REFERENCES

Abe, K. 1987. Relationship between forest harvesting and landslide occurrence: Hunan Impacts and management of mountain forest. Japan: Forest Products Research Institute.

Akbar, T. A. 1998. Integration of GPS, GIS and remote sensing technology for landslide hazard analysis: A case study of western Himalayan Kaghan valley, Pakistan. M.Sc. Thesis, Asian Institute of Technology.

Akkrawintaong, K., Daorerk, V., Chotikasathien, V., and Charusiri, P. 2008. GIS Application for Landslide Hazard Mapping in Phang Nga Region, Southern Thailand. Thailand: Proceedings of the International Symposia on Geoscience Resources and Environments of Asian Terraines (GREAT 2008), 4th IGCP 516, and 5th APSEG.

Aleotti, P. and Chowdhury. 1999. Landslide hazard assessment: Summary review and new perspectives. Bull. Eng. Geol. Env. 58: 21-44.

Alfoldi, T. 1996. Fundamentals of Remote Sensing. Canada: Centre for Remote Sensing, Natural Resources: 258 pp.

Anbalagan, D. 1992. Landslide hazard evaluation and zonation mapping in mountainous terrain. Engineering Geology, 32: 269-277.

Aung, Z. 1991. The Study of Landslide Susceptibility Using the GIS Approach (west of Amphoe Phi Pun, Nakhon Si Thammarat Province. M.Sc. Thesis, Asian Institute of Technology.

Campbell, R. H. 1985. Feasibility of a nationwide program for the identification and delineation of hazards from mud flows and other landslides. U.S. Geological Survey Open File Report 85-276, U.S.Geological Survey: 58 pp.

Carrara, A., Cardinali, M., Detti, R., Guzzetti, F., Pasqul, V., and Reichenbach, P. 1991. GIS techniques and statistical models in evaluating landslide hazard. Earth Surface processes and Landforms, 16: 427-445.

Carrara, A., Cardinali, M., Guzzetti, F., and Reichenbach, P. 1995. GIS technology in mapping landslide hazard. Germany: Geographic Information Systems in Assessing Natural Hazards.

Carrara, A., Guzzetti, F., Cardinali, M., Reichenbach, P. 1999. Uses of GIS technology in the prediction and monitoring of landslide hazard. Natural Hazard, 20: 117 – 135.

Charusiri, P., Daorerk, V., and Supajanya, T. 1996. Applications of Remote-Sensing Techniques to Geological Structures Related to Earthquakes and Earthquake-Prone Areas in Thailand and Neighboring Areas: A Preliminary Study. Journal of Scientific Research, 21: 14-38.

Chowdhury. 1999. Landslide hazard assessment: Summary review and new perspectives. Bull. Eng. Geol. Env., 58: 21-44.

Crist, E. P., and Cicone, R. C. 1984. Application of the Tasseled Cap Concept to Simulated Thematic Mapper Data. Photogrammetric Engineering and Remote Sensing, 50 (3): 343 – 352.

Chotikasathien, W. 2004. Landslide Hazard Mapping and Mitigation Plan of North Pasak Watershed, Phetchabun Province, Thailand. Thailand: Environment Geology Division, Department of Mineral Resources: 20 pp.

Clerci, A., Perego, S., Tellini, C., and Vescovi, P. 2001. A procedure for landslide susceptibility zonation by conditional analysis method. Journal of Geomorphology, 48: 349-364.

Cruden, D. M. 1991. A simple definition of a landslide. Bulletin of the international Association on Engineering Geology, 43: 27-29.

Cruden, D. M. and Varnes, D. J. 1996. Landslide types and processes. In landslides investigation and mitigation, USA: Transportation Research Board, US National Research Council, Special Report 247.

Department of Mineral Resources. 1999. Geological Map of Thailand scale 1:1,000,000. Thailand: Department of Mineral Resources.

Donati, L. and Turrini, M. C. 2002. An objective method to rank the importance of the Factors predisposing to landslide with the GIS methodology: Application to an area of the Apennines, Perugia, Italy. Engineering Geology, 63: 277-289.

Evans, N. C., Huang, S. W., Kinh, J. P. 1997. The Natural Terrain Landslide Study – Phases I and II. Hong Kong : Geotechnical Engineering Office, Special Project Report, 5/97.

Fall, M., Azzam, R. and Noubactep, C. 2006. A multi-method approach to study the stability of natural slopes and landslide susceptibility mapping. Engineering Geology, 82: 241 – 263.

Fell, R. 1994. Landslide risk assessment and acceptable risk. Geotech Journal, 31: 261-272.

Gee, M. D. 1992. Classification of hazard zonation methods and a test of predictive capability. In Environmental planning and Geology, USA: US Dept. of Housing and Urban Dev.

Gokceoglu, C., and Aksoy, H. 1996. Landslide Susceptibility Mapping of the Slopes in the Residual Soils of the Mengen Region (Turkey) by deterministic stability analyses and image processing techniques. Engineering Geology, 44: 147-161.

Greenbaum, D. 1995. Project summary report: Rapid methods of landslide hazard mapping. United Kingdom: Technical Report WC/95/30, International Division, British Geological Survey.

Greenbaum, D., Tutton, M., Bowker, M. R., Browne, T. J., Buleka, J., Grally, K. B., Kuna, G., Mcdonald, A. J. W., Marsh, S. H., Northmorre, K. J., O'Konnor, E. A., and Tragheim, D. G. 1995. Rapid methods of landslide hazard mapping : Papua New Guinea Case Study. United Kingdom: Technical Report WC/95/27 Overseas Geology Series.

Gupta, R. P., and Joshi, B. C. 1990. Landslide Hazard Zoning Using the GIS approach – a case study from the Ramganga catchment, Himalayas. Engineering Geology, 28: 119-131.

Gupta, P.R. 2002. Remote Sensing geology, 2nd Edition. Germany: Springer-Verlag Berlin Heidelberg.

Guzzetti, F., Carrarra, A., Cardinali, M., and Reichenbach, P. 1999. Landslide Hazard Evaluation: a review of current techniques and their application in multi-scale study, Central Italy. Geomorphology, 31: 181-216.

Hervas, J., Barredo, J., Pasuto, A., Montovani, F., and Silvano, S. 2003. Monitoring landslides from optical remotely sensed imagery: The case story of Tessina landslide, Italy. Journal of Geomorphology, 54: 63-75.

Hick, B. G. and Smith, R. D. 1981. Management of steep lands impacts by landslide hazard zonation and risk evaluation. Journal of Hydrology, 20: 63-70.

Hunt, R. E. 1984. Geotechnical Engineering Investigation Manual. USA: McGraw-Hill.

Ives, J. D. and Messerli, B. 1981. Mountain hazard mapping in Nepal: Introduction to an Applied Mountain Research Project. Mountain Research and Development, 10: 185-212.

Iwahashi, J., Watanabe, S. and Furuya, T. 2003. Mean slope-angle frequency distribution and size frequency distribution of landslide masses in Higashikubiki area, Japan. Geomorphology, 50: 249 – 364.

Jadkoski, M. K. 1984. Remote Sensing of Landslide Susceptible Areas. USA: Ph.D., Diss, Utah University.

Jibson, R. W., harp, E. L., and Michael, J. A. 1998. A method to produce probabilistic seismic landslide hazard maps. Italy: Proceeding of International Association for Mathematical Geology 1998 Annual Meeting (IAMG'98): 35-51.

John, A. R. and Jia X. 1999. Remote Sensing digital image analysis-An introduction, 3rd Edition. Germany: Springer-Verlag Berlin.

John, R. D., Marry, R. J., and Leyton, R. L. 1999. Computer simulation of shallow landsliding in New Zealand hill country. JAG, 1 (2): 122-131.

Keefer, D. K. 1984. Landslide Caused by Earthquakes. Geological Society of America Bulletin, vol.95: 406-421.

Khaowiset, K. 2007. Neotectonic Along the Pua Fault in Changwat Nan, Northern Thailand: Evidence from Remote Sensing and Thermoluminescence Dating. M.Sc. Thesis, Chulalongkorn University.

Kosuwan, S. 2005. Geology and Causes of Landslide at Mae Ramat district, Tak Province. Thailand: Environment Geology Division, Department of Mineral Resources: 22 pp.

Kunsuwan, B. 2005. Study of Behavior for Landslides on Upstream Areas in Mae Nam Chantaburi Basin. Thailand: M.En., Kasetsart University.

Land Development Department. 2004. Land Use Map of Nan Province scale 1: 250,000. Land Development Department, Bangkok.

Larsen, M., and Torres-Sanchez, A. 1998. The Frequency and Distribution of Recent Landslides in Three Montane Tropical Regions of Puerto Rico. Geomorphology, 24: 309-331.

Lauver, C. L., and Whistler, J. L. 1993. A Hierarchical Classification of Landsat TM Imagery to Identify Natural Grassland Areas and Rare Species Habitat. Photogrammetric Engineering and Remote Sensing, 59 (5): 627-634.

Lee, S. and Min, K. 2001. Statistic analysis of landslide susceptibility at Yougin, Korea. Journal of Environmental Geology, 40: 1095-1113.

Lee, S. 2004. Landslide hazard analysis using GIS and remote sensing. Korea: Training Note, Korea Institute of Geosciences and Mineral Resources (KIGAM).

Lorente, A., Garcia-Ruiz, J., Begueria, S., and Arnaez. J. 2002. Factors explaining the spatial distribution of hillslope debris flows. Mountain Research and Development, 22: 32-39.

Malczewski, J. 1999. GIS and multicriteria decision analysis. Canada: Department of Geography, University of Western Ontario, John Willey&Sons Inc.

McKean, J., Buechel, S., and Gaydos, L. 1991. Remote Sensing and Landslide Hazard Assessment. Photogrammetric Engineering and Remote Sensing, 57 (9): 1185-1193.

Meesook, A. 2000. Cretaceous environments of Northeastern Thailand. Cretaceous environment of Asia, Elesevier Science, B. V.:207-223.

Metternicht, G., Hurni, L., and Gogu, R. 2005. Remote sensing of landslides: An analysis of the potential contribution to geo-spatial systems for hazard assessment in mountainous environments. Remote Sensing of Environment, 98: 284-303.

Montavani, F., Soeters, R., and Westen, V. 1996. Remote sensing techniques for landslide studies and hazard zonation in Europe. Journal of Geomorphology, 15: 213-225.

Musaoglu, N., Kaya, S., Sekel, D. Z., and Gokzel, C. 2002. A case study of using remote sensing data and GIS for land management: Cataca Region. USA.: XXII FIG International Congress.

Nawavitphaisit, S. 2005. The Landslide Investigation Report of Phang Nga Province. Thailand: Department of Mineral Resources: 125 pp.

Ngugen, Q. P. and Bui, H. B. 2004. Landslide hazard mapping using Bayesian approach in GIS: Case study in Yangsan area, Korea. Korea: International Symposium on Geoinformatics for spatial Infrastructure Development in Earth and Allied Sciences.

Olivier, H. J. 1979. A New Engineering-Geological Rock Durability Classification. Engineering Geology, 14: 225–279

Ostir, K., Veljanovski, T., Podobnikar, T., and Stancic, Z. 2003. Application of satellite remote sensing in natural hazard management: the Mount Mangart landslide case study. International Journal of Remote Sensing, 24 (20): 3983-4002.

Pack, R. T. 1985. Multivariate analysis of landslide-related variables in Davis County, Utah. In delineation of landslide, Flash flood and debris flow hazards in Utha. USA: Utah State University: 50-58.

Pantanahiran, W. 1994. The use of Landsat imagery and digital terrain models to assess and predict landslide activity in tropical areas. USA: Ph.D. Dissertation, University of Rhode Island.

Panthanahiran, W. 2001. Landslide risk map in Surat Thani Province. Thailand: Technical report, Department of Mineral Resources: 77 pp.

Patanakanog, B. 2001. Landslide hazard potential area in 3 dimensions by remote sensing and GIS technique. Thailand: Land Development Department: 5 pp.

Press, S. J., and Wilson, S. 1978. Choosing Between Logistic Regression and Discriminant Analysis. Journal of the American Statistical Association, 73 (364): 669-705.

Rajbhandri, P. C. L. 1995. Application of GIS and remote sensing for landslide hazard zonation and mapping disaster prone area: A case study of the Kulekhari. Thailand: Ph.D Dissertation, Asian Institute of Technology.

Roh, H and Reinhorn, A. M. 2008. Analytical Modeling of Rocking Elements. Engineering Structures, Vol. 31, 5: pp. 1179-1189.

Rouse, J. W., Haas, R. H., Schell, J. A., and Deering. 1974. Monitoring Vegetation System in Great Plains with ERTS. Third ERTS Symposium, NASA Sp-351, A: 309-318.

Rupke, J., Cammeraat, E., Seijmonsbergen, A. C., and Van Westen, C. J. 1988. Engineering geomorphology of Widentobel Catchment, Appenzell and Sankt Gallen, Switzerland: A geomorphological inventory system applied to geotechnical appraisal of slope stability. Engineering Geology, 26: 33-68.

Sarkar, S., Kanungo, D. P. 2004. An integrated approach for landslide susceptibility mapping using remote sensing and GIS. Photogrammetric Engineering& Remote Sensing, 70 (5): 617-625.

Schuster, R. L. 1996. Landslide: effects on the natural environment. Italy: Symposium on Engineering, Geology and the Environment, Int. Assoc. Eng. Geol., Vol.5.

Seker, D. Z., Altan, M. O., Duran, Z., Shrestha, M. B., Yuasa, A., and Kawamura, K. 2004. Producing landslide risk map of Sebinkarahisan by means of remote sensing and GIS techniques. Turkey: Civil Engineering Faculty, Istanbul University.

Soeters, R. and Van Westen, C. J., 1996. Slope stability: recognition, analysis and zonation. In: A. K. Turner, R. L. Shuster (editor) "Landslides: investigation and mitigation". Transportation research Board - National Research Council, Special Report 247: 129-177.

Tantiwanit, W. 1992. Landslide Geohazard at Ban Kathun Nue, Nakhon Srithammarat Province. Thailand: Department of Mineral Resources.

Tantiwanit, W. 2005. Landslides in Thailand. Geological Survey Division, Department of Mineral Resources, Bangkok, Thailand: 30 pp.

Temesgen, B., Mohammed, M. U., and Korme, T. 2001. Natural hazard assessment using GIS and remote sensing methods with particular reference to the landslides in the Wondgenet area Ethiopia. Journal of Phys. Chem. Earth (C), 26 (9): 665-675.

Teerarangsikul, S. 2006. Landslide Prediction Model using Remote Sensing, GIS and Field Geology: A Case Study of Wang Chin District, Phrae Province, Northern Thailand. Ph.D. Dissertation, Suranaree University of Technology.

Thitisawarn, V. 2003. Terrain characterization for landslide susceptibility analysis along Sillong-Silchen highway in northeastern India. India: Geosciences division, Indian Institute of remote sensing: 66 pp.

Townshend, J. R. G. 1984. Agricultural Land-cover Discrimination Using Thematic Mapper Spectral Bands. International Journal of Remote Sensing, 5 (4): 681-689.

Turrini, M. C., and Visintainer, P. 1998. Proposal of a Method to Defined Areas of Landslide Hazard and Application to an Area of the Dolomites, Italy. Engineering Geology, 50: 255-265.

Turner, A. K. 1996. Landslides: Investigation and Mitigation. USA: the National Academy of Sciences: 136 pp.

Varnes, D. J. 1978. Slope movement types and processes. In landslide analysis and control: National Academy of Sciences, Transportation Research Board, Special Report 176: 11-33.

Varnes, D. J. 1984. Landslide hazard zonation: A review of principles and practice. Natural hazard 3, Commission on landslides of the IAGE, UNESCO, Paris, France: 63 pp.

Van Westen, C. J. 1993. Training Package for Geographic Information Systems in Slope Instability Zonation. ITC-Publication, n. 15, Part I: 245 pp.

Van Westen, C. J., Castellanos, E., and Kuriakose. 2008. Spatial data for landslide successility, hazard and vulnerability: An overview. Engineering Geology, 102: 112–131.

Visethrattana, K., Nantasin, P., Udomchoke, V., and Sricharoen, L. 2008. Hydraulic conductivity properties of residual soil for slope stability analysis at Huai Pin watershed, Nan Province. Thailand: Proceedings of the International Symposia on Geoscience Resources and Environments of Asian Terraines (GREAT 2008), 4th IGCP 516, and 5th APSEG: 524-529.

Wang, S. Q., 2001. Landslide on natural terrain. Journal of Mountain Research and Development, 12: 40-47.

Ward, G., Wisloski, A. P., and Pearson, E. J. 1993. Spatial Analysis in GIS for Natural Hazard Assessment. USA: Environmental Modeling with GIS, Oxford University Press.

Wold, R. L., and C. L. Jochim. 1989. Landslide Loss Reduction: A guide for state and local government planning. Federal Emergency Management Agency.

Woodcocks, C. E., Sham, C. H., and Shaw, B. 1990. Comments on Selecting a Geographic Information System for Environmental Management. Environmental Management, 14 (3): 307-315.

Yumuang, S. 2006a. Evaluation of Potential for 2001 Debris Flow and Debris Flood in the Vicinity of Nam Ko Area, Amphoe Lom Sak, Changwat Phetchabun, Central Thailand. Ph.D. Dissertation, Department of Geology, Faculty of Science, Chulalongkorn University.

Yumuang, S. 2006b. 2001 debris flow and debris flood in Nam Ko area, Phetchabun Province, central Thailand. I nternational Journal of Sciences, Environmental Geology, Vol. 51, No. 4: 545-564.

Zinck, A. J., and Lopez, J., Metternicht, G. I., Shrestha, D. P., and Vazques-Selem, L. 2001. Mapping and modeling mass movement and gullies in mountainous areas using remote sensing and GIS techniques. JAG, 3 (1): 43-53.

APPENDICES

Appendix A: Table A1 to A8

Table of Relationship between Landslide Occurrence and Factors

Table A1. Landslide occurrence related with lithology.

Unit	Lithologic Units	Area (Pixel)	% Area of Lithology (a)	Point of Landslide	% (Ls)
1	Alluvial sediments	748,743	5.53	0	0.00
2	Terrace sediments	487,761	3.61	38	2.10
3	Semi-consolidated rocks	515,188	3.81	36	1.99
4	Very coarse-clastic sediments	1,515,490	11.20	79	4.36
5	Coarse-clastic sediments	4,897,763	36.20	979	54.06
6	Fine-clastic sediments	168,202	1.24	21	1.16
7	Limestone dominated rocks	1,162,005	8.59	229	12.64
8	Granitic rocks	81,885	0.61	11	0.61
9	Tuffaceous and Volcanic	3,587,771	26.52	407	22.47
10	Metamorphic and ultramafic	358,878	2.65	11	0.61
Total		**13,528,880**	**100**	**1,811**	**100**

Table A2. Landslide occurrence related with distance from lineament.

Unit	Dist. From Lineament (m)	Area (Pixel)	% Area of distance from lineament (a)	Point of Landslide	% (LS)
1	0 - 100	2,799,147	20.69	506	27.94
2	100 - 200	2,650,850	19.59	423	23.36
3	200 - 300	2,105,803	15.57	285	15.74
4	300 - 400	1,523,105	11.26	233	12.87
5	400 - 500	1,033,819	7.64	154	8.50
6	500 - 600	676,146	5.00	93	5.14
7	600 - 700	434,488	3.21	54	2.98
8	700 - 800	283,457	2.10	27	1.49
9	800 - 900	189,694	1.40	21	1.16
10	900 - 1000	135,802	1.00	15	0.83
11	>1000	1,696,569	12.54	0	0.00
Total		**13,528,880**	**100**	**1,811**	**100**

Table A3. Landslide occurrence related with land use / land cover.

Unit	Land use / Land cover Units	Area (Pixel)	% Area of Land use (a)	Point of Landslide	% (Ls)
1	Crop and Orchard	4,558,539	33.69	545	30.09
2	Teak Plantation	1,190,196	8.80	270	14.91
3	Open Forest	3,118,178	23.05	525	28.99
4	Wasteland	215,988	1.60	53	2.93
5	Deforestation Area	4,384,197	32.41	418	23.08
6	Reservoir	61,782	0.46	0	0.00
Total		**13,528,880**	**100**	**1,811**	**100**

Table A4. Landslide occurrence related with elevation.

Unit	Elevation Units (m)	Area (Pixel)	% Area of Aspect (a)	Point of Landslide	% (Ls)
1	50 – 100	110	0.00	0	0.00
2	100 – 200	237,386	1.75	2	0.11
3	200 – 300	2,230,823	16.49	67	3.70
4	300 – 400	2,275,734	16.82	236	13.03
5	400 – 500	2,016,478	14.90	328	18.11
6	500 – 600	1,554,593	11.49	277	15.30
7	600 – 700	1,367,537	10.11	224	12.37
8	700 – 800	946,913	7.00	176	9.72
9	800 – 900	785,800	5.81	138	7.62
10	900 – 1000	583,392	4.31	106	5.85
11	1000 – 1100	440,601	3.26	81	4.47
12	1100 – 1200	349,729	2.59	56	3.09
13	1200 – 1300	260,159	1.92	47	2.60
14	1300 – 1400	190,878	1.41	28	1.55
15	1500 – 1600	136,436	1.01	33	1.82
16	1400 – 1500	80,922	0.60	8	0.44
17	1600 – 1700	41,159	0.30	1	0.06
18	1700 – 1800	18,932	0.14	2	0.11
19	1800 – 1900	8,627	0.06	1	0.06
20	1900 – 2000	2,255	0.02	0	0.00
21	2000 – 2060	416	0.00	0	0.00
Total		**13,528,880**	**100**	**1,811**	**100**

Table A5. Landslide occurrence related with slope steepness.

Unit	Slope Units	Area (Pixel)	% Area of Slope (a)	Point of Landslide	% (Ls)
1	0°-10°	3,474,443	25.68	268	14.80
2	10°-20°	4,028,072	29.77	654	36.11
3	20°-30°	3,646,485	26.95	578	31.92
4	30°-40°	1,578,020	11.66	246	13.58
5	40°-50°	345,437	2.55	41	2.26
6	50°-60°	162,113	1.20	13	0.72
7	60°-70°	135,716	1.00	4	0.22
8	70°-80°	113,997	0.84	5	0.28
9	80°-90°	44,597	0.33	2	0.11
Total		**13,528,880**	**100**	**1,811**	**100**

Table A6. Landslide occurrence related with slope aspect.

Unit	Aspect Units	Area (Pixel)	% Area of Aspect (a)	Point of Landslide	% (Ls)
1	North	1,574,506	11.64	163	9.00
2	Northeast	1,650,934	12.20	142	7.84
3	East	1,656,535	12.24	156	8.61
4	Southeast	1,801,369	13.31	176	9.72
5	South	1,844,007	13.63	407	22.47
6	Southwest	1,752,961	12.96	357	19.71
7	West	1,613,770	11.93	227	12.53
8	Northwest	1,634,798	12.08	183	10.10
Total		**13,528,880**	**100**	**1,811**	**100**

Table A7. Landslide occurrence related with flow direction.

Unit	Flow Direction Units	Area (Pixel)	% Area of Flow direction (a)	Point of Landslide	% (Ls)
1	N to NE	1,703,622	12.59	146	8.06
2	NE to E	1,593,825	11.78	230	12.70
3	E to SE	2,059,780	15.23	348	19.22
4	SE to S	1,671,960	12.36	284	15.68
5	S to SW	1,883,611	13.92	152	8.39
6	SW to W	1,424,878	10.53	233	12.87
7	W to NW	1,702,555	12.58	254	14.03
8	NW to N	1,488,649	11.00	164	9.06
Total		**13,528,880**	**100**	**1,811**	**100**

Table A8. Landslide occurrence related with NDVI.

Unit	NDVI Units	Area (Pixel)	% Area of NDVI (a)	Point of Landslide	% (Ls)
1	-1 to - 0.75	344,027	2.54	36	1.99
2	-0.75 to -0.50	276,384	2.04	34	1.88
3	-0.50 to -0.25	505,409	3.74	58	3.20
4	-0.25 to 0.00	997,075	7.37	134	7.40
5	0.00 to 0.25	2,051,996	15.17	234	12.92
6	0.25 to 0.50	3,449,653	25.50	422	23.30
7	0.50 to 0.75	3,633,221	26.86	517	28.55
8	0.75 to 1.00	2,271,115	16.79	376	20.76
Total		**13,528,880**	**100**	**1,811**	**100**

Appendix B: Table B1 to B8

Table of Probability Ratio between Landslide Occurrence and Factors

Table B1. Probability ratio of landslide occurrence within lithology.

Unit	Lithologic Units	% Area of Lithology (a)	% Point of Landslide (Ls)	(Ls/a = Pr)
1	Alluvial sediments	5.53	0.00	0.00
2	Terrace sediments	3.61	2.10	0.58
3	Semi-consolidated rocks	3.81	1.99	0.52
4	Very Coarse-clastic sediments	11.20	4.36	0.39
5	Coarse-clastic sediments	36.20	54.06	1.49
6	Fine-clastic sediments	1.24	1.16	0.93
7	Limestone dominated rocks	8.59	12.64	1.47
8	Granitic rocks	0.61	0.61	1.00
9	Tuffaceous and Volcanic	26.52	22.47	0.85
10	Metamorphic and ultramafic	2.65	0.61	0.23
Total		**100**	**100**	

Table B2. Probability ratio of landslide occurrence within buffered lineament area.

Unit	Dist. From Lineament (m)	% Area of distance from lineament (a)	% Point of Landslide (Ls)	(Ls/a = Pr)
1	0 - 100	20.69	27.94	1.35
2	100 - 200	19.59	23.36	1.19
3	200 - 300	15.57	15.74	1.01
4	300 - 400	11.26	12.87	1.14
5	400 - 500	7.64	8.50	1.11
6	500 - 600	5.00	5.14	1.03
7	600 - 700	3.21	2.98	0.93
8	700 - 800	2.10	1.49	0.71
9	800 - 900	1.40	1.16	0.83
10	900 - 1000	1.00	0.83	0.83
11	>1000	12.54	0.00	0.00
Total		**100**	**100**	

Table B3. Probability ratio of landslide occurrence within land use / land cover.

Unit	Land use / Land cover Units	% Area of Land use (a)	% Point of Landslide (Ls)	(Ls/a = Pr)
1	Crop and Orchard	33.69	30.09	0.89
2	Teak Plantation	8.80	14.91	1.69
3	Open Forest	23.05	28.99	1.26
4	Wasteland	1.60	2.93	1.83
5	Deforestation Area	32.41	23.08	0.71
6	Reservoir	0.46	0.00	0.00
Total		**100**	**100**	

Table B4. Probability ratio of landslide occurrence within elevation.

Unit	Elevation Units (m)	% Area of Aspect (a)	% Point of Landslide (Ls)	(Ls/a = Pr)
1	50 – 100	0.00	0.00	0.00
2	100 – 200	1.75	0.11	0.06
3	200 – 300	16.49	3.70	0.22
4	300 – 400	16.82	13.03	0.77
5	400 – 500	14.90	18.11	1.22
6	500 – 600	11.49	15.30	1.33
7	600 – 700	10.11	12.37	1.22
8	700 – 800	7.00	9.72	1.39
9	800 – 900	5.81	7.62	1.31
10	900 – 1000	4.31	5.85	1.36
11	1000 – 1100	3.26	4.47	1.37
12	1100 – 1200	2.59	3.09	1.20
13	1200 – 1300	1.92	2.60	1.35
14	1300 – 1400	1.41	1.55	1.10
15	1500 – 1600	1.01	1.82	1.81
16	1400 – 1500	0.60	0.44	0.74
17	1600 – 1700	0.30	0.06	0.18
18	1700 – 1800	0.14	0.11	0.79
19	1800 – 1900	0.06	0.06	0.87
20	1900 – 2000	0.02	0.00	0.00
21	2000 – 2060	0.00	0.00	0.00
Total		**100**	**100**	

Table B5. Probability ratio of landslide occurrence within slope steepness.

Unit	Slope Units	% Area of Slope (a)	%Point of Landslide (Ls)	(Ls/a = Pr)
1	0°-10°	25.68	14.80	0.58
2	10°-20°	29.77	36.11	1.21
3	20°-30°	26.95	31.92	1.18
4	30°-40°	11.66	13.58	1.16
5	40°-50°	2.55	2.26	0.89
6	50°-60°	1.20	0.72	0.60
7	60°-70°	1.00	0.22	0.22
8	70°-80°	0.84	0.28	0.33
9	80°-90°	0.33	0.11	0.34
Total		**100**	**100**	

Table B6. Probability ratio of landslide occurrence within slope aspect.

Unit	Aspect Units	% Area of Aspect (a)	% Point of Landslide (Ls)	(Ls/a = Pr)
1	North	11.64	9.00	0.77
2	Northeast	12.20	7.84	0.64
3	East	12.24	8.61	0.70
4	Southeast	13.31	9.72	0.73
5	South	13.63	22.47	1.65
6	Southwest	12.96	19.71	1.52
7	West	11.93	12.53	1.05
8	Northwest	12.08	10.10	0.84
Total		**100**	**100**	

Table B7. Probability ratio of landslide occurrence within flow direction.

Unit	Flow Direction Units	% Area of Flow direction (a)	%Point of Landslide (Ls)	(Ls/a = Pr)
1	N to NE	12.59	8.06	0.64
2	NE to E	11.78	12.70	1.08
3	E to SE	15.23	19.22	1.26
4	SE to S	12.36	15.68	1.27
5	S to SW	13.92	8.39	0.60
6	SW to W	10.53	12.87	1.22
7	W to NW	12.58	14.03	1.11
8	NW to N	11.00	9.06	0.82
Total		**100**	**100**	

Table B8. Probability ratio of landslide occurrence within NDVI.

Unit	NDVI Units	% Area of NDVI (a)	% Point of Landslide (Ls)	(Ls/a = Pr)
1	-1 to - 0.75	2.54	1.99	0.78
2	-0.75 to -0.50	2.04	1.88	0.92
3	-0.50 to -0.25	3.74	3.20	0.86
4	-0.25 to 0.00	7.37	7.40	1.00
5	0.00 to 0.25	15.17	12.92	0.85
6	0.25 to 0.50	25.50	23.30	0.91
7	0.50 to 0.75	26.86	28.55	1.06
8	0.75 to 1.00	16.79	20.76	1.24
Total		**100**	**100**	

Appendix C: Table C1 to C8

Table of Ranking and Weighting the Importance of Factors

Table C1. The reliability importance of lithology as a predictor of landsliding.

Class	Lithologic units	Ls/a=Pr	% (LS)	% Area of lithology	Reliability of lithology
1	Coarse-clastic rocks	1.49	54.60	36.02	67.85/45.22
2	Limestone dominated rocks	1.47	12.64	8.59	
3	Granitic rocks	1.00	0.61	0.61	
Total			67.85	45.22	1.50

Table C2. The reliability importance of lineament as a predictor of landsliding.

Class	Dist. Lineament units (m)	Ls/a=Pr	% (LS)	% Area Dist. lineament	Reliability of Dist. lineament
1	0 – 100	1.35	27.94	20.69	93.55/79.75
2	100 – 200	1.19	23.36	19.59	
3	400 – 500	1.14	8.50	7.64	
4	300 – 400	1.11	12.87	11.26	
5	500 – 600	1.03	5.14	5.00	
6	200 – 300	1.01	15.74	15.57	
Total			93.55	79.75	1.17

Table C3. The reliability importance of land use as a predictor of landsliding.

Class	Land use / Land cover units	Ls/a=Pr	% (LS)	% Area of Land use	Reliability of Land use
1	Wasteland	1.83	2.93	1.60	46.83/33.45
2	Teak plantation	1.69	14.91	8.80	
3	Open forest	1.26	28.99	23.05	
Total			46.83	33.45	1.40

Table C4. The reliability importance of elevation as a predictor of landsliding.

Class	Elevation units (m)	Ls/a=Pr	% (LS)	% Area of Elevation	Reliability of Elevation
1	1500 – 1600	1.81	1.82	1.01	82.50/63.81
2	700 – 800	1.39	9.72	7.00	
3	1000 – 1100	1.37	4.47	3.26	
4	900 – 1000	1.36	5.85	4.31	
5	1200 – 1300	1.35	2.60	1.92	
6	500 – 600	1.33	15.30	11.49	
7	800 – 900	1.31	7.62	5.81	
8	400 – 500	1.22	18.11	14.90	
9	600 – 700	1.22	12.37	10.11	
10	1100 – 1200	1.20	3.09	2.59	
11	1300 – 1400	1.10	1.55	1.41	
Total			82.50	63.81	1.29

Table C5. The reliability importance of slope steepness as a predictor of landsliding.

Class	Slope units	Ls/a=Pr	% (LS)	% Area of Slope	Reliability of Slope
1	10°-20°	1.21	36.11	29.77	81.61/68.38
2	20°-30°	1.18	31.92	26.95	
3	30°-40°	1.16	13.58	11.66	
Total			81.61	68.38	1.19

Table C6. The reliability importance of slope aspect as a predictor of landsliding.

Class	Aspect units	Ls/a=Pr	% (LS)	% Area of Aspect	Reliability of Aspect
1	South	1.65	22.47	13.63	54.71/38.52
2	Southwest	1.52	19.71	12.96	
3	West	1.05	12.53	11.93	
Total			54.71	38.52	1.42

Table C7. The reliability importance of flow direction as a predictor of landsliding.

Class	Flow direction units	Ls/a=Pr	% (LS)	% Area of Flow dir.	Reliability of Flow direction
1	SE to S	1.27	15.68	12.36	74.50/62.48
2	E to SE	1.26	19.22	15.23	
3	SW to W	1.22	12.87	10.53	
4	W to NW	1.11	14.03	12.58	
5	NE to E	1.08	12.70	11.78	
Total			74.50	62.48	1.19

Table C8. The reliability importance of NDVI as a predictor of landsliding.

Class	NDVI units	Ls/a=Pr	% (LS)	% Area of NDVI	Reliability of NDVI
1	0.75 to 1.00	1.24	20.76	16.79	56.71/51.02
2	0.50 to 0.75	1.06	28.55	26.86	
3	-0.25 to 0.00	1.00	7.40	7.37	
Total			56.71	51.02	1.11

BIOGRAPHY

Mr. Krittapob Akkrawintawong was born on September 21, 1979 in Bangkok, Central Thailand. He graduated at high school level from Debsirin School, Bangkok, in 1997. In 2001, he received a B.Sc. degree in Geology from the Department of Geology, Faculty of Science, Chulalongkorn University, Thailand. After his graduation, he started his work in 2001 as a petroleum engineer at International Logging Oversea Company. In 2004, he has moved to work in Geo-hazard Section, Environmental Geology Division, Department of Mineral Resources (DMR), and have been employed until present time. In 2005, he enrolled as a graduate student for M.Sc. program of Geology Programme at Graduate School, Chulalongkorn University, Bangkok, Thailand.