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Working Notes

Lecture 5: Geospatial Information for Urban Green Infrastructure Modeling

Yosef Prihanto, S.Si., Msi
Dita Trisnawan, S.T., M. Arch., STD

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This lecture concentrates on how to use remote sensing and GIS in architecture. Architectural design often starts from the micro perspective. However, starting with the macro scale first and then looking at the micro scale is another way. Remote Sensing is the science of understanding the art of objects or phenomena detection without any contact to the object. The discipline includes aerial photography, radar, satellite images, etc.). The GIS (**Geographic Information System**) is comparable to fortune telling in that its limits are intangible. GIS involves geographical referenced information for data collection, compilation, recall updates and simulation of spatial data as an architectural tool. The components of GIS include abstraction or simplification of the database which is useful for architectural design.

Without GIS, the compilation of data is more complicated, inefficient, costly and difficult to manage with many layers of paper. With GIS the whole process is simplified and more effective in terms of cost and budget. Data accuracy and good management of data is possible. You can use a hard disk instead of a paper-based culture to manage the data.

The GIS infrastructure includes human resources, programmers, geographers, surveyors and civil engineers. The software includes RS (Remote Sensing) software, such as ERDS, ER MAPPER, ENFI, IUNIS, IDRISI). GIS software also includes ARCGIS, ArchInfo, ArcView, MapInfo, MapObject and Arc Explorer, etc. The hardware includes PCs, **GPS (Global Positioning System),** hand phones, satellite discs, digitizer tablets, and digital cameras. GIS data sources include aerial photos (either from satellites, airplanes, or drones, which is relatively expensive) and ground collected information through GPS or phones (e.g. to record latitude/longitude points of where shops, facilities or other things are on the ground). Other data and information used to build a GIS are: census information, reports, land surveys, coordinates data by GPS, topographic and thematic maps.

Data acquisition vehicles include space borne and airborne. Space borne vehicle characteristics include the use of satellites from outer space, no need for flight permissions and limitless areas. However, the resolution in satellite data is lower than airborne data. Airborne vehicle characteristics include the use of aircraft, provide higher resolution and accuracy, easier updating of data, but smaller coverage area, flying risks and the requirement for flight permissions from government jurisdictions.

One example of satellite data is the NSDI project in Medan. Cars, buildings and the central square *(alun-alun)* are visible in the 20cm resolution with Ultracam X20cm, 1 pixel map with a scale of 1:1000. This is a suitable architectural scale. LandSat 1 offers a range with a 15-30 meter (pixel) resolution, *(i.e. 1 pixel equals a square of 15 x 15m or 30 x 30m, which is too low for architectural purposes.)*

Light Detection and Ranging (LIDAR) radar provide 3D information which includes buildings and vegetation. The radar data is collected airborne at 3,000 feet, using a laser to detect the surface. The

data can be used for 3D mapping at a scale of 1:5000. The data is available for Jakarta and for Depok at a scale of 15 meters. Such data is available by formal letter from the Spatial Information Agency.

In making a map from raw data using GIS applications, cartography is combined with other available data. Geometric corrections are made to increase the accuracy of the raw data with coordinate information. Orthorectification and image filters are used to enhance the image, which is part of the Spatial Information Agency's responsibilities. Classification and digitation is shown in colored layers to indicate streets, land boundaries, contours, and buildings, etc.

The visual cartography layout is done in accordance with the desired output and needs. The information can be analyzed with overlays to get new information or data. GIS Multi-criteria Analysis can be possibly used for suitable land. Analytical software tools can be used for buffering to create new information. Overlays, not just 1 or 2, but up to 1,000 overlays can be used in filtering data to create road maps, settlement maps, soils maps, and water maps, which all yield an analytical result.

The Depok Existing Land Use (2005) map can be compared with the 2015 map to understand the land uses changes around the lakes. Setu Babakan is in Jakarta. Soils data can be analyzed to obtain special data for contour and topographic mapping as well as soil types. Also rain, microclimate, geological, and base rock data can be obtained to determine whether or not the water body is sustainable.

Land use changes require thinking about the catchment areas. Architects must think about these issues beyond the surface, not only water, but also where the water comes from and how it stays in the soil. Most of the information is available on GIS. Architects must learn to assess information on a global basis on a macro scale for a greater understanding about the landscape. For example, the Depok/Bogor area is a catchment area to supply water to many water bodies. Gunung Salak is shown with SRTM 30 meter data in a digital elevation model. This kind of data was also used as the basis for a book about the Tsunami in Aceh in 2004.

SLTM satellite radar data has a topographic mission using radar sensors to record data. The data not only records the color, but also information about radiation and uses the data to construct 3D images. The radar sends a sound wave and bounces back the data from the geographic features. The ground surface takes a longer time to travel than the mountain, which is obviously higher. Then the GIS device calculates the sound waves based on the distance and the heights. The radar scales the distance between the site and the reflection.

The map shown is an incredible range of pastel colors rivaling 17th century antique water color maps. Wind, precipitation and how water arrives in the Depok area from the south to the north is indicated. Using a grid, the contour map using a zoom feature enlarges the map to locate the bodies of water. The other satellite information is joined together in a low resolution 15m/pixel, (which is admittedly not very clear.) The water bodies can be identified as a dark mass in a field of red and green. The black points shown on the gird are the location of the public facilities. The GIS point and line area data are shown for classification purposes. The data can be analyzed one-by-one or combined together. The light spots on the map are clouds and can be recognized. Remote sensing data include color, texture and distribution

include in 9 key identifications for each object. For example, the clouds also cast a shadow, which is the same shape, but it is a different object from the lake, even though both are black on the map.

Questions-Answers

1. *What is the difference in time between one set of data and another?*

   The remote sensing satellite is geo-synchronized and returns every 16 hours to the same area on its orbit around the earth. But, an image is not recorded every time; it depends on the requests because of the cost involved.
   QuickBird or WorldView II data need 4-8 gigabytes of digital data. The server is huge, the size of this room, possibly 50m2, in order to cover analytical and computing power.

2. *Are there regulations for access to GIS data?*

   Yes, but the first regulating factor depends on the budget since the Indonesian archipelago is so large so Papua, Kalimantan and Java cannot be recorded at the same time.
   There are 800 people working in the agency. - The process of mapping all of Indonesia will not be completed for years.

3. *What software programs do you use?*

   Global Mapper is easier to use if you have the capability of using GIS. It is not open source, but the prices are friendly for students. There is also QGIS.

4. *Your agency is recording and mapping the whole of Indonesia. Are there maps available for every area?*

   Jakarta maps have a higher resolution than Depok maps. Thirty million people live in greater Jakarta, which indicates the priority.

5. *How do local government agencies get the data?*

   It is free. The resolution depends on the need. 1:15,000 scale data is freely downloadable on the website. For more detailed data for Jakarta, Surabaya and Bandung, say 1:10,000 scale is available. Other places are not available.

6. *If the area is covered with trees in the US, we wait until the autumn season when the trees lose their leaves to get better views of the ground. How do you handle data collection in Indonesia?*

   That is a good question. Advanced Remote Sensing (LIDAR) data combined with conventional satellite data is used for mapping in forested areas. The maps are at a scale of 1:100,000.

7. *How widely adopted is the use of GIS data in Indonesia to improve planning and development?*

   We started using GIS technology 10-15 years ago, which has helped.

8. *Are there any outreach programs from the university or the government agencies for training future GIS professionals?*

   Yes, the Faculty of Geography at the University is involved as well as hosting and training for local government the private sector within the agency.

9. *Is there any data on the outer islands?*

   Yes, it depends on the budget. The agency also tried to cover all the islands, but there are over 17,000 islands in Indonesia.

10. *Is there any specific program that is more effective for mapping the environment?*

    ArcGIS has more tools than GlobalMapper.

11. *What kinds of projects have you done using GIS for spatial planning for Jakarta?*

    Spatial modeling to manage the flooding, also spatial planning and the drainage systems are some of the projects. After Mount Merapi in Yogyakarta exploded in 2010, we launched a volcano project about managing the lava flow in the rainy season. Lava came down through the rivers as 'cold lava.' We also have produced the National Indonesia Atlas.

Concluding Remarks

Yosef Prihanto is currently a PhD candidate at the University of Indonesia in Environmental Sciences. His background is in civil engineering and geography. He has a degree from Gadjah Maja University in Environmental Sciences.

Dita Trisnawan (English interpretor) is an urban planner, architect and Ui lecturer who has had experience on GIS projects (San Francisco, Miami, and New York) in the United States when he was working on his Master's Degree. The projects included GIS information on topography, water, climate and vegetation. His experience includes a project in Miami concerning the 100-year flood zone. The data is also useful for building resorts in mountainous areas. Historical landscape and heritage data projects also use GIS data. Another project was using historical landscape data for an Armed Forces retirement home in Washington D.C. to record and maintain actual historical landscape data, including a golf course and housing.

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