University of Nairobi

School of Engineering

Application of Web-GIS in Monitoring and Evaluation of Donor Funded Projects

Case Study: National Environment Trust Fund

By

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Declaration

I, Gabriel Kihara, hereby declare that this project is my original work. To the best of my knowledge, the work presented here has not been presented for a degree in any other Institution of Higher Learning.

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Name of student	Signature	Date

This project has been submitted for examination with our approval as university supervisors.

DR.-ING F.N. KARANJA	……	……
Name of supervisor	Signature	Date

Dedication

This work is dedicated to my late mother Ms. Dina Wamuyu Thangau, who was a mother, a sister, a brother and a father to me. I give her all my gratitude and appreciation for believing in me.

Acknowledgement

I thank the almighty Jehovah God for giving me the strength and intelligence to pursue the Masters of Science in Geographic Information System program.

I also thank my supervisor, Dr.-Ing. F.N. Karanja for insights, guidance and contribution in making this research project possible and the staff of the Department of Geospatial and Space Technology for their support.

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Finally, I would like to give a special appreciation to my wife Maureen Wanjiku for her continued support and encouragement all through the time of my studies.

Abstract

This study focused on the development of a web-based Geographic Information System Monitoring and Evaluation portal, a data collection application and a mobile navigation application for the National Environment Trust Fund Green Innovation Awards Programme (NETFUND GIA). The NETFUND GIA programme goal is to award and recognize best practices in order to encourage replication of these practices. The programme has been operational in Kenya since 2012. The overall study objective was to develop a web-based GIS Monitoring and Evaluation portal to enhance programme management at the National Environment Trust Fund. The study spans in 29 sampled counties from the 30 counties NETFUND operates which were incorporated in the system to demonstrate the significance of a system with a national wide outlook. Projects data was acquired from the NETFUND programmes department, phone interviews and onsite data collection of projects nearby Nairobi. Attribute data of the projects provided included funds disbursements, project beneficiary project details and impact data. Actual geographic data was collected for nearby projects and simulated geographic point data was generated using google maps. Photos for projects nearby were taken and archived photos from NETFUND M&E exercise were used for projects that were not easily accessible. County boundaries data was extracted from shapefiles obtained from secondary sources. The datasets were imported on to Google Fusion Tables for analysis and visualisation. Hyper Text Markup Language (HTML) and Cascading Style Sheets (CSS) were used to create a Front-end User Interface. Google Maps JavaScript Application Programming Interface (API) was used to embed maps visualised in Fusion Tables on to the web pages. The final output was a web-based GIS portal that displayed layers of NETFUND GIA data in form of interactive maps that had added functionality such as pan, zoom and query. The mobile application utilized Open Data Kit suite of software that is open source and the navigation application developed using MIT App inventor utilized google navigation application capabilities. The findings is that Web-based GIS M&E system is effective in monitoring and evaluation since it provides a geographical dimension to project investment, implementation and impact evaluation. This provides a value-add to development of projects, planning on their implementation and making of decisions on areas to invest which will bring a high value for money. It was recommended that government organization should adopt an upgraded system of the same in all state corporation to monitor and evaluate project efficiency and effectiveness with a spatial dimension.

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Abbreviation and Acronyms

AIDS	Acquired Immune Syndrome
AMIS	Award Management Information System
API	Application Programming Interface
CBO	Community Based Organizations
CLEAR	Center for Learning on Evaluation and Results
COP21	the 21 Conference of Parties
CSS	Cascading Style Sheets
CSV	Comma Delimited Values
EMCA	Environmental Management and Coordination Act
GDP	Gross Domestic Product
GIS	Geographic Information System
GOK	Government of Kenya
GPS	Global Positioning System
HIV	Human Immuno Deficiency Syndrome
HTML	Hyper Text Markup Language
HTTP	Hyper Text Transfer Protocol
IDE	Integrated Development Environment
IFAD	International Fund for Agricultural Development
IMF	International Monetary Fund
IOS	Iphone Operating System
JSON	JavaScript Object Notation
KML	Keyhole Markup Language
M&E	Monitoring and Evaluation
MIT	Massachusetts Institute of Technology
MMS	Multimedia Messaging Services
MTP's	Medium Term Plans
NCCAP	National Climate Change Action Plan
NCCRS	National Climate Change Response Strategy
NDC's	Nationally Determined Contribution
NETFUND	National Environment Trust Fund

NETFUND-GIA	National Environment Trust Fund Green Innovation Awards
NGO's	None Governmental Organizations
ODK	Open Data kit
PGA	Prestigious Green innovation Award
RDBMS	Relational Database Management System
SDG's	Sustainable Development Goals
SME	Small and Medium size Enterprises
SMS	Short Message Services
SPSS	Statistical Package for the Social Sciences
UN	United Nations
URL	Uniform Resource Locator
USSD	Unstructured Supplementary Service Data
XML	Extensible Markup Language

1. INTRODUCTION

1.1 Background

As an establishment of the Government of Kenya, The National Environment Trust Fund (NETFUND) exists 'to facilitate research intended to further the requirements of environmental management; environmental awards; capacity building; environmental publications; scholarships and grants. NETFUND's vision is to ensure that sufficient resources are always available to maintain a clean, healthy and productive environment. NETFUND's mission is to mobilize, manage and avail resources for environmental management in Kenya.

The Environmental Management and Coordination Act (EMCA) of 1999 recognized environment awards as an important tool in supporting environmental conservation and management. The National Environment Trust Fund (NETFUND) is mandated to facilitate environmental awards. Pursuant to this mandate, NETFUND developed the NETFUND Green Innovations Award (NETFUND GIA), previously known as the Prestigious Green Award (PGA). NETFUND GIA exists to recognize, celebrate and award initiatives that uphold sustainable environmental management.

This programme rewards green innovations contributing to environmental protection and wellbeing. The categories include individuals, institutions of higher learning, SMEs, CSOs, and other entities in all the 47 counties in the country. The programme provides a platform that elevates diverse environmental initiatives, which aim to conserve environmental integrity. It also provides winners with capacity building, incubation and refinement of the innovations, with the aim of introducing them to the market place. In addition to this, it also offers substantial seed money to environmental innovations that shows great potential to transform environmental management in the country. The initiatives that are awarded are of four thematic areas. Including energy, water, waste management and agribusiness.

NETFUND administration cost is funded by the National treasury of Kenya and programmes cost are funded by donors. NETFUND receives millions of shillings each financial year for running affairs of its operations ranging from recurrent expenditure to development and implementation of projects. The spending of the allocated funds and raised funds from donors requires constant monitoring and evaluation for each project to achieve a meaningful

development impact as well as visualize reports, which are understandable by the public and donors.

A web-GIS is a system of software, hardware, procedures and persons involved in the capturing, storing, editing and manipulation, management, analysis, sharing and displaying of geospatial data (Fu and Sun, 2011). It is comprised of a client and server architecture and can be categorised as a thin client and a thick client architecture (Agrawal and Gupta, 2017). Web mapping technologies have brought progressive impacts in GIS like interactive access to geospatial data, constant reconciliation and transmission of information and provision of platform autonomous GIS analytical tools, which perform geospatial processing over the internet (Karnatak etal. 2012). Thematic web map applications enables tracking and visual interpretation of the implemented variables. The visual representation from thematic maps helps in identifying assessing and identification of areas with low distribution of services since they enable identification of proportion using the different shades of a colour (Pulsani, 2015).

GIS is a useful tool in monitoring and evaluation since it integrates different information categories such as demography socio-economy and natural environment on various topographical scale. Moreover, geospatial analysis displays different favourable circumstances such as an immediate comparison between thematic layers in relation to their geographical location, and the creation of maps, graphs, and tables, which provide valuable insights (Duruz, etal. 2017). A web based M&E GIS system ensures timely reporting to stakeholders of potential risks and failures thus providing an opportunity to take mitigation measure to avoid the risks and challenges (Sanga, etal. 2013).

On the other hand, Geographic Information System and Remote Sensing has been implemented in land use and land cover changes monitoring and evaluation to inform intervention impacts to the environment. This has been possible due to the repetitive visit of the satellite globally. It has also been used in the monitoring and evaluation of disaster risk reduction and planning this enabled the monitoring of long term, short term and near real time changes that occur on the earth surface and their impact to the natural and manmade environment (Ranganath, B.K., 2006)

In using web-based GIS for mapping, monitoring and evaluation of NETFUND GIA, the study focus is to demonstrate the relevance, potential and suitability of such a system in the

management, monitoring and evaluation of the projects under this programme, navigation to project site and finally dissemination of information to project stakeholders.

1.2 Problem Statement

NETFUND GIA is a programme with only five years and therefore relatively new. The programme is on its third phase and is geared towards improving environmental wellbeing by promoting the use of natural resources in a sustainable manner for economic growth otherwise known as green growth. The programme is partially supported by government and mainly supported by donors and implemented through collaboration with partners. This means that the project has a number of stakeholders with varying interest on the programme's performance, outcomes and ultimately its impacts.

In recent times, there has been a lot of controversy about the management of the funds with regard to accountability; allocation, targeting and priority setting; and overall effectiveness. This has been cited to be due to the weak and poor M&E mechanism that has resulted to a lack of information on how projects and programmes are performing and the impacts thereof hence leaving programmes decision makers, partners, stakeholders and donors uninformed. In National Environment Trust Fund, M&E has proven to be a challenge with lack of consistency in data collected, poor dissemination of information on details, outcomes and impacts of the individual projects funded and a lack of geolocation attribute on the data collected.

This has therefore, brought the need for developing a system that is cost effective and would enhance accessibility, availability, accountability, and transparency on how programmes are managed, monitored and reported. This study proposes the use of a web-based GIS monitoring and evaluation system to address this challenge.

1.3 Objectives

1.3.1 Overall Objective:

The overall objective was to develop a web-based GIS Monitoring and Evaluation system that will enhance programmes and project management at National Environment Trust Fund through monitoring and evaluation. It involved mapping the projects under the awards programme to enhance transparency, accountability and accessibility of information to its donors and the public.

1.3.2 Specific Objective

The specific objectives of the study were to:

- Investigate the role of GIS in monitoring and evaluation of donor funded projects
- Design a web-based GIS portal, Data collection and Navigation application for monitoring and evaluation of donor funded projects
- Populate the web-based GIS portal for monitoring and evaluation of donor funded projects
- Demonstrate functionalities of the system in the management, monitoring, evaluation dissemination of reports for donor funded projects.

1.4 Justification for the Study

NETFUND-GIA programme formerly known as PGA, has been running since 2012 when it was successfully launched in the country and was focusing on all types of environmental initiatives such as tree planting and waste management. Now it has expanded and considers innovations in different categories including individual, SMEs, CBOs, schools and Women Groups. It has also expanded its thematic areas into renewable energy, waste management, water and agribusiness in an effort to curb climate change, improve livelihoods and enhance food security. Due to the limited characteristic of the resources available, the government and donor resources allocation to combat poverty, improve livelihood and environmental wellbeing brings a serious distribution problem in the government sector. Hence, it is important for development practitioners, donors, decision makers and other relevant stakeholders to have accessibility to accurate and up-to-date information on donor funded environmental projects and beneficiaries in the country in order to prevent duplication of efforts thus ensuring effective and efficient investment or funding on environmental friendly projects. This information also enables the public to ensure accountability of the government and transparency on what their tax money and donor funds has been used on.

NETFUND uses the Award Management Information System (AMIS) for managing the NETFUND-GIA programme. The system was only developed to provide project and beneficiaries details leaving out the location of the project. This led to the lack of geospatial locational data, which provides spatial dimension of the projects.

GIS provides a number of advantages for geo-visualizing data in in the form of dynamic and interactive map enabling interaction with the data in contrast to only view the data in tabular format. This study therefore tries to fill this gap by developing a web GIS-M&E system that makes use of geo-referenced project data in order to produce a number of interactive graphs, map products and applications that can be employed in the dissemination of programme and project related information to NETFUND staff and its stakeholders.

1.5 Scope of work and limitation

The NETFUND-GIA is a national programme and therefore mandated to cover all the 47 counties. To monitor and evaluate such projects in line with the Project Cycle Manual requires continuous data collection and analysis. However, due to resources and time constraints such as material, financial and human resources. The researcher had to narrow the scope to only develop a web-based GIS-M&E system and a mobile-based navigation application. The data collection module for the system is not included in the design of this system and therefore data is collected and analysed outside the system and then imported into fusion tables for integration. The web map includes maps on beneficiaries and projects, amount disbursed per county and impact made per county.

The research project utilized archived data in the NETFUND-GIA database hosted in NETFUND programmes department. to identify the format, content and type of information to be contained in the application. The project names and details captured are the actual project names and information. Internet-based geocoding tool was used to generate the geographic location of the projects that were not near Nairobi and its environs. The details on the amount of funds disbursed and geospatial coordinates of projects supported by NETFUND are estimated values but are in the county stated in the information window. However, images displayed in the information window and impact stated in the maps and graphs are for the actual beneficiary project. The mobile navigation application was only developed for the android platform, which utilized the google navigation module using google API and not for the IPhone operating system (IOS) platform.

The geodatabase used on MS-Excel spreadsheet database instead of a Relational Database Management System (RDBMS). Hence, there is need for adjustment to be made in linking the system with the upgrade of the AMIS to be able to capture the locational data for storage in a RDBMS.

The GIS-M&E system developed does not focus on the entire project management cycle and only comes in during the project implementation. This involves collection of data on:

- The indicators set during the project design to evaluate on outcomes and impact made
- The inputs and the outputs to monitor the project progress

Finally, in the reporting of monitoring and evaluation GIS was used to report findings through visualization.

1.6 Organization of the Report.

The researcher organized the report in five chapters, with each chapter containing several sub-topics outlined in the table of contents. Chapter one gives the background of the research project, the problem statement and objectives, justification of why the study was conducted, the extent of the scope and limitation that the study faced and finally a section of how the report is organized.

Chapter two of the report provides the literature review of the study. Chapter three gives details of the study area, material and methods that were employed to arrive to the stated results. Chapter four provides details of the results that have emanated from the study. Lastly, chapter five gives the conclusion and recommendation that were identified in the study.

2. LITERATURE REVIEW

This chapter provides use of GIS as a monitoring and evaluation tool for donor funds using a case study of NETFUND GIA. It also provides a brief background of the environmental and social challenges that the program addresses due to their spatial nature and the significance of using a GIS system to monitor and report project intervention geared the challenges identified.

2.1 Environmental and Social Challenges

Goal 13 of the Sustainable Development Goals (SDG's) notes that Climate change could have an alarming and profound impact worldwide and that concerted action is needed to stem climate change and strengthen resilience to pervasive and ever-increasing climate-related hazards. Increasing energy demands are also major global challenges at the top of the international agenda. At the Paris climate conference (COP21) held in December 2015, 195 countries adopted the first-ever universal, legally binding global climate deal (United Nations, 2015). The agreement sets out a global action plan to put the world on track to avoid dangerous climate change by limiting global warming below 2°C. The impacts and effects of this global phenomenon has also impacted Kenya as evidenced by the erratic weather patterns characterized by devastating floods and cycles of droughts which have become more frequent with increasing intensity. Figure 2.1 shows the disaster profile of Kenya.

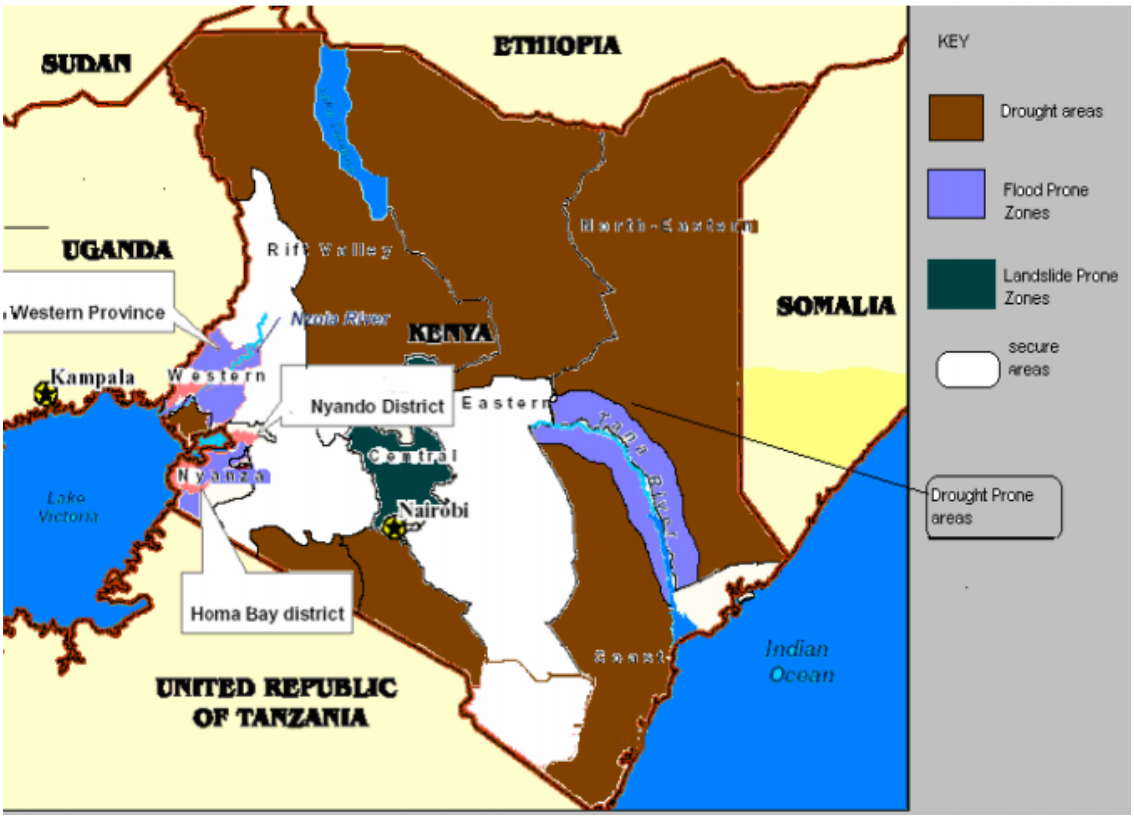

Figure 2.1: Disaster profile of Kenya (Source: UNDP 2007)

In response to climate-related challenges, Kenya has developed the National Climate Change Response Strategy (NCCRS 2010), National Climate Change Action Plan (NCCAP 2013), a National Adaptation Plan (NAP) that provides a vision for low carbon and climate resilient development pathway. The Climate Change Act, 2016 commenced on 27th May 2016. This law provides a regulatory framework for an enhanced response to climate change, and adopts a mainstreaming approach that integrates climate change concerns in the development agendas of all sector agencies and at all levels of government. Kenya has also developed its Nationally Determined Contribution (NDC), (Republic of Kenya, 2015) that seeks to achieve mitigation and adaptation goals in line with Paris Agreement that the country has ratified. Kenya's INDC sets out priority adaptation actions, stating that: "Kenya will ensure enhanced resilience to climate change towards the attainment of Vision 2030 by mainstreaming climate change adaptation into the Medium Term Plans (MTPs) and implementing adaptation actions. Any reasonable achievement of the adaptation goal will require financial, technology and capacity building support."

The economy of the nation is vulnerable to climate change including agriculture, tourism, and energy. Climate change has been noted to be one of the greatest threat for Kenya to achieve its vision 2030 development strategy.

Climate hazards have caused considerable misfortunes across various sectors in different countries throughout the years. The main climate hazards range from dry spells and floods, which estimated loss of 3% of the nation's, Gross Domestic Product (GDP). The World Bank has identified vulnerability to climate change and poverty as the main challenges facing Kenya development agendas (Republic of Kenya, 2013)

The economic recovery strategy wealth and employment creation report (2007-2013) indicates that poverty has risen in Kenya by 40%. Figure 2.2 shows population below the poverty line by county in Kenya. The report further explains that unemployment is a key determinant factor of poverty in Kenya. Kenya's poverty reduction strategy (International Monetary Fund, 2010) highlights that Kenya's first priority should be to restore the economy on a path of high growth as a condition for the achievement of all development objectives. It is therefore critical that measures to address climate change also inculcate deliberate measures to address poverty.

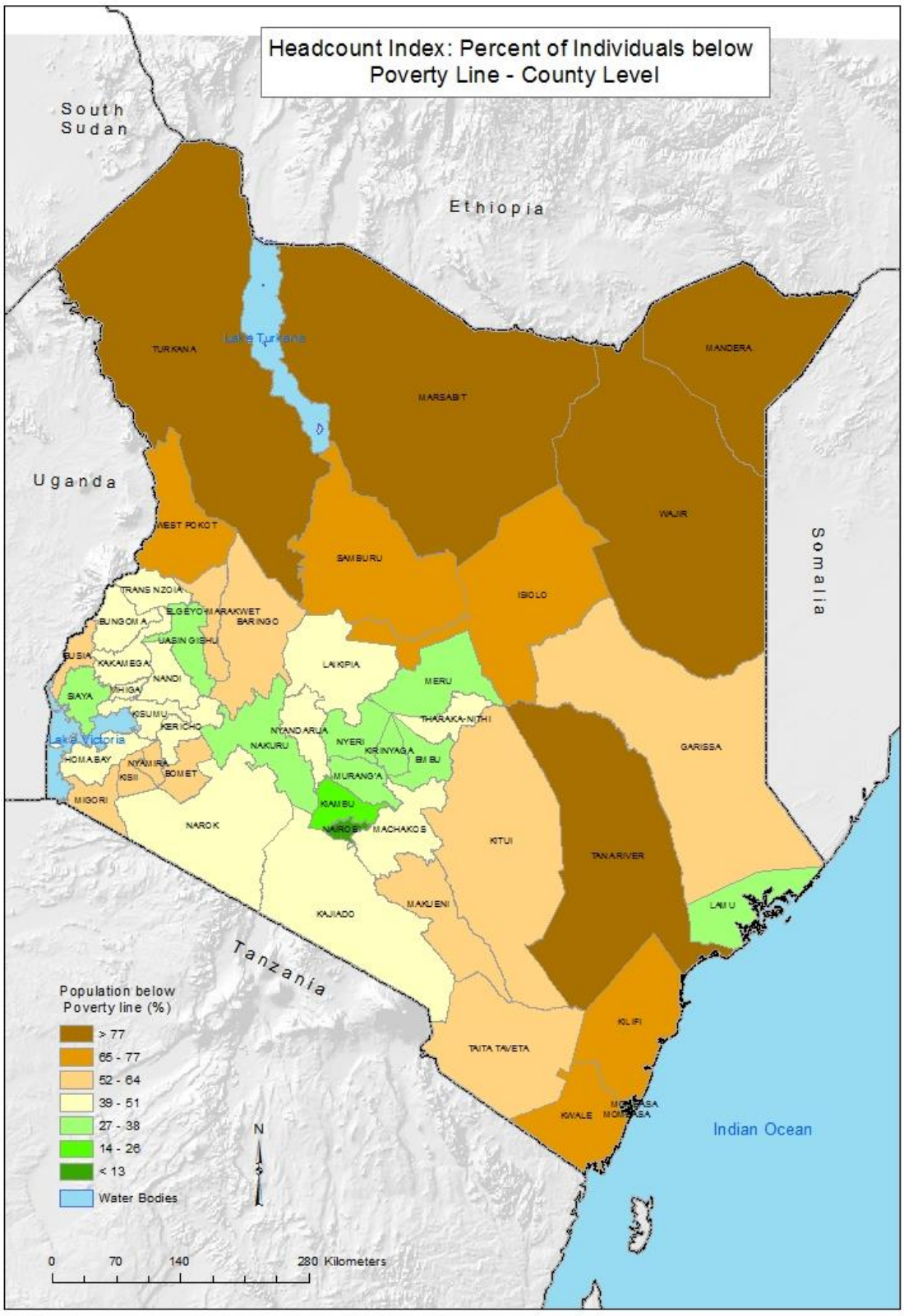

Figure 2.2: Poverty by County (KNBS and SID 2013)

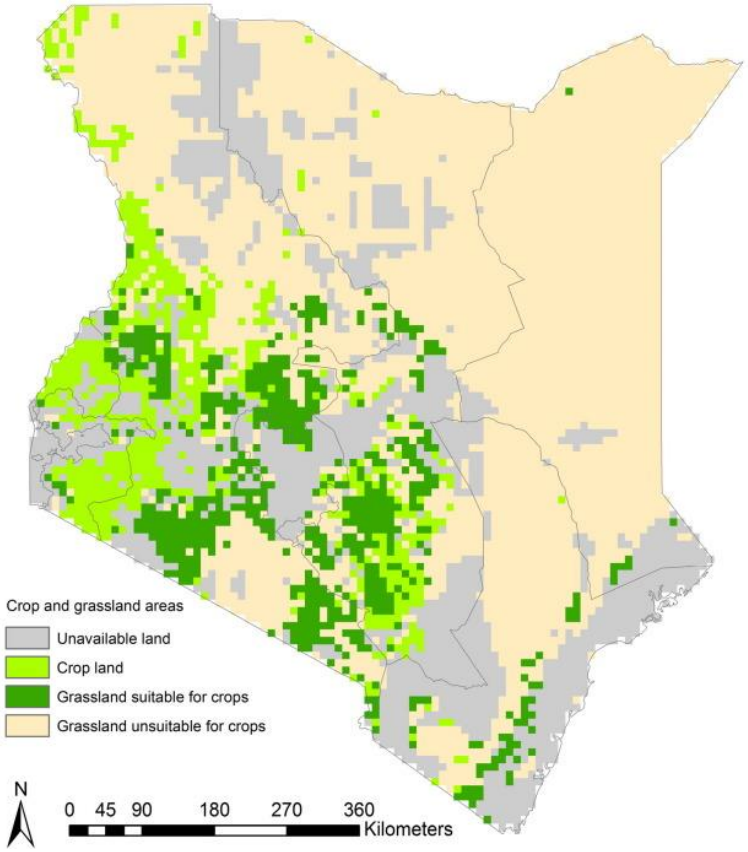

Figure 2.3: Crop and grassland areas (Source: Bosire etal 2016)

Agricultural land was reported at 48.55% in 2014 according to World Bank collection of development indicator. Figure 2.3 shows cropland and grassland suitable for cropland that is under threat due to climate change.

Agriculture is the mainstay of the economy of Kenya with a direct contribution of 25% GDP share. This share is at an approximate value of USD 55.24 billion in 2013 and another 27% indirectly. The sector accounts for 70% of informal employment in rural areas. The sector's vulnerability stems from increasing temperatures, changing rainfall patterns and extreme weather events. Extended periods of drought erode livelihood opportunities and community resilience in these areas; leading to undesirable coping strategies that damage the environment and impair household nutritional status, further undermining long-term food security. The energy sector too has largely relied upon hydropower which contributes to about half of the total national energy generation. This sector has been most impacted by dry seasons and unreliable rainfall.

Kenya continues to make investments with both domestic and international resources to adapt to climate change and realize its abatement potentials. The government and other stakeholders are implementing several climate change adaptation and mitigation programs that cover an extensive variety of sectors including infrastructure, agriculture, energy and water. Some of the initiatives include promoting irrigated agriculture, value addition, climate information to farmers, early warning systems for droughts and flood, conserving water catchment areas, promotion of renewable energy and afforestation and agroforestry programs.

The country's population is rich in innovations; creativity and entrepreneurship that provide opportunities to address climate change create employment and improve livelihoods. The increased application of green technologies or innovations is an essential part of Kenya's climate action. There is however need for an enabling policy environment and capacity to support the development, uptake and diffusion of these technologies or innovations for greater impact. It is on this premise that the NETFUND Innovation Awards was implemented. The award programme identifies, recognizes and supports development climate resilient innovations to sustainable green business in the energy, water, agriculture and waste management thematic areas. Geographically the award program is supposed to have at least one innovator in each county but currently it only covers 30 Counties. Besides coverage, the other important aspect of the programme is the impact created which includes social, economic and environmental impact and the effectiveness of achieving them. A number of tools such as Statistical Package for the Social Sciences (SPSS), Excel, ATLAS-Ti among others are able to do complex statistical analyses with a limitation of not being able to handle geospatial data. Geographic Information System (GIS) has been identified to be a suitable candidate due to its ability of being able to handle spatial and statistical dimension of data and show the results graphically.

2.2 Monitoring and Evaluation

Monitoring and Evaluation (M&E) offers effective administration instruments that enhances the management of government's ventures. Thus may include results realized by them, outcomes and impacts. M&E provides good performance feedback systems.

Monitoring involves continuous collection of information from projects and programmes. It's usually conducted in a systematic manner and routinely structured. The main purpose for collecting the information include:

- To capture lessons learnt and best practices during project implementation. This enables improvement of practices and project activities in future project implementation;
- To achieve both internal and external accountability of the results obtained by the project and the resources used to attain those results;

- To inform future planning and decisions on project and program activities;
- To effectively draw in the recipients of the project activities consequently advancing their strengthening in venture execution.

Monitoring is a continuous undertaking starting from the beginning of the project planning stage all through implementation and project or programme closeout. Monitoring is usually characterized by the documentation of results, processes and experiences, which are then used as a basis to steer decision-making and learning processes. Monitoring also involves checking project or programme progress against set plans. The monitoring data is then used for evaluation of the project or programme.

Evaluation is the efficient and target appraisal of a progressing or finished tasks or projects. Evaluation can likewise be utilized to survey a finished period of a continuous undertaking or program. Evaluation assesses information and data that illuminate vital choices, therefore enhancing the venture or program later on.

Assessments should reach determinations on five principle parts of the mediation including:

Evaluations enables drawing of conclusions on five primary parts of the project intervention including:

- sustainability
- efficiency
- impact
- relevance
- effectiveness

An evaluative analysis can then be determined with information assembled in connection to the above angles amid the M&E procedure.

Monitoring and Evaluation gives vital tools targeting components such as effectiveness and sustainability. M&E should traverse through the whole life cycle of a project (Figure 2.4) giving consistent information stream and feedback. M&E can help in creating and clearing up the objectives and goals in the underlying procedure of tasks and project planning. When venture is operational, M&E can advance or enhance accountability and transparency inside

associations, partner organizations and donors. Input from M&E findings amid venture execution implies modifications can be made to enhance the possibility of managing effective results. Finally, It does not require an officer to wait until project closure and final reporting to assess if a project has achieved its goals or not.

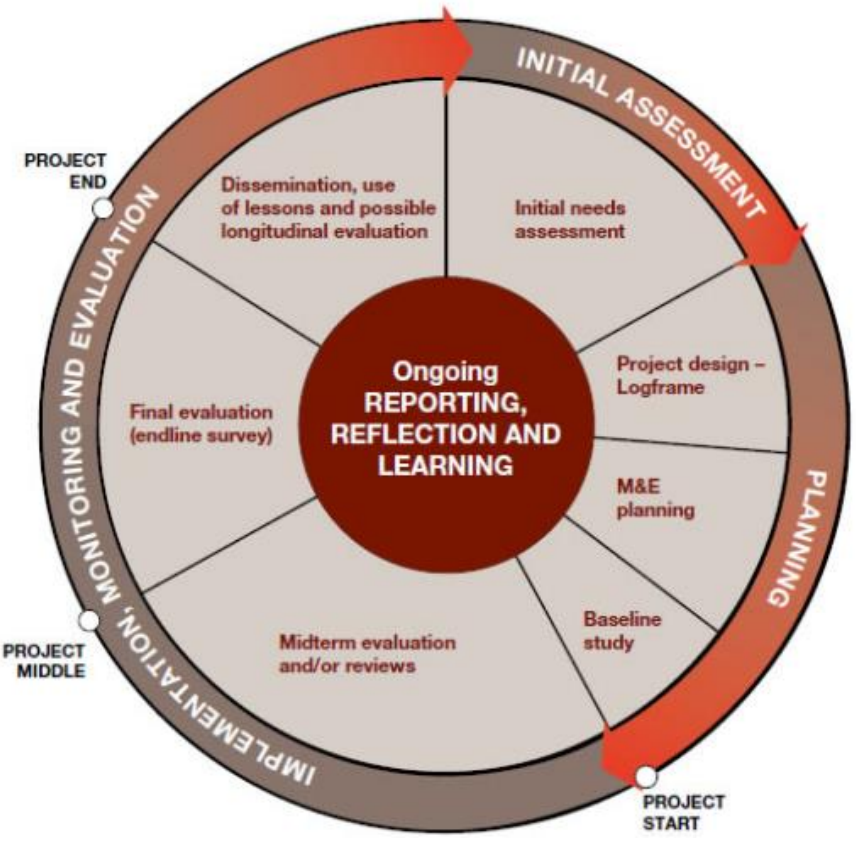

Figure 2.4: M&E along the project management cycle (IFRC 2011)

There are ten steps necessary to assemble a powerful M&E system. The Ten Steps to a Results-based Monitoring and Evaluation System, 2004 portray a well-ordered approach that has been utilized as a part of different developing nations in the outlining and development of M&E systems. (Kusek and Rist, 2004)

Step One: Conducting a Readiness Assessment

Step Two: Agreeing on Outcomes to Monitor and Evaluate

Step Three: Developing Key Indicators to Monitor Outcomes

Step Four: Gathering Baseline Data on Indicators.

Step Five: Planning for Improvements—Setting Realistic Targets

Step Six: Monitoring for Results

Step Seven: Evaluating Information to Support Decision-making

Step Eight: Analyzing and Reporting Findings

Step Nine: Using the Findings

Step Ten: Sustaining the M&E System within the Organization

Step 4 involves collection of baseline data. M&E data usually has a geographical location and therefore impact extent can be measured. The eighth step of this ten-step approach addresses "reporting findings" and recommends the utilization of "visual presentations—charts, graphs, and maps". Examples of charts, graphs and maps are incorporated to report the findings of M&E. Adding a GIS-based map for the M&E results can enhance the communications of results to management, stakeholders and end-clients. This guarantees easy management and dissemination of findings from the monitoring and evaluation exercise. M&E and GIS have a fundamental distinction: M&E is temporally in nature and focuses in measuring changes and results happening after some time and GIS is concerned with the spatial attribute of the results – recognizing where the results are happening. Examples of GIS and M&E integration include Fieldata, which is a data-collection portal developed by Arthify and Ki-projects™ which is a web based project monitoring and evaluation software application for building results-based projects and M&E systems developed by Kimetrica Limited.

2.2.1 Monitoring and Evaluation tools

Organizations use different tools, some of which are either complementary or substitute to each other, while others are either broad or narrow (World Bank, 2002). The M&E tools include performance indicators, logical framework approach, theory-based evaluation, and formal surveys, rapid appraisal methods, and participatory methods, public expenditure tracking surveys, impact evaluation, cost benefit and cost effectiveness analysis.

Organizations utilize diverse tools, some of which are either complementary or substitute to each other, while others are either broad or narrow (World Bank, 2002). The M&E tools incorporate performance indicators, logical framework approach, theory-based evaluation, formal overviews, rapid appraisal techniques, and participatory strategies, impact evaluation, tracking cost benefit and effectiveness analysis.

Chaplowe (2008). highlighted the importance of identifying appropriate methods, procedures, and tools that meet specific project's M&E needs. This is because programs require diverse M&E tools relying upon the operational setting, executing agency capacity and benefactor necessities. World Bank (2002) acknowledges the use of different M&E tools and approaches which increases effectiveness of the processes as some tools are complementary or substitute to cover broad or narrow scope of the M&E processes. For a successful and effective M&E tool there is need for an organization to be flexible and imaginative as well as compare experiences from other organizations before selecting the tool to be used for M&E of their projects (Briceno, 2010; Jha et al., 2010). This study however does not give a clear guideline of how flexible M&E for environmental projects should be.

Lahey (2009), reports that M&E tools as central in designing development and implementation of M&E. The process is reported to be a long term and iterative with emphasis on the "process" of implementation as an important mechanism in developing an "evaluation culture" or "results culture" in an organization and across the entire system. Realizing this the Canadian M&E system has invested heavily in both evaluation and performance monitoring as key tools to support accountability and results-based management.

The annual report of 2008 of International Fund for Agricultural Development (IFAD) provides details regarding results and impact, demonstrates intermittent reactions against M&E tools. Among the criticism, include limited scope, complexity, low data quality, inadequate resources, weak institutional capacity, lack of baseline surveys and lack of use. Frequent criticism of M&E tools in IFAD projects relates to the type of information included in the stools. According to the report most of the information collected and processed in IFAD projects are not based on results achieved, the purpose or impact level.

Singh et al., (2009), studied the numeric paper forms for NGOs", expressed concern regarding data collection processes namely: cost, time, training, data accuracy and consistency, storage,

and means of data analysis. Additionally, those NGOs who had experimented with electronic M&E tools highlighted difficulties with infrastructure and maintenance. Among the key findings of the study was that data collection and form-filling are important activities for many NGOs; cost and ease of-use are major concerns, often preventing technology-heavy tools; and digitized data is desired, but digitizing data was the bottleneck for data-collection efforts. Center for Learning on Evaluation and Results (2012), reported that despite the Benin monitoring and evaluation tools having improved, access to data and information there remained a great challenge, particularly in accessing data to be collected. Processed data gathered through Benin M&E tools was not sufficient and credible for decision-making.

Ediau (2012), provides details regarding strengthening of the M&E system of HIV and AIDS initiatives in Child Fund Uganda. He found that, data was not routinely gathered, aggregated, stored, analyzed and shared by Child Fund Uganda and task stakeholders. Therefore, such data was not successfully used to track and measure performance as well as illuminate program change and learning. Additionally, Obure (2008), in an investigation of RBM in Northern Ghana revealed the challenge with M&E tools associated with post gathering data management. As many field officers admitted to incapable handling, storing, preparing and interpretation of data, results from the examination unequivocally point to a weakness in tools utilized as a part of handling and preparing data.

Mobile data collection is a viable M&E tool due to its high penetration with statistics as of late 2013 putting it at 96% globally and 89% in the developing countries (International Telecommunication Union, 2012). Data captured in mobile phones is easily transmitted to other devices through Bluetooth, Short Message Services (SMS), Multimedia Messaging Services (MMS), Unstructured Supplementary Service Data (USSD), wireless internet or physical transfer of data from a memory card through exchange. Mobile phones also store data collected locally in the device if there is low mobile signal connectivity or a lack of it. Once the signal is established from the cell tower the mobile can the transmitting the data to the central server. Mobile data collection has numerous advantage as a tool for data collection due to the following attributes (Trucano, 2014). :

Speed: Mobile based data collection speed the process of data collection enabling real time data transmission allowing the administrator to identify any gaps and problems of the data

collected and be able to correct them immediately before the field enumerators return to the office or station.

Accuracy: Data captured digitally using mobile phones has minimal or no transcription error and usually does not get lost easily in the field since most of the data is stored and accessed through a cloud server. This gives easy access and security of data.

Easy to train: Due to the use of mobile phone devices for many purposes, people are usually comfortable in using them for the purpose of data collection. Once the software has been installed and setup the only training required is how the enumerator/field assistant can use the user interface of the application to input and edit data.

Data Combination: Mobile phone data collection enables capturing of data in different format including numerical, text, photographic images, video, audio and geo-locational data if the phone functionality allows.

Low cost: Mobile phone data collection exercise is relatively cheaper to conduct compared to traditional means.

An example of mobile-based data collection application is the Open Data Kit Collect application, which is a free and open-source set of tools, which helps in authoring, field, and manage mobile data collection solutions. This application was used in the project to provide the data collection module for the entire M&E system to be developed and therefore enhance monitoring and impact evaluation when the system is deployed.

2.3 GIS and Web GIS Technology for M&E

2.3.1 GIS for M&E

Geographic Information Systems (GIS) refers to a system of hardware, software and procedures that capture, store, edit, manipulate, manage, analyses, share and display georeferenced data. The system provides tools for conducting geospatial and statistical analysis thus revealing relationships, patterns, and trends that are not readily apparent.

Geographic Information Systems (GIS) alludes to a system of hardware, software and methodology that capture, store, alter, manipulate, manage, analyses, share and display georeferenced data. The system provides tools to conducting geospatial and statistical analysis

thus enabling discovery of relationships, trends and patterns that are not readily apparent. (Fu and Sun, 2011).

GIS for monitoring and evaluation generally provides a tool to integrate spatial and non-spatial. It can be applied as an information database, analytical tool and a decision support system (Ranganath, 2006).

Mapping is used in several planning stages in the M&E cycle. This is because maps provides the ability to collect and visualize project data including baseline data. It also provide a guide in the planning of intervention strategies, planning for allocation of resources and visualization of monitoring and evaluation data collected in order to identify result gaps. (Raftree and Bamberger, 2014). Mobile data collection and mobile GIS application are usually used to collect geospatial data this can also include survey data, geographic coordinates and images. This data can then be uploaded to a database, visualized and analyzed to generate results.

Maps can be combined with other data such as demographics to assess the impact the project has on equity and enabling the project staff to address any shortcoming that may arise. GIS Provides:

- Storage of information in geodatabases making the information concrete and bound to actual location on the ground.
- Provides statistics and data tables that can be easily communicated and understood through geo-visualization.
- Maps provides easy visualization of distribution of development projects and therefore give a spatial distribution of funds invested countrywide. This enables creation of fairness in implementing development projects.

A case study of GIS implementation in monitoring a project in Kenya is the Map Mathare Project. This project made use made use of GIS to map Mathare in order to improve water and sanitation. This was a participatory project approach to which the members of the community were engaged in conducting baseline surveys and developing the digital map that shows the incidence of public defecation. The map has enabled the community to make decisions about

water and sanitation project activities and programme. The map also helps demonstrate change and the different results over a period. (Raftree and Bamberger, 2014).

For land cover land use monitoring and evaluation, is possible due to the repetitive nature of satellite images (Ranganath, 2006). This provides an opportunity to monitor the land use, land cover changes and evaluate its overall impact on the environment. Satellite images can show the changes of the environment at a large scale such as population migration, forest cover change, forest and agricultural land fires. This can be used to monitor programme activities, plan for the appropriate intervention, or advocate for the favorable changes in policy at higher level.

2.3.2 Web GIS for M&E

Web GIS is a type of distributed information system with a server and client component. The server is usually a GIS server such as geoserver or ArcGIS server the web browser application installed in a computing system as the client. The client can also be any desktop application, or mobile application accessing services from the GIS server (ESRI, 2017). Web GIS utilizes web technology to conduct communication between a server and a client. Web GIS includes:

- **Server:** This provides a Uniform Resource Locator (URL), which is an address of a page in the World Wide Web, which enables clients to locate it on the web.
- **Requests:** Hyper Text Transfer Protocol (HTTP) specification enables a client to send request messages to the server.
- **Response:** After a HTTP server receives the request, it performs the GIS operations requested and sends back the responses to the requesting clients through the HTTP. The response may be in different formats, such as Hyper Text Markup Language (HTML), image format, Extensible Markup Language (XML), or JavaScript Object Notation (JSON) see figure 2.5.

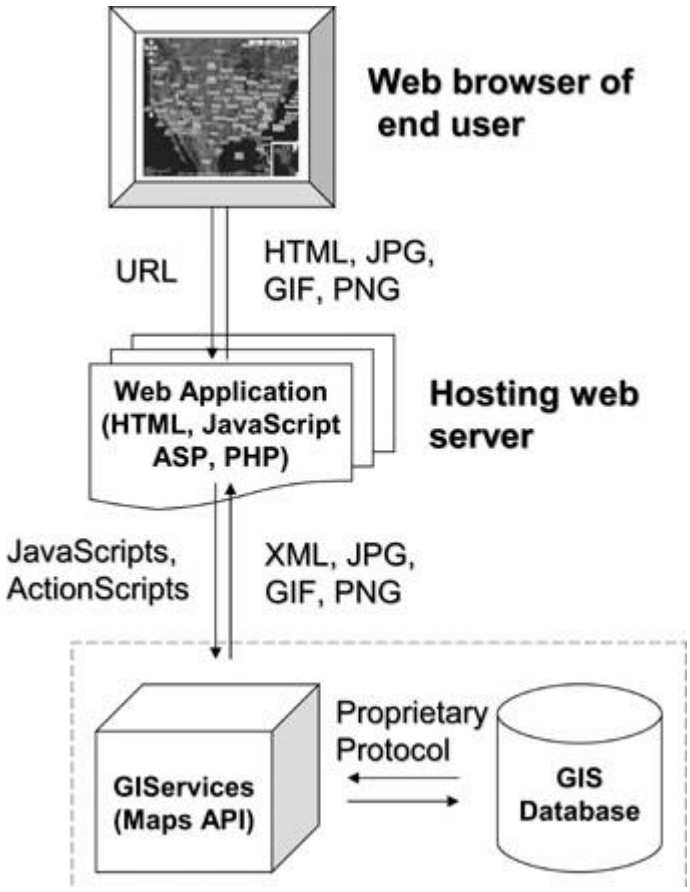

Figure 2.5: Simplest Web GIS Architecture Source: Edwin Chow (2008)

The web has enhanced monitoring and evaluation by allowing visual interaction with data and in real time. A web server enables clients to produce maps and charts and publishing them on the internet for a wider audience. This enables other clients to view updates of projects and M&E exercise in real time speeding up dissemination of project information. Web GIS also enables data to be easily and widely accessible. This is because clients can work remotely from a different location.

Second, because of the near ubiquitous nature of the Internet, the geospatial data can be widely accessible. Clients can work on it from almost any location. Web GIS is best for Monitoring and evaluation since it is capable of having a global reach, serve a large number of users, easy to use interface, unified updates and has an increased cross platform.

Web GIS also provides capability of map visualization, collection of geospatial information, geospatial analysis and queries and dissemination of geospatial information (Usun, 2011).

A Case study for such a system is the Electoral and Boundaries Commission 2017 election whereby GIS was employed to monitor and track the election results. This however was not well utilized as compared to United States of America 2016 election where web GIS was used to visualize and monitor real time election results as they were received by the returning officers. For example Politico is a website that provided users with the a map containing each State in the US linked to a tabular votes list alongside a running count of percentage reporting, poll closing times and electoral votes. 2016 Election Operations Dashboard a Web GIS platform of ArcGIS online enabled visualization of the election results in real time (Gletham, 2016).

Finally, Election Results application, which is a web app, developed using Web AppBuilder for ArcGIS enables citizen and any interested party to review results from the election. The application also provides a functionality for sharing tabulated real-time results and historical results after each election enabling evaluation of voter's awareness and campaigning effort (Environmental Systems Research Institute, 2018).

3. MATERIALS AND METHODS

3.1 Study Area

The NETFUND-GIA is a countrywide programme but currently spans 30 counties in Kenya. The counties include Kisumu, Nairobi, Uasin-gishu, Laikipia, Wajir, Kiambu, Nakuru, Nyandarua, Marakwet, Homa Bay, Kakamega, Makueni, Trans-nzoia, Kericho, Taita-taveta, Kajiado, Narok, Siaya, Bungoma, Muranga, Meru, Kirinyaga, West Pokot, Embu, Tharaka Nithi, Nyeri, Trans Nzoia, Garissa, Mombasa and Machakos. NETFUND has supported a total number of 55 project in these 30 counties in different capacities including capacity building, business development, product development and financing. Figure 3.1 shows the project coverage of NETFUND projects. The system design incorporated 29 projects from the different counties to demonstrate the significance of a system with a national wide outlook.

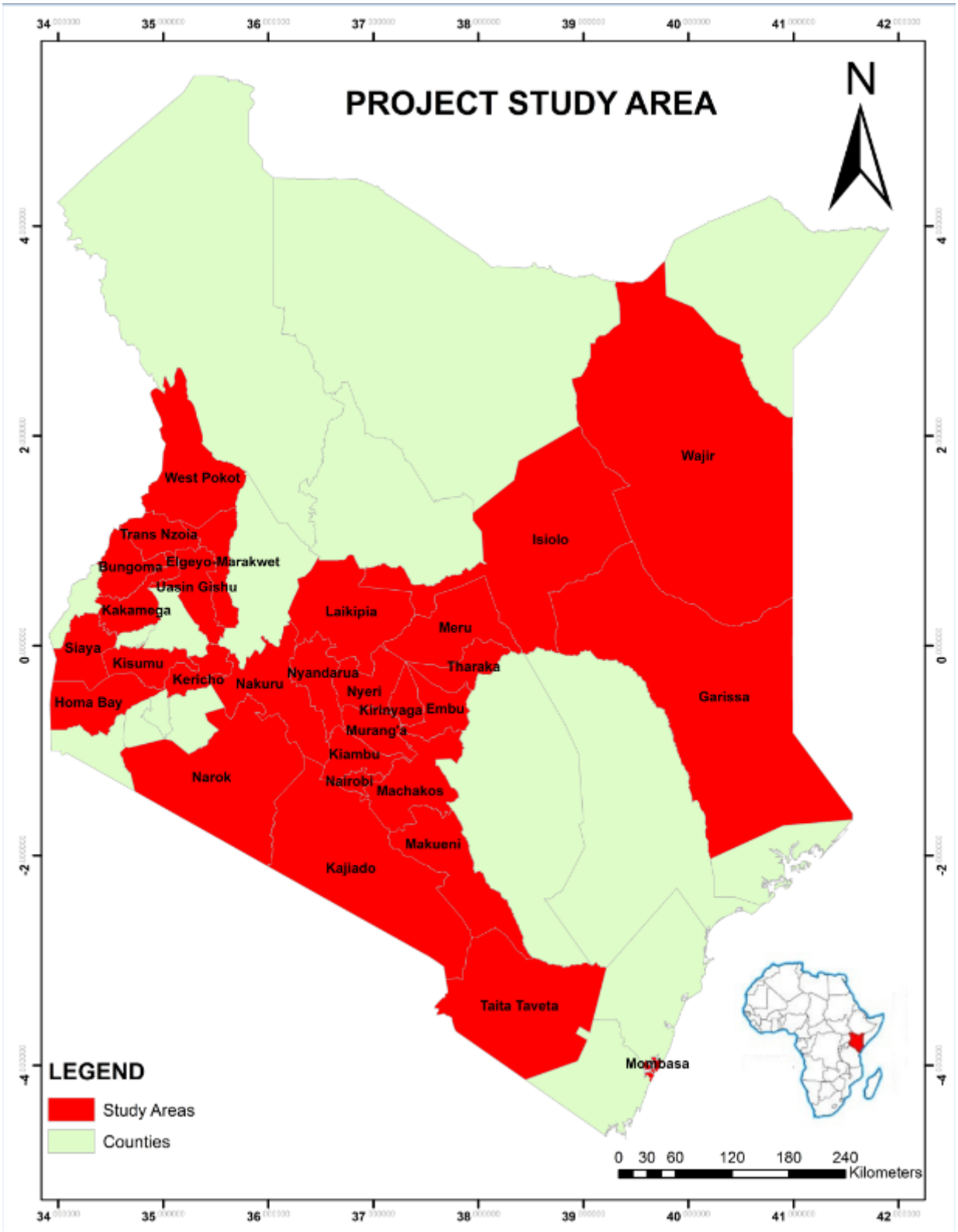

Figure 3.1: Project study areas

3.2 Data Sources and Tools

3.2.1 Data Sources

The study data was mainly derived from the NETFUND GIA programme. The beneficiates details was acquired from the NETFUND Programmes department. Additional data was acquired from various other sources. Table 3.1 below provides the datasets lists and their characteristics.

Table 3.1: Data sources

Data	Source	Characteristics
Geographic Location data (x,y) for beneficiary projects in the NETFUND-GIA programme	• Google Maps • Internet based geocoding tool (http://gmapssamples.googlecode.com/svn/trunk/geocoder/singlegeocode.html)	Geographic coordinates (x,y) in Decimal Degrees. (Generated using Internet based geo-coding tool)
NETFUND-GIA data • **Beneficiary project register** • **Disbursement report** • **Impact report**	NETFUND Programmes department, Ministry of Environment and Forestry	MS-Excel Spreadsheets Ms-Word reports
Administrative Boundary Maps **• Kenya Counties** **• Locations**	ArcGIS Website (http://www.arcgis.com)	Shapefiles
Online Base Map	Google Maps	Google map showing road maps, satellite imagery and terrain).

3.2.2 Tools

a) Hardware

- HP Pro-book 4440S Laptop; Intel Core i7-3230M @2.60GHz 250GB Hard Disk, 3.0 GB RAM, 15.6" LED Display and running 64-bit Windows 7 professional was used in this project.
- Kyocera Taskalfa 250Ci KX was used to print a hard copy of the project report.
- 8.0 GB Transcend Flash disk was used to store data and backup copies of the project report and source codes for the applications.
- Tecno L9 mobile phone was used for testing of the data capture and navigation application.

b) Software

Microsoft office 2013 suite of software was used as follows:

- NETFUND-GIA data provided in MS-Excel based database format was done in Microsoft Excel 2013. This was conducted to incorporate geographic coordinates data, that has been simulated, for the beneficiary's projects. The software was also used in the conversion of the resultant database into a comma delimited (csv) files for easy exporting to Google Fusion Tables.
- Microsoft Power Point 2013 was used to develop the preliminary and final project presentations.
- Microsoft Word 2013 was used to develop the project report.
- Microsoft Excel 2013 was used to design data collection form

Adobe Photoshop and Illustrator CS6 was used to develop the web page banners for the Web-based Monitoring and evaluation system for the GIS portal.

Hyper Text Markup Language (HTML) was used to structure the web pages.

Cascading Styles Sheet (CSS) was used to style the different components and elements of the web pages.

JavaScript was used to make the web pagers interactive when displayed.

Brackets (text editor) was used to code and edit HTML, CSS and JavaScript to create the GIS portal web pages.

Google Fusion Tables provided a platform for visualizing and sharing data tables with other applications. This application provided visualization and storage capabilities for the NETFUND-GIA geo-database.

Shape Escape an Internet-based tool was used to convert the County shapefiles to format supported by Google Fusion Tables.

Google Maps JavaScript Application Programming Interface (API) and Google Fusion Tables API's was used to embed Fusion tables visualized map layers and graphs in the web pages of the portal.

Google Maps, an online application that provides web-mapping service, was linked to the portal to provide base maps upon which NETFUND-GIA map layers was overlaid.

ODK collect, a free and open source mobile data collection application, was used for collection of primary data and submission of the data for aggregation. The software provided seamless integration with the GIS web portal by providing a common fusion table that can be linked.

ODK Aggregate is the intermediary server storage platform that accepts the data and can send it on to external applications. It also allows downloading of datasets in aggregated formats, such as one .csv file.

ODK build a form designer with a drag-and-drop user interface. Build is an HTML5 web application and works best for designing simple forms. The data collection form was designed with

Google Cloud Platform lets developers build scalable web and mobile backend in any language on Google's infrastructure. This cloud platform was used in the deployment of ODK aggregate.

App inventor for android (MIT AppInventor) is an open-source web application for developing mobile applications which was provided by Google but currently maintained by Massachusetts Institute of Technology MIT was used for the development of the navigation application.

3.3 NETFUND-GIA M&E Web-Based GIS Portal Development

The flow diagram illustrated in Figure 3.2 gives an overview of the methodology employed in carrying out the study. The study begins with the identification and acquisition of the appropriate datasets from NETFUND Programmes department. After the relevant data was acquired it was geo-referenced, edited and formatted to ensure compatibility with the designed, web interface design and development and visualization of the NETFUND GIA programme data using the resultant system to produce various outputs and finally show the analysis and querying functionality of the system.

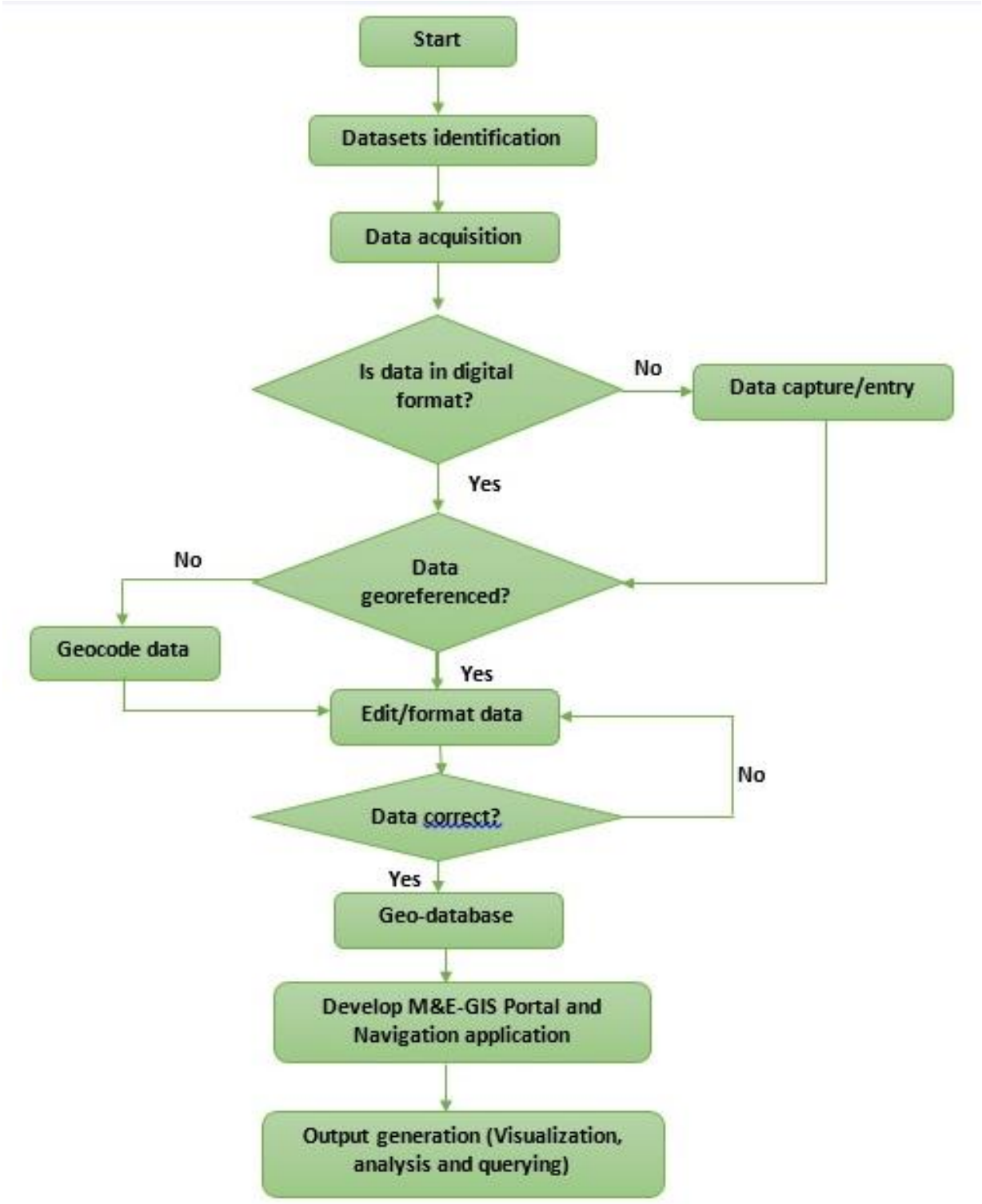

Figure 3.2: Methodology Flowchart

3.4 Data Collection

User needs assessment was conducted by carrying out a survey of the programmes department, administration department (transport section), Resource mobilization department and communication department. This survey and interview was used to assess the needs of the staff in order to address them during the system design. Google forms were used and administered online to NETFUND staff emails. The discussions revealed that NETFUND had a challenge in getting accurate and real time data. There was need for an easy to use mobile application that can be rolled out to the beneficiaries who can be able to fill regular data and submit it to the NETFUND programme staff. The respondent also noted the existing Awards Management Information System (AMIS) did not have geographic location for current and previous beneficiaries in the awards programme. However, most of the respondent felt that there is need for incorporating geographic coordinates for the beneficiaries in all the Award Cycles and show spatial distribution of funds disbursed and impacts of the NETFUND GIA programme. The other advantage of adding location was that the newly recruited staff, NETFUND board members, stakeholders and donors will be able to use it to familiarize themselves with the funded project in the NETFUND-GIA programme and it will also enable carrying out. Impromptu visits and auditing of the funded project to find their compliance towards agreed targets and workplan. The respondents also highlighted that there was poor information sharing within and outside the organization and there is need for M&E data to be disseminated to the public in a, graphical, and accessible way. Most of the respondent felt that to increase accessibility the M&E information should be disseminated online rather than using a monthly newsletter hence ensuring real time updates are received by stakeholders.

Data collection software, ODK collect, was deployed using ODK aggregate hosted in Google Cloud Platform. Data collection form was developed using ODK build and was converted into XML format and uploaded into ODK aggregate.

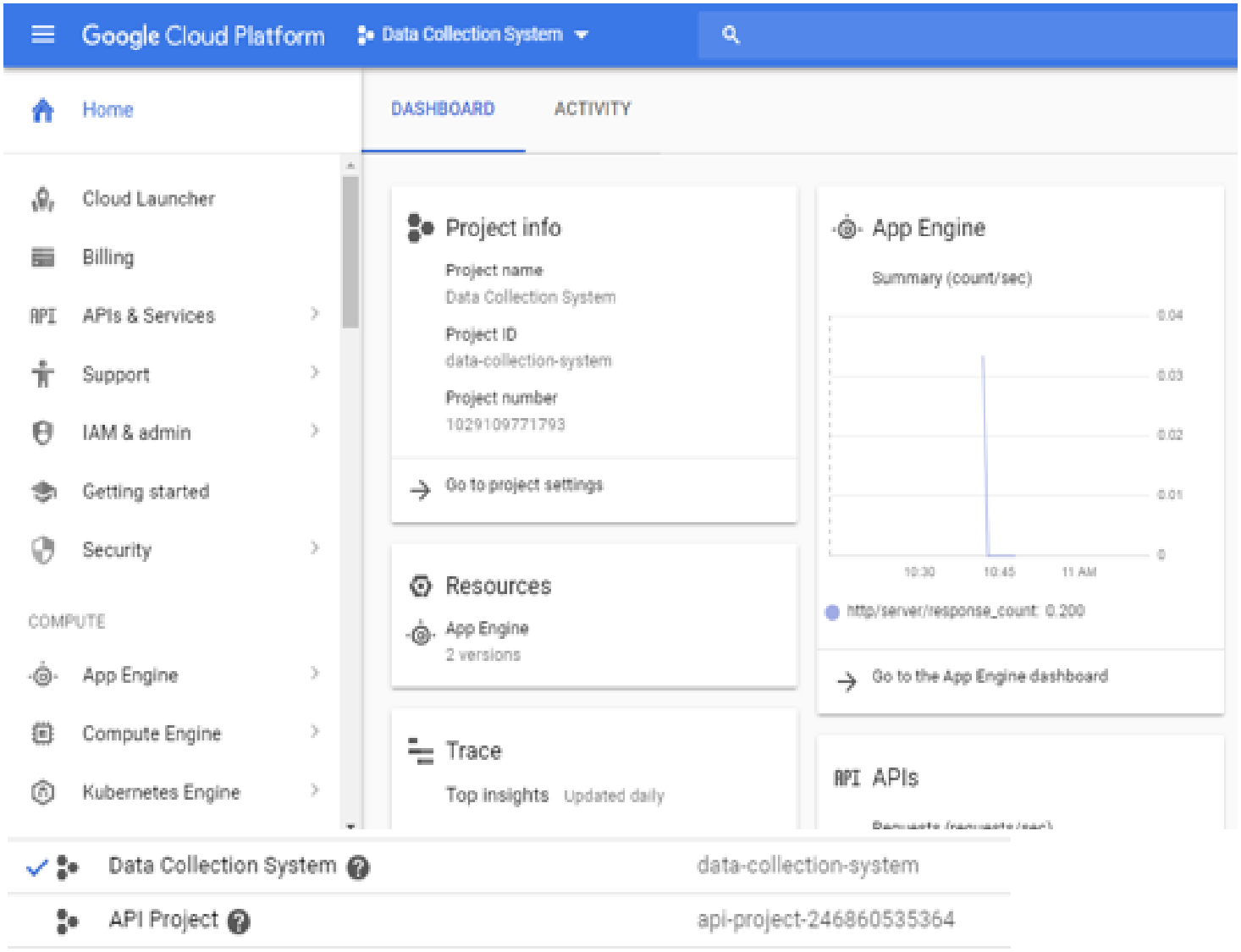

Figure 3.3 : Google Cloud Platform for hosting ODK aggregate server deployed

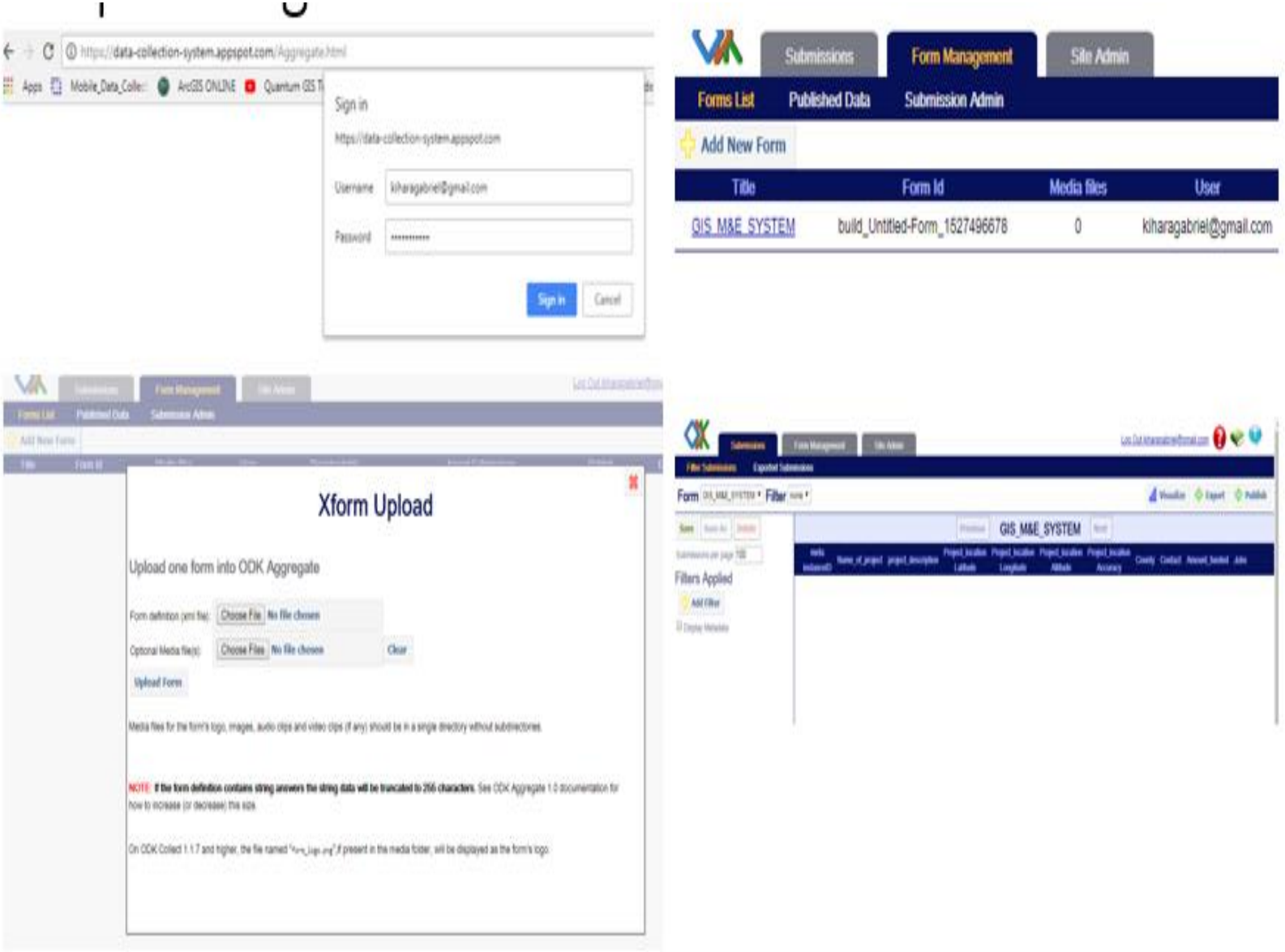

Figure 3.4: Uploading XML form in ODK aggregate server

Figure 3.5: Data Collection form in XML format

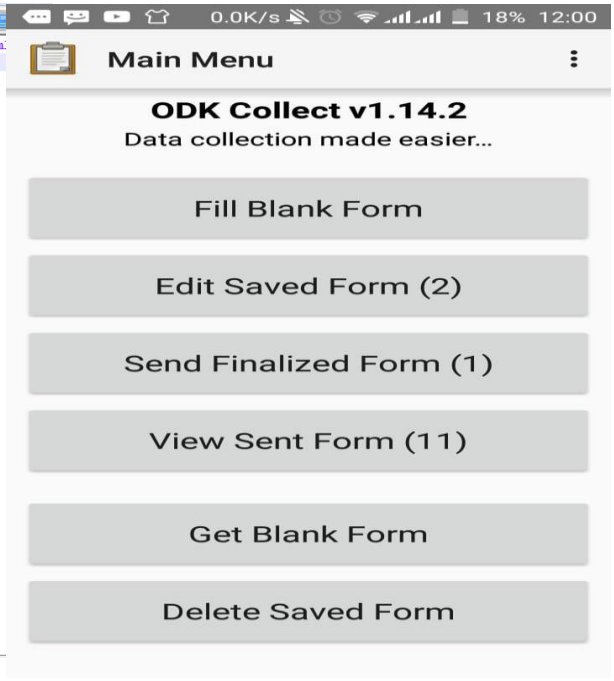

Figure 3.6: Data collection application for collecting primary data deployed

Primary data was acquired from NETFUND's beneficiaries through fieldwork and phone calls. The researcher conducted onsite visits to beneficiaries closer to Nairobi and its environs and recorded their responses and actual geographic coordinates using ODK Collect. For beneficiaries further from Nairobi and its environs a simulated geographic coordinate was generated using web-based geocoding tools and recorded. Other datasets such as project description and other attribute data were shared in MS-Excel database format by the NETFUND programmes department.

3.5.1 Data pre-processing

This process involved editing of the attribute and spatial data collected. The editing process involved:

- Data cleaning: This involves mapping collected data in their correct type such as numerical, text, locational data. It also involves completing any incomplete data.
- Masking of beneficiary's personal information and grants details to ensure privacy of the actual beneficiaries in NETFUND-GIA programme. Using an estimate of their grants and omitting some personal details.

- Removal of unnecessary fields in the NETFUND GIA project database and funds attribute information, which is irrelevant to the developed system and subsequent maps.
- Inclusion of geographic co-ordinates of beneficiary projects.
- Typographical errors correction of data aggregated in ODK
- Conversion of Excel document (XLS) to Comma Delimited Values (CSV) format to enable compatibility with Google Fusion Tables once imported.
- Conversion of shapefiles into google fusion compatible format (KML) using Quantum GIS
- Importing KML data into fusion tables

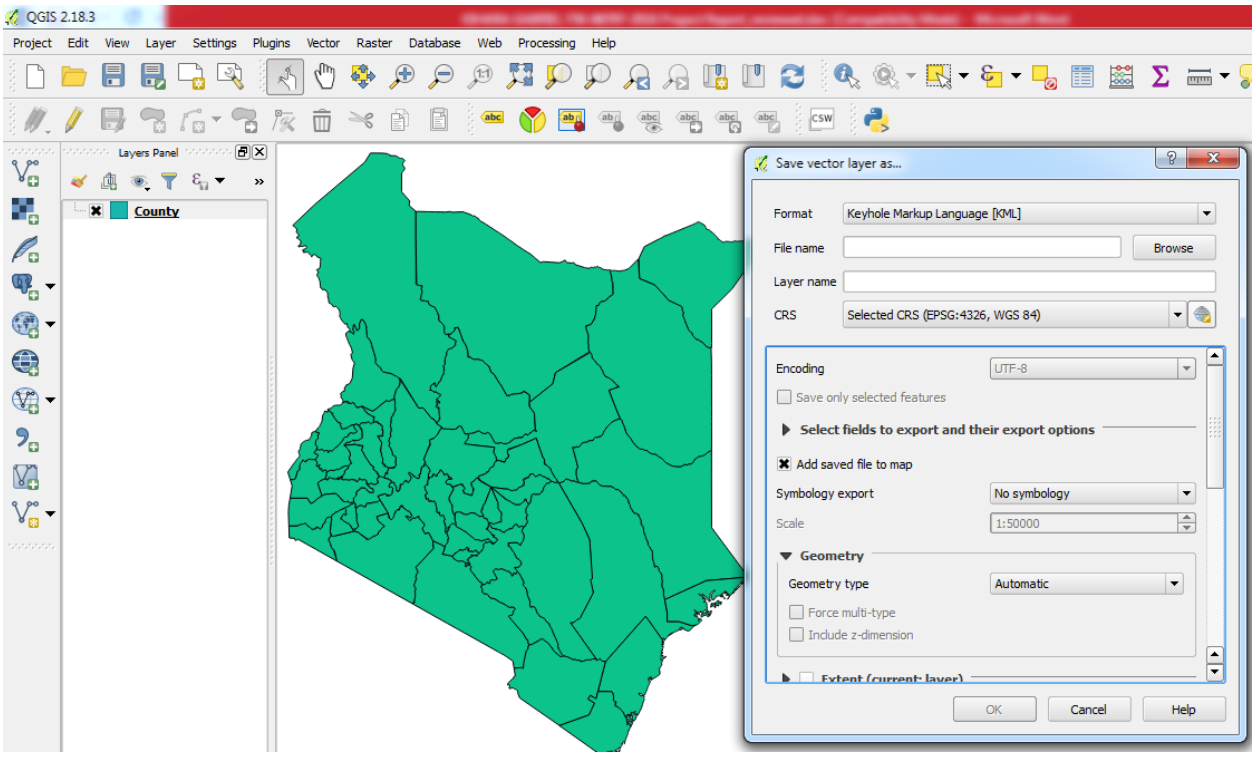

Figure 3.7: Kenya County Shapefile converted from Vector layer to KML using QGIS

3.5 Geodatabase development for M&E

Data collected was stored in the ODK aggregate server as seen in Figure 3.8, which was deployed. The mobile app collects this data and stores them offline until it a network connection is established with the server and is sent.

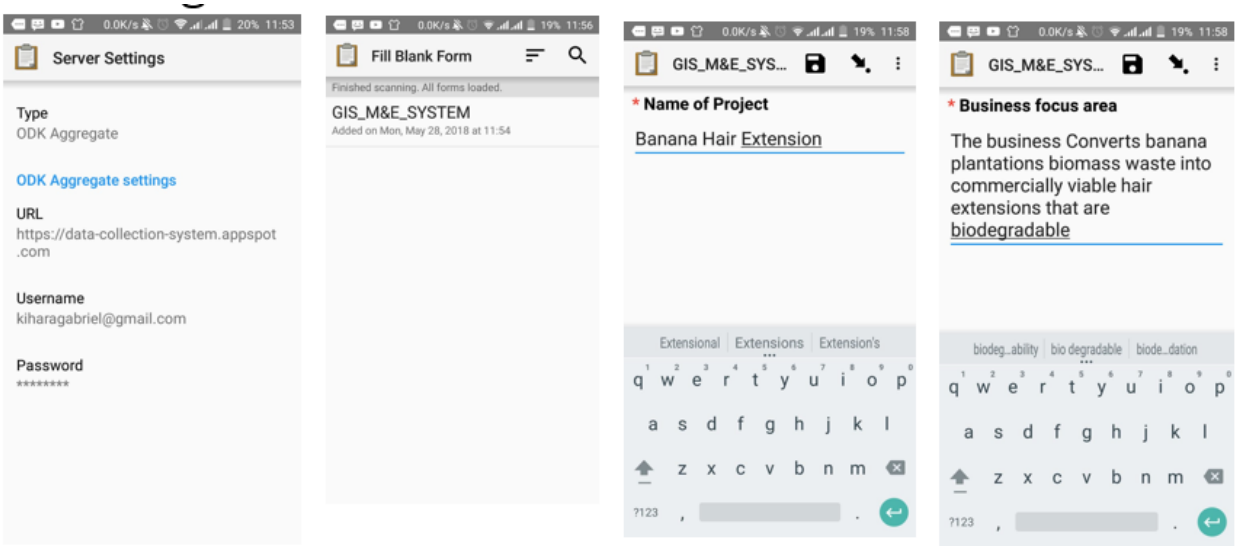

Figure 3.8: Setup of ODK Collect app and collection of data

The schema of the form was developed to correspond to the geodatabase that was designed in Fusion tables. After all data was collected and uploaded to the ODK aggregate as shown in Figure 3.9, the data was then published to Google Fusion tables.

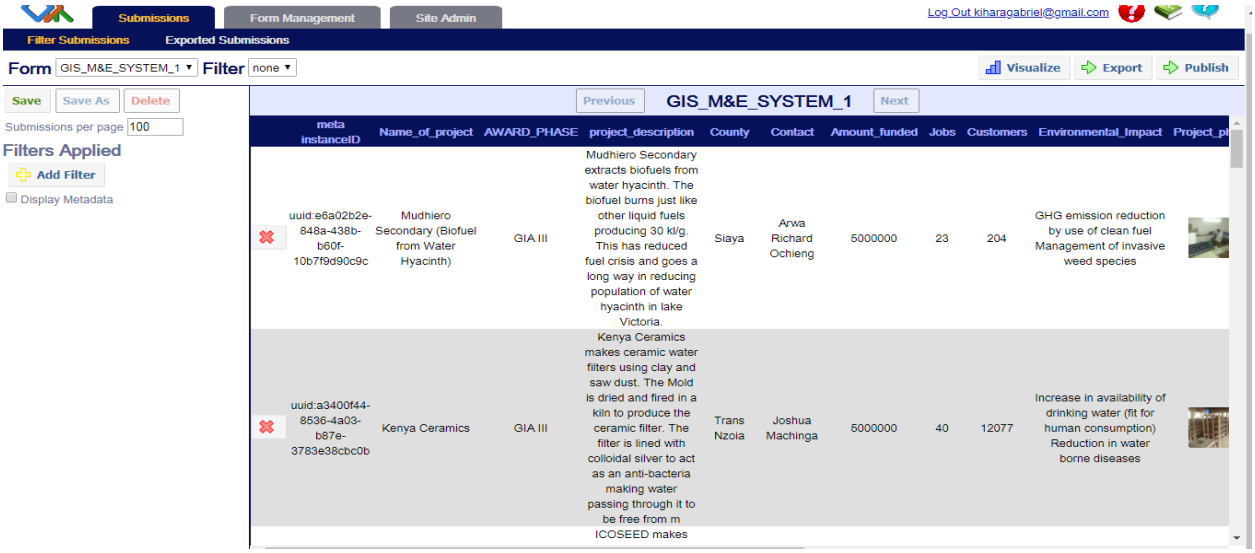

Figure 3.9: Aggregated collected data in ODK aggregate server

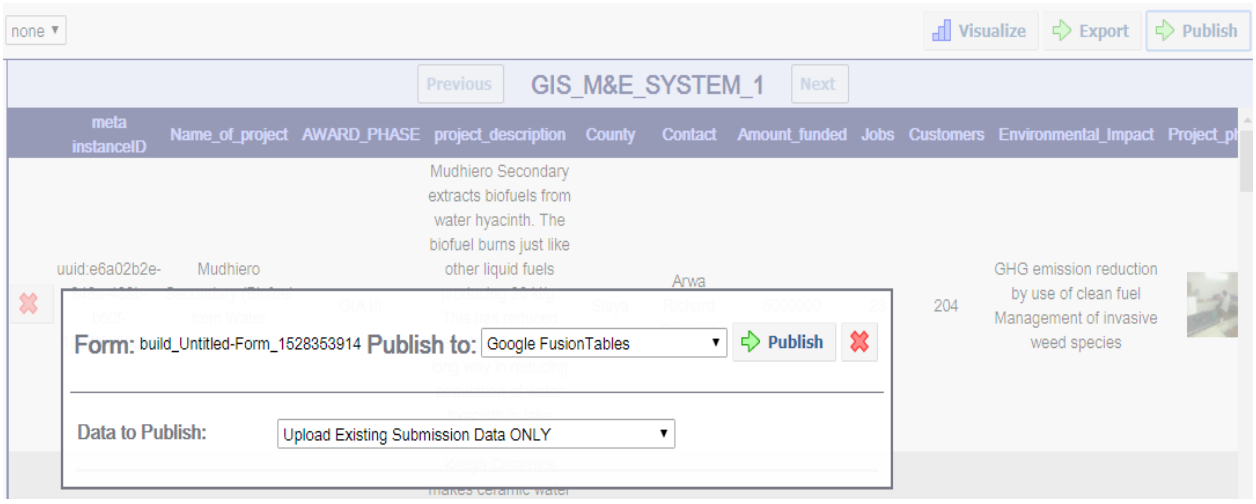

Figure 3.10: Publishing of beneficiaries' data in Google Fusion Tables

The KML data of the shapefile was imported in Google Fusion tables where it was edited to include the data of amount disbursed for each counties.

The data now stored in Google Fusion tables enabled development of Geodatabase through modifying the imported tables and ODK aggregate published data include some columns and exclude columns that are not necessary for the design of the GIS-M&E portal. The following procedures were followed to develop the Geodatabase that stores NETFUND GIA data in the backend.

1. Importation of KML data and ODK published data into Google Fusion Tables creates data files that are stored in Google Drive as shown in Figure 3.11. These databases can be opened and viewed in order to geocode them into geo-databases. Figure 3.12 and 3.13 shows the tables "NETFUND GIA Project Database" and "NETFUND GIA Grants Disbursed" displayed in Fusion Tables

Figure 3.11: NETFUND GIS M&E Databases in Fusion tables' format in Google Drive cloud storage

NETFUND GIA Project Database

GIS_M&E_SYSTEM_1 2018-06-24T11:07:00.000+0000 - data
Edited on 2018 June 24

Share

File Edit Tools Help | Project_database | Cards 1 | Project Map

Filter | No filters applied

1-30 of 30

Name_of_project	Thematic Area	AWARD_PHASE	project_description	County	Contact	GPS_location_Latitude	GPS_location
ICOSEED Enterprises Ltd	Agribusiness	GIA III	ICOSEED makes valuable products (handcrafts) using banana pseudo stem extracts. Koikalazurigo Enterprises Ltd, a Mumbai Co that works together with the authoritative Indian Fibre Foundation has tested and confirmed ICOSEED's fiber of outstanding density,	Kirinyaga	Patrick Gatare Muriuki	-0.487494	37.304796
Kaigoro Star Women - Banana Value Addition	Agribusiness	GIA III	Kaigoro women group deals with value addition to bananas. The group uses banana flour to make banana crisps and cakes for sale.	Embu	Caroline Mbugua	-0.5481006	37.4613973
Kloppet Complete liquid foliar	Agribusiness	GIA III	The Kloppet Complete is an organic fertilizer that addresses soil acidity that was evident due to excess use of chemical fertilizers (intensive farming). Vunalot enterprises developed an innovative foliar product known as Kloppet Complete Liquid Foliar which is from assorted weed natural plant which include water hyacinth and adapted with a 25% chemical component to improvise on the NPK (nitrogen, phosphorus, potassium).	Nakuru	Nyingi Mungai Joseph	-0.711286	36.4341123
Green Charcoal	Energy	GIA III	Energy efficient kiln used to carbonize Mathenge tree (Prosopis juliflora) charcoal. Carbonized charcoal is crashed to add value. Natural binders are then used. The final product is a smokeless charcoal briquette which burns for more hours.	Garissa	Mohamed Abass Bulale	-0.444427	39.645838
Isiolo Women - Bone-Made Accessories	Waste Management	GIA III	This is a group of women who recycle bones from the slaughter house to make keyholders, necklaces, earrings, chains, curtain holders and cups. The technology has been tested and found to be effective by both local persons and tourists who buy their ornaments. Since 2014 they have made good sales of the beauty ornaments especially in festivals and expos and their products were very popular at each of these events.	Isiolo	Godano Tuke Dabelo	0.367456	37.581362
Kitui Enterprise Promotion Company	Agribusiness	GIA III	This project is aimed at addressing post-harvest loss, improving income and eradicating poverty among households in Kitui by adding value to the mango fruit. Kitui Enterprise particularly focuses on drying of mangoes and converting it into powder for various uses	Kitui	Crack Munyao	-1.376241	38.013576

Figure 3.12: Project Geodatabase table displayed in Google Fusion tables

NETFUND GIA Grants Disbursed

Imported at Mon Jun 5 01:16:29 PDT 2018 from Grants Disbursed.kml.
Add Attribution - Edited on 2018 June 11

File Edit Tools Help | Grants per county disbursed data | Cards 1 | Grants Map

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1-47 of 47

description	name	COUNTY3_	COUNTY3_ID	COUNTY	Grants	geometry
		2.00000000000	1.00000000000	Turkana	0	KML...
		5.00000000000	4.00000000000	Wajir	300000	KML...
		6.00000000000	5.00000000000	West Pokot	2000000	KML...
		8.00000000000	7.00000000000	Isiolo	2000000	KML...
		10.00000000000	9.00000000000	Elgeyo-Marakwet	1000000	KML...
		11.00000000000	10.00000000000	Trans Nzoia	5000000	KML...
		12.00000000000	11.00000000000	Bungoma	500000	KML...
		13.00000000000	12.00000000000	Garissa	6000000	KML...
		15.00000000000	14.00000000000	Kakamega	1000000	KML...
		20.00000000000	19.00000000000	Siaya	5000000	KML...
		21.00000000000	20.00000000000	Nakuru	1000000	KML...

Figure 3.13: Grants disbursed database displayed in Google Fusion tables

2. To geocode the project database, the column containing latitude and longitude data was set as the "location" type field enabling Google Fusion Tables to geocode the database based on the column and overlay the data on Google maps during visualization. For example, The GPS_Location_Latitude column in the "NETFUND GIA Project Database" table was marked as the "location" as shown in Figure 3.14.

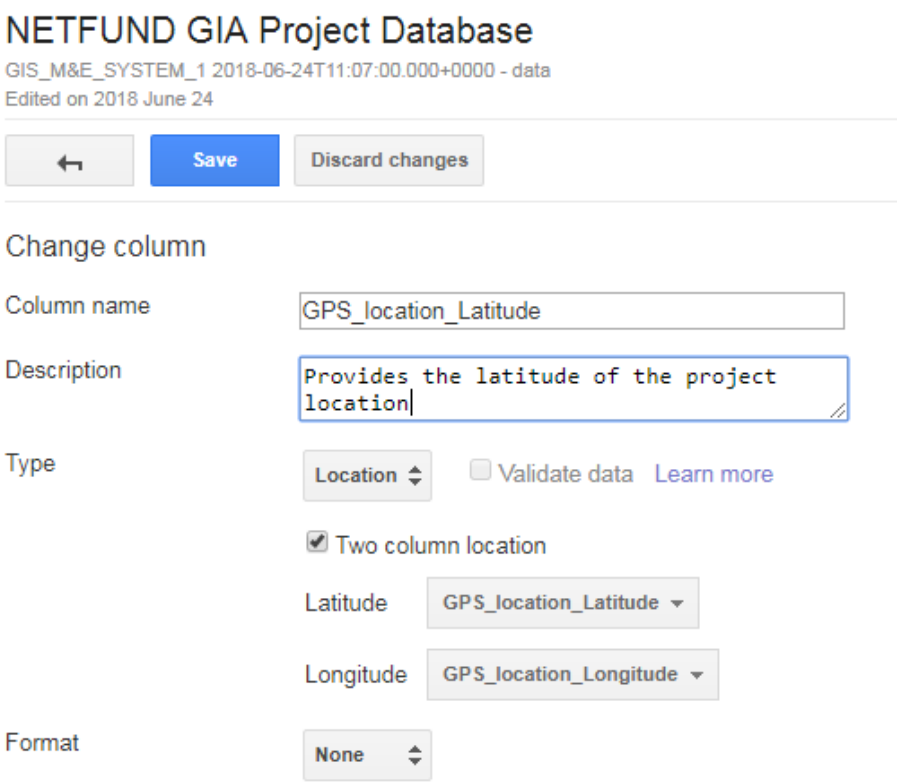


Figure 3.14 'GPS_location_Latitude' Field 'Type' set as "Location" in Google Fusion tables.

3. Visualization of the NETFUND-GIA geodatabase was conducted in the Google Fusion Tables to produce various map layers that were overlaid on Google maps as shown in Figure 3.15.

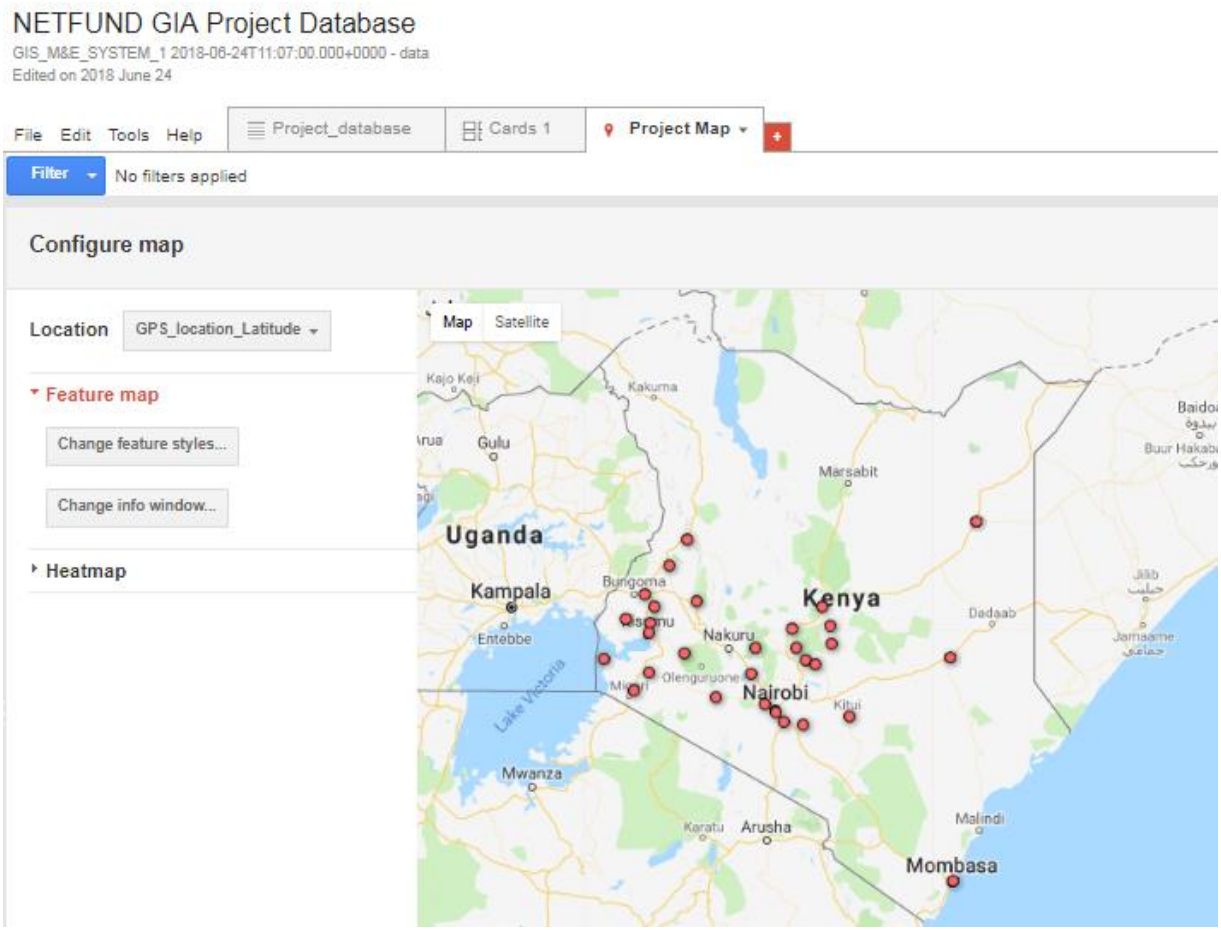


Figure 3.15: NETFUND GIA Project Geodatabase table as seen in Google Fusion Tables

4. The configuration of the information pop up window of the project marker icon was done to show the fields to be displayed in the windows whenever a user clicked on a marker icon on the map as shown in Figure 3.16 and Figure 3.17. Columns to be displayed on the information window were checked while those to be omitted were left unchecked.

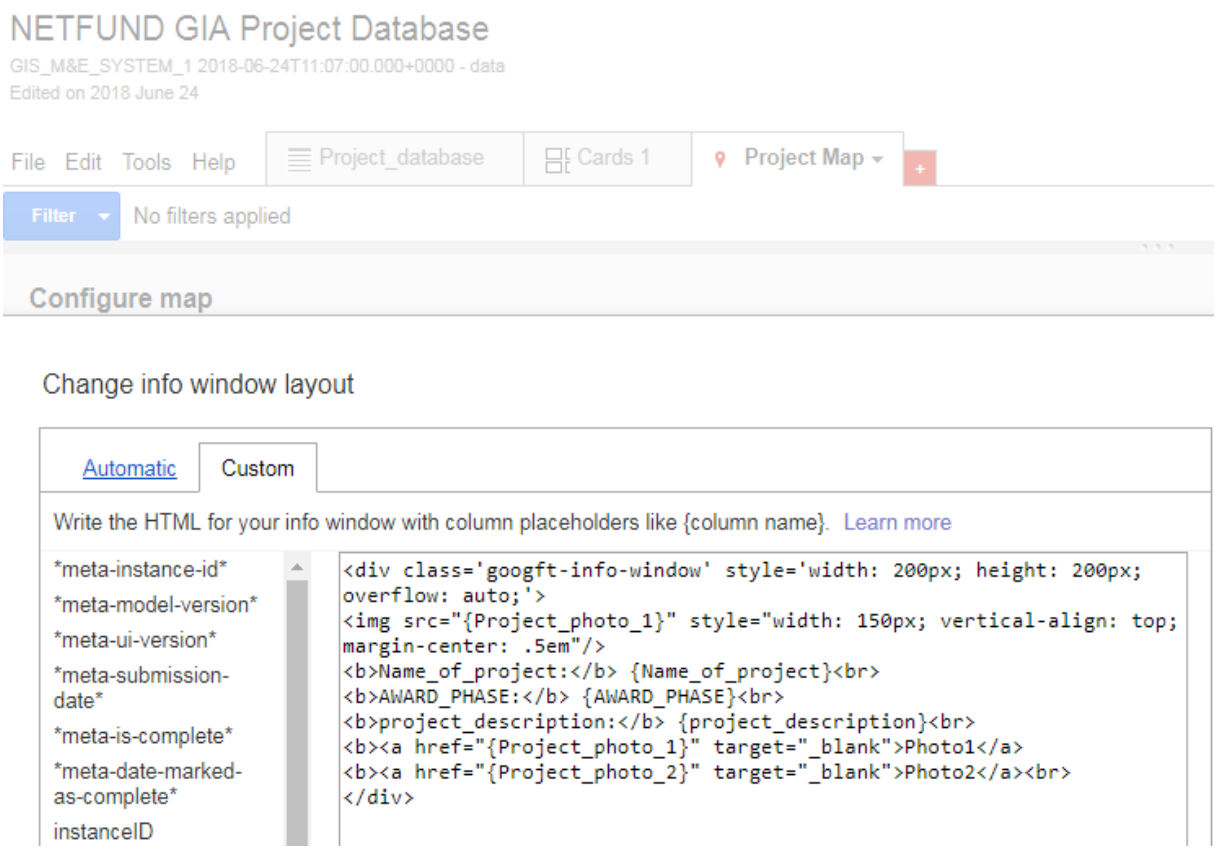


Figure 3.16: Custom editing of the Information pop-up windows using HTML code

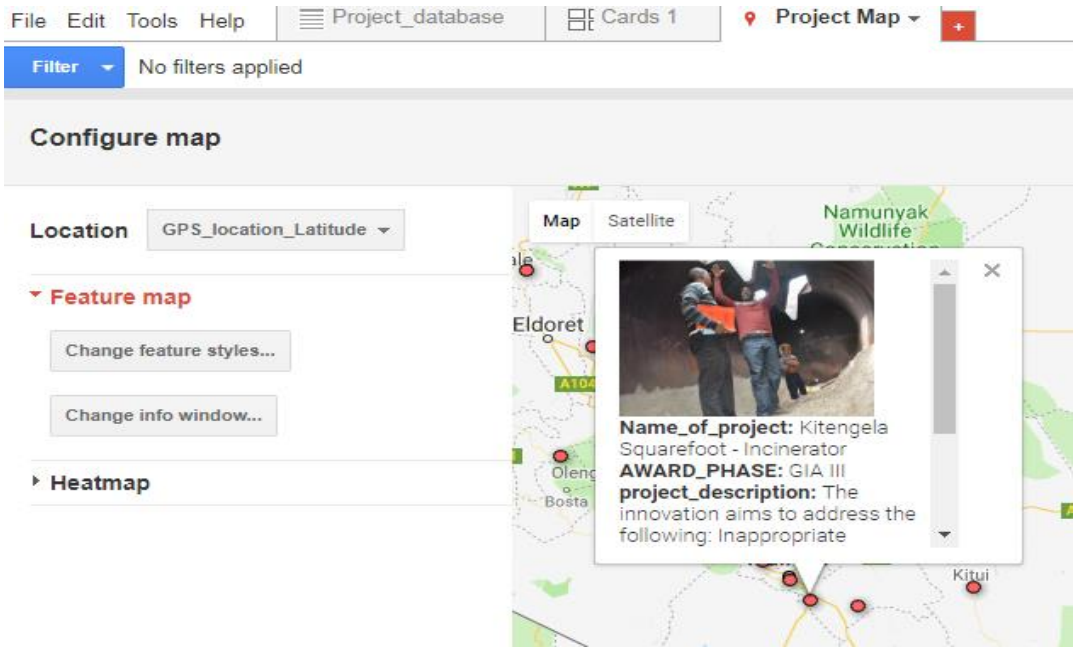


Figure 3.17: Displayed Information pop-up window based on edited HTML code

5. The map feature styles was defined in a column named 'Symbolization' and was selected in Fusion tables to apply styles on the visualized map marker icons as shown in Figure 3.18 and 3.19.

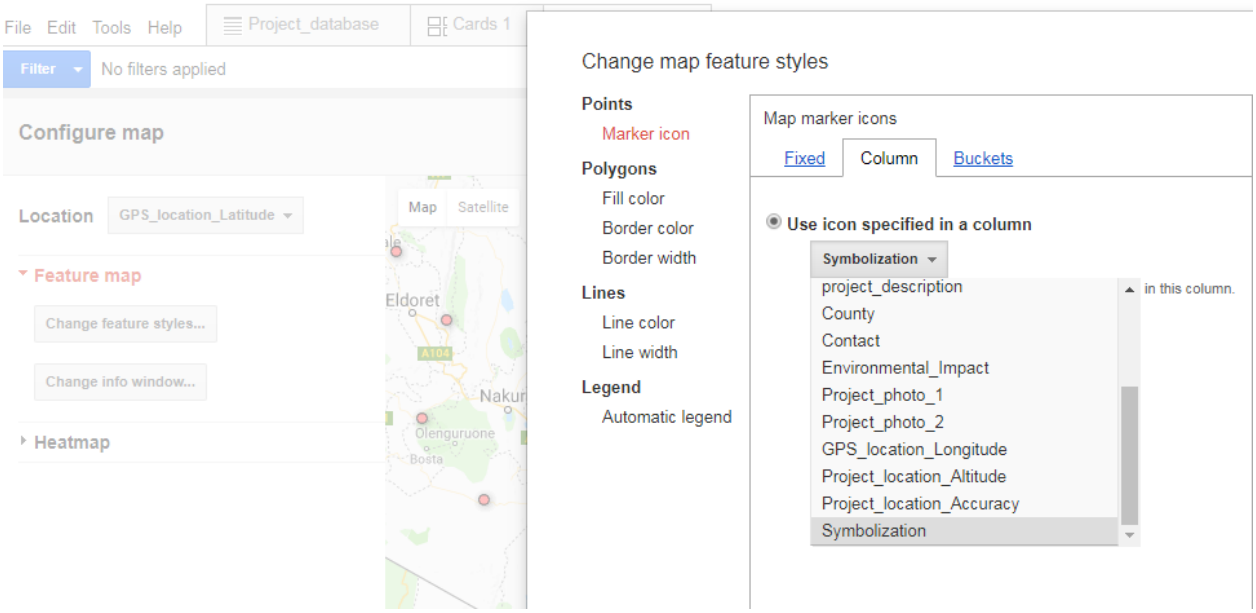


Figure 3.18: Map symbolization setting

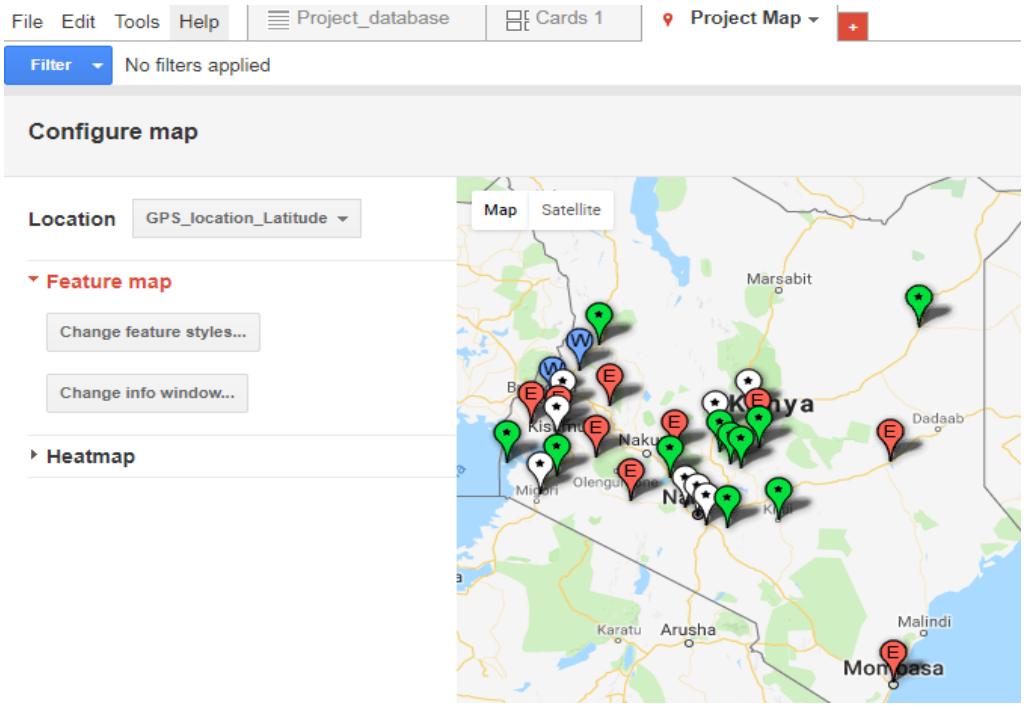


Figure 3.19: Configured map symbolization applied to visualized map

6. Impact data on green jobs and customers with access to green products was visualized in the form of charts and configured in Google Fusion Tables.

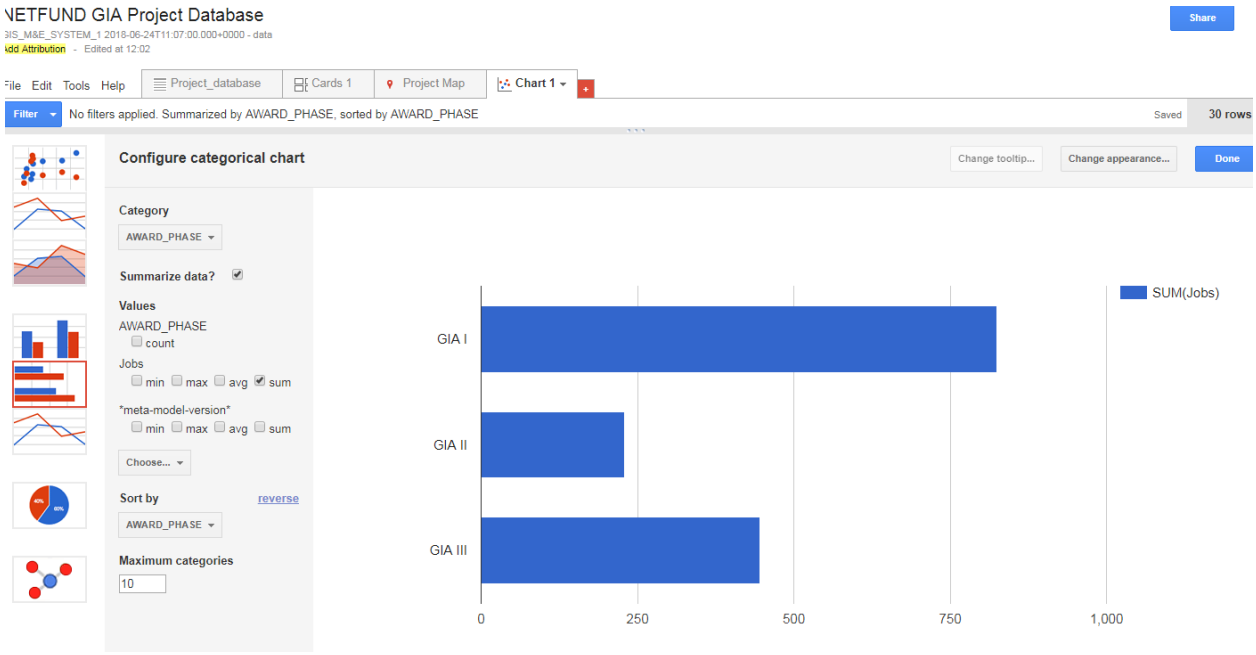
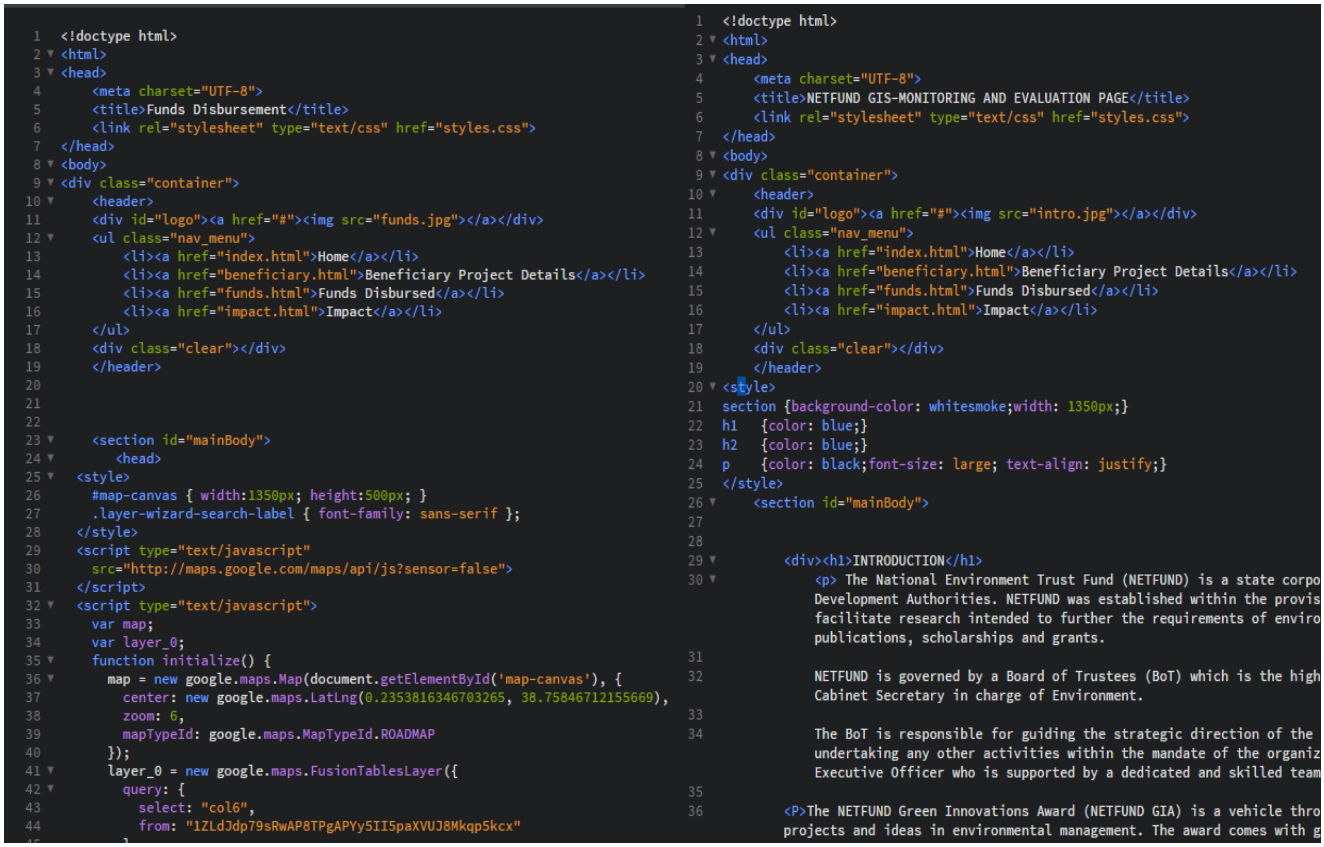


Figure 3.20: Impact Charts Configured in Google Fusion Tables

These procedures above were repeated for all NETFUND GIA Google Fusion tables' geodatabases to prepare them for the development of the web GIS portal.

3.6 Design of the NETFUND-GIA monitoring and evaluation Web GIS portal

The researcher made use of HTML, CSS and JavaScript to develop the web page view that the user will interact with when using the web portal. This was done using Brackets code editor. The search/query form was designed using HTML. The form enabled querying of the maps based on the criteria that the user selects. Each map or web page had a query form that provided different criteria. The visualized map layers was embedded on the portal web pages using Google Maps JavaScript API. The API also enabled implementation of the changing map type, map pan , scaling of the map and finally the zoom control.



```
<!doctype html>
<html>
<head>
    <meta charset="UTF-8">
    <title>Funds Disbursement</title>
    <link rel="stylesheet" type="text/css" href="styles.css">
</head>
<body>
<div class="container">
    <header>
    <div id="logo"><a href="#"><img src="funds.jpg"></a></div>
    <ul class="nav_menu">
        <li><a href="index.html">Home</a></li>
        <li><a href="beneficiary.html">Beneficiary Project Details</a></li>
        <li><a href="funds.html">Funds Disbursed</a></li>
        <li><a href="impact.html">Impact</a></li>
    </ul>
    <div class="clear"></div>
    </header>



    <section id="mainBody">
       <head>
  <style>
    #map-canvas { width:1350px; height:500px; }
    .layer-wizard-search-label { font-family: sans-serif };
  </style>
  <script type="text/javascript"
    src="http://maps.google.com/maps/api/js?sensor=false">
  </script>
  <script type="text/javascript">
    var map;
    var layer_0;
    function initialize() {
      map = new google.maps.Map(document.getElementById('map-canvas'), {
        center: new google.maps.LatLng(0.2353816346703265, 38.75846712155669),
        zoom: 6,
        mapTypeId: google.maps.MapTypeId.ROADMAP
      });
      layer_0 = new google.maps.FusionTablesLayer({
        query: {
          select: "col6",
          from: "1ZLdJdp79sRwAP8TPgAPYy5II5paXVUJ8Mkqp5kcx"
```

```
<!doctype html>
<html>
<head>
    <meta charset="UTF-8">
    <title>NETFUND GIS-MONITORING AND EVALUATION PAGE</title>
    <link rel="stylesheet" type="text/css" href="styles.css">
</head>
<body>
<div class="container">
    <header>
    <div id="logo"><a href="#"><img src="intro.jpg"></a></div>
    <ul class="nav_menu">
        <li><a href="index.html">Home</a></li>
        <li><a href="beneficiary.html">Beneficiary Project Details</a></li>
        <li><a href="funds.html">Funds Disbursed</a></li>
        <li><a href="impact.html">Impact</a></li>
    </ul>
    <div class="clear"></div>
    </header>
<style>
section {background-color: whitesmoke;width: 1350px;}
h1   {color: blue;}
h2   {color: blue;}
p    {color: black;font-size: large; text-align: justify;}
</style>
    <section id="mainBody">


        <div><h1>INTRODUCTION</h1>
            <p> The National Environment Trust Fund (NETFUND) is a state corpo
            Development Authorities. NETFUND was established within the provis
            facilitate research intended to further the requirements of enviro
            publications, scholarships and grants.

            NETFUND is governed by a Board of Trustees (BoT) which is the high
            Cabinet Secretary in charge of Environment.

            The BoT is responsible for guiding the strategic direction of the
            undertaking any other activities within the mandate of the organiz
            Executive Officer who is supported by a dedicated and skilled team

        <P>The NETFUND Green Innovations Award (NETFUND GIA) is a vehicle thro
        projects and ideas in environmental management. The award comes with g
```

Figure 3.21: Brackets User interface used in the development of portal.

The web GIS portal constituted of:

- The web portal banners: The banners were designed using Adobe Photoshop and exported to JPEG format. The banners provided a header for each web page and represented the brand colours of NETFUND.
- The navigation tabs: This are found below the web page banner provide navigation capability to the user to explore the portal and interact with the visualized data
- The Map canvas: This is the area visualizing the maps and layers based on what the user has selects on the query form.
- The footer: The footer provided a copyright tagline as shown in Figure 3.22 and additional information for downloading navigation application, which can be found in the bottom right corner of the 'Home Page'.

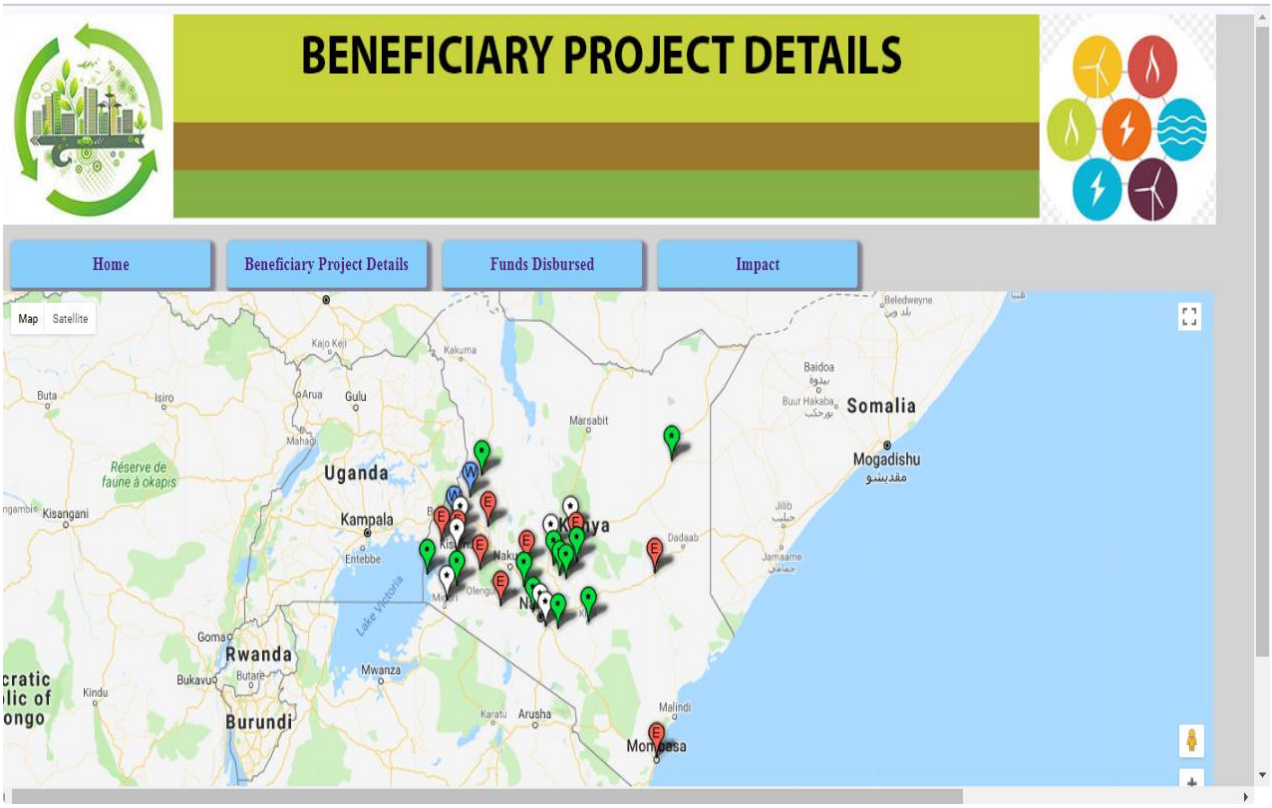


Figure 3.22: The web page view of the NETFUND GIA GIS-M&E Portal

3.6.1 Search and Query Functionality

Search and query functionality is provided in the portal. This function is located at the bottom left of the web page and was created utilizing HTML code as attached in Appendix 1. The search was set mainly to give a single field/criteria inquiry. Multi-field search capability was not implemented in this system and provides an opportunity for future development into the system. The form providing the search capability was created in all the web pages containing maps to allow client to choose pre-set options to avoid mistakes when the client is typing in the contents of the inquiry as appeared in Figure 3.23.

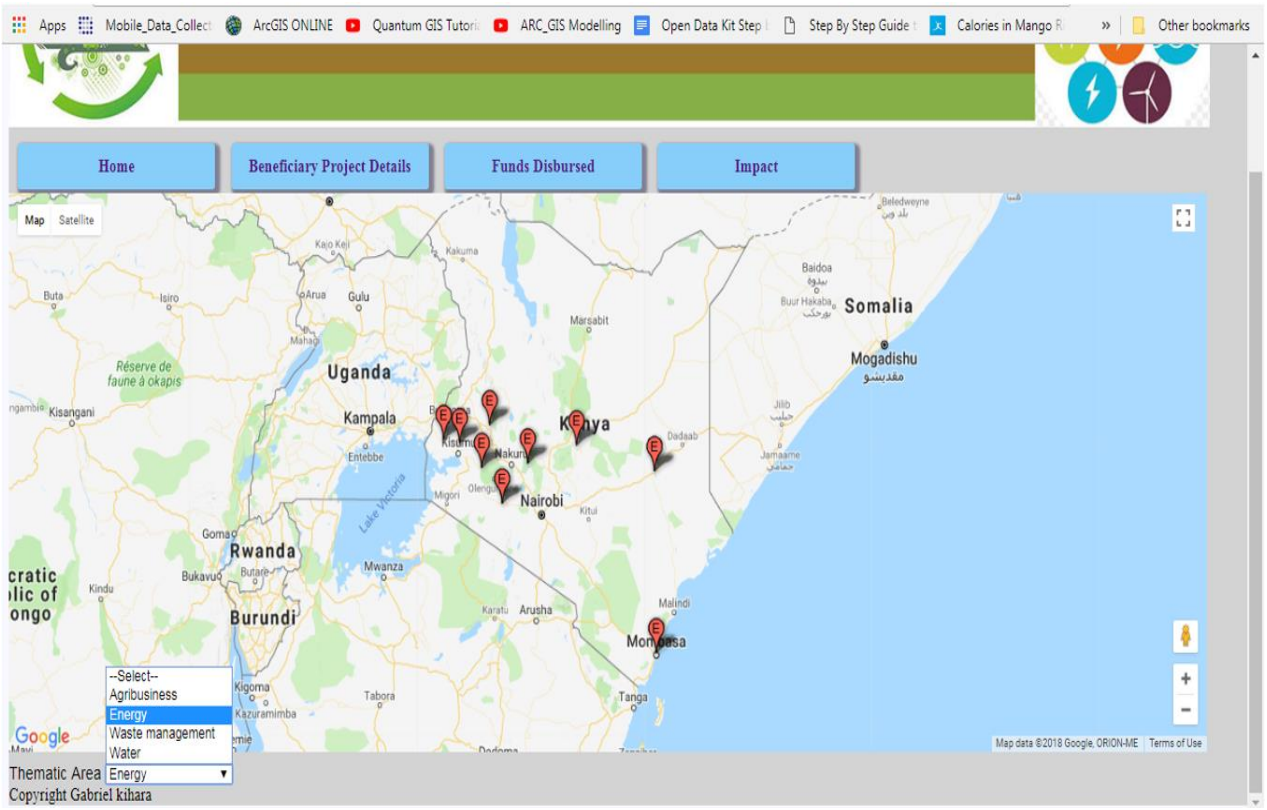


Figure 3.23: Query and Search functionality initialized on beneficiary page

3.7 Design and Development of Navigation Application

The navigation application was developed using Google Maps JavaScript and utilizes the Google application infrastructure. The maps were imbedded in the mobile application using Google API this enabled visualization and rendering of in the mobile application. Buttons and initiation command were designed and coded using MIT App inventor. This is a user-friendly mobile app development platform see Figure 3.24 and 3.25.

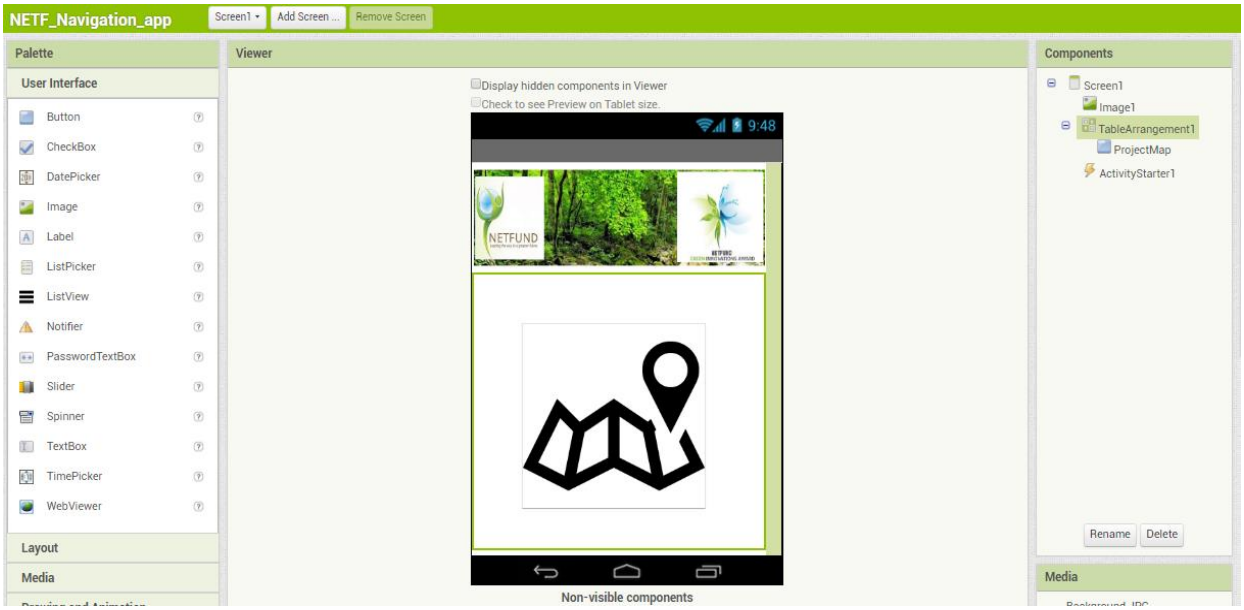


Figure 3.24: User Interface development for Navigation application in MIT app inventor

Figure 3.25: Block Coding of NETFUND Navigation application

The completed application was compiled and downloaded using the MIT app inventor platform as seen in Figure 3.26.

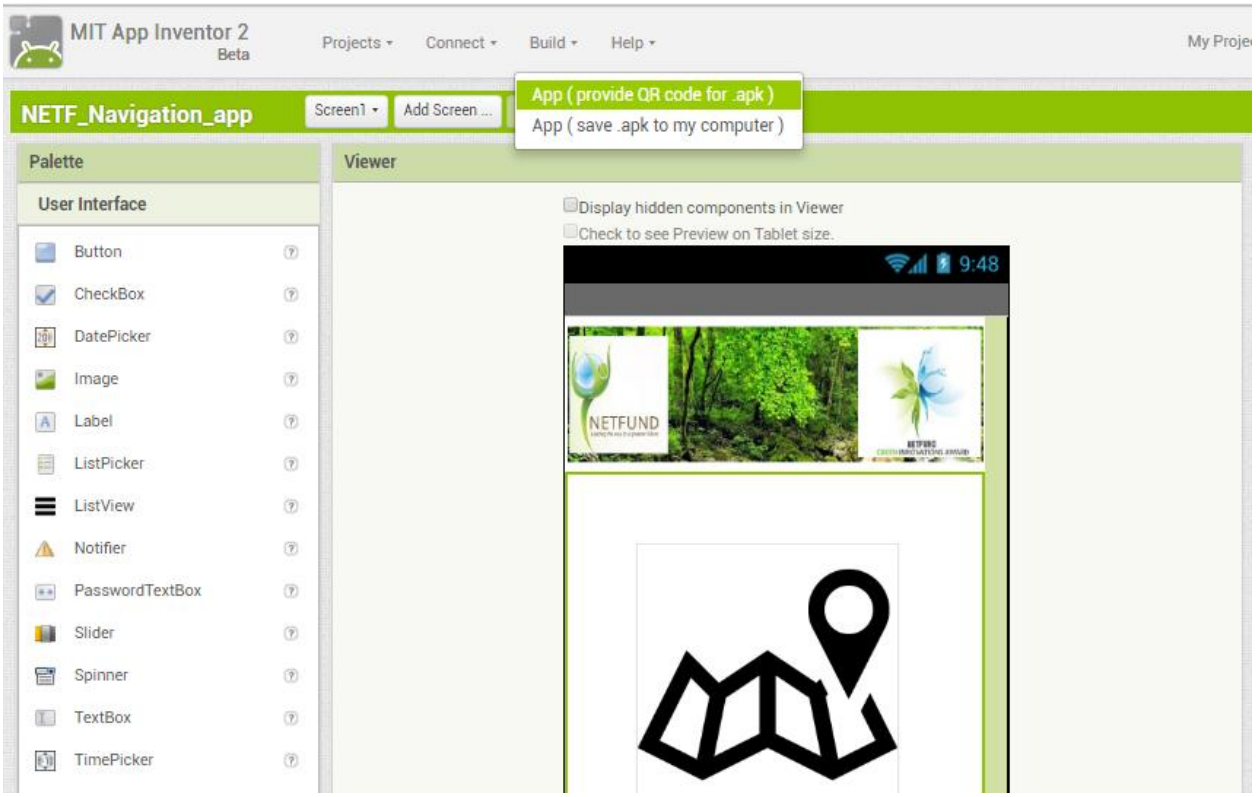


Figure 3.26: Compiling and downloading the Navigation Application

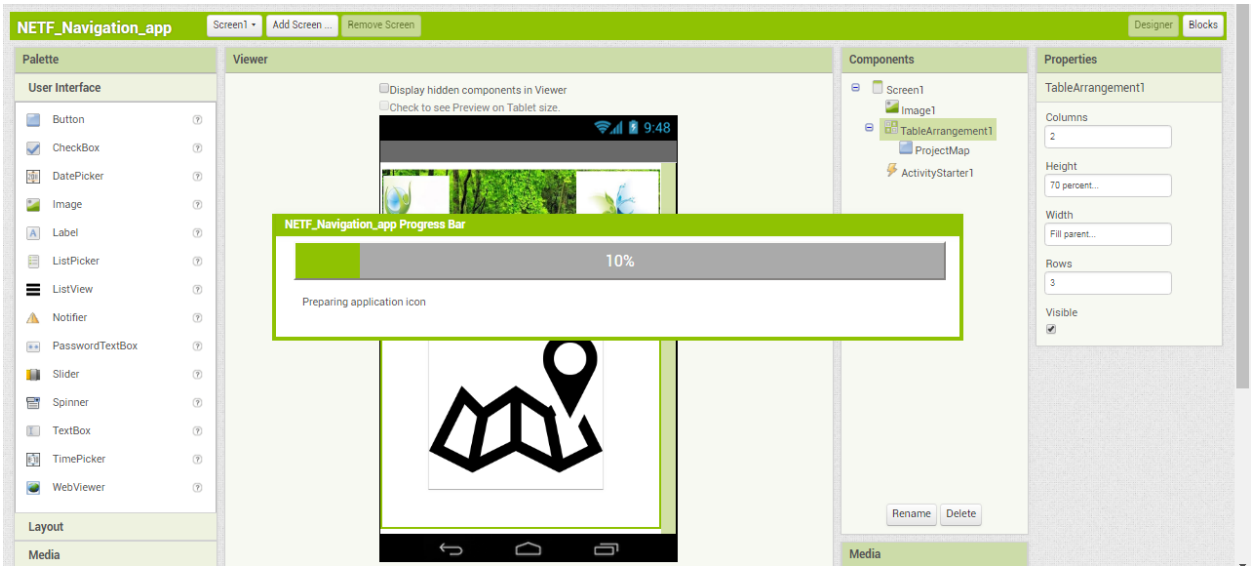


Figure 3.27. App inventor Compiling application

Once the application is installed (see Figure 3.28), it provides fast access to the NETFUND-GIA Project geodatabase by using the Google Maps API. It provides a user with the project geodatabase and attribute data of each project and its location and utilizing the google, navigation features as seen in Figure 3.29.

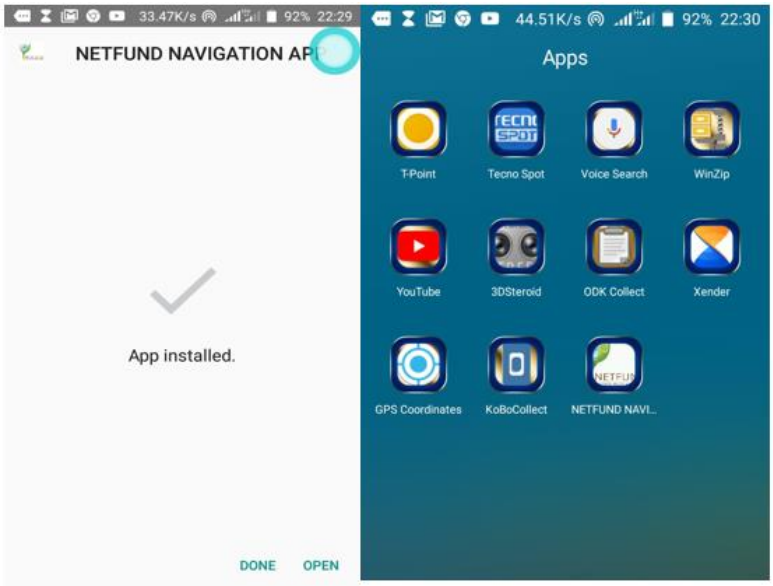


Figure 3.28: Installation of Navigation application in android phone

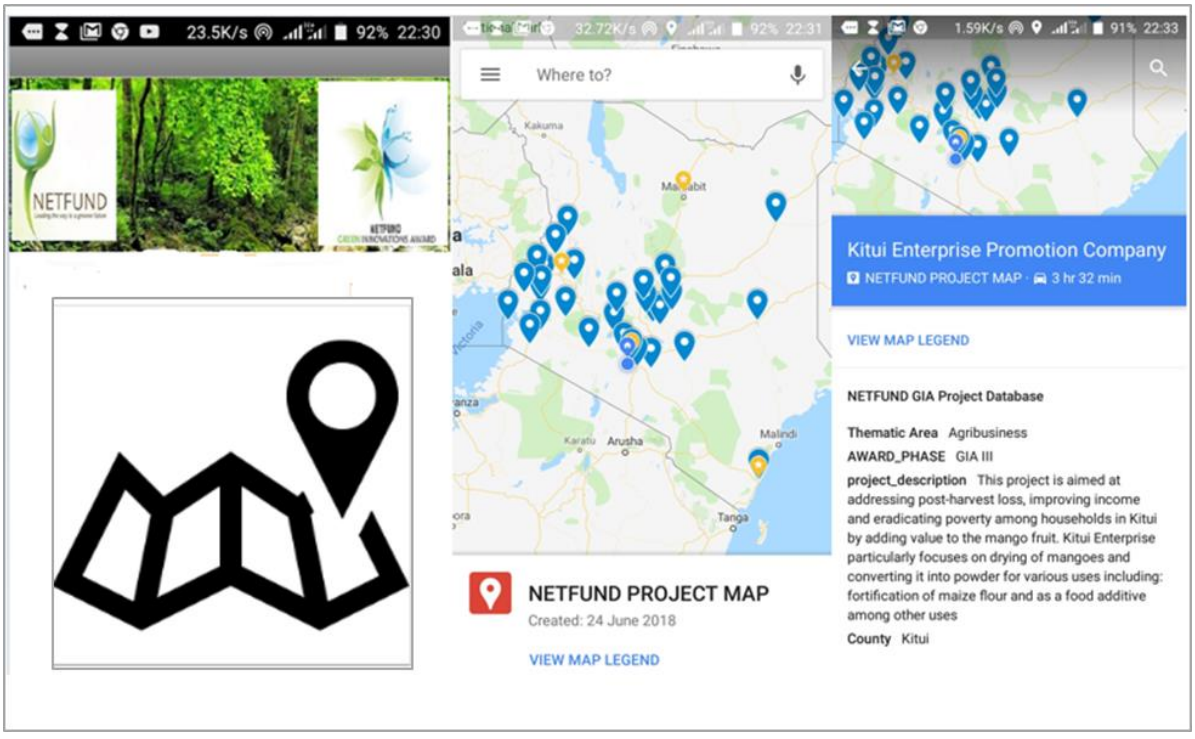


Figure 3.29: Navigation mobile application user interface showing the geodatabase and attribute data together with the estimated time of arrival to the project location

3.8 Testing of the Developed Applications and Feedback

This link, https://ql2gmnmhvkpt3vp6idtj6q-on.drv.tw/GIS_portal/ , to the developed application was shared to the staff to test the system. Mobile navigation application and data collection application was installed to their phones. The staff were given 3 days to test the applications. The researcher made face-to-face follow-ups on their feedback on the applications and their response were recorded.

On the web portal, the staff noted that due to its accessibility online it was easy for information dissemination to the entire organization. The maps and graphical representation of data was praised due to its interactivity and easy to understand pop-up information windows. The querying capability integrated in the system was noted to be helpful and enabled the staff to know how many projects are in each thematic area and their distribution countrywide. This also provided an opportunity to know which type of innovations dominate which regions however, they requested that further enhancement be done to enable multi criteria querying.

The staff found the data collection mobile application was user friendly and easy to use with little training needed. The ability to collect real time data made mobile application to be accepted easily. The staff also noted that the presentation of collected data in tabular format provided a clear overview of the beneficiaries whose data has been collected and provides an overview of the overall data collection progress by the M&E team.

The navigation application was pilot tested with transport staff to visit two beneficiaries near Nairobi. The staff found it to be useful due to its precise location and direction information. The additional beneficiary information in the application was noted to be a big advantage especially with staff and partners who are not aware of the beneficiary details and description hence enabling them to easily familiarise with the projects being visited.

4. RESULTS AND DISCUSSIONS

4.1 NETFUND GIS-M&E Systems

The results of the development exercise of the systems that were under investigation was the mobile application for data collection, an interactive Web based M&E-GIS portal and a mobile navigation application. The products utilized geo-referenced NETFUND GIA programme data for the production of several interactive map products and graphical visualization depicting NETFUND GIA programme spatial distribution.

4.2 Data Collection Application

The mobile data application is made up of the ODK aggregate server deployed and hosted in Google Cloud Platform. This platform acts as the application engine and provides storage of data collected by ODK collect. ODK aggregate also hosts all forms, developed by ODK Build and converted to XLS or XML format, that are uploaded to it. This enables ODK collect to fetch the form for data collection as shown in Figure 4.1. The form for data collection enabled capturing of text data, numerical data, Location data and Images as seen in Figure 4.2. Once the user completes data collection it is saved in the device until an internet connection is established to which all filled forms can be submitted to the aggregate server. The aggregate server enables publishing of this data to Google Fusion Tables for Further analysis and online publishing.

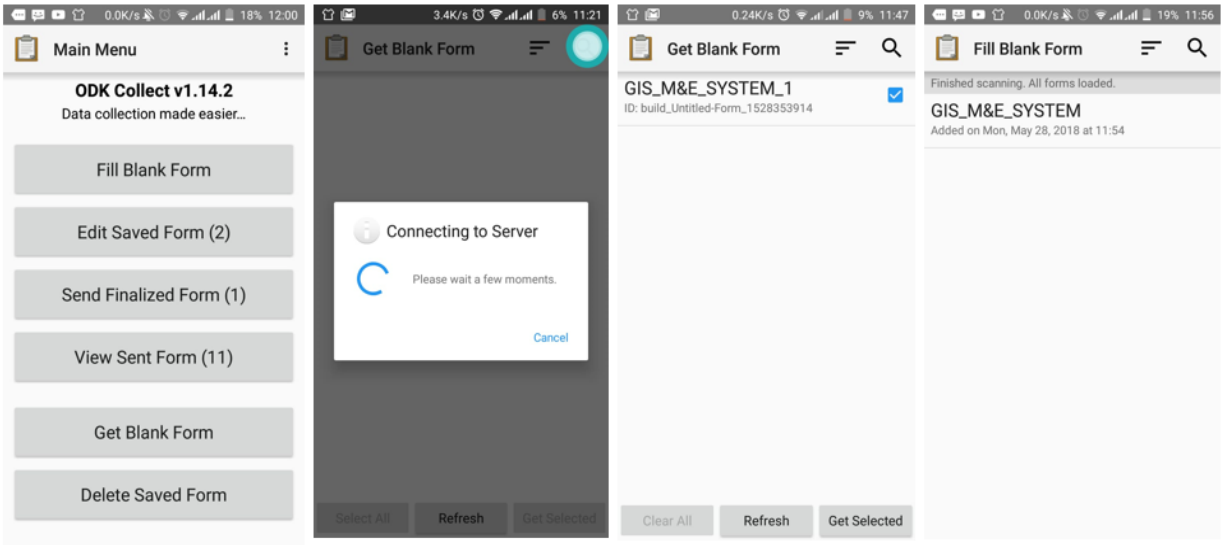


Figure 4.1: The ODK collect user interface enables fetching of the developed form and data entry of collected data

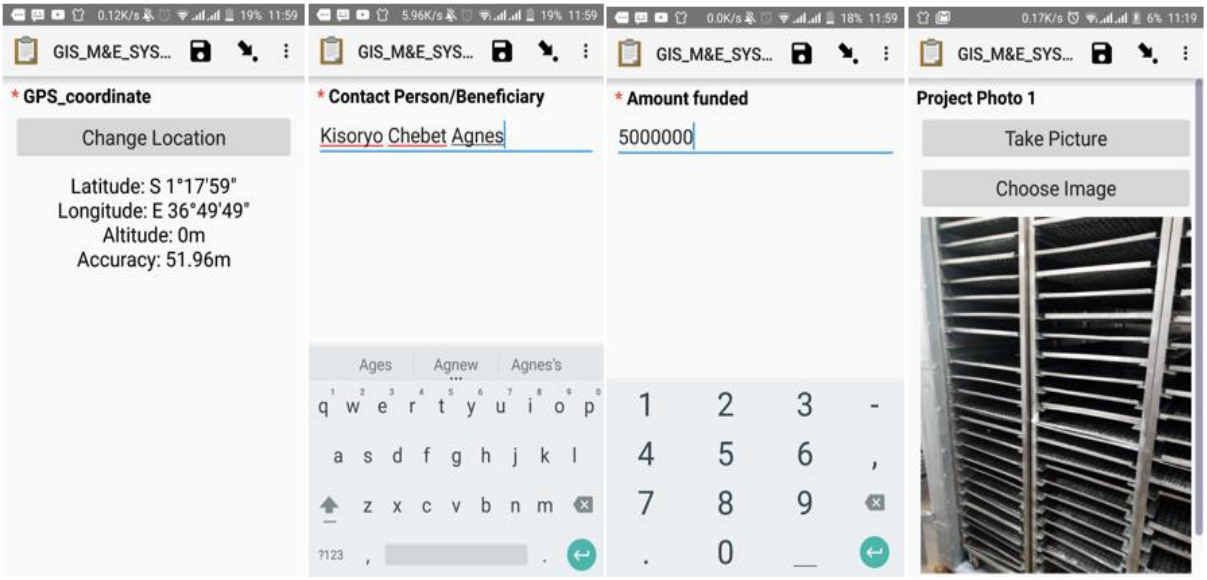


Figure 4.2: Mobile form capability of collecting Locational, text, Numerical and Image data

4.3 NETFUND GIS-M&E Client Web Page View

The portal comprised of a geo-database hosted in Google Fusion Tables that provided backend functionalities for the portal. The client end provided four web pages that enable users to interact with the maps. The portal pages included The Home page, Beneficiary Project Details page, Funds Disbursed page and Impact page.

4.3.1 Home Page

This page is the landing page for the GIS M&E portal it provides a brief introduction of NETFUND and the NETFUND GIA programme and proceeds to give you details on the use of the portal. At the top of the Home page, navigation tabs were included to enable users' access the other pages as portrayed in Figure 4.3. Users are also provided with a dashboard that gives the individual and overall progress of projects to enable monitoring and tracking of project progress as shown in Figure 4.4. When the user hovers on the charts, an information window appears providing details of the chart in this case the progress of individual projects or the number of projects on-progress, behind schedule or closed.

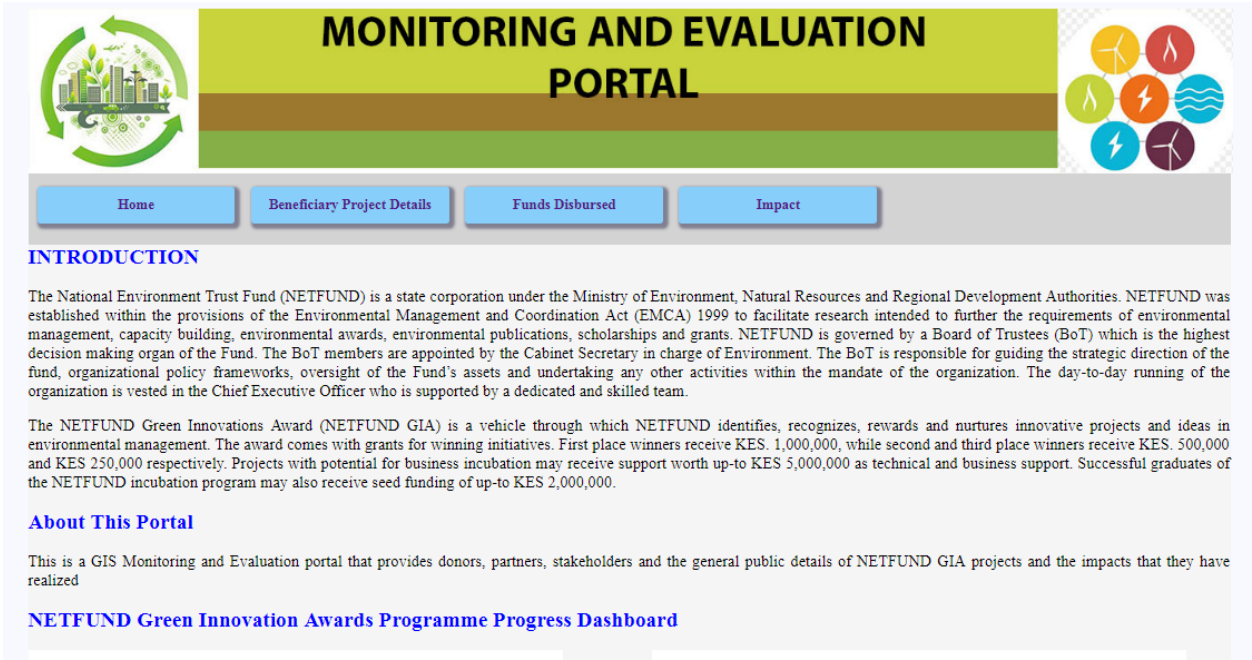


Figure 4.3: Home page, which acts as the landing page to the portal

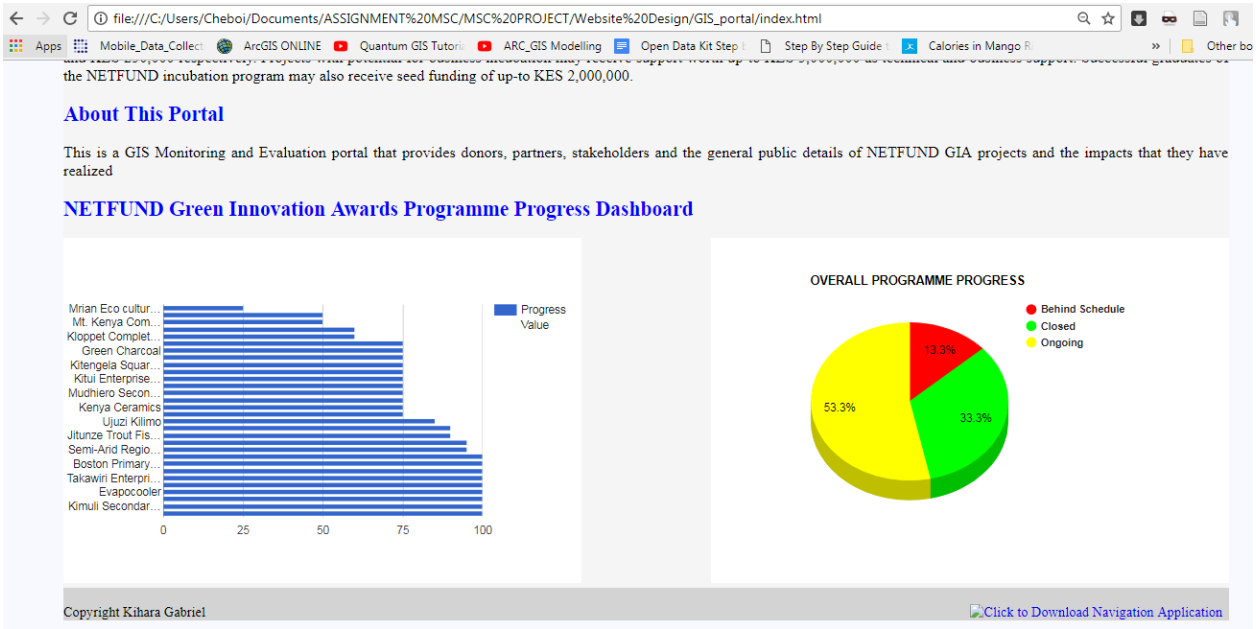


Figure 4.4: Home page showing project progress and overall programme progress

4.3.2 Beneficiary Project Details page

This page presented a map of beneficiaries supported by the NETFUND GIA programme as shown in Figure 4.5. The place markers on the map showed the geographic location (latitude and longitude co-ordinates) where a beneficiary project was located based on the data recorded in the geo-database. The markers could also be used to differentiate the projects thematic areas and enhanced visual interpretation of map information as appeared in Figure 4.5. The marker symbols on the map depicted the geographic location (latitude and longitude co-ordinates) where a beneficiary was located based on the geo-database data. The marker symbols also provided a means to differentiate the beneficiaries' thematic areas and enhanced visual interpretation of map information.

Each marker icon represents a single project on the ground. When the marker icon was clicked, it provided an information window with the project images and details of the project. The information window also enables the user to scroll using the scroll bar to for them to the information provided. The page also has a search capability that enables querying the geodatabase per thematic area. This query hides all the other marker and only displays the projects as per search query as shown in Figure 4.6. The user is also provided with the capability of changing the map type (see Figure 4.7) and controllers to perform zooming of the map and panning the map to a desired position enabling further interaction with the map. The zoom is located at the lower right corner of the Beneficiary Project Details webpage and map type at the upper left corner of the same web page. The pan capability was enabled by holding the left mouse button while the pointer is on the map. The page also provided navigation tabs to enable users to navigate to other pages in the portal.

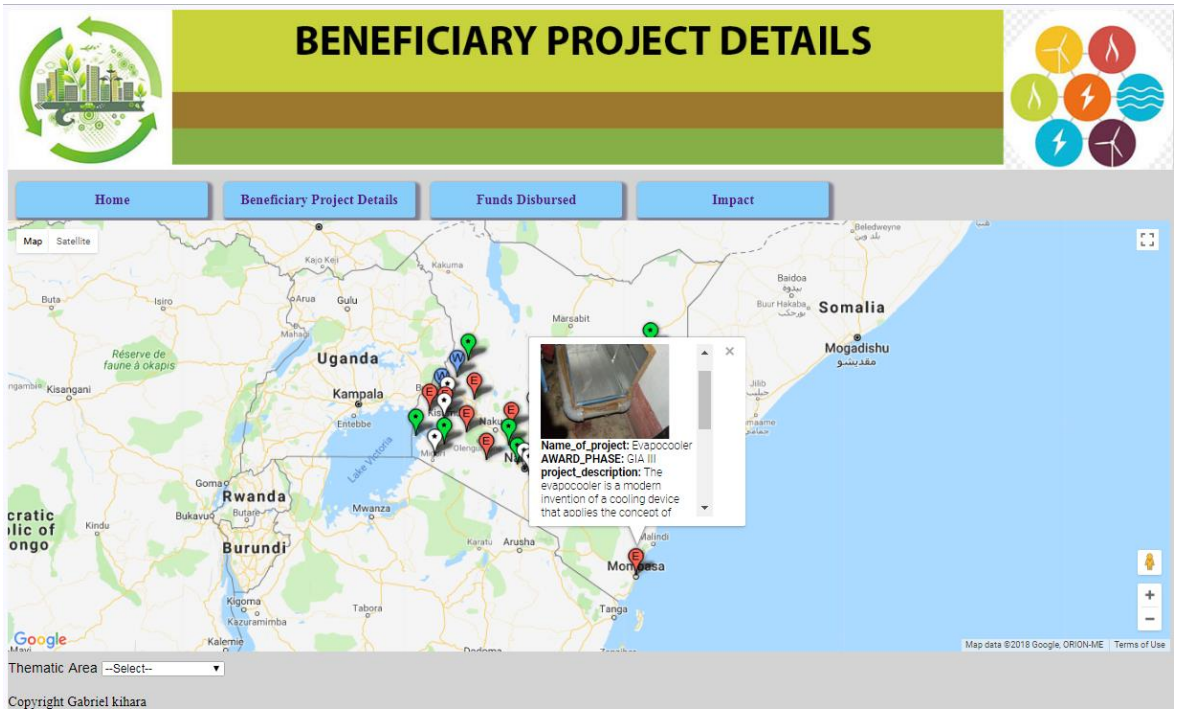


Figure 4.5: Beneficiary Project Details Page - Information Window showing project information

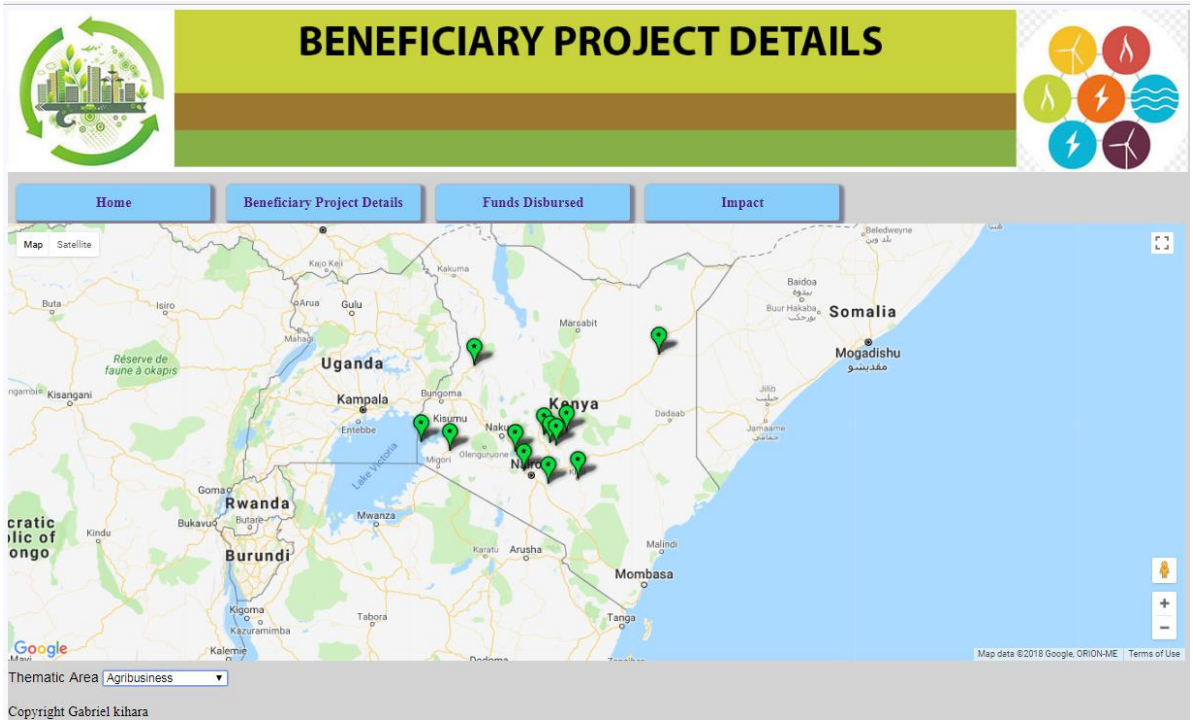


Figure 4.6: Beneficiaries project details Page: Thematic Area results query

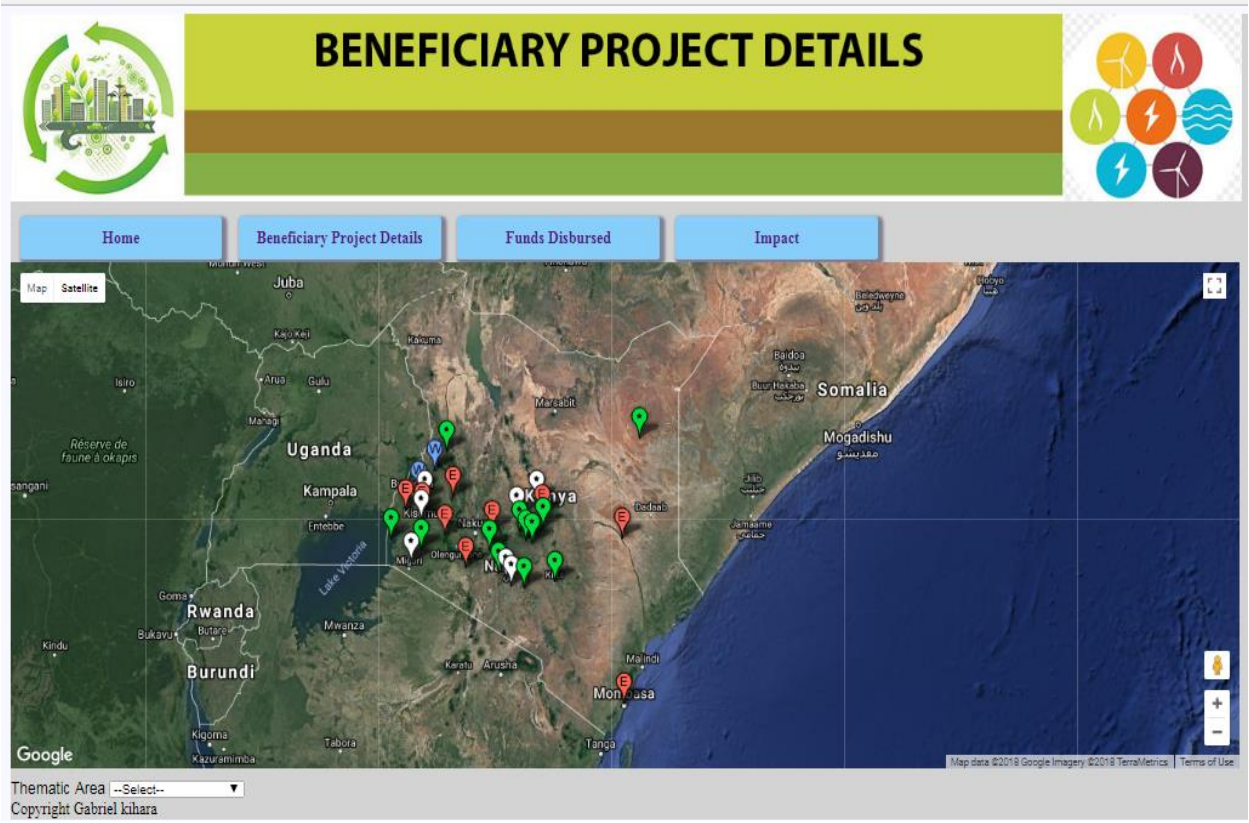


Figure 4.7: NETFUND Beneficiaries Project map based on Satellite Imagery Map Type

4.3.3 Funds Disbursement Page

The page shows distribution of disbursed funds by County (see Figure 4.8). The user interface enables user to click inside the boundaries of a county shapefile to reveal a pop-up window showing information of the Funds disbursed. The user was also provided with a search form located . The form had all the counties of Kenya as the pre-set criteria of which a user could select as shown in Figure 4.9. When a user selected a county in the form, the selected would then be displayed to show the underlying NETFUND disbursement data and all the other counties not selected will be hidden. The user was also provided with the zoom controller, and pan mouse functionality on the map area to enable them interact with the map as stated under the Beneficiary Project Details page. The Navigation bar at the top also enabled users to navigate to other pages on the portal.

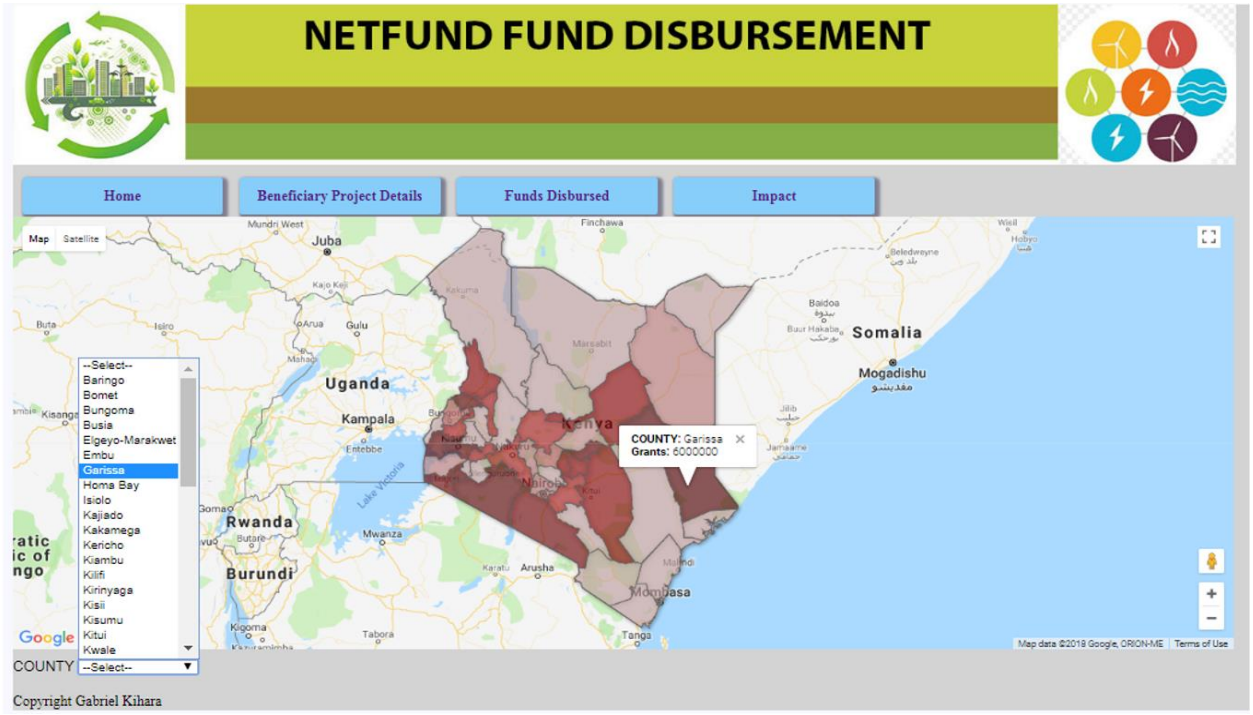


Figure 4.8: Fund Disbursement page displaying a queried County

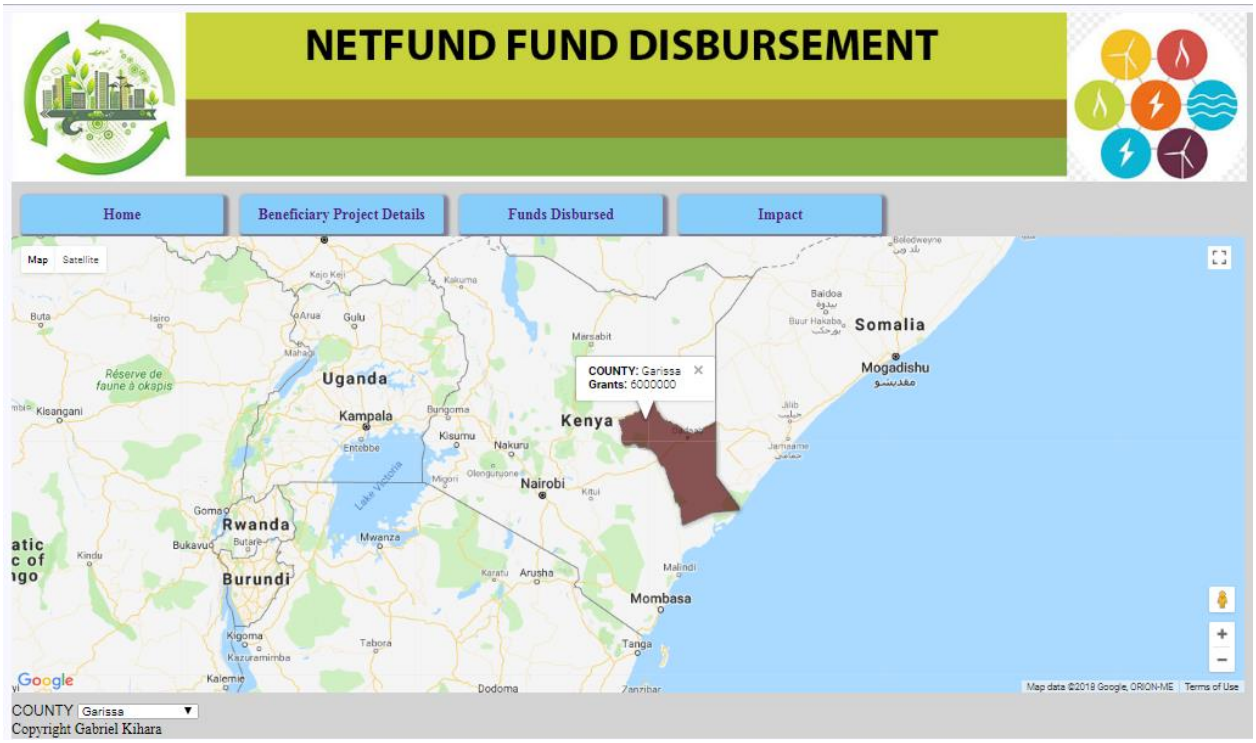


Figure 4.9: Queried results of selected county in this case Garissa County

4.3.4 Impact Page

The Impact page shows the spatial distribution and graphical representation of NETFUND GIA intervention impact. It provides a map that shows distribution of jobs created by NETFUND GIA beneficiary projects by county (see Figure 4.10). The map can also be searched through the query form at the bottom of the map to select the county of interest and display details of green jobs created in that county when clicked within the boundaries of the county. The page also provides graphical representation showing customers with access to green products (see Figure 4.11) and aggregated jobs created as per each Award Cycle and the baseline before the intervention (see Figure 4.12). These graphs are interactive and when the user hovers on the bars, a pop up window opens providing information of that respective bar of the graph. An additional impact table can also be seen at the end of the page providing side-by-side comparison of the impacts achieved by the project. It also has a scroll bar on the right enabling users to scroll down and see the cumulative impacts of the beneficiary projects in other counties.

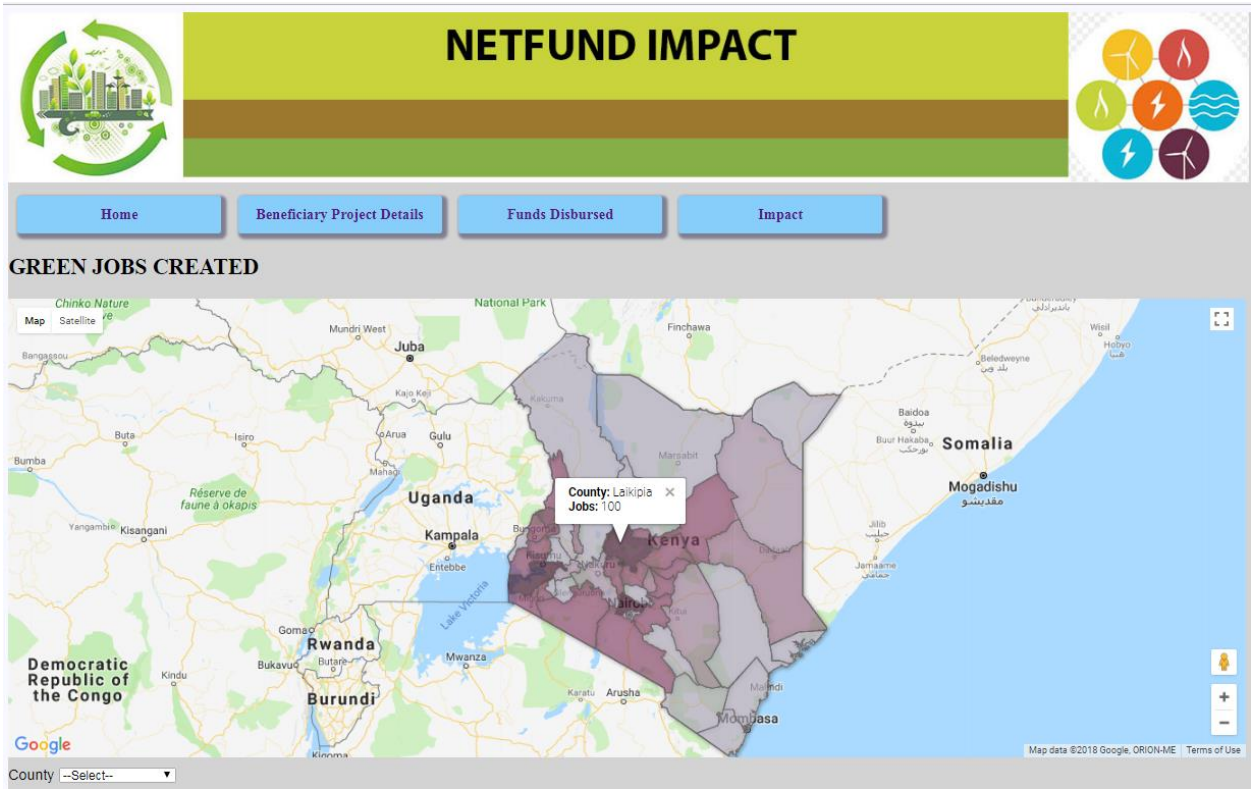


Figure 4.10: Impact page displaying a map of distribution of jobs created by County

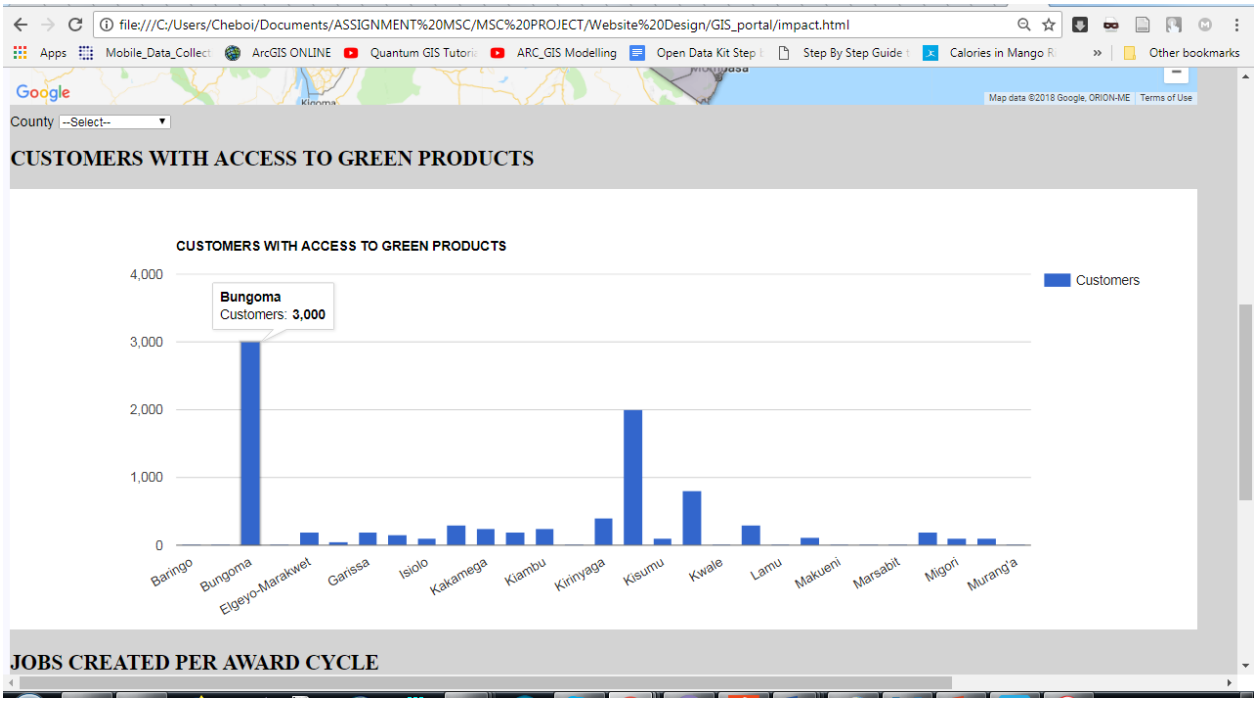


Figure 4.11: Impact page showing graphical representation of customers with access to Green Products

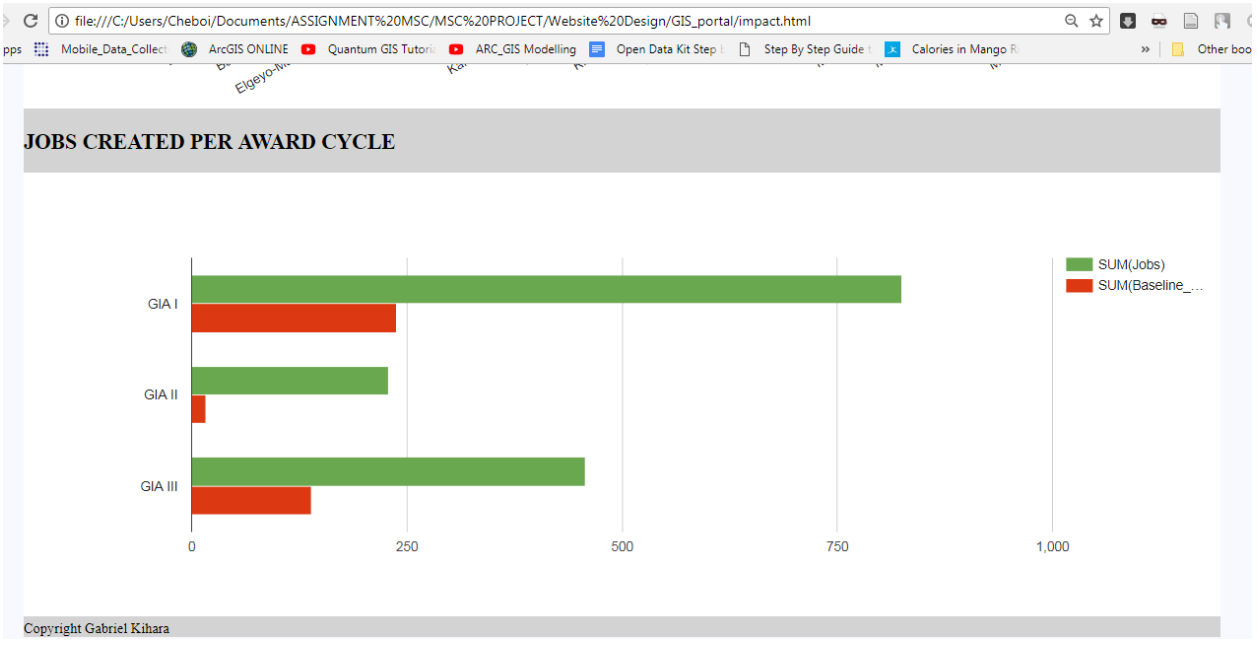


Figure 4.12: Impact page displaying Jobs created per Award Cycle and baseline jobs before the intervention

IMPACT TABLE

County	Jobs Created	Access to Green Products
Trans Nzoia	40	3050
Bungoma	20	3000
Kisii	20	2000
Kitui	7	800
Kirinyaga	10	400
Nakuru	4	360
Narok	20	300
Laikipia	100	300
Kajiado	20	300
Nyandarua	20	250
Kiambu	700	250
Kakamega	24	250
Siaya	23	204
Elgeyo-Marakwet	10	200
Meru	20	200
Kericho	5	200
Wajir	5	200
Garissa	10	200
Nyeri	20	150
Homa Bay	82	150
Tharaka-Nithi	22	150
Machakos	27	120
West Pokot	25	120
Nairobi	3	100
Mombasa	4	100

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Figure 4.13: showing impact table as seen in the system

4.4 Navigation Application Features and Functionalities

The android navigation application can be downloaded at the bottom left of the home page (see Figure 4.14). The application once installed and opened, the users are provided with a navigation icon. When the icon is clicked, it takes users to the NETFUND-GIA project map containing details of the project. When the user clicks an icon on the map, they are provided with two options, which is to get more information of the selected location or to get direction. When the user clicks 'MORE INFO' window comes up with the information of the project. When the user clicks 'DIRECTIONS' and their mobile GPS is on, a line is plotted along the shortest route on the map from the location of their device to the project location. It also provides the distances and estimated time of arrival to the destination of the project as shown in Figure 4.15. When the user is in the direction window, they are provided with 'STEPS&MORE' and 'START' buttons.

If the user clicks, steps and more they are provided with a graphical representation of the traffic on the route of choice and detailed systematic instructions. When the user clicks 'START' the application uses google voice to provide vocalized direction as the user moves towards the project destination as shown in Figure 4.16.

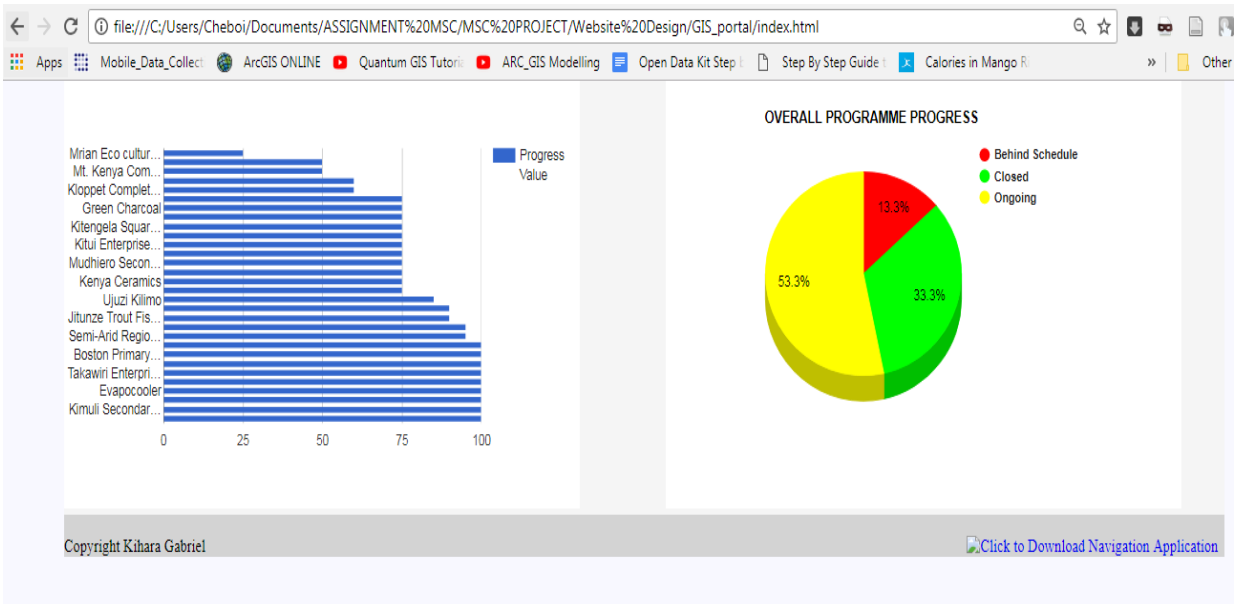

Figure 4.14: Navigation application link at the bottom right of Home Page

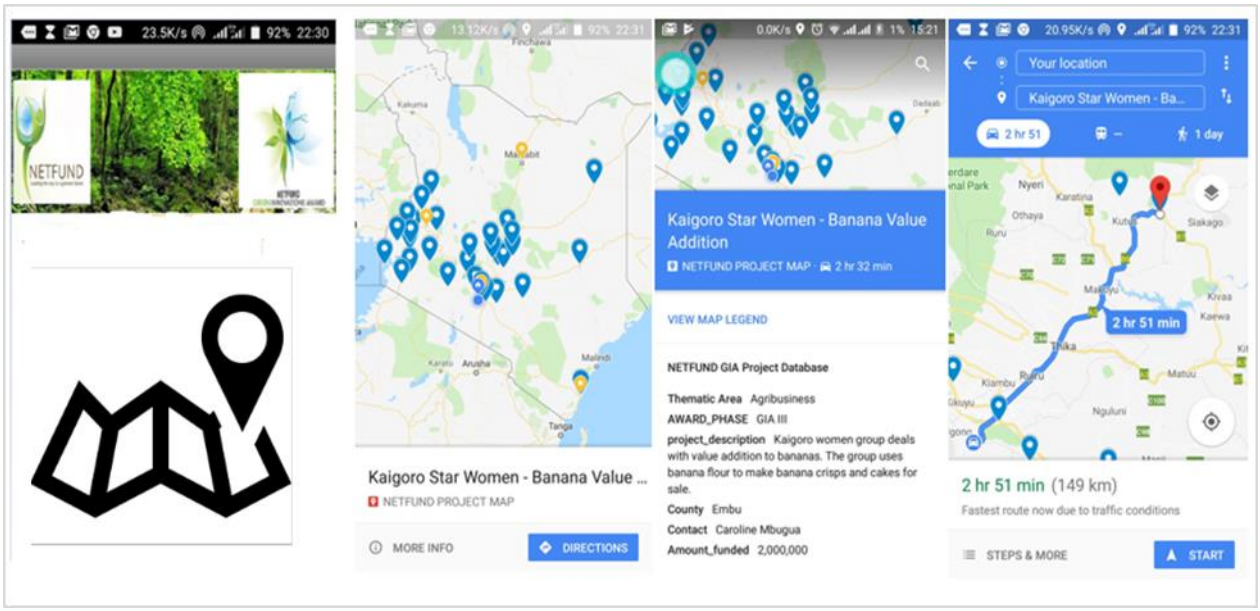

Figure 4.15: User Interface of the Navigation application showing project map, project details and navigation route

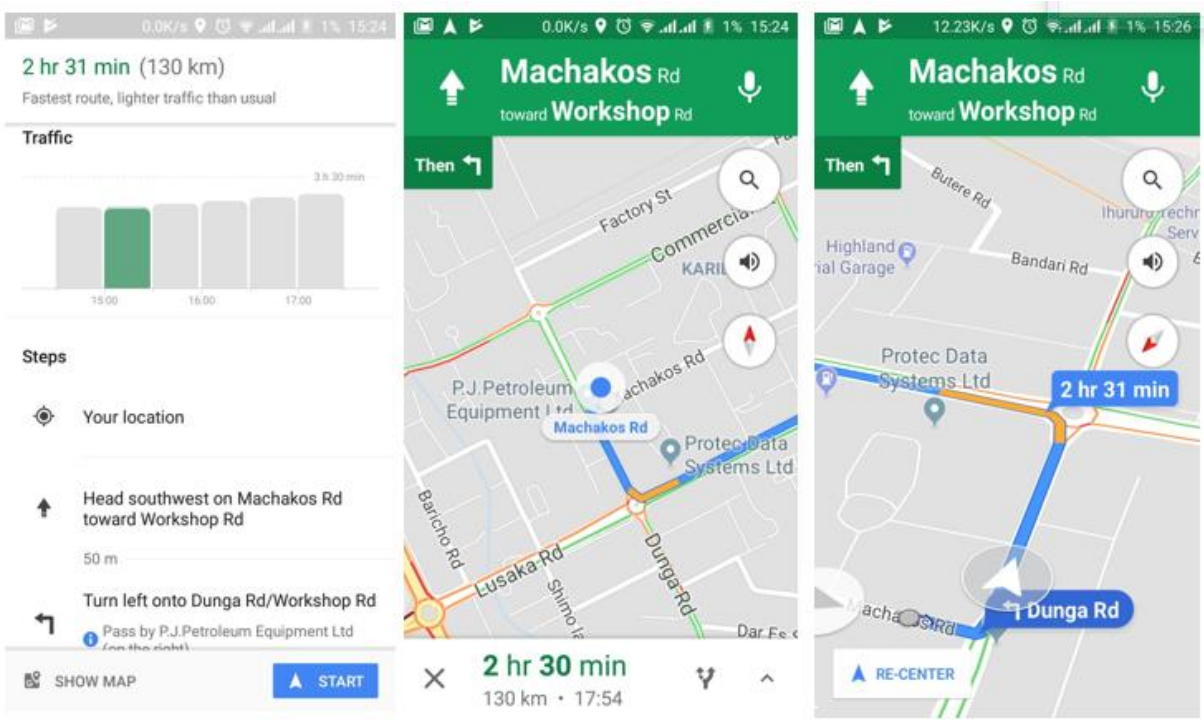

Figure 4.16: Navigation application providing details of the route traffic and systematic text direction and a voiced direction by Google voice as the user moves towards the destination

4.5 Discussions of the Results

Developing countries such as Kenya continue to face challenges in running effective monitoring and evaluation specifically for environmental projects (Chesos, 2010). The Kenya Social Protection Review Report (2012), states that M&E in Kenya is we ak and information obtained from such exercise is not made public for replication of best practices. Monitoring and Evaluation as a subset of Management Information System ensures regular collection and analysis of data to assess the relevance of a programme's including its objectives, effectiveness, impact, efficiency and sustainability.

The mobile form developed and deployed in the ODK data collect enables regular data collection of indicators. This not only ensures the collection of the progress of the indicators but also enables capturing project location and pictures as evidence of activities and milestones done and achieved. The application has an easy to use interface, the mobile application can be bundled in the field assistant's or the beneficiary mobile phone to continuously provide updated collected data for each indicator.

The study also addressed the problem of poor information dissemination as highlighted in the review report of 2012 of the Kenya Social Protection sector. The web GIS and M&E portal developed in this study has shown potential of addressing this problem effectively if it is up scaled and adopted. The system enables broad dissemination of reports to a broad audience with limited technical skills because of the visualization of graphs and maps that are easily understandable. This solves the problem of communication monitoring and evaluation report that usually tend to be in technical language and with advanced economic concepts and statistical technique.

Mackay (2007) noted that the economic policy makers need the information generated from M&E functions to improve their economic policies while donors and stakeholders need M&E findings to ensure accountability of resources while at the same time improving the overall effectiveness of the policies. The web-based GIS-M&E portal developed is capable of doing this. This is because it has made use of attribute data exported in Google Fusion tables and ODK aggregate data. The database was georeferenced, analysed, visualized and graphs generated from it using Google Fusion Tables. The variety of interactive maps and graphs produced provides an easy justification as to why integrating GIS in M&E enhances

accountability. The maps generated enable the user to see the spatial dimension of projects under implementation and querying capability. The user can also access information of beneficiary projects by selecting a marker icon or a specific thematic area by using the query form. The ability to show the spatial distribution of funds disbursed and projects distributed in the counties enables donors to ensure accountability of resources and identify priority areas that can be supported. This also prevents duplication of projects and ensures effectiveness of funds disbursed. The portal also enables downward accountability to beneficiaries of the projects and their communities by providing clear and understandable information with no jargon and reports on programme implementation progress are displayed on the portal 'Home' page enabling the project staff to know whether the project is on track or if there's need to fast track some activities. The portal also includes the distribution of funds in each county in the 'Funds Disbursed' page this enables spatial assessment of funds disbursed ensuring equity. The different colours and marker icons that have been implemented in the system promote visual cues of the project it presents. This enables people from different backgrounds to understand the contents easily. The dissemination of information has also been enhanced due to the graphical and map presentation of programme information. This can be easily seen in the 'Beneficiary Project Details' page which shows the different projects with different symbolizations as per the thematic area of which the project is addressing. For example, red markers with 'e' on them symbolize energy thematic area, green markers symbolize agribusiness, blue markers with 'w' on them symbolize water thematic area and white markers symbolize waste management thematic area.

The portal also enables donors and partners to assess value for money of funds disbursed by seeing the spatial distribution of funds vis a vis the impacts achieved in each county. For instance values from the Funds disbursement page is divided by the values from the impact page its easy to compute the value for money. In this case, Laikipia has brought back a high value for money compared with Garissa because with each 100 USD invested 1 job is created and with each 33.4 USD invested 1 customer accesses green products. While Garissa with each 6000 USD invested, 1 job is created and with each 300 USD invested 1 customer is able to access green products. This will enable donors make decision on what type of projects to invest more in order to achieve the biggest impact. The graphs on the 'Impact' page also provided baseline information enabling donors and partners to evaluate the project impact for each Award Cycle. For instance, it is clearly visible that GIA II created more jobs than its

baseline, followed by GIA 1 and finally GIA III. This provides more insight to the project management team to evaluate the programme on what they have done right and wrong while implementing the programme to yield such results.

The navigation application provides nearly the same functionalities as the portal in terms of dissemination of information to partner, donors and the public but also provides the capability for navigation. This is essential for independent auditing of projects for partners and donors or for impromptu visits by the funding organization to monitor the project progress and compliance to set standards and targets. This application also enables newly recruited staff in the M&E team to familiarise with the project and easily visit the project without getting lost.

The NETFUND web-based GIS-M&E system relies on Google Fusion tables to provide storage, map and graphical visualization of the data stored in the geodatabase. Google Fusion table is a proprietary software by from Google and can be discontinued with a short period notice requiring migration of large datasets to another database server. The tool provides limited storage capacity of data in the geodatabase and therefore requires purchase an institution to purchase more space from Google, which may be costly for a geodatabase with large datasets. Therefore, the system and all its components needs to be deployed locally in NETFUND servers. This will enable extending the geodatabase capacity and preventing loss of data if Google Fusion Tables is discontinued.

5. Conclusions and Recommendations

5.1 Conclusions

The main objective of this study was to develop a web-based GIS Monitoring and Evaluation system that will enhance programme management at the National Environment Trust Fund through monitoring and evaluation. The system was successfully developed and numerous interactive maps and graphs were generated and used to demonstrate the system's functionality as a management, monitoring and reporting tool.

The system applications were developed as per the findings the needs assessment. These systems enabled the user to see the spatial distribution of beneficiaries in the different counties, know where they are exactly located, and view the project details and progress. Through the Fund Disbursements web page, the user is able to see a map of how much money was disbursed to each county in the country and is able to differentiate how much each county has received using the different shades of red. From the impact web page, they could see the number of jobs and customers in an area and thereby determine the programmes progress to achieve its impacts and accessibility of green products respectively. The data collection application enables continuous data collection of indicator data thus enhancing continuous review of project progress towards its indicators. The navigation application provides opportunity for continuous audit of project by stakeholders.

The system was populated using both primary and secondary data. Data was collected using the mobile application and was uploaded to ODK aggregate which was then exported to fusion table. Secondary data acquired from the programmes department was imported in the fusion table and geocoded and visualized in the web based GIS, Monitoring, and Evaluation portal.

The functionality of the different system applications was demonstrated including:

1. The querying, pan, zoom changing of map type functionality of the web portal
2. The capability of ODK collect to capture text, numeric, image and geolocation data
3. The ability of the navigation application to provide direction and beneficiary details

The target user of the system was the NETFUND programme management and stakeholders, due to the ease by which the map and graphs are understood hence making it efficient as an information sharing and dissemination tool which is critical for monitoring and evaluation. The target users for the mobile application was NETFUND M&E staff and project beneficiaries to enable them easily collect data on specified indicators thus enhancing monitoring of project progress on specified indicators. Finally, the navigation app target group was for the stakeholders and NETFUND staff. The application provides navigation capability to users visiting project areas without getting lost, hence time saving when conducting an M&E exercise or audit.

The overall finding of this study was that Web-based GIS M&E system is effective in monitoring and evaluation since it provides a geographical dimension to project investment, implementation and impact evaluation. This provides value addition to development of projects, planning on their implementation and making of decisions on areas to invest in this case funding.

5.2 Recommendations

The outcome of this study has shown that a Web-based M&E-GIS System can provide great value proposition to the NETFUND GIA programme as a management, monitoring, evaluation, and information dissemination tool. The recommendations of this study are therefore:

- NETFUND GIA Programme management adopt the findings of this study.
- Capacity building of M&E staff and project beneficiary on the use of mobile data collection tools
- Geographic location data for beneficiary projects, fund disbursements and impact data be incorporate into the Awards Management Information System (AMIS).
- Full deployment of ODK data Toolkit (Aggregate and Collect) in NETFUND servers
- Full integration of mobile data collection tools with the AMIS providing seamless data entry and analysis in one system without relying on exportation and importation of collected data from one system to another.

- Integration of multi criteria querying in the future development and upscaling of the system.
- Adoption and rollout of the system to all state departments and cooperation.

The limitation of the system is that it relies heavily on Google Cloud Services and may attract a subscription fee if such a system is deployed to monitor and evaluate projects for all state corporations. Therefore, further research should be conducted to assess the practicability of deploying locally such a system in all state departments and corporation this may include the server capacity, the ease of integration to existing government computing systems and the rate at which it will be easily adopted with less resistance.

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APPENDICES

Appendix A: Home Page Source Code

```
<!doctype html>
<html>
<head>
   <meta charset="UTF-8">
   <title>NETFUND GIS-MONITORING AND EVALUATION PAGE</title>
   <link rel="stylesheet" type="text/css" href="styles.css">
</head>
<body>
<div class="container">
   <header>
   <div id="logo"><a href="#"><img src="intro.jpg"></a></div>
   <ul class="nav_menu">
      <li><a href="index.html">Home</a></li>
      <li><a href="beneficiary.html">Beneficiary Project Details</a></li>
      <li><a href="funds.html">Funds Disbursed</a></li>
      <li><a href="impact.html">Impact</a></li>
   </ul>
   <div class="clear"></div>
   </header>
<style>
section {background-color: whitesmoke;width: 1350px;}
h1   {color: blue;}
h2   {color: blue;}
p    {color: black;font-size: large; text-align: justify;}
</style>
   <section id="mainBody">


      <div><h1>INTRODUCTION</h1>
```

 The National Environment Trust Fund (NETFUND) is a state corporation under the Ministry of Environment, Natural Resources and Regional Development Authorities. NETFUND was established within the provisions of the Environmental Management and Coordination Act (EMCA) 1999 to facilitate research intended to further the requirements of environmental management, capacity building, environmental awards, environmental publications, scholarships and grants.

NETFUND is governed by a Board of Trustees (BoT) which is the highest decision making organ of the Fund. The BoT members are appointed by the Cabinet Secretary in charge of Environment.

The BoT is responsible for guiding the strategic direction of the fund, organizational policy frameworks, oversight of the Fund's assets and undertaking any other activities within the mandate of the organization. The day-to-day running of the organization is vested in the Chief Executive Officer who is supported by a dedicated and skilled team.

<P>The NETFUND Green Innovations Award (NETFUND GIA) is a vehicle through which NETFUND identifies, recognizes, rewards and nurtures innovative projects and ideas in environmental management. The award comes with grants for winning initiatives. First place winners receive KES. 1,000,000, while second and third place winners receive KES. 500,000 and KES 250,000 respectively. Projects with potential for business incubation may receive support worth up-to KES 5,000,000 as technical and business support. Successful graduates of the NETFUND incubation program may also receive seed funding of up-to KES 2,000,000. </P>

<h2>About This Portal</h2>

This is a GIS Monitoring and Evaluation portal that provides donors, partners, stakeholders and the general public details of NETFUND GIA projects and the impacts that they have realized

<h2>NETFUND Green Innovation Awards Programme Progress Dashboard</h2>

<p><iframe width="650" height="400" scrolling="no" frameborder="no" src="https://fusiontables.google.com/embedviz?containerId=googft-gviz-canvas&q=select+col7%2C+col25+from+13L1YwByO-iLQTLv9P-I3k3N48cjRw-980ad-cKtj+order+by+col25+asc+limit+30&viz=GVIZ&t=BAR&uiversion=2&gco_forceIFrame=true&gco_hasLabelsColumn=true&gco_tooltip=%7B%22isHtml%22%3Atrue%7D&tmplt=6&width=600&height=400" ></iframe>

<iframe width="650" height="400" scrolling="no" frameborder="no" align="right" src="https://fusiontables.google.com/embedviz?containerId=googft-gviz-canvas&q=select+col24%2C+count()+from+13L1YwByO-iLQTLv9P-I3k3N48cjRw-980ad-cKtj+group+by+col24+order+by+col24+asc+limit+10&viz=GVIZ&t=PIE&uiversion=2&gco_forceIFrame=true&gco_hasLabelsColumn=true&gco_useFirstColumnAsDomain=true&gco_legacyScatterChartLabels=true&gco_is3D=true&gco_pieHole=0&gco_booleanRole=certainty&gco_hAxis=%7B%22useFormatFromData%22%3Atrue%2C+%22viewWindow%22%3A%7B%22max%22%3Anull%2C+%22min%22%3Anull%7D%2C+%22minValue%22%3Anull%2C+%22maxValue%22%3Anull%7D&gco_vAxes=%5B%7B%22useFormatFromData%22%3Atrue%2C+%22viewWindow%22%3A%7B%22max%22%3Anull%2C+%22min%22%3Anull%7D%2C+%22minValue%22%3Anull%2C+%22maxValue%22%3Anull%7D%2C%7B%22useFormatFromData%22%3Atrue%2C+%22viewWindow%22%3A%7B%22max%22%3Anull%2C+%22min%22%3Anull%7D%2C+%22minValue%22%3Anull%2C+%22maxValue%22%3Anull%7D%5D&gco_title=OVERALL+PROGRAMME+PROGRESS&gco_titleTextStyle=%7B%22color%22%3A%22%23000%22%2C+%22fontSize%22%3A%2214%22%2C+%22bold%22%3Atrue%7D&gco_legend=right&gco_slices=%7B%220%22%3A%7B%22color%22%3A%22%23ff0000%22%7D%2C+%221%22%3A%7B%22color%22%3A%22%2300ff00%22%7D%2C+%222%22%3A%7B%22color%22%3A%22%23ffff00%22%7D%7D&gco_pieSliceTextStyle=%7B%22color%22%3A%22%23000000%22%2C+%22fontSize%22%3A%2213%22%7D&gco_backgroundColor=%7B%22fill%22%3A%22%23ffffff%22%7D&gco_legendTextStyle=%7B%22color%22%3A%22%23222%22%2C+%22fontS

```
ize%22%3A12%2C+%22bold%22%3Atrue%7D&amp;amp;width=600&amp;amp;height=400"></ifra
me></p>



      </div>
   </section>

<footer>Copyright Kihara Gabriel

<a href="file:///C:\application\NETF_Navigation_app.apk" download><img border="0" src="/images/images.png" alt="Click to Download Navigation Application" width="300" height="300" align="right"></a>
</footer>
</div>
</body>
</html>
```

Appendix B: Beneficary Project Details Page Source Code

```
<!doctype html>
<html>
<head>
   <meta charset="UTF-8">
   <title>Our new webpage</title>
   <link rel="stylesheet" type="text/css" href="styles.css">
</head>
<body>
<div class="container">
   <header>
   <div id="logo"><a href="#"><img src="beneficiary.jpg"></a></div>
   <ul class="nav_menu">
      <li><a href="index.html">Home</a></li>
      <li><a href="beneficiary.html">Beneficiary Project Details</a></li>
      <li><a href="funds.html">Funds Disbursed</a></li>
      <li><a href="impact.html">Impact</a></li>
   </ul>
   <div class="clear"></div>
 </header>
      <section id="mainBody">
      <head>
 <style>
   #map-canvas { width:1350px; height:500px; }
   .layer-wizard-search-label { font-family: sans-serif };
 </style>
```

```
<script type="text/javascript"
 src="http://maps.google.com/maps/api/js?sensor=false">
</script>
<script type="text/javascript">
 var map;
 var layer_0;
 function initialize() {
  map = new google.maps.Map(document.getElementById('map-canvas'), {
   center: new google.maps.LatLng(-0.4614207935306084, 38.47599020950736),
   zoom: 6,
   mapTypeId: google.maps.MapTypeId.ROADMAP
  });
  layer_0 = new google.maps.FusionTablesLayer({
   query: {
    select: "col18",
    from: "13L1YwByO-iLQTLv9P-I3k3N48cjRw-980ad-cKtj"
   },
   map: map,
   styleId: 2,
   templateId: 2
  });
 }
 function changeMap_0() {
  var whereClause;
  var searchString = document.getElementById('search-string_0').value.replace(/'/g, "\\'");
  if (searchString != '--Select--') {
```

```
    whereClause = "'Thematic Area' = '" + searchString + "'";
   }
   layer_0.setOptions({
    query: {
     select: "col18",
     from: "13L1YwByO-iLQTLv9P-I3k3N48cjRw-980ad-cKtj",
     where: whereClause
    }
   });
  }
  google.maps.event.addDomListener(window, 'load', initialize);
</script>
</head>
<body>
  <div id="map-canvas"></div>
  <div style="margin-top: 10px;">
   <label class="layer-wizard-search-label">
    Thematic Area
    <select id="search-string_0" onchange="changeMap_0(this.value);">
     <option value="--Select--">--Select--</option>
     <option value="Agribusiness">Agribusiness</option>
     <option value="Energy">Energy</option>
     <option value="Waste management">Waste management</option>
     <option value="Water">Water</option>
    </select>
   </label>
```

```
   </div>

  </body>

</section>

    <footer>Copyright Gabriel kihara</footer>

</div>

</body>

</html>
```

Appendix C: Funds Disbursement Page Source Code

```
<!doctype html>
<html>
<head>
   <meta charset="UTF-8">
   <title>Funds Disbursement</title>
   <link rel="stylesheet" type="text/css" href="styles.css">
</head>
<body>
<div class="container">
   <header>
   <div id="logo"><a href="#"><img src="funds.jpg"></a></div>
   <ul class="nav_menu">
      <li><a href="index.html">Home</a></li>
      <li><a href="beneficiary.html">Beneficiary Project Details</a></li>
      <li><a href="funds.html">Funds Disbursed</a></li>
      <li><a href="impact.html">Impact</a></li>
   </ul>
   <div class="clear"></div>
   </header>
   <section id="mainBody">
     <head>
  <style>
   #map-canvas { width:1350px; height:500px; }
   .layer-wizard-search-label { font-family: sans-serif };
  </style>
```

```
<script type="text/javascript"
 src="http://maps.google.com/maps/api/js?sensor=false">
</script>
<script type="text/javascript">
 var map;
 var layer_0;
 function initialize() {
  map = new google.maps.Map(document.getElementById('map-canvas'), {
   center: new google.maps.LatLng(0.2353816346703265, 38.75846712155669),
   zoom: 6,
   mapTypeId: google.maps.MapTypeId.ROADMAP
  });
  layer_0 = new google.maps.FusionTablesLayer({
   query: {
    select: "col6",
    from: "1ZLdJdp79sRwAP8TPgAPYy5II5paXVUJ8Mkqp5kcx"
   },
   map: map,
   styleId: 2,
   templateId: 2
  });
 }
 function changeMap_0() {
  var whereClause;
  var searchString = document.getElementById('search-string_0').value.replace(/'/g, "\\'");
  if (searchString != '--Select--') {
```

```
    whereClause = "'COUNTY' = '" + searchString + "'";
   }
   layer_0.setOptions({
    query: {
     select: "col6",
     from: "1ZLdJdp79sRwAP8TPgAPYy5II5paXVUJ8Mkqp5kcx",
     where: whereClause
    }
   });
  }
  google.maps.event.addDomListener(window, 'load', initialize);
</script>
</head>
<body>
  <div id="map-canvas"></div>
  <div style="margin-top: 10px;">
   <label class="layer-wizard-search-label">
    COUNTY
    <select id="search-string_0" onchange="changeMap_0(this.value);">
     <option value="--Select--">--Select--</option>
     <option value="Baringo">Baringo</option>
     <option value="Bomet">Bomet</option>
     <option value="Bungoma">Bungoma</option>
     <option value="Busia">Busia</option>
     <option value="Elgeyo-Marakwet">Elgeyo-Marakwet</option>
     <option value="Embu">Embu</option>
```

```
<option value="Garissa">Garissa</option>
<option value="Homa Bay">Homa Bay</option>
<option value="Isiolo">Isiolo</option>
<option value="Kajiado">Kajiado</option>
<option value="Kakamega">Kakamega</option>
<option value="Kericho">Kericho</option>
<option value="Kiambu">Kiambu</option>
<option value="Kilifi">Kilifi</option>
<option value="Kirinyaga">Kirinyaga</option>
<option value="Kisii">Kisii</option>
<option value="Kisumu">Kisumu</option>
<option value="Kitui">Kitui</option>
<option value="Kwale">Kwale</option>
<option value="Laikipia">Laikipia</option>
<option value="Lamu">Lamu</option>
<option value="Machakos">Machakos</option>
<option value="Makueni">Makueni</option>
<option value="Mandera">Mandera</option>
<option value="Marsabit">Marsabit</option>
<option value="Meru">Meru</option>
<option value="Migori">Migori</option>
<option value="Mombasa">Mombasa</option>
<option value="Murang'a">Murang'a</option>
<option value="Nairobi">Nairobi</option>
<option value="Nakuru">Nakuru</option>
<option value="Nandi">Nandi</option>
```

```
        <option value="Narok">Narok</option>
        <option value="Nyamira">Nyamira</option>
        <option value="Nyandarua">Nyandarua</option>
        <option value="Nyeri">Nyeri</option>
        <option value="Samburu">Samburu</option>
        <option value="Siaya">Siaya</option>
        <option value="Taita Taveta">Taita Taveta</option>
        <option value="Tana River">Tana River</option>
        <option value="Tharaka">Tharaka</option>
        <option value="Trans Nzoia">Trans Nzoia</option>
        <option value="Turkana">Turkana</option>
        <option value="Uasin Gishu">Uasin Gishu</option>
        <option value="Vihiga">Vihiga</option>
        <option value="Wajir">Wajir</option>
        <option value="West Pokot">West Pokot</option>
      </select>
    </label>
  </div>
 </body>
</section>
   <footer>Copyright Gabriel Kihara</footer>
</div>
</body>
</html>
```

Appendix D: Impact Page Source Code

```
<!doctype html>
<html>
<head>
   <meta charset="UTF-8">
   <title>IMPACT</title>
   <link rel="stylesheet" type="text/css" href="styles.css">
</head>
<body>
<div class="container">
   <header>
   <div id="logo"><a href="#"><img src="Impact.jpg"></a></div>
   <ul class="nav_menu">
      <li><a href="index.html">Home</a></li>
      <li><a href="beneficiary.html">Beneficiary Project Details</a></li>
      <li><a href="funds.html">Funds Disbursed</a></li>
      <li><a href="impact.html">Impact</a></li>
   </ul>
   <div class="clear"></div>
     </header>
   <section id="mainBody">
      <h1>GREEN JOBS CREATED</h1>
   <head>
 <style>
   #map-canvas { width:1350px; height:500px; }
   .layer-wizard-search-label { font-family: sans-serif };
```

```
</style>
<script type="text/javascript"
 src="http://maps.google.com/maps/api/js?sensor=false">
</script>
<script type="text/javascript">
 var map;
 var layer_0;
 function initialize() {
  map = new google.maps.Map(document.getElementById('map-canvas'), {
   center: new google.maps.LatLng(0.11961224368474663, 38.334534471275674),
   zoom: 6,
   mapTypeId: google.maps.MapTypeId.ROADMAP
  });
  layer_0 = new google.maps.FusionTablesLayer({
   query: {
    select: "col6",
    from: "142_vCkzfziUfpmoRr9xB2S8OufBMEUaE8mrv8_v6"
   },
   map: map,
   styleId: 2,
   templateId: 2
  });
 }
 function changeMap_0() {
  var whereClause;
  var searchString = document.getElementById('search-string_0').value.replace(/'/g, "\\'");
```

```
    if (searchString != '--Select--') {
      whereClause = "'County' = '" + searchString + "'";
    }
    layer_0.setOptions({
      query: {
        select: "col6",
        from: "142_vCkzfziUfpmoRr9xB2S8OufBMEUaE8mrv8_v6",
        where: whereClause
      }
    });
  }
  google.maps.event.addDomListener(window, 'load', initialize);
</script>
</head>
<body>
  <div id="map-canvas"></div>
  <div style="margin-top: 10px;">
    <label class="layer-wizard-search-label">
      County
      <select id="search-string_0" onchange="changeMap_0(this.value);">
        <option value="--Select--">--Select--</option>
        <option value="Baringo">Baringo</option>
        <option value="Bomet">Bomet</option>
        <option value="Bungoma">Bungoma</option>
        <option value="Busia">Busia</option>
        <option value="Elgeyo-Marakwet">Elgeyo-Marakwet</option>
```

```
<option value="Embu">Embu</option>
<option value="Garissa">Garissa</option>
<option value="Homa Bay">Homa Bay</option>
<option value="Isiolo">Isiolo</option>
<option value="Kajiado">Kajiado</option>
<option value="Kakamega">Kakamega</option>
<option value="Kericho">Kericho</option>
<option value="Kiambu">Kiambu</option>
<option value="Kilifi">Kilifi</option>
<option value="Kirinyaga">Kirinyaga</option>
<option value="Kisii">Kisii</option>
<option value="Kisumu">Kisumu</option>
<option value="Kitui">Kitui</option>
<option value="Kwale">Kwale</option>
<option value="Laikipia">Laikipia</option>
<option value="Lamu">Lamu</option>
<option value="Machakos">Machakos</option>
<option value="Makueni">Makueni</option>
<option value="Mandera">Mandera</option>
<option value="Marsabit">Marsabit</option>
<option value="Meru">Meru</option>
<option value="Migori">Migori</option>
<option value="Mombasa">Mombasa</option>
<option value="Murang'a">Murang'a</option>
<option value="Nairobi">Nairobi</option>
<option value="Nakuru">Nakuru</option>
```

```
        <option value="Nandi">Nandi</option>

        <option value="Narok">Narok</option>

        <option value="Nyamira">Nyamira</option>

        <option value="Nyandarua">Nyandarua</option>

        <option value="Nyeri">Nyeri</option>

        <option value="Samburu">Samburu</option>

        <option value="Siaya">Siaya</option>

        <option value="Taita Taveta">Taita Taveta</option>

        <option value="Tana River">Tana River</option>

        <option value="Tharaka-Nithi">Tharaka-Nithi</option>

        <option value="Trans Nzoia">Trans Nzoia</option>

        <option value="Turkana">Turkana</option>

        <option value="Uasin Gishu">Uasin Gishu</option>

        <option value="Vihiga">Vihiga</option>

        <option value="Wajir">Wajir</option>

        <option value="West Pokot">West Pokot</option>

      </select>

    </label>

  </div>

 </body>

        <h1>CUSTOMERS WITH ACCESS TO GREEN PRODUCTS</h1>

 <iframe width="1350" height="500" scrolling="no" frameborder="no"
src="https://fusiontables.google.com/embedviz?containerId=googft-gviz-
canvas&amp;q=select+col4%2C+col5+from+1oPZarrm3Z2Hee_EeQRCqOGVWwGmXdGKMcdYDFuk6+
order+by+col4+asc+limit+29&amp;viz=GVIZ&amp;t=COLUMN&amp;uiversion=2&amp;gco_forceIFra
me=true&amp;gco_hasLabelsColumn=true&amp;gco_vAxes=%5B%7B%22title%22%3Anull%2C+%22
minValue%22%3Anull%2C+%22maxValue%22%3Anull%2C+%22useFormatFromData%22%3Atrue%2C
+%22viewWindow%22%3A%7B%22max%22%3Anull%2C+%22min%22%3Anull%7D%2C+%22logScale
```

%22%3Afalse%7D%2C%7B%22useFormatFromData%22%3Atrue%2C+%22viewWindow%22%3A%7B%22max%22%3Anull%2C+%22min%22%3Anull%7D%2C+%22minValue%22%3Anull%2C+%22maxValue%22%3Anull%2C+%22logScale%22%3Afalse%7D%5D&gco_useFirstColumnAsDomain=true&gco_legacyScatterChartLabels=true&gco_isStacked=false&gco_booleanRole=certainty&gco_hAxis=%7B%22useFormatFromData%22%3Atrue%2C+%22minValue%22%3Anull%2C+%22maxValue%22%3Anull%2C+%22viewWindow%22%3Anull%2C+%22viewWindowMode%22%3Anull%7D&gco_legend=right&gco_title=CUSTOMERS+WITH+ACCESS+TO+GREEN+PRODUCTS&width=1350&height=500"></iframe>

<h1>JOBS CREATED PER AWARD CYCLE</h1>

<iframe width="1350" height="500" scrolling="no" frameborder="no" src="https://fusiontables.google.com/embedviz?containerId=googft-gviz-canvas&q=select+col8%2C+SUM(col13)%2C+SUM(col26)+from+13L1YwByO-iLQTLv9P-I3k3N48cjRw-980ad-cKtj+group+by+col8+order+by+col8+asc+limit+10&viz=GVIZ&t=BAR&uiversion=2&gco_forceIFrame=true&gco_hasLabelsColumn=true&gco_useFirstColumnAsDomain=true&gco_legacyScatterChartLabels=true&gco_isStacked=false&gco_booleanRole=certainty&gco_hAxis=%7B%22useFormatFromData%22%3Atrue%2C+%22viewWindow%22%3A%7B%22max%22%3Anull%2C+%22min%22%3Anull%7D%2C+%22minValue%22%3Anull%2C+%22maxValue%22%3Anull%7D&gco_vAxes=%5B%7B%22useFormatFromData%22%3Atrue%2C+%22minValue%22%3Anull%2C+%22maxValue%22%3Anull%2C+%22viewWindow%22%3Anull%2C+%22viewWindowMode%22%3Anull%7D%2C%7B%22useFormatFromData%22%3Atrue%7D%5D&gco_legend=right&gco_title=&gco_series=%7B%220%22%3A%7B%22color%22%3A%22%236aa84f%22%7D%7D&width=1350&height=500"></iframe>

</section>

<footer>Copyright Gabriel Kihara</footer>

</body>

</html>

Appendix E: Mobile data collection XML form

```
<h:html xmlns="http://www.w3.org/2002/xforms" xmlns:h="http://www.w3.org/1999/xhtml"
xmlns:xsd="http://www.w3.org/2001/XMLSchema" xmlns:jr="http://openrosa.org/javarosa">
 <h:head>
  <h:title>GIS_M&amp;amp;E_SYSTEM_1</h:title>
  <model>
   <instance>
    <data id="build_Untitled-Form_1528353914">
     <meta>
      <instanceID/>
     </meta>
     <Name_of_project/>
     <AWARD_PHASE/>
     <project_description/>
     <County/>
     <Contact/>
     <Amount_funded/>
     <Jobs/>
     <Customers/>
     <Environmental_Impact/>
     <Project_photo_1/>
     <Project_photo_2/>
     <GPS_location_Latitude/>
     <GPS_location_Longitude/>
     <Project_location_Altitude/>
     <Project_location_Accuracy/>
```

```
  </data>
 </instance>
 <itext>
  <translation lang="English">
   <text id="/data/Name_of_project:label">
    <value>Name of Project</value>
   </text>
   <text id="/data/AWARD_PHASE:label">
    <value>AWARD PHASE</value>
   </text>
   <text id="/data/project_description:label">
    <value>Business focus area</value>
   </text>
   <text id="/data/County:label">
    <value>County</value>
   </text>
   <text id="/data/Contact:label">
    <value>Contact Person/Beneficiary</value>
   </text>
   <text id="/data/Amount_funded:label">
    <value>Amount funded</value>
   </text>
   <text id="/data/Jobs:label">
    <value>jobs created</value>
   </text>
   <text id="/data/Customers:label">
```

```
      <value>Number of customers</value>
    </text>
    <text id="/data/Environmental_Impact:label">
      <value>Environmental Impact</value>
    </text>
    <text id="/data/Project_photo_1:label">
      <value>Project Photo 1</value>
    </text>
    <text id="/data/Project_photo_2:label">
      <value>Project photo 2</value>
    </text>
    <text id="/data/GPS_location_Latitude:label">
      <value>GPS location Latitude</value>
    </text>
    <text id="/data/GPS_location_Longitude:label">
      <value>GPS location Longitude</value>
    </text>
    <text id="/data/Project_location_Altitude:label">
      <value>Project location Altitude</value>
    </text>
    <text id="/data/Project_location_Accuracy:label">
      <value>Project location Accuracy</value>
    </text>
  </translation>
</itext>
```

```
    <bind nodeset="/data/meta/instanceID" type="string" readonly="true()"
calculate="concat('uuid:', uuid())"/>
    <bind nodeset="/data/Name_of_project" type="string" required="true()"/>
    <bind nodeset="/data/AWARD_PHASE" type="string"/>
    <bind nodeset="/data/project_description" type="string" required="true()"/>
    <bind nodeset="/data/County" type="string" required="true()"/>
    <bind nodeset="/data/Contact" type="string" required="true()"/>
    <bind nodeset="/data/Amount_funded" type="int" required="true()"/>
    <bind nodeset="/data/Jobs" type="int"/>
    <bind nodeset="/data/Customers" type="int"/>
    <bind nodeset="/data/Environmental_Impact" type="string"/>
    <bind nodeset="/data/Project_photo_1" type="binary"/>
    <bind nodeset="/data/Project_photo_2" type="binary"/>
    <bind nodeset="/data/GPS_location_Latitude" type="string"/>
    <bind nodeset="/data/GPS_location_Longitude" type="string"/>
    <bind nodeset="/data/Project_location_Altitude" type="string"/>
    <bind nodeset="/data/Project_location_Accuracy" type="string"/>
  </model>
 </h:head>
 <h:body>
  <input ref="/data/Name_of_project">
   <label ref="jr:itext('/data/Name_of_project:label')"/>
  </input>
  <input ref="/data/AWARD_PHASE">
   <label ref="jr:itext('/data/AWARD_PHASE:label')"/>
  </input>
```

```
<input ref="/data/project_description">
  <label ref="jr:itext('/data/project_description:label')"/>
</input>
<input ref="/data/County">
  <label ref="jr:itext('/data/County:label')"/>
</input>
<input ref="/data/Contact">
  <label ref="jr:itext('/data/Contact:label')"/>
</input>
<input ref="/data/Amount_funded">
  <label ref="jr:itext('/data/Amount_funded:label')"/>
</input>
<input ref="/data/Jobs">
  <label ref="jr:itext('/data/Jobs:label')"/>
</input>
<input ref="/data/Customers">
  <label ref="jr:itext('/data/Customers:label')"/>
</input>
<input ref="/data/Environmental_Impact">
  <label ref="jr:itext('/data/Environmental_Impact:label')"/>
</input>
<upload ref="/data/Project_photo_1" mediatype="image/*">
  <label ref="jr:itext('/data/Project_photo_1:label')"/>
</upload>
<upload ref="/data/Project_photo_2" mediatype="image/*">
  <label ref="jr:itext('/data/Project_photo_2:label')"/>
```

```
    </upload>
    <input ref="/data/GPS_location_Latitude">
      <label ref="jr:itext('/data/GPS_location_Latitude:label')"/>
    </input>
    <input ref="/data/GPS_location_Longitude">
      <label ref="jr:itext('/data/GPS_location_Longitude:label')"/>
    </input>
    <input ref="/data/Project_location_Altitude">
      <label ref="jr:itext('/data/Project_location_Altitude:label')"/>
    </input>
    <input ref="/data/Project_location_Accuracy">
      <label ref="jr:itext('/data/Project_location_Accuracy:label')"/>
    </input>
  </h:body>
</h:html>
```

Appendix F: Block Code for mobile navigation application