

# アムール川流域における三江平原の土地被覆変化 Land cover change in Sanjiang plain in Amur river basin

増田佳孝\*, 春山成子\*, 近藤昭彦\*\*

Yoshitaka MASUDA\*, Shigeko HARUYAMA\*, Akihiko Kondoh\*\*

(\*東京大学大学院新領域創成科学研究科, \*\*千葉大学環境リモートセンシング研究センター)

(\*The University of Tokyo, Graduate School of Frontier Science, \*\*Center for Environmental Remote Sensing, Chiba University)

## 1. はじめに

国際河川であるアムール川は、延長距離4,350km、流域面積2,051,500 km<sup>2</sup>の巨大河川である。アムール川流域では1980年代以降、中国の経済発展に伴う都市開発や国家事業としての大規模な農業開墾がなされてきた。特に人間活動によるアムール川流域の土地被覆変化は、黒龍江省の三江平原及び松嫩平原で顕著であり、統計資料の解析から当該地域では湿地の農地転換が大きいことが示されている。近年、湿地や森林の改変が海洋生態系に影響を与えるという仮説が提唱されており、また生物多様性の観点からも三江平原の湿地開発については高空間分解能の衛星データを用いたさらに詳細なマッピングが必要である。そこで本研究では、高空間分解の衛星データであるLandsat/MSS, TMを用いて1980年代と2000年代の三江平原の土地被覆変化を明らかにすることを目的とする。

## 2. データ及び研究手法

三江平原の土地被覆の経年変化解析には、1989年6月12日と2000年7月4日に撮影されたLandsat5/TMデータ(Path 114, Row 027)を用いた。TM (Thematic Mapper) とはLandsat5に搭載されたセンサのことであり、可視域から熱赤外域に7バンドを持ち、空間分解能は30m (Band6のみ120m) である。

2 時期の画像に対してバンド6以外の全バンドを用いて教師無し分類を行った。なお、2005年及び2006年の9月にGPSとデジタルカメラを用いたグラウンドトリスを行っており、分類結果の解釈に用いた。

## 3. 結果と考察

下図の左上にある河川がアムール川であり、途中で中国の松花江と合流している。1989年と2000年では、三江平原東部の湿地が大きく減少し耕地面積が増加していることが分かった。本解析では耕地や湿地植生を細かく分類していないため、今後さらに分類項目を詳細に分けて各土地被覆の面積推移を解析する予定である。

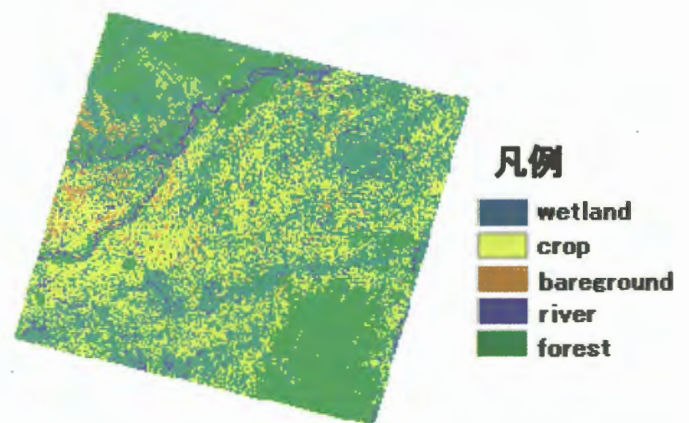


図1. 2000年7月4日 Landsat/TMの教師無し分類画像

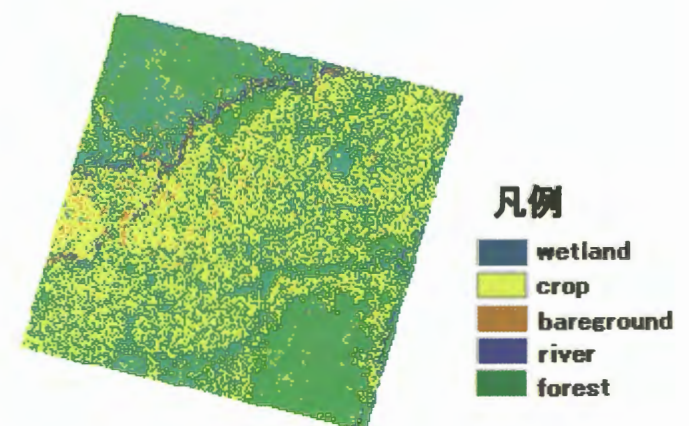


図2. 1989年6月12日 Landsat/TMの教師無し分類画像

## Urban Monitoring using Former Japanese Army Maps (Gaihozu) and Remote Sensing : The 100 Years of Urban Change of Jakarta City

J. Tetuko S. S.<sup>1</sup>, and Y. Murayama<sup>2</sup> and I. Indreswari S.<sup>3</sup>

1 Center for Environmental Remote Sensing, Chiba University, 1-33, Yayoi, Inage, Chiba 263-8522 Japan, Tel +81(0)43 290 3840 Fax +81(0)43 290 3857, Email jtetukoss@faculty.chiba-u.jp

2 Department of Geo-Environmental Science, Faculty of Science, Tohoku University, Sendai 980-8578 Japan  
Tel / Fax +81(0)22 795 7761

3 Department of Architecture, School of Graduate Study, Institute of Technology Bandung, Jalan Ganesha 10, Bandung 40132 Indonesia, Tel +62(0)22 250 1214 Fax +62(0)22-250 8059 Email innes@bdg.centrin.net.id

### I. Introduction : a brief history of Jakarta city

From prehistoric time to Muslim and Hindu-Javanese kingdoms, the Jakarta area (now the capital of Republic of Indonesia) was a small village called Sunda Kalapa in twelfth century<sup>1)</sup> which appears to have been a harbour for a Hindu-Javanese kingdom called Padjajaran, the capital of which was near the present mountain resort of Bogor, south of Jakarta. A port on the Ciliwung river (see Figure 1) emerged as an important part of Indonesian trade. The importance of Sunda Kalapa was similarly affected as the port of Malacca on the west coast of Malaya that was conquered by the Portuguese in 1511. The Sunda Kalapa was renamed to Jayakarta (Victorious and Prosperous) by the sultanate of Banten

Then this area was started to develop by building of Dutch East India Company (VOC) fort on west bank of the River Ciliwung in 1619<sup>2)</sup>. Then this area was familiar by calling 'Batavia' and about ten thousands people were living in this small city. Traders from India, China, England, Holland and other islands of the archipelago are recorded continuing to visit the port for spices trading.

Total population of Jakarta (inside the wall or fort Batavia) in 1673 was recorded 27,068 people. By the end of the eighteenth century, the VOC was bankrupt that affected the total population would be 35,000 peoples in 1730. This economic situation was worse; hence the population of city had dropped to 12,131, with 160,986 living in the environs, a large area extending south to the mountains (Bogor area or former Buitenzorg city). In 1815, although the power of VOC declined, the population increased slowly to be 47,000. The city was sprawling by the installing of modern public transport, therefore the population increased to be 70,000 in 1850, and 116,000 in 1900. The city was strung out over 10 to 12 km from north to south. By the 1930, the population of the city of Batavia had grown to 435,000 where the immigration caused it to expand. Most of the road network had been asphalted and public services (electricity and telephone) were established in 1940. In 1942, Japanese occupied the archipelago and divided it into regions, and changing the capital's name to Jakarta that was treated as the capital of one such region, Java. 1942 to 1949 periods is the struggle period of Indonesian for Independence of Indonesia from Dutch, and Jakarta assumed as the capital of an independent Indonesian nation-state in December 1949. Van des Plas reported the population was 844,000 in September 1945. After the independent and Jakarta was decided as the capital of Republic of Indonesia, the urbanization made increasing the population that recorded 1,050,000 in 1948, almost double the figure for 1930. President Soekarno's visions had little relevance to the dominant fact of Jakartan life in the period, official figures show the the population was increasing drastically 1,782,000,

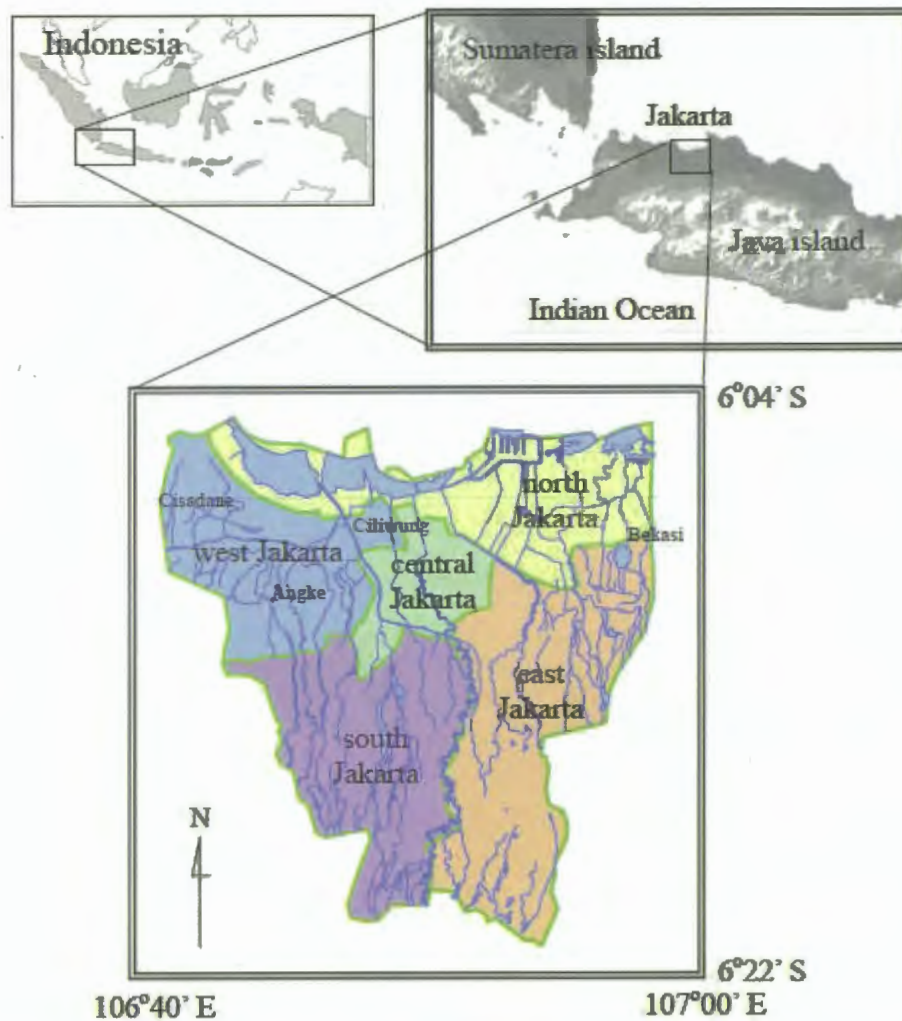


Figure 1. Study site : Jakarta city, Indonesia and its environment

2,973,000 and 3,813,000 in 1952, 1961 and 1965, respectively. Base on the census report of Indonesian Governmental Statistics<sup>3)</sup>, the population in 1971, 1980, 1990, 1995, 2000 and 2004 are 4,579,303; 6,503,449; 8,259,266; 9,112,652; 8,389,443; and 9,792,000, respectively. The population in 2000 decreased comparing to 1995, it is assumed the impact of Asian economic crisis in 1997. The population in 2004 was increasing again by the economy recovery for the economic crisis. The population trend of Jakarta city from 1815 to 2004 can be seen in Table 1.

The Statistics shows that the urban area coverage of Jakarta 93,7% in 1980, and 100% after 1990s (see Table 2), where total area is 661 km<sup>2</sup>. The data shows the lack of information of urban area coverage before 1980. Therefore, in this research, old maps and satellite images were employed to obtain the urban area coverage before 1980. The detail analysis will be explained next.

## II. Study site

Figure 1 shows the study site, Jakarta city (capital of Republic of Indonesia) that located in 106°40'E - 107°00'E, 6°04'S - 6°22' S and covering about 661 km<sup>2</sup>. The area around the mouth of the Ciliwung river in west Java, the site of present-day Jakarta, has known human settlement from prehistoric times. Built up from the silt

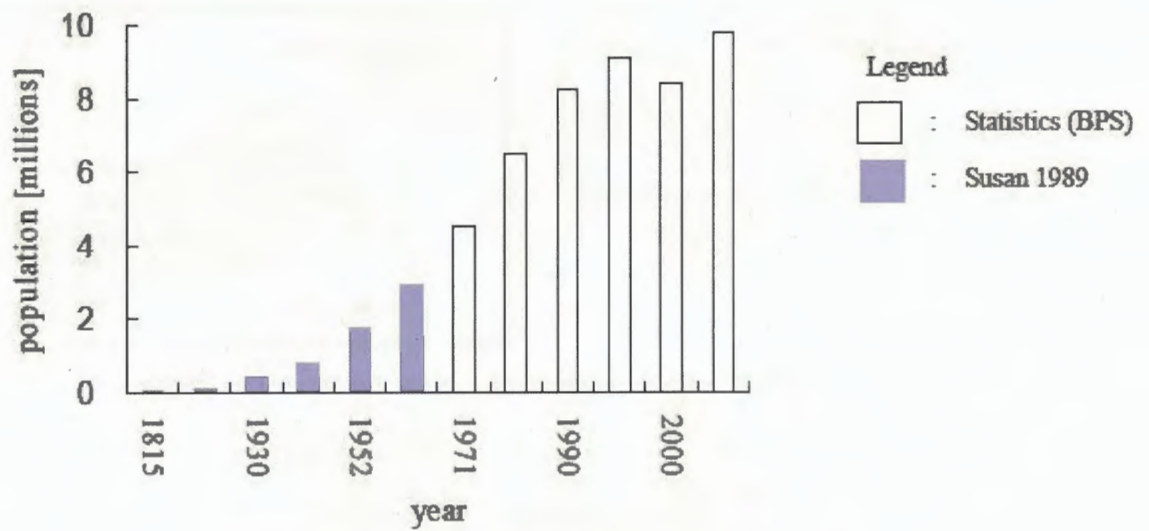


Table 1 Population of Jakarta city

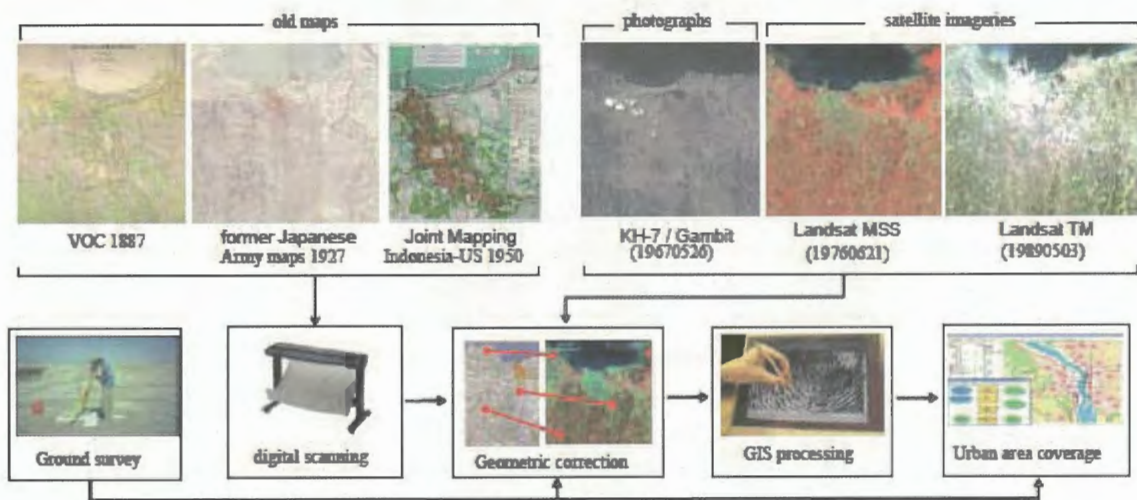


Figure 2 Flowchart of analysis

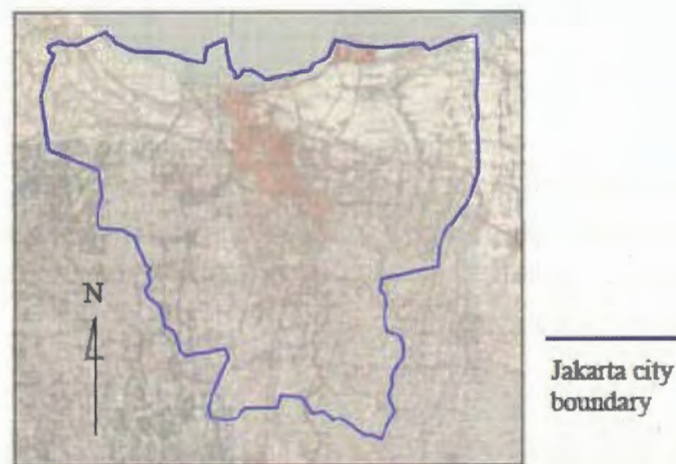


Figure 3 Mosaic maps of the former Japanese Army

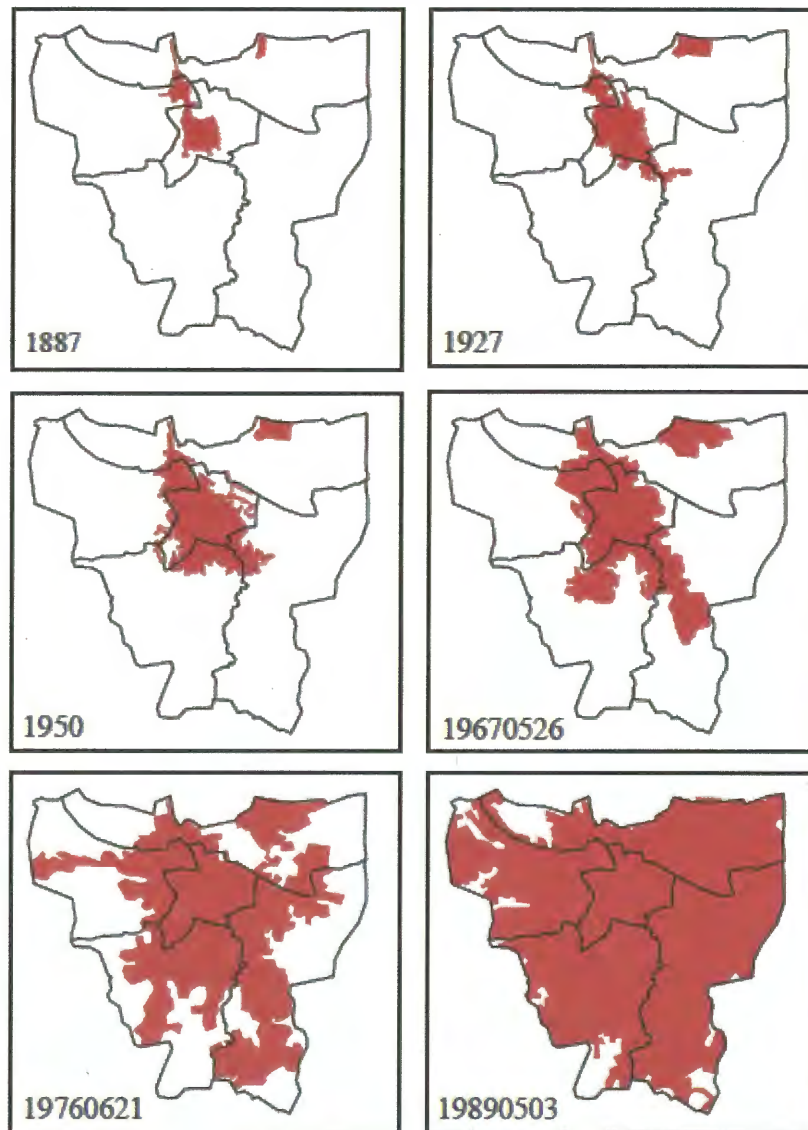


Figure 4. Urban area change of Jakarta city in time series

washed down from the volcanic mountain range to the south, an alluvial plain spreads out in a fan shape traversed by several rivers: Cisadane, Angke, Ciliwung, Bekasi and Citarum.

### III. Analisis

The urban area change of Jakarta city is investigated by using old maps and satellite images. The employed old maps are VOC (1887), former Japanese Army map (1927), and Joint Mapping Indonesia - US 1950 maps. Especially, the former Japanese Army map is composed or mosaicked by 11 maps<sup>4)</sup> as shown in Figure 3. Jakarta city boundary in this Figure shows the present boundary of Jakarta. Then the satellite images are KH-7 / Gambit (26 May 1967), Landsat MSS (21 June 1976) and Landsat TM (3 May 1989).

As shown in Figure 2, firstly the old maps are scanned. Secondly, the maps were geometric corrected before digitizing process (visually) to obtain the urban area class. The satellite images are also geometric corrected, then supervised classification process was employed to acquire the urban area class. The topographic maps<sup>5)</sup> with

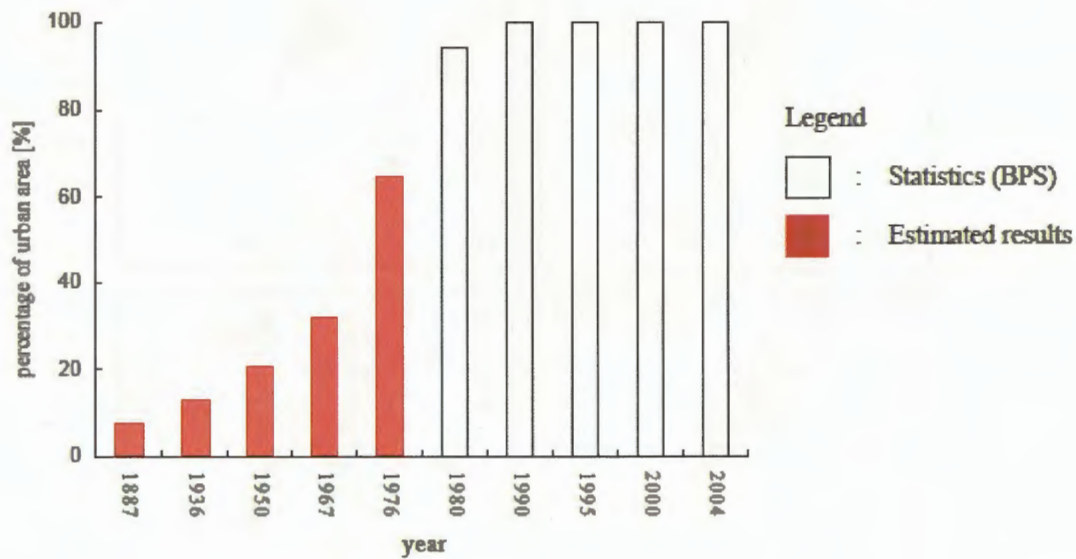


Table 2 Urban area of Jakarta in time series

1:25,000 scale were used in the geometric correction. Then the urban area class only was delineated to obtain the urban area distribution more clearly. Base on the digitizing or delineation process, the coverage of urban city of Jakarta in each date could be acquired as shown in Figure 4. This Figure shows (visually) that the urban area was increasing drastically after 1945 or the independent year of Republic of Indonesia. Figure 4 shows that the urban area coverage is 8%, 13%, 21%, 32% and 64% in 1887, 1927, 1950, 1967 and 1976 respectively. Base on Landsat TM data (3 May 1989), the coverage in 1990s is almost 90% or matches well with the statistics data. Table 1 and Table 2, or the population and urban area change of Jakarta city respectively show the strong relationship. These tables mean the increased population caused the sprawling of urban area.

#### IV. Conclusions

Like many big cities in developing countries, Jakarta city has almost 250 years history and suffers from major urbanization problems. The population has sharply risen after 1960s, and base on the old maps and satellite images extracting the urban area, this area covers whole of city (661 km<sup>2</sup>) in 40 years after the independent and the declaring of Jakarta as the capital of Republic of Indonesia. The result shows that the old maps (1887 - 1950) include former Japanese Army maps (Gaihozu), and satellite images (1967 - 1989) combination can be employed to monitor the city sprawling and its problems.

In the near future, the authors will employ these data and Geographical Information System (GIS) to retrieve the city spatial information and its change. The information of urban area, vegetation, digital elevation model (DEM), annotation, transportation network and hydrologic network will be retrieved from the former Japanese Army map to obtain the topographic information of 1900s. The high resolution of satellite images also will be employed to monitor the area around Jakarta city or known as buffer zone of Jakarta (Bekasi, Bogor, Tangerang, and Banten) called Jakarta Megapolitan area.

### Acknowledgement

Thank to the Museum of Natural History, Tohoku University to the Gaihozu, Pandhito Panji Foundation - Remote Sensing Research Center for old maps; and University of Maryland for Landsat datas. This work was carried out by the joint research program of CEReS, Chiba university.

### References

1. Simon Winchester, Krakatoa - the day the world exploded: August 27, 1883, Sterling Lord Literistic, 2003.
2. Susan Abeyasekere, Jakarta : A History, Revised edition. Oxford University Press, 1989.
3. BPS, Indonesian Statistics Report, 2005.
4. Gaihozu, Blad 36/XXXVIIA (oud No.17A) Maoek, 36/XXXVIIC (oud No.17C) Tangerang, 36/XXXVIII A (oud No.18A) Paroeng Pandjang, 36/XXXVIIB (oud No.17B) Batavia, 36/XXXVIID (oud No.17D) Kebajoran, 36/XXXVIII B (oud No.18B) Paroeng, 37/XXXVIIA (oud No.23A) Tandjoeng Priok, 37/XXXVIIC (oud No.23C) Meester Cornelis, 37/XXXVIII A (oud No.24A) Depok, 37/XXXVIIB (oud No.23B) Moeara Bekasi, 37/XXXVIID (oud No.23D) Bekasi, 24B Tjibaroesa : the Museum of Natural History, Tohoku University, 1927.
5. Bakosurtanal, Jakarta 1209-441, Tangerang 1209-432, Cakung 1209-442, Pasar Minggu 1209-423, Pondok Gede 1209-424, Teluk Naga 1209-434, Ancol 1209-443, Tanjung Priok 1209-444, 2001.