Fuel Station Inventory Mapping for Data Management & Compliance Enforcement

Presenter, Victor Wanderi Wahome, & Benson Kipkemboi Kenduiywo[1]
Jomo Kenyatta University of Agriculture & Technology

SUMMARY

Petroleum is one of the main sources of commercial energy in Kenya. Therefore, management of petroleum is crucial in ensuring that the energy sector is an independent organized entity. State regulations are developed and implemented in order to ensure health, human safety and the preservation of the environment as a whole. Such regulations existent in the Energy Sector are established to oversee operations and activities of fuel stations within the country. However, the data management and compliance enforcement processes in the sector are manual and inefficient. A web-based mapping solution was devised in order to improve on the current status where information on the facilities is stored and displayed and subsequent compliance monitoring procedures on the same facilities can be done using web-based tools. The paper also discusses other potential methods that could be utilized in regulation and monitoring operations such as use the of Remote Sensing and crafting of Codes of Environmental Management Practice by the industry and non-industry groups. These efforts will ensure that the nation lives in a clean, secure and sustainable environment in line with Vision 2030.

Victor Wanderi, Wahome
Jomo Kenyatta University of Agriculture and Technology
P.O. Box 62000-00200
Nairobi
KENYA
Tel. +254 725 587783
Email: wahome.victor@students.jkuat.ac.ke

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[1] Co-author +254 720 879920, bkenduiywo@jkuat.ac.ke,

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Wahome, KENYA.

1. INTRODUCTION

Fossil fuels[2] supply almost 80 percent of world energy use and will continue doing so through to 2040 (Sieminski, 2013). Oil is the driving force in both industrial development and economic activities in most countries. How we manage both the benefits and costs of oil production and consumption will help determine the wealth, health, and safety of the planet (Rourke & Connolly, 2003). Here in Kenya petroleum[3] constitutes the main source of commercial energy (ERC, 2013). State regulation of import, transport, storage, refinery and sale of petroleum products is vital in ensuring human safety and overall environmental management. The operations of fuel stations[4] in the country are governed by various key regulations prescribed under law by state regulatory bodies in the likes of Energy Regulation Commission of Kenya (ERC), National Environment Management Authority (NEMA), Kenya Revenue Authority (KRA) and Kenya Bureau of Statistics (KeBS). Their efforts in licensing and compliance enforcement are aimed at spurring sustainable economic growth in the sector and to ensure both human safety and environmental management.

The petroleum sector faces several challenges such as the proliferation of substandard petroleum dispensing and storage sites which pose environment health and safety risks; diversion of petroleum products destined for export into the local market by unscrupulous business people to evade tax and a dominance of the market by a few companies among others (ERC, 2013). Also, there is lack of joint monitoring process and data sharing on the

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[2] Fossil fuel includes petroleum, coal and natural gas.

[3] Petroleum is defined as a naturally occurring mixture consisting of hydrocarbons in the gaseous, liquid, or solid phase (Council, 2011).

[4] Fuel stations are facilities within which petroleum-based goods and services are retailed. Some of the products they sell include petrol, diesel, kerosene, LPG and lubricants.

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facilities among state regulatory bodies to beef up compliance enforcement. Data management has been a major issue affecting most environmental agency officials in different countries around the world (OECD, 2009). Such challenges are quite often addressed using strategic plans and different compliance assurance instruments established by Lead Authorities of the State Government. This aims to streamline the sector by intensively monitoring, auditing, giving incentives and assistance where required and enforcing compliance measures for a set time period, normally 5-8 years. This has been practiced in the US (OECD, 2009).

There is thus need to monitor these facilities both at the regional and at a nation-wide level. Currently, inventories of all fuel stations in more than 32 counties already exist in an on-going High Risk Facilities Inventory Mapping project by NEMA (March 2013).

Updating, sharing and management of the inventories are not harmonized. An approach for efficient management and monitoring of fuel station is inevitable for compliance enforcement. Mapping, managing and updating the location of the facilities through the internet platform using web mapping can lead to better monitoring and compliance enforcement. For example, the US Department of Energy launched the AFDC website that displays mapped fuel stations within the country[5].

Therefore, the aim of this study is to design a web platform where information on existing fuel stations can be publicly displayed and where data on those facilities can be stored and managed by a State Authority. Based on the web mapping tools compliance enforcement can be exercised in a more efficient manner.

2. ROLE OF REGULATORY AUTHORITIES

Regulatory authorities establish legally binding rules and regulations to govern the operations and activities that impact human wellbeing and the environment. There is need to monitor and audit facilities that generate or manage hazardous waste which have a potential to cause significant damage to the environment and the communities that

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[5] **Error! Main Document Only.**

surround them (Sigman & Stafford, 2011). Therefore the regulations seek to ensure sustainable development and propel the growth of the nation as a whole.

In Kenya a Command and Control[6] approach is in place where the Government sets rules and regulations to govern the activities in this sector. Several Ministry regulations have been passed to regulate petroleum transportation and sale. For example the Petroleum Regulation Levy ((Energy Regulation Commission, 2008) which details how petroleum-retail revenue should be handled. There also exists stringent rules and regulations on the licensing of transport, sale and handling of Liquefied Petroleum Gas within the country ((Energy Regulation Commission, 2009). Other state regulations that affect operations of fuel stations have been gazetted and published with the aim of streamlining the Energy Sector as whole.

Fuel stations in the country are required by law to obtain genuine Environmental Impact Assessment, the Annual Environmental Audit and Effluent discharge licences from NEMA before and during their operation. These licences form the basis of assessing the compliance level in this study.

3. SECTOR MANAGEMENT AND COMPLIANCE ENFORCEMENT

The regulations are established by the authorities where subsequent monitoring, auditing and compliance enforcement processes are followed based on these regulations. However (Sigman & Stafford, 2011) explains that the limited effectiveness of traditional enforcement tools and the effectiveness of alternative compliance initiatives is an indication that standard economic models fail to include important costs and benefits of compliance. Therefore more up-to-date methods of compliance enforcement need to be explored and adopted where they benefit the overall superintendence or oversight process.
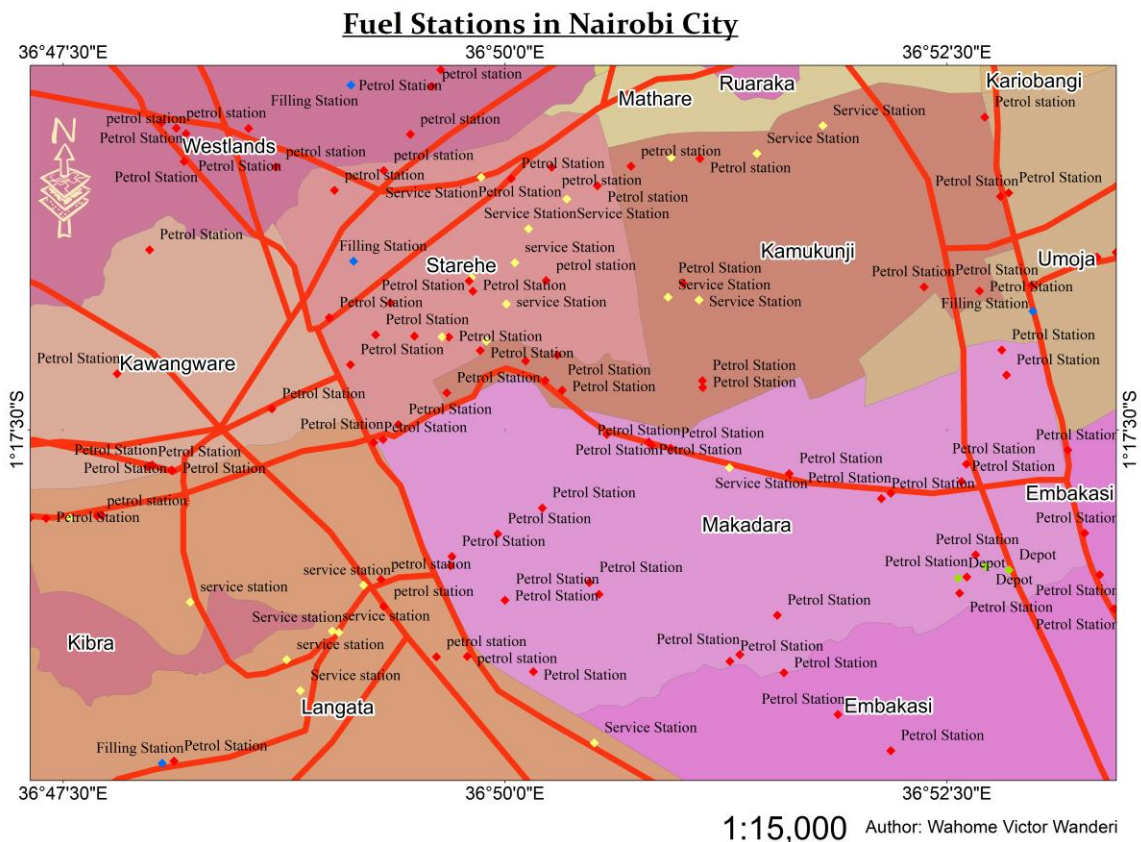
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[6] "Command and control" refers to a public policy approach that relies on centralized regulatory commands to implement environmental goals. Governments issue detailed requirements and follow up with inspections, enforcement and sometimes punishment, (Nash & Ehrenfeld, 1997).

Environmental authorities in countries such as UK, France, Russia, China and US among others are increasingly rely on technological advances to obtain, manage, and disseminate compliance information (OECD, 2009). Sophisticated interactive web-based systems are gaining prominence as compliance assistance tools. The web map application developed and described in this paper is one such tool that can further boost the management of the fuel station facilities in the Energy Sector and revamp the compliance monitoring and enforcement process.

4. STUDY AREA

The project covers the county of Nairobi. There are 242 mapped fuel stations in the area which seek to meet the needs of the growing population of about 4 million people in the County. They range from Petrol Stations, Service Stations, Filling Stations, Kerosene Pumps and Fuel Depots spread across 17 constituencies. There are 95 facilities found within 500m of the existing road network, and an extra 55 facilities within a 1 km radius of the major roads covering Nairobi.

Fuel Stations in Nairobi City

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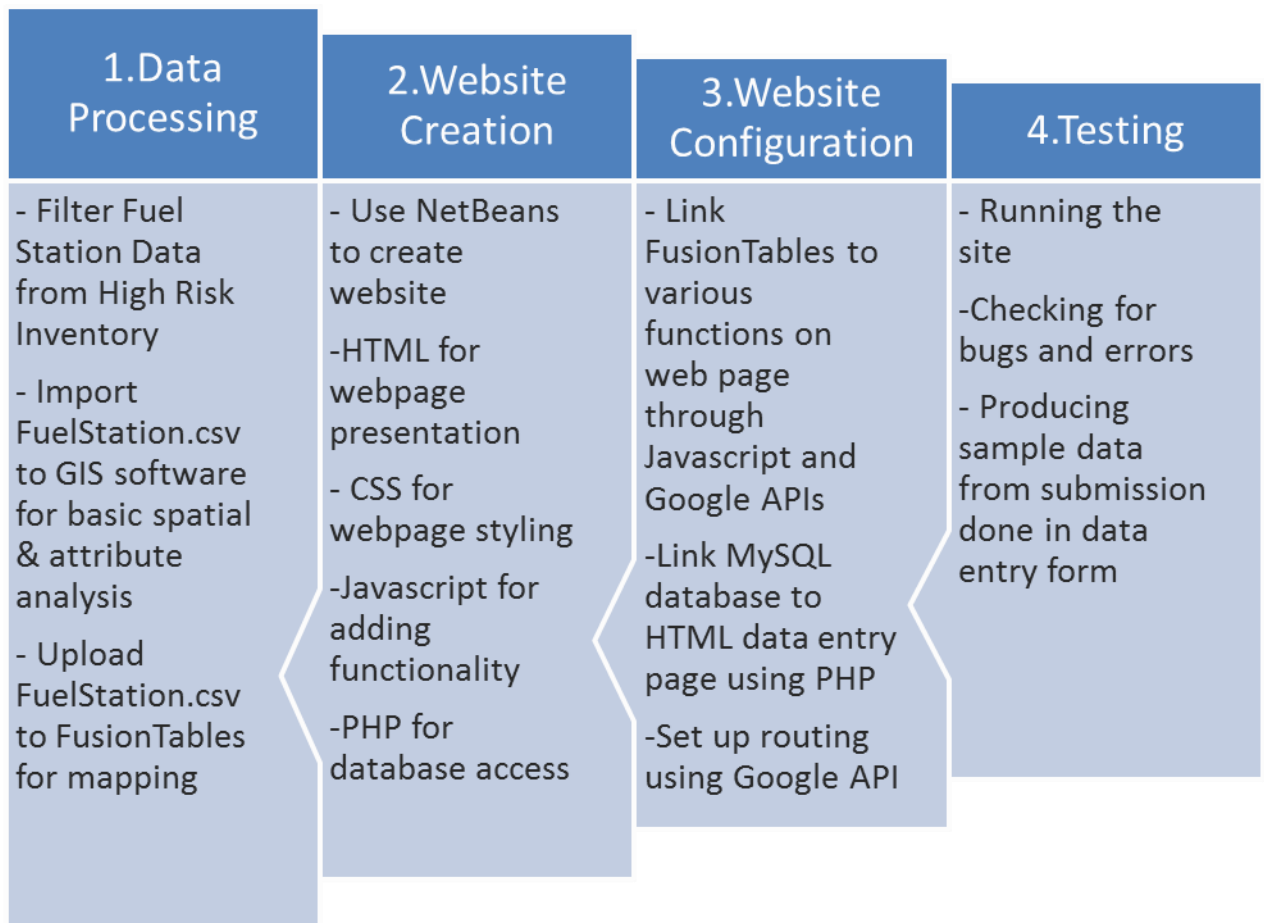
5. METHODOLOGY

The project mainly relies on the High Risk Facilities Inventory Mapping data collected by NEMA in the year 2012. The data itself covers several key industries in the likes of Commercial, Tourism, Energy and Processing. Fuel stations are found under the Energy Sector and thus has to be isolated as an independent entity. GIS analysis tools from ArcGIS were used to determine basic attribute and location information with regards to the mapped fuel stations as noted in the results section. Also, ArcGIS was used for map production. Google APIs were also used to develop online visualization and processing capabilities over the internet infrastructure. Database management on server side was implemented using XAMPP software where users can submit the collected field data to a central repository. The combination of these tools resulted in the development of the Fuel Station Inventory website that has the following functionalities:

    a. A viewing platform for public interaction and scrutiny
    b. A data entry point for field officers to update and manage the facilities inventory
    c. A query and routing system to be used for inspection runs and compliance monitoring

The steps undertaken in the development of the website are as follows:

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1. Data Processing	2. Website Creation	3. Website Configuration	4. Testing
- Filter Fuel Station Data from High Risk Inventory - Import FuelStation.csv to GIS software for basic spatial & attribute analysis - Upload FuelStation.csv to FusionTables for mapping	- Use NetBeans to create website -HTML for webpage presentation - CSS for webpage styling -Javascript for adding functionality -PHP for database access	- Link FusionTables to various functions on web page through Javascript and Google APIs -Link MySQL database to HTML data entry page using PHP -Set up routing using Google API	- Running the site -Checking for bugs and errors - Producing sample data from submission done in data entry form

6. RESULTS

It is observed from analysis of the data on Fuel Stations that only 5% of all the Fuel Stations have all three Environmental Licenses required by Law that are of interest to NEMA. Majority of these facilities are petrol stations with two service stations appearing among them. Also, most of these full-compliant facilities are found within Lang'ata Constituency of Nairobi County at 26% of the total number of fuel stations here. These facilities include the likes of Total, National Oil and Kenol Kobil including others. On the other-hand 22% of the fuel stations do not have any of the three licenses. The majority of defaulters are found in Westlands, Starehe and Kasarani constituencies. 38% of all fuel stations that are found within the county of Nairobi have Environmental Impact Assessment licenses. Also from the data it is evident that majority of the fuel stations observe site construction standards when it comes to fulfilling the requirements of having a Canopy over the pumps, a tank farm and an interceptor area. 61% have fulfilled these requirements whereas 37% have not. Waste treatment by facilities is also of environmental importance and it was found that majority of the facilities do not treat their waste.
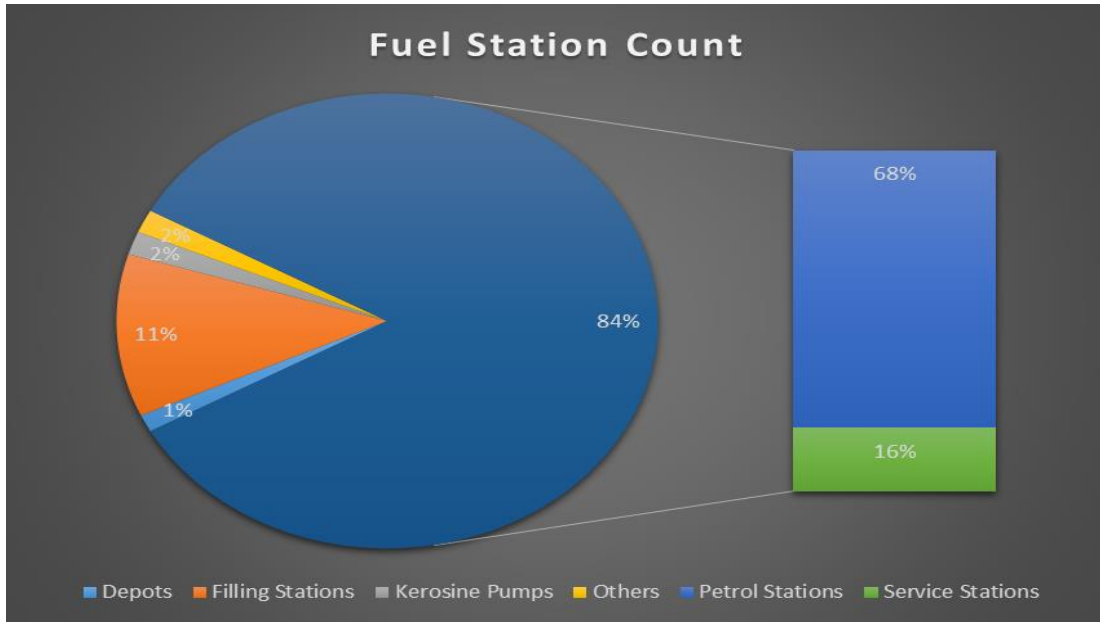
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Figure 1: The greatest percentage of fuel stations is Petrol Stations within the County followed by Service Stations.
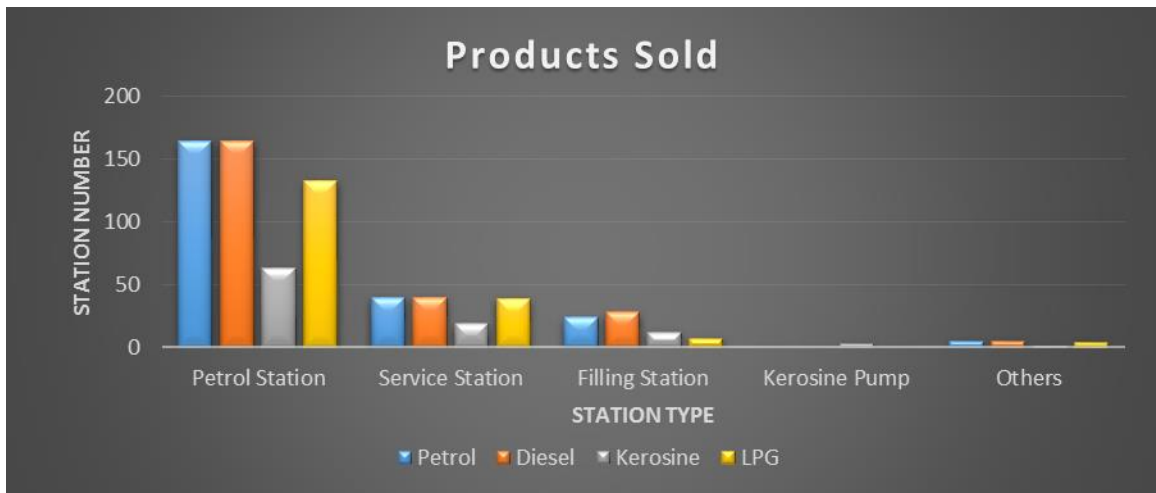

Figure 2: This indicates the number of station types retailing various petroleum products. Petrol is most retailed commodity, especially in Petrol Stations.

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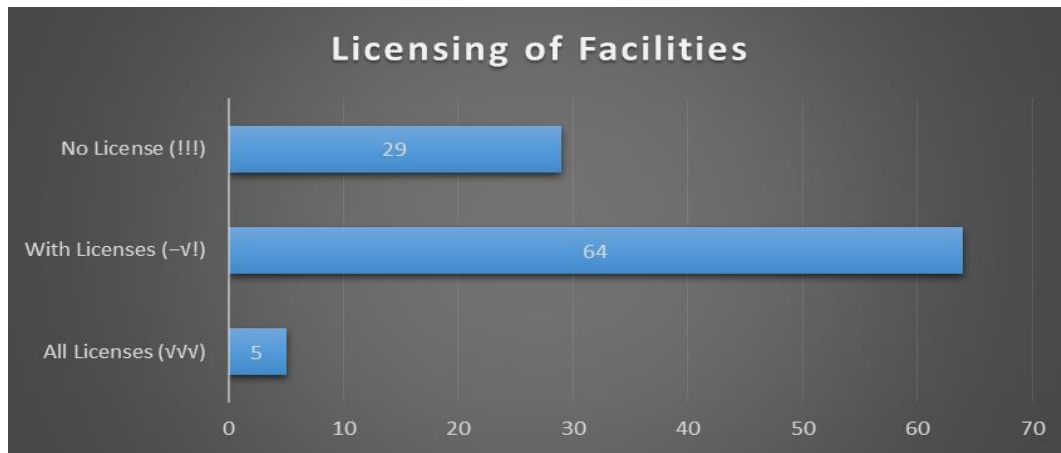17 – 18 September, 2013 | Kenyatta University, Kenya

Figure 3: This shows the level of compliance to NEMAs licensing regulations. The licenses considered include Environmental Impact Assessment, Environmental Annual Audit and Effluent Discharge Licences

The aim of this project was to create web map application where information on fuel stations will be accessible to both the public and for state monitoring purposes. These is as shown below:
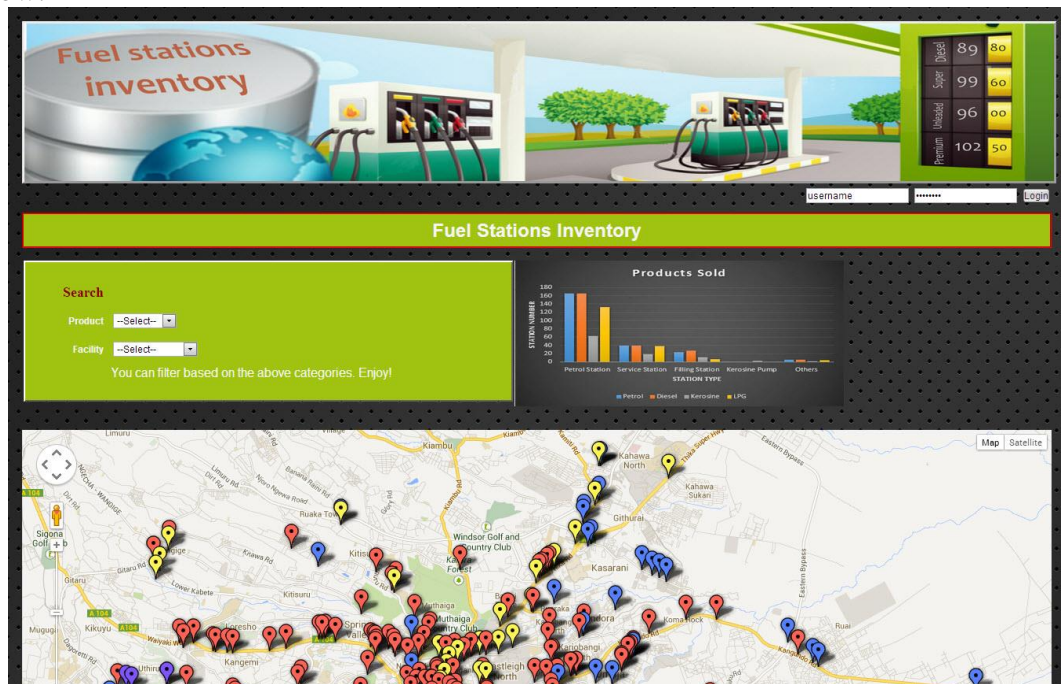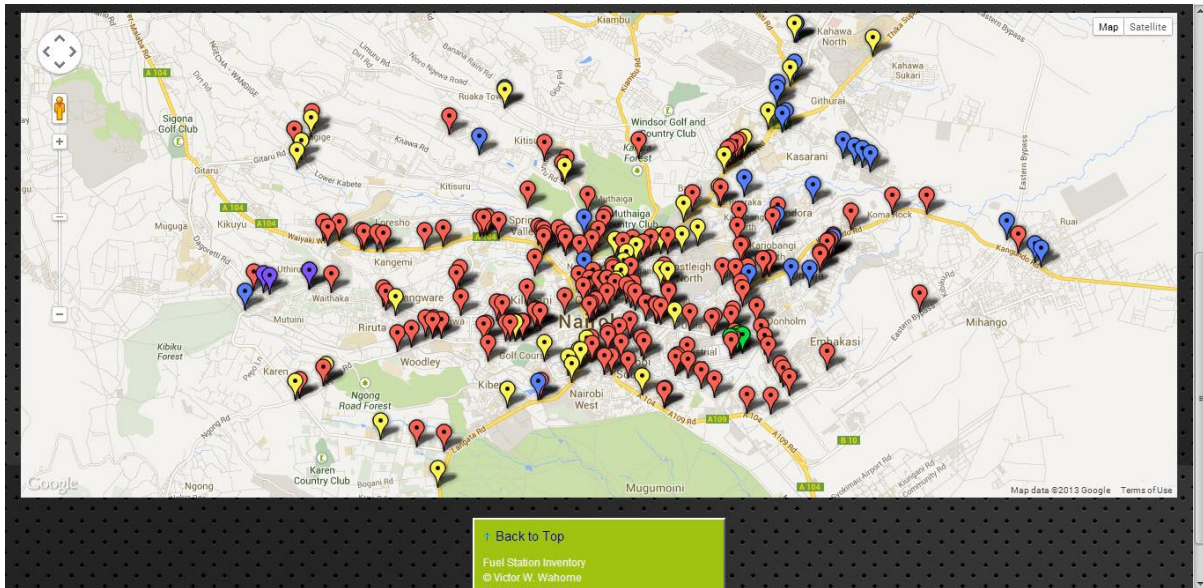

Figure 4: Homepage with User Defined Query. The Homepage allows for the display of all the Fuel Stations to the public. Also, limited information about the fuel stations is also available such as Facility name and its location. Further still, basic querying can be done, for example if one wants to filter stations based on type, e.g. Petrol Stations.

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Figure 5: Map displaying Facilities. *The map is prepared using FusionTables provided by Google. It's a quick and easy way of visualizing spatial data over Google Maps API with custom styling and data publishing features.*
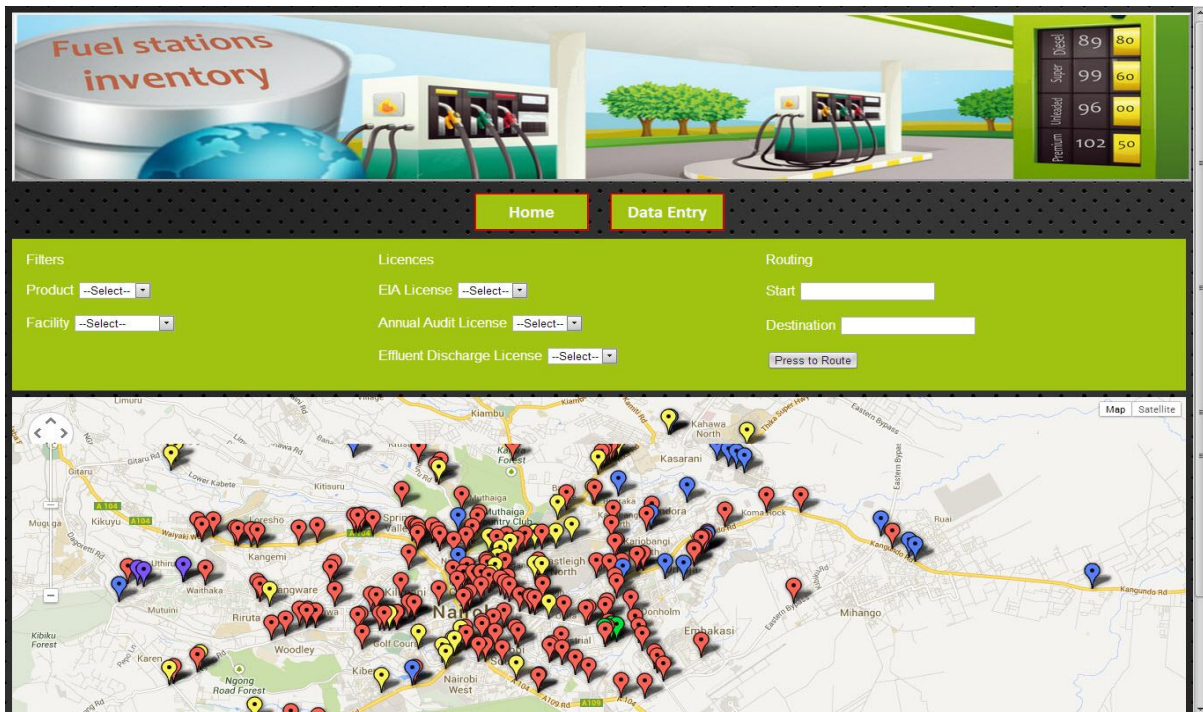
Figure 6: Admin Page*. Once an administrator logins in they can access more web-interactivity such as query based on licensing, see more information on the facilities, and do a route analysis based on the existing fuel station facilities.*
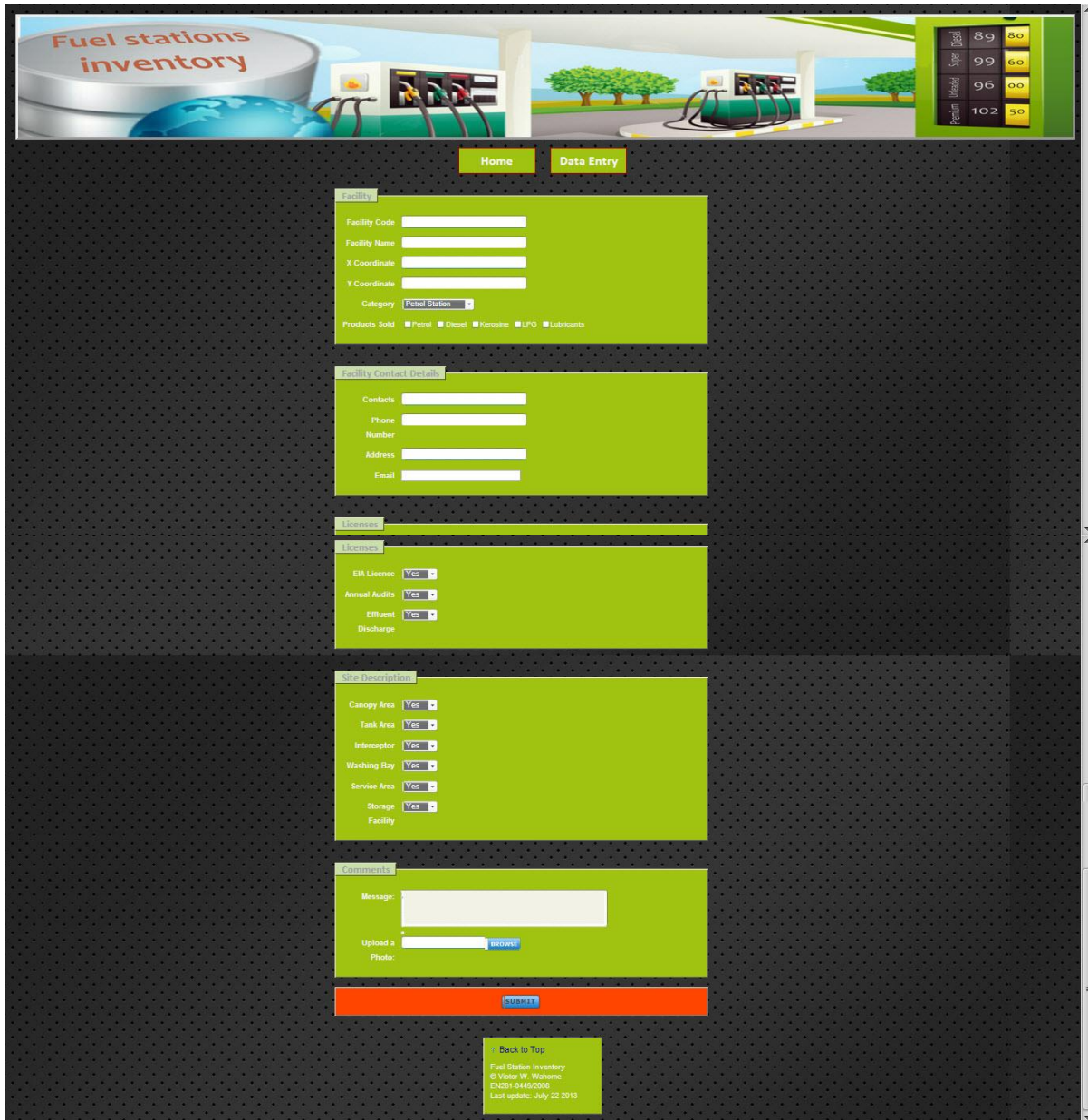
Figure 7: Data Entry page. *This web page serves as an entry point for field collected data. This allows field officers to submit data about the facilities within the region of jurisdiction. Submitted data is transferred to a database. Currently a local database is being used, i.e using phpMyAdmin. Future system would have a database hosted online.*

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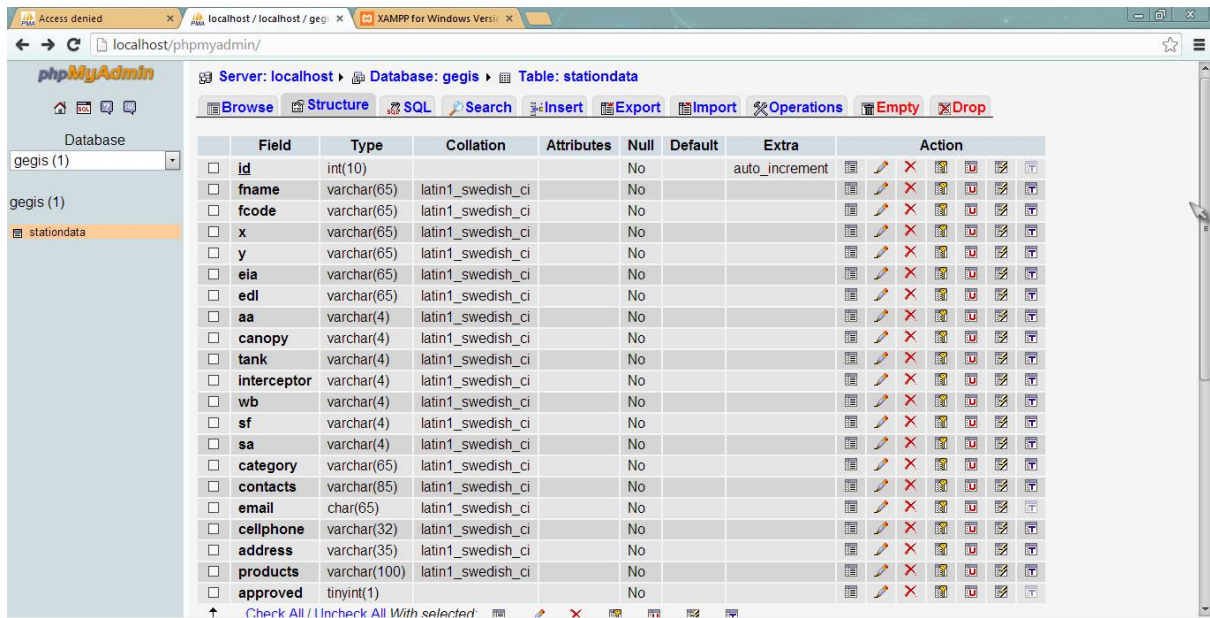
Figure 8: MySQL database. *The data submitted in the Data Entry form is uploaded to the MySQL database through XAMPP. From here the Moderator can view and approve the submitted data forwarded by the field officers. Summary reports can be produced in .csv, PDF, MS EXCEL, and MS Word formats. This can later be updated to the FusionTables for display.*

7. CONCLUSION

The level of compliance to licensing of fuel stations based data collected in the county of Nairobi is one of concern to the relevant authorities and environmentalists alike. Only 5% of stations in the area were found to be fully compliant in terms of licensing with NEMA. Also, 22% of the fuel stations did not have any of the prescribed licenses. Subsequent routine inspections on these facilities is vital in order to ascertain that rules and regulations imposed upon them by the law are followed. The majority of defaulters were found to be in the following constituencies; Westlands, Starehe and Kasarani. Therefore further monitoring and enforcement practices are necessary in order to increase the level of compliance not only in these areas but in the study area as a whole.

State authorities should reconsider their current methods fuel station management. Such methods as using web-interactive platforms to conduct compliance monitoring can be used to make the system more efficient. State authorities would benefit from the use of the web map application developed in this project which seeks to increase the efficiency of compliance monitoring and enforcement. (Purdy, 2009) also explains the use of satellite technology for better regulatory compliance and enforcement of environmental law. Authorities should consider the use of remote sensing in planimetric mapping of the facilities for base years and monitoring their condition by employing high resolution

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imagery such as GeoEye, Pleiades or QuickBird in conjunction with GIS/Remote Sensing Software. Sharing of data among the authorities would boost monitoring and enforcement procedures across the board, from taxes to environmental licenses to operating licenses. The ERC did recognize this and held a meeting which was reported by Xinhua and printed on the Nation Daily[7]. The objective of the meeting was to raise awareness amongst government agencies and thus increase the level of compliance in the sector.

In addition, Kenya's promising oil exploration highlights the need to employ more efficient management and monitoring practices in this sector. (Rourke & Connolly, 2003) describes the needed for regulations at each and every stage in the Oil Industry for environmental, social, health and safety reasons. The potential impact of exploration and production activities must be considered in the context of national and global protection policies and legislation (E&P/UNEP, 1997). The sooner the current management and monitoring procedures improve the better suited the sector will be to exploit the oil resource to its full potential and in an environmentally sustainable manner.

Another recommendation would be to establish Codes of Environmental Management Practice where industry and non-industry groups other than the State Authorities come together to form specifications and codes that govern there activities and functions which impact the environment. Codes emphasis on self-audit rather than State and whose aim is to continuously reduce their environmental impacts, practice product stewardship, and conserve natural resources (Nash & Ehrenfeld, 1997). Such systems would largely improve environmental management and lead to higher compliance levels in the associated sector of the economy. This will ensure that the nation lives in a clean, secure and sustainable environment in line with Vision 2030 ("Kenya Vision 2030," 2008).

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[7] Daily Nation, Monday 6th May 2013.Page 30.

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CONTACTS

Fuel Station Inventory Mapping for Data Management and Compliance Enforcement, Victor Wanderi, Wahome
Jomo Kenyatta University of Agriculture and Technology
P.O. Box 62000-00200
Nairobi
KENYA
Tel. +254-725-58-77-83
Email: wahome.victor@students.jkuat.ac.ke

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