YANGON RIVER GEOMORPHOLOGY IDENTIFICATION AND ITS ENVIROMENTAL IMAPACTS ANALSYSI BY OPTICAL AND RADAR SENSING TECHNIQUES

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ABSTRACT:

The Yangon river, also known as the Rangoon river, is about 40 km long (25miles), and flows from southern Myanmar as an outlet of the Irrawaddy (Ayeyarwady) river into the Ayeyarwady delta. The Yangon river drains the Pegu Mountains; both the Yangon and the Pathein rivers enter the Ayeyarwady at the delta. Fluvial geomorphology is based primarily on rivers of manageable dimensions. The emphasis is on geomorphology, sedimentology of Yangon river and techniques for their identification and management. Present techniques such as remote sensing have made it easier to investigate and interpret in details analysis of river geomorphology. In this paper, attempt has been made the complicated issues of geomorphology, sedimentation patterns and management of river system and evolution studied. The analysis was carried out for the impact of land use/ land cover (LULC) changes on stream flow patterns. The hydrologic response to intense, flood producing rainfall events bears the signatures of the geomorphic structure of the channel network and of the characteristic slope lengths defining the drainage density of the basin. The interpretation of the hydrologic response as the travel time distribution of a water particle randomly injected in a distributed manner across the landscape inspired many geomorphic insights. In 2008, Cyclone Nargis was seriously damaged to mangrove area and its biodiversity system in and around of Yangon river terraces. A combination of digital image processing techniques was employed for enhancement and classification process. It is observed from the study that middle infra red band (0.77mm - 0.86mm) is highly suitable for mapping mangroves. Two major classes of mangroves, dense and open mangroves were delineated from the digital data.

1. INTRODUCTION

1.1 Landforms formed by rivers

Running water in fixed channels is the most widespread agent of land sculpturing working on earth's surface. Therefore, the landforms created are more important than those formed by other agents. Flow of water takes place in rivers under the influence of gravitation. The type of flow can be laminar or turbulent. `Laminar' flow is a flow in which the streamlines remain parallel to the axis of the flow. In a `turbulent' flowing river, a mixing of water by turbulent eddies takes place.
A river can erode when it transports material. The transport can take place in different ways:

- in solution
- in suspension - these are the small particles carried in suspension.
- in saltation - sand grains hop over the bottom, the sand grain reaching the bottom gives an impulse to another sand particle.
- shoving: coarse material rolls over the river bed.

Coarse material is often deposited as riffles and bars in the riverbed, these bars are placed alternating in the left and right side of the river and form bank bars. In braided channels with criss crossing waterways, channel-bars and islands develop between the water courses. Laboratory experiments have shown that the cross section of a channel transporting the same volume of water is dependent on the type of bed material. Fine material gives a deeper bed, coarse material a flatter, broader river bed.

A river can have a straight, a sinuous, meandering, or a braiding channel. A meandering river flows in sinuous curves. Meanders are arbitrarily confined to a ratio of channel length to valley length. The water in the meander moves as a corkscrew, the so called helicoidal flow, that means that the flow is downstream, but besides that a movement in perpendicular direction occurs, formed by the centrifugal force on the water in the bend. This type of flow causes erosion in the outer(concave) side of the meander and deposition in the inner(convex) side. The strongest erosion takes place a short distance after the central part of the bend. This causes "point bars" to develop on the inner side, and the meander to migrate downstream. A meander tries to broaden and to move downstream. When meanders attain extreme looping, a cutting of the meander can be formed during avulsions. In the cut-off part an oxbow-lake is formed. In aerial photographs old cut-off meanders, meander scrolls or point bars etc. can be easily distinguished.

The zone where the meanders are formed is called "meander-belt". Sometimes a relation between the width of the channel and the width of the meander belt exists, according to different authors the relation varies between 1:12 and 1:18. A 'braiding' river is characterised by different criss-crossing channel ways around alluvial islands. The growth of an island begins as the deposition of a central bar starts. The bar grows downstream and in height and forces the water to pass through the flowing water channels.

1.2 Remote sensing techniques for landform Analysis

Remote sensing techniques have opened new vistas for landform analysis (both static and dynamic aspects), coupled with field verification surveys. Landforms can be directly and best viewed using remotely sensed data, since relief forms are well expressed on the surface of the earth and recorded in images. The combination of systems (DIGITAL IMAGE PROCESSING, multi-date and multi-scale data analysis) increases information generation capability and thematic map generation facility. These modern techniques have contributed tremendously towards terrain analysis, understanding of site conditions, spatial distribution of features, and resources.

Analysis of remotely sensed data using standard interpretation techniques is particularly useful in channel change detection, identifying palaeo-channels, regional landform distribution, as well as detection of shallow buried channels and buried valleys under special conditions using thermal IR and radar imagery. In radar imagery over extremely dry sands of desert areas of Sahara in northern Sudan, buried valleys at 1.5 meters depth below surficial cover have been detected (SIR-A data, 1981). Dynamical aspects of geomorphology, landslides etc. can also be monitored. Digital enhancement techniques are useful for improved interpretation of terrain features. The development of landforms depends on the climatic regime, the operative processes of denudation and sedimentation during and after their formation as well as their intensity in time and space, and the rocks and materials (their composition, nature, and structure) acted upon. Man-made or anthropogenic causes also affect landform development.

The identification of landforms and geomorpholoical domain on remotely sensed data is based on area association (arid, mountainous, glacial, coastal, flood plain, tropical etc.), association of features, landform shape and size, drainage patterns/ dissection, relief, tone, texture, land use/land cover, erosion and other patterns etc. leading to "convergence of evidence" upon logical inductive and deductive reasoning. Analytical "Keys" can also be developed for an area of study based on field criteria and a priori knowledge of typical forms as seen on images.

Remote sensing provides a regional, synoptic view and permits recognition of large structural patterns and landforms over contiguous geomorphic domains. It enables the location and delineation of extent of identified features observed over large areas. The repetitive coverage of terrain in multispectral mode provided by satellite mounted sensors enables comparison of scenes of the same location in different periods/ seasons. This is extremely valuable for monitoring change, as well as extracting more information about significant earth features from scenes by viewing under seasonal conditions (temporal and spectral resolutions).

2. REGIONAL GEOLOGY AND TECTONICS

2.1 Study area and its existing conditions

The present study area covering the Yangon and its surrounding region falls in 96° and 96° 15'E and 16° 45'and 17° N as referred as map index of UTM Sheet No. 1969-01. The central part of the Yangon comprises Miocene consolidated sediments overlain by the Quaternary sands, silts and clay. Win Naing (1972) stated the uppermost part of the Mingalardon Ridge as the Irrawaddy Formation of Pliocene age. But, thinly laminated, weathered shale exposed in Shwegondaing area during excavation for motor road extension works in 2003 and completely weathered sandstone during excavation for the foundation of the Yanshin Centre at the Shwegondaing Junction reveal that the lithological character is resemble to that Miocene sediments exposed in the Taikkyi Taungnio area (Tint Lwin Swe, 2002). Kyaw Htun (1996) explained that Thadugan sandstone and Besapat alternations in the Thadugan area were belonged to the Upper Pegu Group of Miocene age; namely, the Kyaukkok and Obogone formations. In addition, some rock exposed in the left and right abutments of Inyar Lake and geological drilled data for water well at the junction of the Inyar and the Damazete roads (Tint Lwin Swe, 1998) show that the lithological type is especially similar to that of the Thadugan.

The Quaternary sediments widely distributed at the outskirt of the Yangon, consisting of thick, high plastic, stiff clay underlain by sand and silt. Win Naing (1972) classified generally the Quaternary sediments into valley-filled deposit and the alluvium. The valley-filled deposit includes the Pleistocene older alluvium of a particular type of terrace deposit (Leicester, 1959 and Kyaw Htun, 1996) of unconsolidated gravels, sands and silts and the alluvial is younger age clayey deposit. The pattern and distribution of rock basement and soil deposit are depicted in Figure (1).

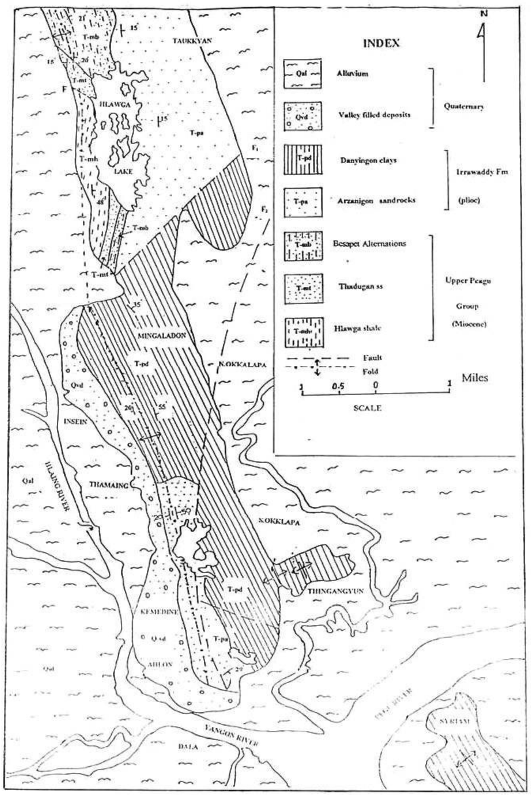

Figure 1. Soil and rock distribution of the Yangon area (Win Naing, 1972)

Tectonically, the Yangon is situated in the southern part of the Central Lowland, which is one of three major tectonic provinces of Myanmar. The Taungnio Range of the Gyophyu catchments area of Taikkyi District, north of Yangon, through the Thanlyin Ridge, south of Yangon forming a series of isolated hill is probably resulted from the progressive deformation (Ramsay, 1967) of the Upper Miocene rocks as the eastern continuation of the subduction or stretching and compression along the southern part of the Central Basin and regional uplifting of the Pegu Yoma.

2.2 Yangon river in and around soil investigations

The different varieties of the individual soil characteristics are Meadow and Meadow Alluvial Soil, Gley and Gley swampy soils, Swampy soils, Lateritic soils, Yellow brown forest soils, Dune forest & Beach sand, Mangrove forest soils and Saline swampy meadow gley soils. The meadow soils which occur near the river plains with occasional tidal floods are non-carbonate. They usually contain large amount of salts. Meadow

Alluvial soils (fluvic Gleysols) can be found in the flood plains. They have the texture of silty clay loam and they have the neutral soil reaction and are rich in available plant nutrients. nMeadow Gley soils (Gleysol) and Meadow swampy (Histic Gleysol) occur in the regions of lower depressions where the lands are inundated for more than 6 months in a year. The texture of these soils is clayey to clay and usually having very strong acid reaction, and contain large amount of iron.

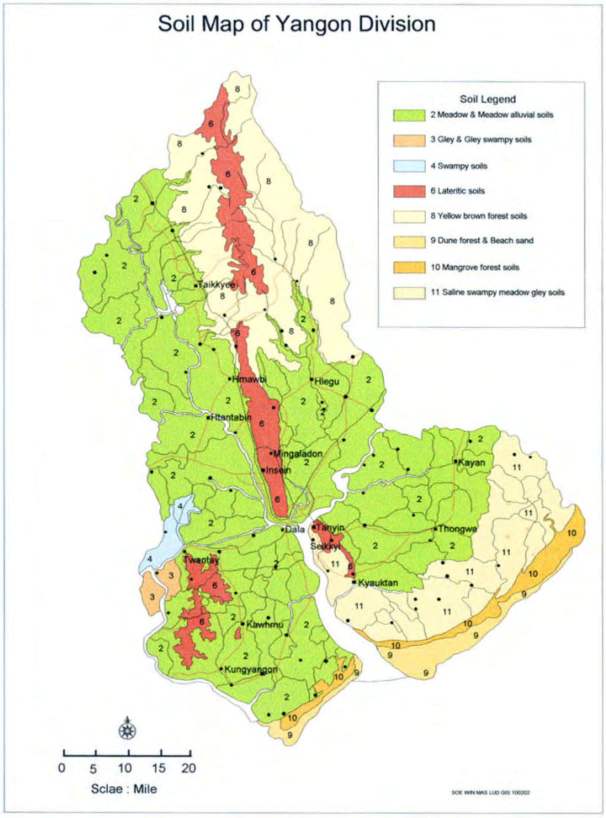

Figure 2. Soil map of the Yangon area (copyright of Land use division, Myanma Agriculture Service (Feb 11, 2002)

Dune forest and Beach sand can be found only at the coastal line of Myanmar. The areas of their occurrence are insignificant. The coastal line should be under wind and water erosion control. Mangrove forest soils occur in very small area along the coastal line of Myanmar, especially in the region of Ayeyarwady Delta. These are marine flat lowlands, which are affected by daily tides. Saline swampy meadow gley soils in Ayeyarwady Delta and along the river bands of the Gulf of Motama and the marine flat lowlands influenced by the tidal sea water, which is always salty.

2.3 Typical Drainage Patterns

This area almost fluvial food plain, other is lower coastal plains where there may be few surface drainage channels. In and around Yangon river areas, the water table is often high; relatively young and subjected to a minimum of dissection. A high water table minimizes runoff and restrict system that may from between floods.

Many major streams in level regions are constructional. They build up their own flood plains and have little contact with the underlying material of the area. Some major streams in level areas, however, are engaged in eroding and are, therefore destructional. Examples of such streams may be found in coastal plains and in lakebeds.

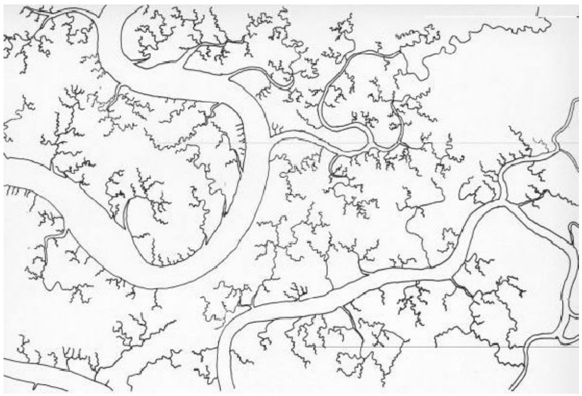

Figure 3. Typical Tidal Flood Pattern in Myanmar

3. METHODOLOGY APPROACH

The methodology used in this study involved distinct steps of digital processing of individual remote sensing data, multi-sensor data integration, and visual interpretation of the geomorphological products. The processing of remote sensing images was done using ENVI 4.7 and Sufer version 10.7.972 software, following schemes for enhancements and integration of optical and SAR images successfully used for Yangon river geomorphology and terrain analysis. The corresponding information was acquired on the terrain based on a ground positioning system (GPS) campaign and used as ground control points (GCPs). Since the area presents low relief and no digital elevation model (DEM) was available, an ortho-rectification scheme, assuming a flat terrain model.

4. RESULTS AND DISSUSION

4.1 Interpretation and terrain analysis from optical data

Long ago back from more than 10 years, AVNIR imagery taken by Japan Advanced Earth Observation Satellite (ADEOS)

Figure 4. ADEOS/AVNIR 432 FCC Color Composite Image acquisition at December 25, 1996

at December 25, 1996. In this imagery, we easily interpreted by visually for land use land cover condition of Yangon river in and around and City area.

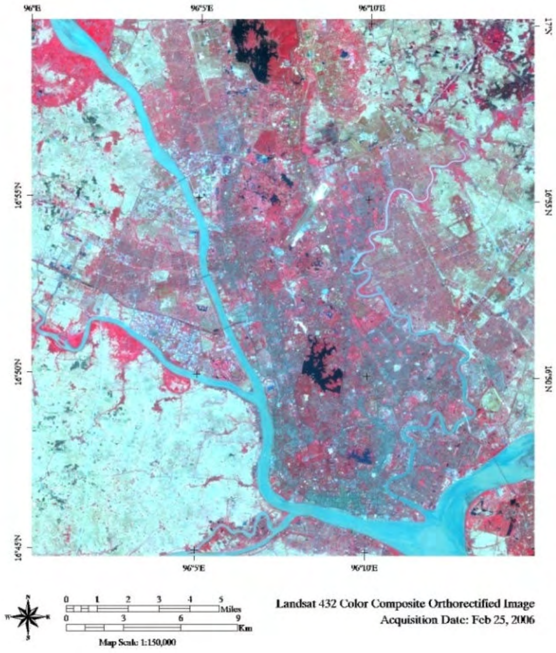

Figure 5. Landsat 432 Color Composite Ortho-rectified Image acquisition at Feb 25,2006

In Figure 5, Landsat Satellite acquired with ETM+ Sensor for the study area. After composite of FCC 432 combination was done and carefully analyzed for landuse landcover extended and urban, sub-urban sprawled areas.

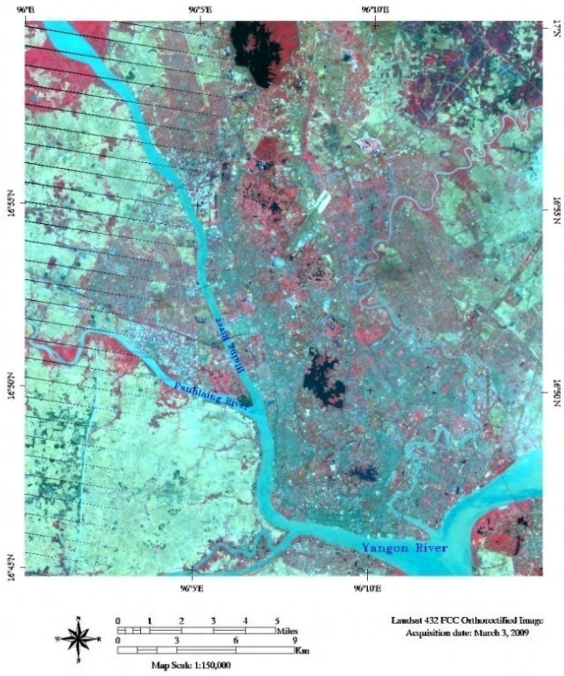

Figure 6. Landsat 432 Color Composite Ortho-rectified Image acquisition at March 3,2009

In May 2 of 2008, Myanmar was seriously hit by Cyclone Nargis and there was damaged to coastal mangrove areas and its biodiversity system in and around of Yangon river terraces (see figure 6).

4.2 Interpretation and terrain analysis from RADAR data

Figure 7. JERS 1 SAR Multi Temporal image of study area

In Figure 7, Japan Earth Observation Satellite was taken Synthetic Aperture Radar (SAR) imagery for 3 different seasons of around 1996. Coastal surveillance and environmental monitoring has motivated the development of automatized feature extraction tools using remote sensing data. Target detection by Synthetic Aperture Radar (SAR) has been extensively studied in recent years. In carefully interpretation from SAR Imagery, river boundary and coast line field give high radar backscattered energy due to their high surface for roughness. Strong waves and tides (surfing in particular) make seawater very rough which leads to very high radar backscattered energy at places. Coastline is therefore masked at places between land and water boundary.

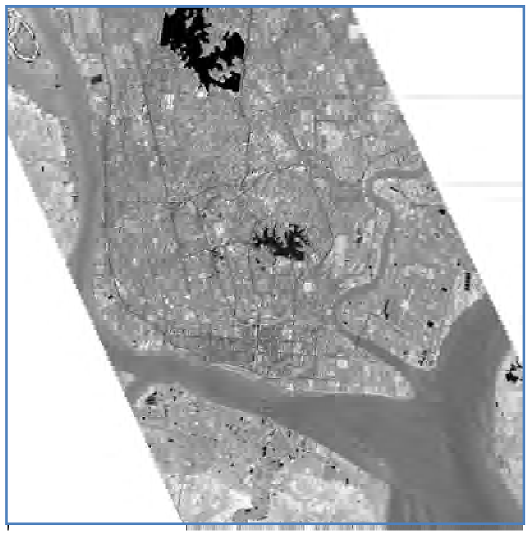

Figure 8. SRTM data of Yangon river rings

In Figure 8, Shuttle Range Topographic Mission (SRTM) data was prepared for shaded and relief map for terrain conditions. This study area is almost flat and fluvial flood plains. The product generated from SRTM data to topographic analysis is important for descriptions of soil contacts and structural features. The perspective of the relief, through the simulations of different angles of illuminations, gave the shadow of the relief, giving the impression of concavity and convexity, allowing the identification of structural features, soil contacts, erosion zones and other geomorphological features of the study area.

4.3. Gemorphological Map generation

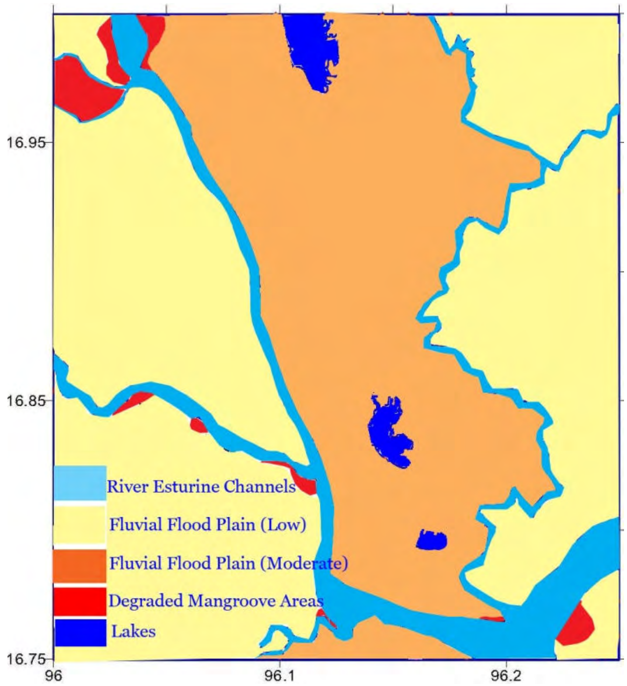

Figure 9. Geomorphological Map of Yangon river in and around area.

The landform classification system is based on geomorphologic principles, i.e., classification on the basis of landforms, and the dominant processes in operation related to historical processes. Additional factors, including land use and land cover, were also used for classification. The final geomorphological map is presented in Figure 9. Integration of both optical and radar data was implied for geomorphic landform mapping, in details of terrain conditions, manmade features and lanuse land cover around Yangon river bed and around Coastal flood plain terraces.

5. CONCLUSION

The contribution of TM band 4 was related to the discrimination of dense mangrove forest from secondary vegetation of the coastal plateaus, whose spectral response is mixed with exposed soil produced by human activity and disaster affected. The JERS-1 SAR data have contributed to the enhancement of distinct coastal vegetation height, geometry, water content, and degraded and regenerating mangrove regions. The Multi temporal SAR product was fundamental in providing consistent information about the geo-botany (vegetation and coastal sedimentary environment relationship) and emerged and submerged coastal geology that cannot be accomplished from field investigations alone..

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