REPORT
ON
THE INTRODUCTORY TRAINING ON GIS AND
REMOTE SENSING

4th to 13th Jan 2017
GIS LAB, EF 03, KENYATTA UNIVERSITY

EED level 400 students 2017
Environmental Education level 4 students engage in introductory GIS Training

The Department of Environmental Education whose curriculum lack a GIS and remote sensing component requested for practical training on GIS and Remote Sensing for the 4th year students. The eight-day training started on 4th January and ended on 13th January 2016. The primary objective of the training was to provide a practical approach on the principles and concepts of GIS and Remote Sensing. The other objective of the training was to demonstrate how GIS and Remote Sensing can be applied in natural resource management, environmental advocacy and sustainable development. The students were introduced to the components and systems of a GIS and the role of Environmental Management Information Systems in resource planning and management. The nature of the training was computer-based interaction hence it entailed a step by step guided approach. The students were given an introductory training on GIS using Esri’s ArcGIS for Desktop 10.4.

The first part of the course focused on GIS, where the structure and format of GIS data, data input and transformation, database compilation, and the use of search criteria and data querying procedures and spatial modeling to carry out suitability mapping were examined. In Remote Sensing, emphasis was placed on processing of satellite images and how data from various satellite platforms are used
in natural resource management. The second part of the training focused on the application areas of GIS and Remote Sensing within the realm of natural resource management and environmental advocacy. The instructional design adopted in this part included demonstrations, field data collection activities and lectures. Projects done by previous students and other case studies were also used as instructional support content. The students were exposed to the use of GIS within an organizational set up. Given that the university has an Esri enterprise license implemented through a MoU signed with Esri Eastern Africa, the students were able to access and use various resources available in the ArcGIS Online platform. The resources included datasets, map products and other publications owned by Esri. The training saw the students gain a hands-on experience in ArcGIS for Desktop, ArcGIS Online and Mobile GIS. The students gained an understanding of the principles, concepts and systems of a GIS. The students acquired practical skills in the use of spatial data sets such as maps and satellite imagery and accompanying statistics. The students also appreciated the relevance of geospatial knowledge in natural resource management, environmental advocacy and sustainable development.
WEEK 1: INTRODUCTION TO GIS

1. Wednesday 4th Jan 2017: Opening remarks and an Introduction to GIS Components and System

The training started with an opening remark from Prof. Simon M. Onywere, the Director of Research Dissemination and Uptake and Associate Professor in the Department of Environmental Planning and Management in Kenyatta University. Prof. Onywere was the lead facilitator hence he introduced the other facilitators to the students. The training objective on this week was to introduce students to GIS concepts, ArcGIS software basics and applications; Arc Catalog, Arc Toolbox, and ArcMap. The other objective was to make the students appreciate the relevance of geospatial knowledge.

The training on this day comprised of four sessions. In the first session, 08:00hrs to 10:00 hrs. Prof Onywere made a presentation on the introduction to GIS. The objective of the presentation was to introduce the students to the principles and concepts of a GIS and explain what GIS entails. At the end of the session, the students dispersed for a 20-minute break.

In the second session, 10:30hrs to 11:00 hrs. an introduction to ArcGIS Components and system was done by Prof. Onywere as indicated in figure 1. The role of Environmental Management Information Systems and GIS in resource planning and management was covered in this session. The rest of the team ensured that the students were able to access the requisite files located in desktop stations. The facilitation team also ensured that the training data was distributed to all the desktop stations.

![Figure 1: Illustration of the components of a GIS.](image-url)
The late morning session was followed by a midday session of 2 hours. In this session, an introduction to Arc Catalog was facilitated by Haron Ongeri, Erica Atieno and Ben Mwangi. A practical demonstration of how to explore Arc Catalog and Arc Toolbox was done by Haron and the rest of the team guided the supported the students and helped them to follow through. The students dispersed for a one hour lunch break at the end of the session.

In the afternoon session, Victor Okoth and Monicah Njeri took the students through data types in ArcGIS. The three main categories of data as indicated in Table 1.0 below.

1. Numeric data- represents statistical data which includes a geographical component or field that can be joined with vector files.
2. Vector data-represents data that has a spatial component, or X, Y coordinates assigned to it. Further categorized into:

Table 1.0: A description of the various vector data types used to draw and represent information in Maps

<table>
<thead>
<tr>
<th>Vector data type</th>
<th>Explanation</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point geometry</td>
<td>representation of XY coordinates</td>
<td>KE_Hospitals</td>
</tr>
<tr>
<td>Line geometry</td>
<td>represent linear features like railways and roads</td>
<td>KE_MajRoads</td>
</tr>
<tr>
<td>Polygon Geometry</td>
<td>represents set of vertices joined in a particular order and closed</td>
<td>KE_Census</td>
</tr>
</tbody>
</table>

3. Raster data- made up of pixels (also referred to as grid cells). They are usually regularly-spaced and square but they don’t have to be as indicated in figure 2. Raster data often look pixelated because each pixel is associated with a value or class. Example,

![Figure 2: Icons used to represent raster file types in Arc Catalog](image)

They expounded on Data structures and spatial data arrangement. The rest of the facilitation team guided the students throughout the practical stages. The facilitation team guided the students through the session and ensured that each one of them had a correct copy of the training data. The three-hour session ended at 17:00 hrs. and the students appreciated the significance of spatial knowledge on this day.
2. **Thursday 5\textsuperscript{th} Jan 2017: Exploring GIS data formats, Introduction to ArcMap, Displaying and Presenting Data.**

The one-hour morning session on this day started at 08:00hrs with Victor Okoth and Ben Mwangi instructed the students on how to explore the various GIS data formats, Geo-referencing and coordinate systems. Geo-referencing entails associating a feature with actual locations in physical space as indicated in figure 3. The major aim of the morning session was to show the students that geographic datum is an integral part of any GIS system. The target on this day was to make sure that the students are able to make a simple map.

![Geo-referencing KU quick bird image.](image)

**Figure 3: Geo-referencing KU quick bird image.**

The morning session was followed by a one-hour session from 09:30hrs to 10:30hrs. In the session, an introduction to ArcMap was done by Haron Ongeri. An exploration of ArcMap tools was done by Ben Mwangi. In the session, the students were able to familiarize with the interface of the application and navigate to files and folders. Erica Atieno made a presentation on how to work and organize layers and the students dispersed for a short break thereafter.
In the midday session, Asige Alex demonstrated to the students how to display and manage layers. In the second part of the session, Erica Atieno showed the students how to adjust layer properties and symbolize data. This was a practical intensive part because layer properties and data symbols are the key items that make up a map. The facilitator team helped the students to follow through the instructional steps. The students dispersed for a lunch break at the end of the session.

The three-hour afternoon session started with a presentation from Dorsy Aluoch on the best practices to adopt when presenting GIS data. Victor Okoth made a presentation on map design principles. A practical demonstration on designing a map and presenting data was done by Monica Njeri. Victor Okoth and Dorsy Aluoch demonstrated how to use different page layout options and templates available in ArcMap. The students were also shown how to add map elements to a map. At the end of the session, each student was able to design a simple map as shown in figure 4 below.
3. **Friday 6th Jan 2017: Exploring Geo-processing tools, Data Querying, and Arc Scene**

The morning session started at 08:30hrs with the exploration of Geo-processing tools. Asige Alex and Ben Mwangi facilitated the process. The Arc Tool box was explored intensively. A demonstration on how to use the Model Builder tool was done. The Model Builder is an essential tool that is used to model processes and functions hence it can be used to make activity templates.

In the midday session, the various methods of querying GIS data were explored. The querying methods explored included Spatial Query, Attribute Query and the Query Builder. The facilitation was done by Erica Atieno and Dorsy Aluoch while the rest of the team helped the students to follow through the steps. Data querying is an essential element of any GIS system.

In the afternoon session, Ben took the participants through Arc Scene and 3D visualization in ArcGIS. Arc Scene is a desktop application of ArcGIS that is used in the 3D visualization and analysis GIS data. The students were taken through the process of using data with the “z” value or elevation.
information to facilitate in visualization of 3D models. A Digital Elevation Models, (DEM), of Kenya (250M) was used in visualizing the altitude of Kenya. The students were taken through the process of draping features without elevation values, by use of the DEM as the custom floating surface, which gives the features. The various tools on 3D visualization were also explored and most importantly the fly through capabilities, which gave students insights on the diverse visualization aspects a GIS system provides.

**Week 2: GIS AND REMOTE SENSING APPLICATION AREAS**

The second week of the training started on 9th Jan 2016. At the start of the morning session, Prof. Onywere urged the students to keep up with the motivation they had exhibited in the first week. He also reminded the students to inform their colleagues who hadn’t reported to school that the training had started. The major objectives of the training on this week were to expose students to the various application areas of GIS, Introduce the students to Remote Sensing, Satellite Image processing and Enterprise GIS.

1. **Monday 9th Jan 2017: Elements of a GIS, Data Organization, Creation of Geo-database, and Online Exam from Esri.**

The morning session started with a presentation on the elements and stages of a GIS by Alex Asige and Monicah Njeri. The major statement emphasized in the presentation was that GIS is a tool ought to be used by everyone to solve real problems in the real world. GIS is a tool comprising software, hardware, data input and output component, resource personnel and the user segment. Each of the individual components works in collaboration with the other.

The mid-morning session started at 10:45 hrs. with Ben Mwangi and Haron Ongeri taking the students through spatial data organization and management. The Arc Catalog was reviewed because it is the main tool within ArcGIS for organizing and managing GIS data. Data organization using Arc Catalog also allow for easy access, storing, retrieval and querying data in the geo-database.

In the midday session, the students were taken through the process of creating a personal geo-database as indicated in figure 5 below. A personal geo-database is a Microsoft Access database that can store, query, and manage both spatial and non-spatial data. Designing a geo-database enabled the students to create various features based on the geometry classes for creating features. The geometry classes include points, lines and polygons. Feature Classes. Erica Atieno and Dorsy Aluoch
facilitated the session while the rest of the team helped the students to follow through the steps.

Figure 5: Creating a personal Geodatabase in Arc Catalog.

The afternoon session saw the students take a short course from ArcGIS Online learning platform available at https://www.esri.com/training/ The site is a platform hosted by Esri offering free courses on GIS, where students are awarded a certificate on reaching a pass mark of 80%.

At the end of the short course, the students took an online exam and each student was awarded a certificate upon a successful completion of the exam. Alex Asige and Ben Mwangi facilitated the session and the rest of the team guided the student through the steps.

Plate 2: Alex A. Asige (right) and Ben Mwangi (with the laptop on the podium), guiding the students through the Massive Open Online Course platform provided by Esri.
2. Tuesday 10th Jan 2017: Creating and editing features, Working with tables, and Performing Analysis.

The geo-database was explored in the early morning session. The students were taken through the rules and procedures in designing a geo-database. Additionally, they were also taken through the procedures to follow when populating tables within a geo-database. Victor Okoth and Erica Atieno facilitated the process while the rest of the facilitation team guided the students to follow through the steps.

In the mid-morning session, the students were taken through the process of creating and editing features. Erica Atieno and Dorsy Aluoch facilitated the process. The students were also taken through the process of editing attribute tables in ArcMap and digitization from geo-referenced images. The students dispersed for a short break at the end of the session.

The midday session built up on the topics covered in the early morning and mid-morning sessions. The students were shown how to work with tables. Attribute tables store information that pertains to features drawn in ArcMap. Various tabular data sources such as spreadsheets and MS Access tables were explored. The join and relates functions enables data from other tables to be imported into ArcMap. The students dispersed for a lunch break at the end of the two hour session.

The afternoon session started at 14:00hrs. Ben Mwangi, Dorsy Aluoch and Erica Atieno facilitated the session while the rest of the facilitation team guided the students through the steps. The students were taken through the process of performing various Geoprocessing functionalities of the software. Useful geoprocessing functionalities were in the Arc Toolbox were introduced including spatial analyst, network analyst. The students were particularly taken through spatial analysis of data in terms of density of distribution. The Kernel Density Tool was used in creating a heat map of primary schools distribution in Kenya as captured in figure 6 below. On this day, the afternoon session ended at 17:30hrs.
3. **Wednesday 11\textsuperscript{th} Jan 2017: Data projections, Transformations, and Remote Sensing.**

The students were taken through raster data projections and transformation systems used in GIS. The students were also shown how to convert raster data sets into digital formats. The session was facilitated by Alex A. Asige and Monica Njeri while the rest of the facilitation team guided the students through the steps. The students dispersed for a short break at the end of the two hour session.

The mid-morning session started at 11:00hrs with Ben Mwangi and Haron Ongeri taking the students through processing and analyzing raster data transformations. The rest of the facilitation team guided the students through the steps. Prof. Daniel O. Suman from the School of Marine and Atmospheric Science in the University of Miami paid us a courtesy call towards the end of the session. He encouraged the students to uptake geospatial knowledge as a multidisciplinary tool that can be used to solve much of the environmental problems the world is facing nowadays.
Professor Onywere expounded on the essential role of GIS and environmental information systems in resource planning and management.

In the afternoon session, Prof. Simon Onywere introduced the students to the concepts and techniques of Remote Sensing. He showed the students the various sources of Satellite Imagery and how they are captured. He also demonstrated to the students how to analyze satellite imagery and obtain information. The students had to interact with their computers intensively. The rest of the facilitation team guided the students through the steps.

The morning session started with a brief presentation made by Ben Mwangi on Global Positioning System and GPS receivers. Monicah Njeri later on took the students through collecting and integrating field data using GPS receivers. Dorsy Aluoch made a demonstration on how one can use a mobile phone handset to collect field data. The students dispersed for a short break at the end of the session.

The mid-morning session started at 11:00hrs. Victor Okoth demonstrated to the students how to design data capture forms for a field data collection exercise. Ben Mwangi showed the students how to prepare a work scheme and a project template. Alex A. Asige showed the students how to publish GIS information in the web. Students were able to access a GIS server and post the schemers they had designed for a planned field activity.

The afternoon session saw all the students undertake a field data collection exercise. The students collected feature attributes alongside GPS coordinates using handheld GPS devices and Mobile
phone handsets installed with GPS applications. This can be seen in plate 6 below. The session was a practical demonstration of the content covered in the morning and mid-morning sessions. The facilitation team guided the students throughout the session and helped them to use their devices in collecting field data.

Plate 6: Students in a field data collection exercise using their cellular phones.

The link between Story Maps and Field Data Collection Exercise: An account of the Story Map Journal Template

Erica Atieno and Dorsy Aluoch crafted a field data collection exercise with an objective of equipping students with mapping skills. The students would later on use the mapping skills to collect vital information about a particular topic within Kenyatta University premises. The information was intended to be used in the process of decision making by the University administration. The project, titled Waste Management in Kenyatta University, served as a practical use of GIS in monitoring and
managing waste within the University.

The students were divided into groups ‘KU Group Work Project. The students were divided into four groups within which they would gather field data on the waste holding sites. The aim of the project was to allow students to gain a practical experience on GIS data collection and presentation through mapping. The goal of the exercise was to edify the students on how to create story maps. At 13:30hrs, the students dispersed to collect field data using the ‘Collector for ArcGIS’ mobile application in their mobile phones. An interface of the Collector application is shown on plate 7 below.

![Collector Application Interface](Plate 7: An interface of the Collector application used by the students.)

Data collected was synchronized to the students’ online maps in their respective ArcGIS Kenyatta University enterprise account. The students mapped a total of 6 waste holding sites were mapped, these are as follows:

1) Western Zone waste holding site  
2) Eastern Zone waste holding site (Mfumbiro)  
3) Shopping center waste holding site  
4) Ngong Hostel waste holding site  
5) School of Humanities waste holding site  
6) Science Zone waste holding site.

Data was gathered on the following key attributes of the waste holding sites:

1) The name of the site  
2) Type of waste  
3) Size of the site
4) Types of vectors in the dumping site  
5) Design of the waste holding site (open or closed pit,  
6) Additional comments on the description of wastes in the waste holding sites

During field work, the students noted the size of the waste holding sites, their structure, whether they were closed or open pits, as well as whether or not they have gates. The components of the waste holding sites was also noted, on whether they had plastic, paper, metal or food wastes and their hazardous nature. Data was additionally gathered on the proximity of the waste holding sites to the student hostels, eatery points and food stores. Finally, the type of vectors on the waste holding sites was also gathered, and observations noted on whether there were flies, birds or other insects and animals like cows as illustrated in plate 8 below.

![Plate 8: A waste holding site in Eastern Zone of the University.](image)

In the afternoon, the students created their respective Story Maps using the Story Map Journal template.
Plate 9: An interface of the builder session within the Story Map Journal template. The interface shows descriptive literature on the left panel while the stage on the right displays the spatial location of the referenced information.

The main aim of the project was to inform the students on the wide range of GIS mapping applications. The students were able to learn the potential problem solving capabilities of different GIS web applications.

Plate 10: An interface of the builder session within the Map Journal. The application combines a collection of multimedia file types which can be displayed in the main stage area.
The students discovered that through the use of GIS mapping, they could be able to geo-tag the pictures of the respective waste holding sites. Using the Collector for ArcGIS, the students took pictures of the waste holding sites through its attachments feature. Plates 9 and 10 above show an interface of the Story builder session. A sample Story Map prepared by one of the students can be accessed from the following link; http://arcg.is/2iPPEkC

5. Friday 13th Jan 2017: Enterprise GIS, Collecting GPS Coordinates from Google Maps, and Image Classification.

In the morning session, Alex A. Asige introduced the students to ArcGIS Online. ArcGIS online is a web based platform where GIS resource persons collaborate when working on projects. The platform allows for the sharing of information and working on tasks simultaneously. The students were able to create an account in the ArcGIS Online platform for Kenyatta University. Ben Mwangi and Victor Okoth showed the students how to analyze and present data in ArcGIS Online. In the mid-morning session, Ben Mwangi demonstrated to the students how to pick geographic coordinates from Google Maps.

Plate 11: Google Maps web page displayed on the monitor of a student computer showing geographic coordinates from a location within the boundary of Kenyatta University.

Victor Okoth showed the students how to upload and share data, maps and images in ArcGIS Online. Erica Atieno took the students through Esri Story Maps. Story maps basically give the user
the capacity to combine authoritative maps with narrative text, images, and multimedia content. They make it easy to harness the power of maps and geography to tell your story. The students were taken through the five basic principles of effective story telling.

- Connect with your audience
- Lure people in
- User experience supports the story
- Easy to read maps
- Strive for simplicity

The students were thereafter taken through the practical process of making a story map of one’s choice. Story Maps are free web applications provided by Esri to promote and facilitate the sharing and exchanging of spatially referenced data across social media platforms and other communities.

“Esri Story Maps let you combine authoritative maps with narrative text, images, and multimedia content. They make it easy to harness the power of maps and geography to tell your story.” – www.esri.com

The afternoon session saw Ben Mwangi and Victor Okoth take the students through unsupervised image classification using ArcMap 10.4. The rest of the facilitation team guided the students through the steps. Unsupervised image classification enables one to categorize land uses into various land use classes based on land cover analysis as indicated in figure 7 below. Victor Okoth shared links with the students on supervised classification.
At the end of the session, the chairman of the department of Environmental Education, Dr. James Koske gave a closing remark to mark the end of the eight day training program. The facilitators were introduced to the chairman. Each facilitator went ahead and gave a word of motivation to the students to advance in the realm of geospatial knowledge. The chairman thanked the team of facilitators for their dedicated effort to impart geospatial knowledge to the students. He also congratulated the students for successfully completing the training.
Plate 12: Chairman of the Department of Environmental Education giving a closing remark at the end of the training program.

Plate 11: The GIS training implementation team taking a photo with the chairman of the Department of Environmental Education. From left, Alex A. Asige, Haron Ongeri, Paul Maina, Monica Njeri, Dorsy Aluoch, Dr. James Koske, chairman, Ben K. Mwangi, Erica Atieno, (behind Ben), and Victor Okoth Odhiambo on the extreme right.
Social Media Presence

The EED GIS training was significantly popularized on social media with the participants engaging and showcasing the products, they had been able to prepare since the start of the training. On social media, the conversation about the training was quite interesting with the harsh tag of #KU_JANGIS #KU_EEDGIS with a number of students keeping the interactions going.

Evaluation Report

Table 1.1: Evaluation report developed from a feedback given by students.
CONCLUSION

A GIS system is a useful tool for visualizing, questioning, analyzing, and interpreting data to understand relationships, patterns, and trends. GIS has significant importance to a broad spectrum of industries and organizations. There is a growing interest in and awareness of the economic and strategic value of GIS. Geographically referenced data can be captured, managed, analyzed, and displayed using Esri’s suite of products including ArcGIS for desktop, server, mobile and web.

ArcGIS is suitable in viewing, understanding, questioning, interpreting, and visualizing the world in ways that reveal relationships, patterns, and trends in the form of maps, globes, reports, and charts. It helps to answer questions and solve problems by looking at data in a way that is quickly understood and easily shared across a wide platform of users.

The eight day training was intense and thorough. The team of facilitators engaged to deliver the training implemented the program with dedication and passion. The EED level 400 students appreciated the domain of spatial knowledge which they were introduced to. They showed interest in making use of GIS tools available at their disposal in research projects. The students also expressed confidence that they had built their capacity and acquired skills that give them a competitive advantage in the job market. The cooperation of the support staff, students and all staff members was the foundation to the success of the training program.

RECOMMENDATION

The EED group of students that went through the training confessed that they did not have any unit within their curriculum program that touches on GIS. It is therefore recommended that in the next curriculum review exercise, a unit on GIS and Remote sensing should be considered for incorporation into the EED curriculum. The practical training should also be extended to other departments that do not have the same.

Report prepared by Alex Arila Asige and Dorsy Aluoch in collaboration with Ben Mwangi, Victor Okoth, Erica Atieno, Haron Ongeri and Monica Njeri.