Nguyen Tuan Long</i>	223
<b>Establishment of ground control network by GPS technology for construction of Nuoc Xang hydroelectricity works</b> <i>Nguyen Viet Ha, Nguyen Thi Kim Thanh</i>	229
Establishing and sharing environmental database with web - based GIS application: case study in Thai Nguyen province <i>Pham Thi Thanh Hoa, Vu Ngoc Quang, Nguyen Tien Manh, Nguyen Thi Hoa</i>	235
GIS mapping provision tourist objects in the Irkutsk region <i>Boris N. Olzoev, Vladimir P. Stupin, Nadegda V. Kotelnicova</i>	241
Determination of coordinate transformation parameters between ITRF and Vietnamese Geodetic Datum (VN2000) <i>Pham Thi Hoa, Nghiem Quoc Dung</i>	245
A comparison of GNSS baseline results processed by different methods of adjusting receiver antenna height <i>Nguyen Gia Trong, Dang Nam Chinh, Pham Ngoc Quang, Nguyen Viet Nghia</i>	253
Alternative approach for detecting ionospheric scintillation using GNSS measurements <i>Nguyen Thai Chinh, Le Thi Nhung, Mahdi Alizadeh, Harald Schuh</i>	261
The correction to stake-out coordinate points in constructing Kon Tum Thuong hydropower project <i>Dinh Thi Le Ha</i>	273
Determination of location and height difference at crossover points in satellite altimetry data processing using a direct method <i>Nguyen Van Lam, Nguyen Van Sang, Tran Thi Thu Trang, Le Thi Thanh Tam</i>	279
GIS mapping of debris flows hazard based on concept of morphosystems <i>Vladimir P. Stupin, Leonid A. Plastinin, Boris N. Olzoev</i>	283
Construction of land price map using GIS in Truong Thi ward, Vinh city, Nghe An <i>Pham Thi Ha, Nguyen Van Trung, Nguyen Van Quan</i>	289
Processing GNSS baseline using triple difference <i>Nguyen Gia Trong, Pham Ngoc Quang, Nguyen Van Cuong, Nhu Van Thanh</i>	295
Free network adjustment using the generalized inverse matrix <i>Pham Quoc Khanh, Tran Quynh An</i>	301
The usage of modern surveying instruments in mining <i>Levkin Y. M.</i>	307
Application of informative technology in transforming GNSS-based coordinate to construction plane coordinate in mining area <i>Dinh Cong Hoa, Nguyen Viet Hung, Hoang Thi Thuy</i>	313
Using preset formulas to calculate root mean square error of adjustment for a set of measured values on a traverse <i>Le Ngoc Giang</i>	319
Segmented function prediction method of mining subsidence <i>Cai Lailiang, Zhou Youfeng, Guo Zengzhang, Zhang Hebing</i>	323

Establishment of GIS database for assessment transformed successful group of Vietnam agricultural cooperatives according to the Vietnam Cooperative Law 2012 <i>Nguyen Ngoc Ha, Tran Thi Thai, Vu Minh Huyen, Nguyen Viet Nghia</i>	331
Landslide risk assessment using TRIGRS model. A case study at Tam Dao district, Vinh Phuc province <i>Ngo Thi Phuong Thao, Nguyen Viet Nghia, Ngo Hung Long, Nguyen Thi Hai Yen</i>	338
<b>ADVANCE IN MINING AND TUNNELING</b>	
Variogram Study of gold ore grade at Tungkum Mine in Thailand <i>Pongsak Warin, Panlop Huttagosol</i>	345
Potential use of soil mixture with bentonite and fly ash for bottom liner system of landfill in Vietnam <i>Long Hai Chu, Chau Lan Nguyen</i>	351
Modified blastability index for determination of powder factor in a non homogenous limestone mine <i>P. Chompikun, P. Jaroopattanapong, S. Thiteja</i>	359
Substantiation of geomechanical conditions of recognition of purposes from cleaner chambers for repeated development of scarn-scheelite deposits <i>Sayyidkosimov S. S.</i>	367
Research for waste materials utilization to increase the life of frame support <i>Nguyen Phi Hung, Bui Manh Tung, Pham Manh Tung, Nguyen Cao Khai, Nguyen Van Dung</i>	373
Application of the multi-temporal Landsat in measuring changes of coal mining area: a case study at Ha Tu Mine, Quang Ninh province <i>Vu Dinh Chieu, Ha Thi Hang, Tran Dinh Trong, Bui Ngoc Son, Nguyen Dinh Tu</i>	377
Seismic waves and some basic parameters of the earthquake, determine parameters of earthquakes that can occur in the Hanoi's area <i>Gospodarikov Alexandr, Thanh Nguyen Chi</i>	381
Modelling a fractured rock mass applied to study the benches stability in quarry Ninhdan, Vietnam <i>Nguyen Anh Tuan</i>	387
Safety solution and incident responding countermeasures in application of hydraulic prop dz combined with steel bar HDJB-1200 at longwall face III-8-2, Hong Thai Coal Company - VINACOMIN <i>Dao Van Chi, Le Tien Dung, Mai Van Lam</i>	393
Simulation of the conveyor lines with asynchronous drive <i>Kubrin S. S, Kaung Pyae Aung</i>	399
Assessment of water quality using multi-criteria analysis: a case study of Cam Pha, Vietnam <i>Nguyen Thi Le Hang, Pham Thi Thu Huong</i>	403
Proposing solutions on perfection of internal control system for risk management in Hong Gai Coal Processing Company - VINACOMIN <i>Nguyen Thi Huyen Trang, Nguyen Thi Hoai Nga</i>	409
The effect of tunnel face support pressure on ground surface settlement in urban areas due to shield tunneling <i>Do Ngoc Thai, Protosenya Anatoliy Grigorevich</i>	415
A study on the drainage ability of Deo Nai, Coc Sau and Cao Son open-pit mines <i>Fomin Sergey Igorevich, Do Ngoc Hoan, Vu Duc Tuan</i>	421

Temperature and seasoning effects on Acacia mangium biomass agglomeration <i>Van Quyen, Sándor Nagy</i>	429
Strengthening state management of mineral resources in Vietnam <i>Phuong Hau Tung</i>	437
The model for planning and implementation a business strategy of production materials trading companies in Quang Ninh, Vietnam <i>Nguyen Thi Hong Loan, Phi Manh Cuong</i>	445
Coal preparation in Poland and Vietnam <i>Miguel Waldemar, Nguyen Hoang Son, Nguyen Ngoc Phu</i>	451
Corporate social responsibility of Vietnamese mining sector: case study of Binh Duong province, South Vietnam <i>Hoang Thi Thanh Thuy, Hoang Thi Thanh Huong, Trinh Duong Thuy</i>	457
Reasonable working mode of the main fans in Hong Thai coal mine, Uong Bi - Quang Ninh <i>Nguyen Van Thinh, Nguyen Cao Khai, Dang Vu Chi, Pham Thi Nhung, Nguyen Van Quang</i>	461
The effects of joint roughness on shear strength of sandstone in Doi Saket area, Chiang Mai, Thailand <i>Amarin Boontun, Pornnipa Wangmai, Panus Fansarojvanich</i>	467
Impact of immediate roof strength on the front abutment stress in different main roof conditions <i>Manh Tung Bui, Van Thanh Tran, Phi Hung Nguyen, Duc Hung Pham</i>	473
The use of mining waste for backfill as one of sustainable mining activities <i>Marat Khayrutdinov, Alexander Ivannikov</i>	477
Support for knowledge exchange in Southeast Asian mining schools - case study of society of mining professors <i>Nguyen Thi Hoai Nga, Jürgen Kretschmann, David Laurence</i>	481
Methane forecast in the coal seams of Quang Hanh underground coal mine <i>Nguyen Van Thinh, Dang Vu Chi, Dang Phuong Thao, Pham Thi Nhung, Tran Anh Duong</i>	487
Research in producing block brick from wastes of disposal area of Thong Nhat coal mine <i>Nguyen Phi Hung, Bui Manh Tung, Pham Manh Tung, Nguyen Cao Khai, Nguyen Van Dung, Tran Dai Nghia</i>	493
The use of Game theory to assess and reduce risks of mining enterprises <i>Fari Kostyukhin, Galina Kruzhkova, Alexander Alexakhin, Natalia Lomonosova</i>	499
Cut off grade estimation for taking Tungsten in Scheelite by open pit mining method <i>Pham Van Hoa, Nguyen Thanh Tuan</i>	505
Study on establishing reasonable parameters of waste dump with multi-benches <i>Pham Van Viet, Nguyen Anh Tuan, Le Qui Thao, Le Thi Thu Hoa</i>	509
The increase of the ecological purity during mining in the rivers' floodplains <i>Boris Leonidovich Talgamer, Maksim Evgenyevich Semenov</i>	515
<b>GEOLOGICAL ENGINEERING</b>	
Some results of fracture orientation analysis and its relationship with rockslide on the Carboniferous - Permian limestone in Ha Long Bay area <i>Phi Truong Thanh, Nguyen Thanh Duy, Ngo Thi Phuong Thao, Nguyen Xuan Thanh, Nguyen Tien Dat</i>	521

Evaluation of Thanh Thuy mineral water for tourism <i>Nguyen Dieu Trinh, Ngo Quang Du</i>	529
Geoelectrical prospecting for water-filled fractured basement within Kundu, north central Nigeria <i>C. I. Unuevho, M. Tswako, K. M. Onuoha, E. E. Udensi, Y. Oshin, L.Q. Khang</i>	535
Development of Geo-products example Geosite Suoi Tien - Binh Thuan province <i>Hoang Thi Phuong Chi, Tran Nu Linh Dan, Chenh Ngoc Yen, Ha Quang Hai</i>	547
Potential Mud-debris flow intensity in mountainous area of Thua Thien - Hue, Vietnam: a case study of a Sap river basin <i>Ha Van Hanh, Do Quang Thien, Nguyen Thi Thanh Nhan, Truong Dinh Trong, Nguyen Quang Tuan</i>	553
Method of natural radioactivity environmental assessment for the mineral deposit: a case study of Nam Xe rare earth deposit in Lai Chau province, Vietnam <i>Phan Quang Van, Robert Möckel, Nguyen Phuong, Thomas Heinig, Dao Trung Thanh, Dang Thi Ngoc Thuy, Tran Thi Ngoc, Nguyen Thi Hoa, Nguyen Thi Thu Huyen, Nguyen Thi Hong, Trinh Dinh Huan, Hoang Huu Uoc</i>	563
Surface textures of the detrital quartz grains derived from the Bundelkhand granite in the Khurar River, central India <i>S. Kanhaiya, B. P. Singh, V. K. Srivastava</i>	575
Some preliminary results on rare earth minerals in Nam Xe area, Lai Chau province <i>Chu Minh Tu, Nguyen Thi Thuc Anh, Hoang Van Dung, Nguyen Trung Thinh</i>	583
Using geostatistics in geotechnic to extrapolate the geomechanic values in area lack of data: a case study of the Le Hong Phong 1 new urban area, Nha Trang city, Khanh Hoa province <i>Thai Ba Ngoc, Tran Van Xuan, Ta Quoc Dung, Phi Hoang Quang Trung, Nguyen Tuan</i>	591
Some non-structural measures to prevent and mitigate the damage of natural disasters in the Viet Nam's Northwest region <i>Tran Thi Thanh Ha, Duong Van Manh</i>	605
A method of contouring indicators field <i>Abramyan Georgy, Abrahamvan Albert</i>	613
Application of three-dimensional geological model in reserve estimation of the Khe Cham I coal mine, Cam Pha, Quang Ninh <i>Khuong The Hung, Nguyen Tien Dung, Do Manh An, Nguyen Trong Toan, Tran Van Anh</i>	617
The application of natural kaolin to remove Mn <sup>2+</sup> from groundwater: a primarily results <i>Tu Thi Cam Loan, Hoang Thi Thanh Thuy</i>	621
The people's land use resettlement of Son La hydropower in Chieng Lao commune, Muong La district, Son La province, Vietnam <i>Tong Thi Quynh Huong</i>	625
Mixture with fly ash and cement for road construction material at Hong Ngu town, Dong Thap province, Vietnam <i>Hoang Nguyen Duc Chi, Nguyen The Vinh, Nhu Minh Tuan, Nguyen Chau Lan</i>	629
Application of municipal solid waste incineration bottom ash in roadbase: experimental and numerical analysis <i>Chen Hui, Lu Cong, Yang Changjin, Chen Su, Si Weiqi, Nguyen Chau Lan</i>	635
3D modelling of saltwater intrusion in coastal area combine with geophysics and isotopic approaches <i>Nguyen Bach Thao, Olivier Banton, Adriano Mayer, Hoang Thu Hang</i>	643

<b>Determining the lateral migration rate of the mid-central rivers of Vietnam</b> <i>Do Quang Thien, Hoang Ngo Tu Do, Nguyen Thi Thanh Nhan, Nguyen Quang Tuan, Thanh H. T.</i>	651
<b>The correlation between radioactive content and rare earth mineral, environment impact when rare earth processing zone going to operate in Dong Pao district, Lai Chau province</b> <i>Nguyen Thi Thuc Anh, Nguyen Van Manh, Hoang Van Dung</i>	665
<b>Remote sensing and GPR based paleochannel mapping on Holocene terminal fans in the Ghaggar-Yamuna interfluve, India: a neotectonic perspective</b> <i>Narendra K. Patel, Pitambar Pati, Aditya K. Verma</i>	675
<b>Experimental study for the properties of stress path of soft soil distributed in Phu Ly town, Ha Nam province</b> <i>Nguyen Thi Nu</i>	683
<b>Estimation of soil erosion risk in the upper part of the Dong Nai river basin using RUSLE, GIS and remote sensing to assess priority areas for conservation</b> <i>Pham Hung, Md. Mostafizur Rahman, Vo Le Phu, Le Van Trung</i>	687
<b>Sludge characteristics and performance of oily wastewater treatment using coagulation method</b> <i>Do Khac Uan, Nguyen Hoang Nam</i>	701
<b>Overview of reservoirs in Son La province</b> <i>Duong Van Manh, Tran Thi Thanh Ha</i>	707
<b>Engineering protection of the metropolis territories from geochemical risk in underground construction</b> <i>Elena Kulikova, Alexander Ivannikov, Renata Galikbarova</i>	715
<b>ENVIRONMENTAL ENGINEERING</b>	719
<b>A semi-quantitative flash flood model and its application for Nang river basin, Bac Kan province, Vietnam</b> <i>Le Nhu Nga, Nguyen Ngoc Thach, La Thanh Ha, Pham Tien Dat</i>	721
<b>Delimitating inland aqua-ecological zones in climate change conditions in the Mekong Delta region, Vietnam</b> <i>Nguyen Xuan Trinh, Doan Ha Phong, Le Xuan Tuan, Tho Tran Quang</i>	733
<b>Determination of dioxin sources by patterns of poly chlorinated biphenyl congeners and using chemical mass balance method</b> <i>Shinichi Atsuta, Tsuyoshi Shiga, Shingo Itonaga</i>	745
<b>Capability to apply remote sensing data in forest fire risk fastly mapping: a case study in Ba Vi, Hanoi (Vietnam)</b> <i>Do Thi Phuong Thao, Bui Ngoc Quy, Nguyen Van Loi, Tran Thi Tuyet Vinh</i>	749
<b>Monthly phytoplankton blooms associated with monsoon activity in the gulf of Thailand in El Nino year 2002</b> <i>Le Van Thien</i>	755
<b>Monitoring coastline changes using multi-temporal satellite data and GIS in the Lach Giang estuary, Ninh Co river delta, Nam Dinh</b> <i>Nguyen Van Trung</i>	759
<b>Solutions for sustainable use of water resources in Son La</b> <i>Tran Thi Thanh Ha</i>	765

Deforestation and drought: integrating remotely sensed indices in a Web-GIS environment for the central highlands of Vietnam	773
<i>Pham Viet Hoa, Nguyen An Binh, Leon T. Hauser, Nguyen Vu Giang, Nguyen Thi Quynh Trang, Le Quang Toan, Vu Huu Long, Pham Viet Hong, Le Vu Hong Hai, Nguyen Quang Tuan</i>	
Monitoring of potential sediment contamination in a remote watershed: a case study of mining production contaminated area of the Mae Tao Basin, Thailand	789
<i>Somprasong K.</i>	
Study the impact of climate change and sea level rise on groundwater resources in Thai Binh province, Vietnam	797
<i>Tran Thi Thanh Thuy, Do Van Binh</i>	
Study on the current state of erosion of river banks and coastal areas in the Mekong Delta, Vietnam	803
<i>Tran The Dinh, Nguyen Thi Thanh Nhan</i>	
Forest change in Hoa Binh - Viet Nam using remote sensing and GIS	811
<i>Nguyen Thi Thuy Hanh, Pham Thi Thanh Thuy, Bui Thi Hong Tham</i>	
Integrating satellite imagery and geostatistics for estimating chlorophyll-a concentration in Hoan Kiem lake	827
<i>Nguyen Thien Phuong Thao, Nguyen Thi Thu Ha, Nguyen Thuy Linh</i>	
Flood hazard zoning in Lam river basin, Vietnam, using GIS and analytic hierarchy process (AHP)	837
<i>Dang Tuyet Minh, Nguyen Ba Dung</i>	
Synthesis of crystalline MnO <sub>2</sub> nanotubes by the hydrothermal method	845
<i>Nguyen Hoang Nam, Dang Thi Ngoc Thuy, Nguyen Quang Huy, Nguyen Thi Sen, Nguyen Thi Hong Yen, Nguyen Thuy An</i>	

## Foreword

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- Geo-spatial technologies;
- Advance in mining and tunneling;
- Geological engineering;
- Environmental engineering.

The conference program represents the efforts of many people. We would like to express our gratitude to the members of the Organizing Committee, Scientific Committee, and the external reviewers for their hard work in reviewing submissions. Full recognition is accorded to the kind and generous sponsors: Vietnam National Coal - Mineral Industries Holding Corporation Limited, Dong Bac Corporation, SISC Vietnam JSC, GPS Lands (Malaysia), and Henan Polytechnic University (China).

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GTER-2017 Conference Chair

Prof. Le Hai An

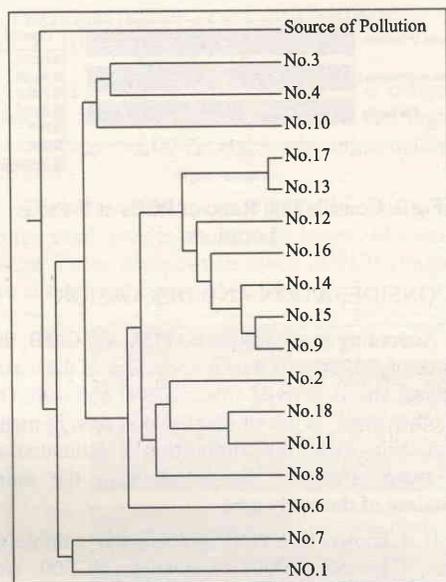


Fig 4. Results of Cluster Dendrograms

## 9. CONCLUSION

Many monitoring wells were installed inside and outside the site to observe the periodical change of water level and chemical conditions. The source of pollution located in the center of the waste disposal site is derived from KC300 and 400 based on PCA and CMBM. As the estimated contribution rates by CA were similar between inside and outside, the PCB pollution was not considered to spread outside the site. PCA, CMBM, and CA are useful methodology to identify the origin of the pollution source or status of its spread at PCB polluted waste-disposal sites.

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## Capability to apply remote sensing data in forest fire risk fastly mapping: a case study in Ba Vi, Hanoi (Vietnam)

Do Thi Phuong Thao<sup>a\*</sup>, Bui Ngoc Quy<sup>a</sup>, Nguyen Van Loi<sup>a</sup>, Tran Thi Tuyet Vinh<sup>a</sup>

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**ABSTRACT:** Warning and preventing forest fires to protect forest ecosystems is essential and must be managed and monitored effectively. Remote sensing data provides extensive information on a wide area that predicts and assesses where and when the risk of forest fires occurred. Nine factors which were extracted from remote sensing data of forest fires was weighted according to the level of influence and overlapped into Ba Vi District's fire risk maps, where the natural national park was located as the largest forest acreage in Ha Noi that needs to be preserved. The results of forest fire occurrence prediction are presented in four levels: low, medium, high and very high. They showed grass, shrubs, pine forest, acacia, etc. and area that near the residential (3670.20 hectares) has the higher probability fire at the dry season, needs to perform effective forest fire prevention first.

**KEY WORDS:** remote sensing, forest fire, risk map, Ba Vi

## 1. INTRODUCTION

Forest is a valuable resource for economic development, climate regulation, reducing natural hazards, preserving water resource and reducing air pollution. However, the forest area has been reducing due to many reasons, including forest fire. As of 31/12/2015, Vietnam has 14,061,856 ha of forest, including about 6 million ha of flammable forest. Ba Vi District is a unit where has the largest natural forest area in Hanoi, Vietnam. There are 15 organizations of tourism around Ba Vi Mountain. A resident living next to Ba Vi National Park is mainly ethnic people. They still use fire without safety in the field working, burning wood, keeping warm cattle etc. Another hand, the forest in Ba Vi has big vegetation cover, grasslands, jungle, reed, reed grass etc. The Ba Vi National Park is classified as high risky of forest fire. The forest fire is always a real risk in this area. Preventing forest fire in Ba Vi National Park is extremely important and necessary. The according to statistics of forest fire in the past three years, Ba Vi National Park has occurred seven fires. Practice shows that apart from objective factors like lightning (not yet), the main cause of forest fire is human being. Therefore, in order to limit forest fires, it is necessary and urgent to develop forecasting maps and identify areas and locations where there is a high risk of fire, mobilizing communities living close to the forest to

improve their sense of responsibility for forest protection.

In order to determine where fires can occur, consideration should be given to factors for causing such as vegetable type, climate, and topography. Traditional data from stations is limited because of lack of approaches to analyze complex factors and to manage large amounts of data (Yakubu et al., 2015). Another face, the traditional analysis is also difficult to consider spatial data and attribute data together. As a result, the fire estimation model is rough with many uncertainties. Today, the development of new remote sensing instruments provides an opportunity to advance studies and researches on forest fire (Jesus et al., 2011). Satellite remote sensing can provide valuable data for all the factors above, example: NDVI (Normalized Difference Vegetation Index), NDWI (Normalized Difference Water index) that is extracted from the infrared visible regional band arithmetic can exhibit the health and moisture contents of the vegetation. Slope, aspect and the altitude used from Aster GDEM are important topographic parameters that can help identify potential areas for forest fire (because elevation relates to precipitation and temperature). The distance from settlement and road were produced by using satellite images classification. Also the temperature distribution was analyzed to associate

with the forest fires by using the thermal band of the Landsat image.

Many studies in Vietnam also use remote sensing data for extraction forest fire information. Luu The Anh et al. (2014), using the Landsat ETM image identifies parameters: forest type, temperature, slope, aspect to warn of the danger of forest fires polluting the dust of Dac Lac province. Vu Thanh Minh et al. (2016), using the Landsat 8 OLI image, extracted fire factors at Cham Chim National Park including biomass density, vegetation type, moisture, surface temperature, water sources and residential areas then overlapping thematic maps show fire-sensitive maps. These methods also have limitations that do not take into account all the factors that affect forest fires.

This paper presents a quick method to extract information for identification of most risky areas of forest fire, help forest department staff, authorities choose the suitable protecting priority area to prevent, minimize damages during fire season in the Ba Vi National Park.

## 2. STUDY AREA

Ba Vi, where is between 21°00' and 21°20' northern parallels, 105°15' and 105°30' eastern meridians, belongs to the northwest of Hanoi, covering an area of 424 km<sup>2</sup>, the population is over 265,000 people (Fig 1). The elevation of terrain in this area decreases from the southwest to the northeast. The mountains cover 47.5% of the area, including Ba Vi National Park that has several over high 1000m peaks, the slope is quite large, so the travel in the National Park is not easy. There are only a few streams in the Ba Vi National Park, so water reserve in this area is very low, especially in the dry season. The climate of hot and humid tropical and monsoon in Ba Vi is divided into two distinct seasons: rainy season lasts from late April to October, dry season from November to the end of April. The annual rainfall is about 2500 mm. The average annual temperature is about 23.4°C. The hottest time of the year is May to August, the temperature can reach 37°C. On driest days, the humidity in the air is very low. The total area of forest land in Ba Vi district is 11,160.3 ha. Forest land is 10,224.6 ha, including natural forest area is 1,754.8 ha and plant forest is 8,465.8 ha. Natural forest is covered by many varied vegetation types, with many species of oily plant and broadleaf trees, which are deciduous in winter and highly flammable.

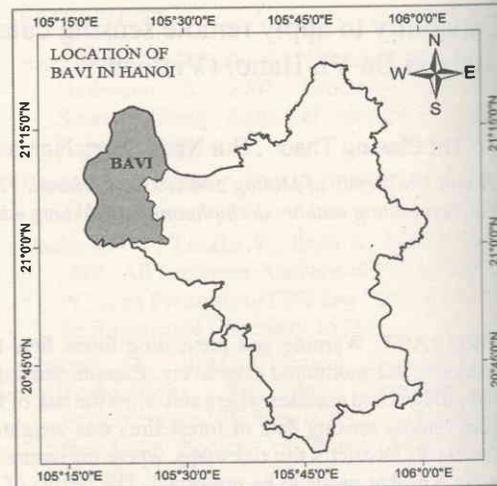


Fig 1. Study area

## 3. MATERIALS AND METHODS:

### 3.1. Materials

The main data used in this study is the Landsat 8 OLI TIR acquired on 01/6/2016 (in the dry season) was used to classify vegetable types and obtain Land Surface Temperature (LST) values. Near infrared, middle infrared and visible red bands of image were used to obtain actual NDVI, NDWI values. Also Aster GDEM digital elevation model was used to create elevation, slope and aspect maps; high-resolution (0.6m) Quickbird data at the same time is also used as a supporting document in the selected sample training for classification and during post-test results. In addition, the topographic map in 1: 25,000 scale was updated in 2014 used to the establishment of geographic basis for thematic maps and reference for classification image.

### 3.2. Methods

In this study, unsupervised and supervised classification algorithms were used to classify Landsat OLI\_TIR images. The images were grouped into 70 clusters using unsupervised classification method with having a number of iterations as 30 and using ISODATA algorithm. After unsupervised classification, the supervised classification was applied for the vegetation type combined with NDVI index and topography maps. The vegetation cover density on the ground is represented by the NDVI index, calculated from the Landsat 8 image.

$$NDVI = \frac{NIR - RED}{NIR + RED} \quad (1)$$

where, NIR is near infrared, RED is the red channel (the highest absorption and reflectance of chlorophyll).

To determine moisture in plants, NDWI is often applied. Roughly optimal wavelengths to calculate NDWI for humidity leaves are from 0.86 μm to 1.24 μm. NDWI is calculated by formulas:

$$NDWI = \frac{NIR - MIR}{NIR + MIR} \quad (2)$$

where, MIR is middle infrared channel.

To obtain temperature distribution of Ba Vi from Landsat 8 thermal band 10 was used (because band 11 is significantly more contaminated stray than band 10). The Landsat sensors acquire temperature data that is in the form of digital number (DN) with a range between 0-255. First, these have to be converting DN to radiance using the following equation:

$$L\lambda = ML * Q_{cal} + AL \quad (3)$$

where, Lλ: TOA spectral radiance [W / (m<sup>2</sup>.sr.μm)]; ML: Band-specific multiplicative rescaling factor from the metadata (RADIANCE\_MULT\_BAND\_x, where, x is the band number); AL: Band-specific additive rescaling factor from the metadata (RADIANCE\_ADD\_BAND\_x, where, x is the band number). In the next step, we convert our reflectance values into Satellite Brightness Temperature (TB, which in Kelvin). The conversion formula radiance to temperature was:

$$TB = \frac{K_2}{\left(\ln \frac{K_1}{K_2} + 1\right)} \quad (4)$$

where, K1, K2 are constants applied for Landsat 8. According to the laws of Planck and Stefan Boltzmann, the estimates of the surface temperature (Ts) can then be calculated as follows:

$$Ts = \frac{TB}{1 + \left(\frac{\lambda * TB}{\rho}\right) * \ln \epsilon} \quad (5)$$

where, Ts = the surface temperature (in Kelvin); λ = the wavelength of the emitted radiation; ρ = h × c / σ (1.438 × 10<sup>-2</sup> m K); h = the Planck constant (6.26 × 10<sup>-34</sup> J s), c = the speed of light (2.998 × 10<sup>8</sup> m /

s); σ is constant by Stefan Boltzmann (1.38 × 10<sup>-23</sup> J K<sup>-1</sup>) and ε the emissivity.

Finally, convert Kelvin values to Celsius = Kelvin - 273.15 unit transformation is used. The buffer maps of settlement and road were produced by using classification image to show the human effect on forest fire as a parameter. AsterGDEM was used for slope, aspect and elevation maps with the GIS technology. Forest fire risk map of the study area was created by performing a multi-criteria analysis by using these data (Jesus et al., 2011).

The forest fire risk map is a combination of parameters, elements will be comparing, AHP (Analytic Hierarchy Process) analysis and numerical weighting are given as: firstly level of the hierarchy is the type of vegetation, the NDVI, secondly the distance to the population, traffic, then temperature, NDWI, and finally elevation, slope and aspect. These weights are calculated based on a matrix that combines from experts in the forestry sector and has a consistency ratio of less than 0.1 for the study area. Forest fire risk prediction (FFRP) was calculated according to the formula:

$$FFRP = 0.15 * \text{"settlement"} + 0.11 * \text{"roads"} + 0.03 * \text{"slope"} + 0.05 * \text{"aspect"} + 0.02 * \text{"altitude"} + 0.21 * \text{"NDVI"} + 0.05 * \text{"Ts"} + 0.3 * \text{"vegetation type"} + 0.07 * \text{"NDWI"} \quad (6)$$

## 4. RESULT

Land surface are classified in 6 different classes can be seen in Fig 2a: (1) agriculture, (2) crops, (3) pine forest, (4) Shrubs, (5) settlement and (6) hydrology. Agricultural land and residential areas are closely related to the risk of forest fire, but the types of vegetation (pine forest, acacia, shrubs, etc) have the greatest impact on the appearance of fire. The overall classification accuracy for Landsat product is 87%. The forest area is 8484.62 ha, the crop vegetation is 2016.97 ha, agriculture is 18119 ha, the shrub is 1501 ha and the water area is 4808 hectares. The NDVI values that are mostly between 0.02 - 0.55 can be seen in Fig 2b reflect the vegetation situation clearly. Similar to the NDWI values show in Fig 2f with values from -0.4 to 0.03. The slope values are not high about 1°-6° in plain, in mountain area the values up to 22° (Fig 2h). The Ts shows that the temperature values vary between 24 - 38°C in the study area (Fig 2e).

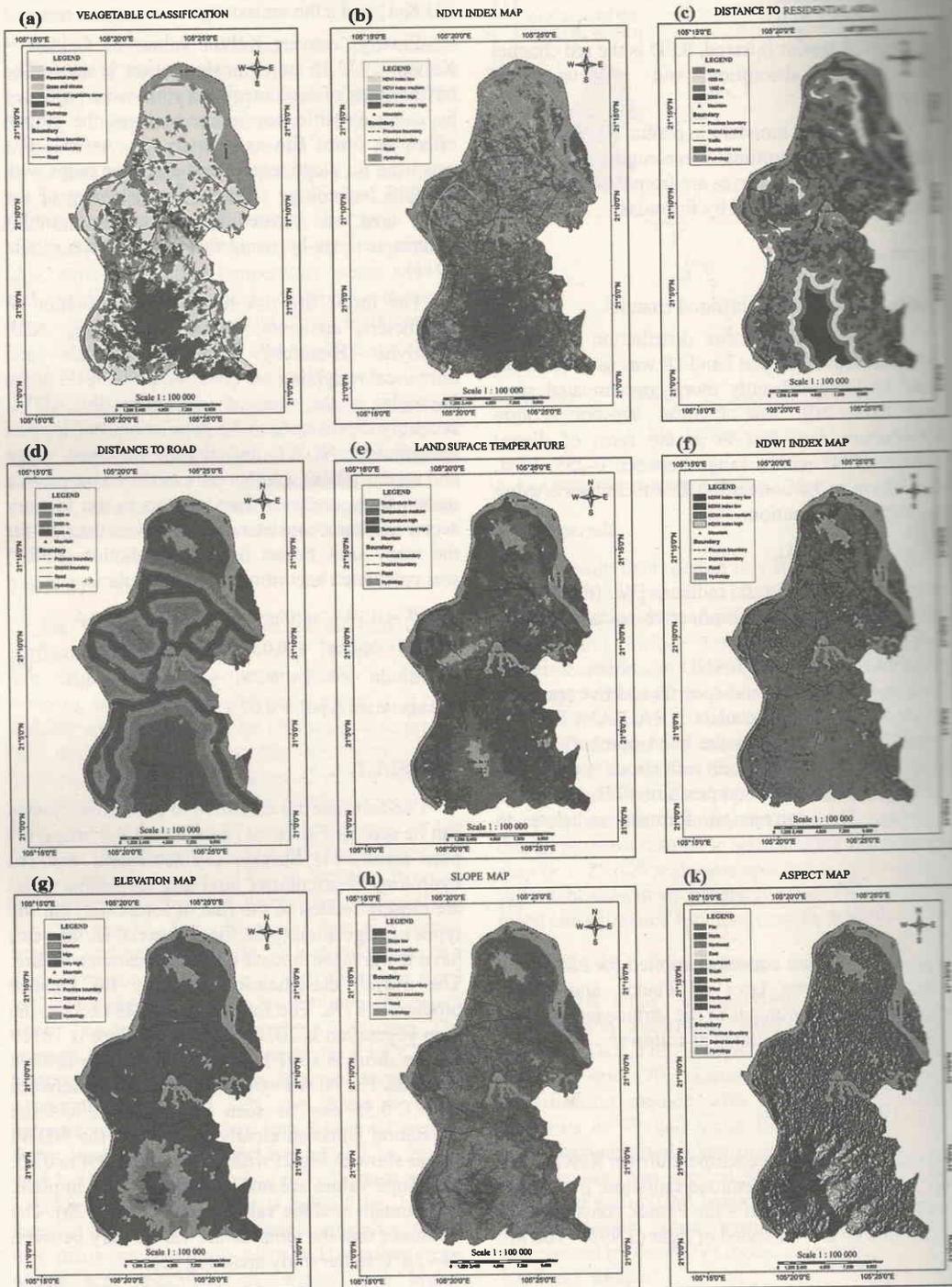


Fig 2. Thematic maps

Aspect is one of dangerous values too, the risk order of the aspect is West > South West > South > North West > North > South East > North East > East (Fig 2k) and the last, with increasing altitude, the temperature values decrease which causes slowly spread of the fire, therefore, high places supposedly safer. Ba Vi only a few places on the 1000m high (Fig 2g). In the study area, the settlement and the road areas are very dense which create very high risk (Fig 2c, d). All parameters (vegetable types, distance to roads, distance to the settlement, slope, aspect, elevation, NDVI, NDWI and LST) are a device in four groups: low, medium, high, and very high. The warning levels are ranked from very low to very high (Table 1), based on Decision No. 127 / QD-BNN- KL on fire risk ratings of Forest Protection Department on December 11, 2000. These results (Fig 3) indicate that Quang Minh commune, Ba Trai commune and the West of Ba Vi district show the risk of fire from "high to very high" compared to other communes in "too low". In addition, the fire risk varies from "medium to high" for different areas of the same commune, such as for the communes at the down of Ba Vi National Park Mountain. As a result, 8.92% of the study area is very high, which means that 3782 hectares area is in fire danger.

FOREST FIRE RISK PREDICTION MAP OF BA VI DISTRICT, JUNE 2016

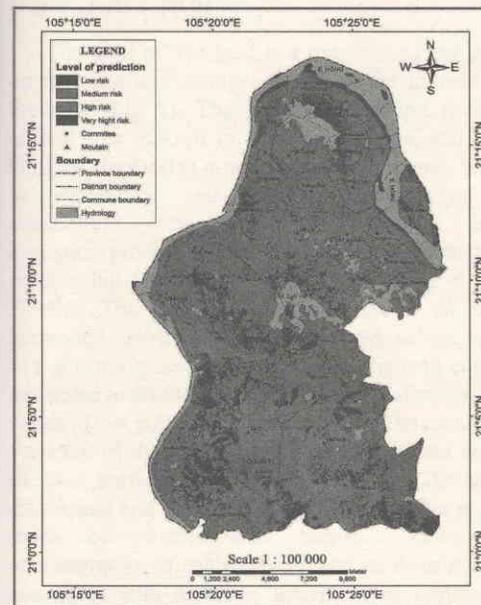


Fig 3. Forest fire risk prediction map

Table 1. Fire risk value, spatial and percentage distribution

Risk Value	Lever	Area (ha)	Percentage (%)
I	low	6461.19	15.69
II	medium	17846.55	43.34
III	high	13196.43	32.05
IV	very high	3670.20	8.92

The accuracy of prediction maps have been checked by using one of the available fire warning maps which was extracted from the Global Fire Management System for this area, then making overlay with the forest fire risk prediction map to assess overall accuracy. Although the direct comparison between the two maps is not absolutely accurate due to the time, space and dynamic of fires, forest fires prediction maps also play an important role in Ba Vi National Park area.

## 5. CONCLUSION

The causes of forest fires are varied, although the number of fires has been negligible in the study area, the development in fast fire prediction maps from remote sensing data are required to management must have a valid plan about the communication, residential area or build fire protection barriers around high risk areas. The combined approach of remote sensing, GIS can be used effectively to forecast forest fire areas from a number of fundamental factors. In this study, the risk of fire in the Ba Vi National Park forest area was analyzed in favor of the vegetation type, human, climatic conditions and natural terrain. The results are quite helpful in describing "fire risk" areas that can also be used as a tool to address national or greater fire risk concerns. The relevant component map elements can vary flexible depending on the data provided and depending on the geographic features of the study area to increase the predicted future risk of fire risk.

## ACKNOWLEDGMENT

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## Monthly phytoplankton blooms associated with monsoon activity in the gulf of Thailand in El Nino year 2002

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**ABSTRACT:** The Gulf of Thailand is a semi-closed Gulf on the west and southwest side of the Indochina Peninsula and experienced reversal monsoon. The object of the present study is to investigate monthly and spatial distributions of the phytoplankton in the Gulf of Thailand during whole El Nino year 2002 by using remote-sensing measurements of chlorophyll-a (Chl-a) and surface wind vectors. Results show that monthly and spatial variations of the phytoplankton blooms are primarily associated with the monsoonal winds. In general, the average monthly Chl-a concentrations were quite low ( $<0.5 \text{ mg m}^{-3}$ ) most area of the Gulf, with a belt of higher Chl-a concentrations along the coast during throughout year. Phytoplankton blooms extensively offshore in the near-coastal area of the Gulf in January and February, which is consistent with the winter northeast monsoon. In particular, one peak of Chl-a concentrations was observed in December. Areas with higher Chl-a concentrations along the coast were observed in winter and summer monsoon months.

**KEY WORDS:** phytoplankton blooms, monsoon, Gulf of Thailand, El Nino

### 1. INTRODUCTION

The Gulf of Thailand is a semi closed sea and on the west and southwest side of the Indochina Peninsula (Fig 1). The human population in the coastal area of Gulf of Thailand is large, and the Gulf of Thailand is a rapidly developing area both in economics and society, particularly in aquaculture sectors. Physical, chemical and biological processes in the ocean are in an intimated relationship (Chaturvedi et al., 1998; Tang et al., 2004b). The physical properties such as the horizontal distribution of bottom cold, saline, and heavy water masses in the Gulf of Thailand could be related to the incidence and direction of monsoon winds in that gulf (Yanagi et al., 2001). The monthly variation of the heat flux could be correlated with the sea surface wind in the Gulf of Thailand (Stansfield and Garrett, 1997). Chlorophyll-a is an index of phytoplankton biomass. However, characteristics of chlorophyll-a and its distribution associated with monsoon activity have remained unknown or poorly known for most of the gulf. In the present study, we investigate monthly and spatial variations of Chlorophyll-a (Chl-a) and sea surface wind conditions in the Gulf of Thailand

during whole El Nino year by examining satellite measurements.

### 2. STUDY AREA AND SATELLITE DATA, AND METHODS

#### 2.1 Study area

The study region is the Gulf of Thailand (area in Fig 1,  $100^{\circ}\text{E} - 104^{\circ}\text{E}$ ,  $6^{\circ}\text{N} - 12^{\circ}\text{N}$ ). The average depth of Gulf of Thailand is about 40m. This region experiences reversal monsoon with the southwest monsoon in the summer and northeast monsoon in the winter.

#### 2.2 Satellite-derived Chlorophyll-a

Sea viewing Wide Field-of View Scanner (SeaWiFS) derived Chlorophyll-a were processed using the Ocean Color 4-band algorithm (OC4) (O'Reilly et al., 1998, 2000). Monthly averaged Chl-a concentrations with  $3 \times 3 \text{ km}$  spatial resolution were obtained and processed for the study region. Ocean Color and Temperature Scanner (OCTS) aboard Advanced Earth Observing Satellite observed the Chl-a concentration in the surface layer from October 1996 to June 1997 with quality similar to that of SeaWiFS (Kawamura and OCTS