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Bringing Geospatial Analysis to the Social Studies: an Assessment of the City Sprawl in China

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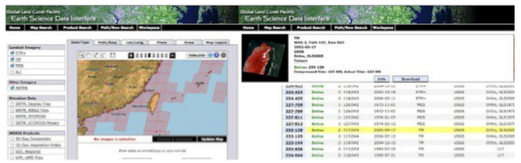
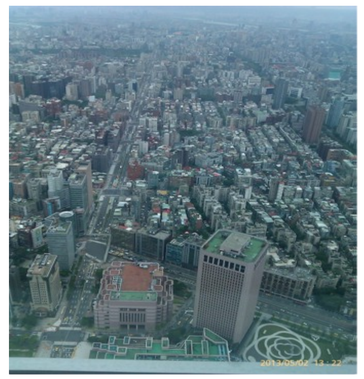
Research area: Taipei urban landscapes, Taiwan. Located on the north of the Taiwan Island, Taipei is the country's core urban political and economic center with population reaching over 2.6 M and continuing to expand within the city
Research aim: spatio-temporal analysis of urban dynamics in study area during 15 years (1990-2005)
Data capture: The data include Landsat TM images taken from the U.S.G.S. website. The software used is ENVI GIS.



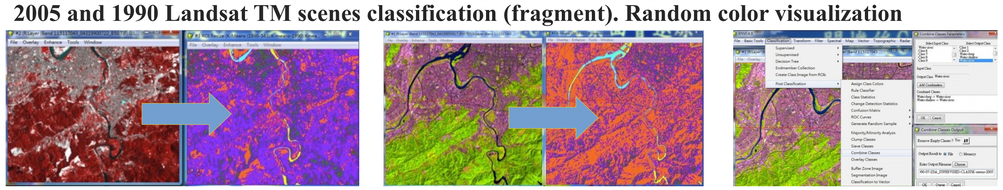


Research objective: application of geoinformatic tools, remote sensing data and application of methodology to spatial analysis for a case study of Taipei

Research problem: In the past decades, the process of urbanization has become more notable in the East Asia. Since past decades, Taipei city undergone serious urban changes.The development of urban landscapes in Taipei has unique feature; Taiwan's exceptional economic and industrial growth since 1980s, which is often referred as "industrial wonder of Taiwan". Recently, the country quickly transformed from an agriculture-based traditional economy into a highly industrialized society. As a result, Taiwan has now a new face of high-technology oriented, economically restructured economy. This caused changes in the face of the country, modifying both its social and natural landscape patterns. Taiwan is nowadays a highly urbanized country with almost 80% of the total population of Taiwan living in urban areas. Intensive urbanization necessarily create new conditions for human-nature co-existence, since rapidly growing city and high urbanization rate affect biodiversity and ecosystems sustainability. The process of urbanization includes transformation of natural landscapes: typical natural land cover type are being transformed into human-affected artificial surfaces and the city area enlarges. Anthropogenic pressure increased rapidly due to the expansion of Taipei metropolitan area. Rapid urbanization affects complex interrelations of natural and urban ecosystems, changes their structure, size and shape, which becames a serious environmental problem. At the same time, Taiwan has unique natural landscapes with high environmental value, outstanding natural beauty, rare and extinct species. In vies of this, environmental monitoring should be considered for effective city management and nature conservation on the island.

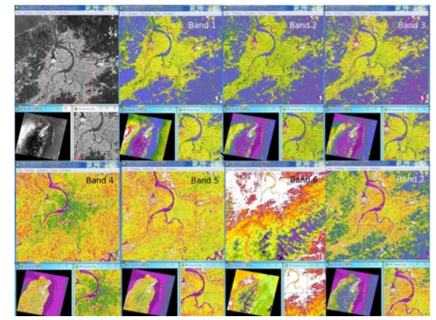
Methods:
Workflow includes following steps: 1) Preliminary processing 2) Creation color composites 3) Classification using K-means algorithm 4) Mapping using classification results 5) Accuracy assessment. The preliminary data processing includes image contrast stretching, which is useful as by default, ENVI displays images with a 2% linear contrast stretch. For better contrast the histogram equalization contrast stretch was applied to the image in order to enhance the visual quality.

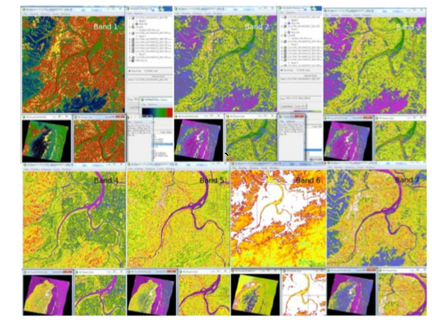
2005 and 1990 Landsat TM scenes classification (fragment). Random color visualization

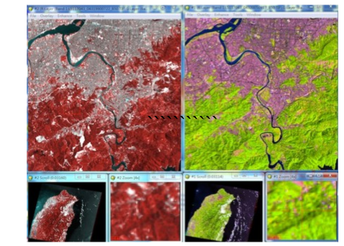


Combining classes

Land Cover Types:
Yeh and Huang (2009) developed classification of the land cover types in the city. Their studies were adopted and adjusted to the current studies suggesting following types: *1) Forests; 2) Urban areas – 2 (roads); 3) Grasslands; 4) Open fields (little or no vegetation); 5) Water areas; 6) Urban vegetation – 1 (bushes); 7) Cultivated lands 8) Agricultural facilities; 9) Urban vegetation –2 (parks and squares); 10) Urban areas -2 (built-up surfaces).*

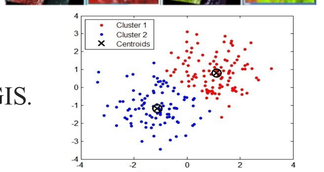






Creating Region Of Interest (ROI)

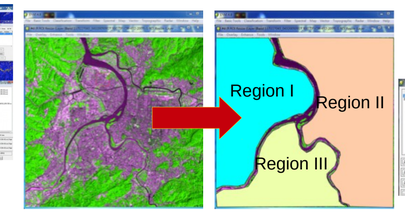
Classification *K-means* by means of ENVI GIS.

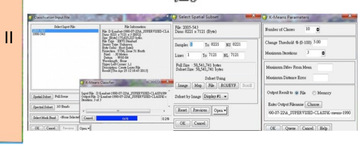


$$J(X,C) = \sum_{i=0} \min_{\mu_j \in C} (||x_j - \mu_i||^2)$$

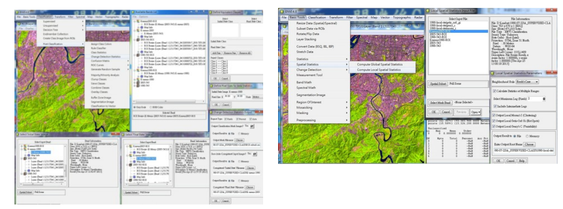
Subset Data via ROI

Regional division of Taipei city





Change detection statistics: process



1). Change detection statistics (selection the tool from the menu)2). Setting options of process 3). Choice of 'Initial Stage' image 4). Choice of 'Final Stage' image 5). Defining equivalent classes 6). Defining pixel size for area statistics 7) Statistics output

To resume a resulting table, following conclusion can be drawn.
Comparing regions I, II and III, the conclusion is the following:

Region I has changes in the land cover types since 1990s. It has much more changes comparing to the core, old city area (region II)

Region II (the core city) is the most stable region. It has the least changes, because this area has been already industrialized for a long time.

Region III, has undergone notable changes. This is caused by the intensive relocation of the population to the Taipei area after 1980s. This is regions is dynamically developing within the Taipei since 1990s.

	1990, %	2005, %
Region I: "urban areas"	17,1	21,9
Region I: "urban vegetation"	5,7	4,1
Region I: "forests"	19,8	18,6
Region I: "grasslands"	21,4	18,3
Region II: "urban areas"	79,3	83,2
Region II: "urban vegetation"	4,3	5,2
Region II: "forests"	32,7	31,8
Region II: "grasslands"	15,9	14,7
Region III: "urban areas"	24,3	38,2
Region III: "urban vegetation"	3,7	4,3
Region III: "forests"	42,4	41,8
Region III: "grasslands"	13,8	12,1

Results: In this research the analysis of changes in landscapes has been done using tools of geospatial analysis. Namely, two satellite images Landsat TM have been processed and classified using ENVI GIS software. As a result of classification, the areas occupied by different landscape types have been calculated and analyzed. Moreover, it has been detected that different parts of the city of Taipei were developing with different rate and intensity. Three (3) different residential types of the city were recognized and mapped. The results demonstrated following outcomes: 1) intensive urban development of the city of Taipei; 2) decline of green areas and natural spaces and, on the contrary, increase in anthropogenic urban spaces; 3) not parallel urban development in different districts of the city of Taipei during the 15-year period of 1990-2005

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