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DESIGN OF ENGINEERING FACILITIES WITH SPACE TECHNOLOGY APPLICATIONS

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Abstract- There is no doubt that the use of advances of modern technology plays highly important role in engineering design and construction processes. It is necessary to mention that today application appropriate technology in all step of engineering implementation has a vital importance. It discovers complexity and demands of projects, suitable management of sources – financial, human, technical and technological facilities and many other aspects. Undoubtedly, a success of engineering executions depends how it can be merged and integrated collected data and their input into the system for analyzing, processing and development of archiving. It is advantage of application of advances of technology. There is one more approach needed to be undertaken with regard to the use of methods of methodology of selected technology for target achievement. It depends of aspirations and circumstances of engineering project execution and expectations of client satisfaction. Up to date circumstances of any engineering activities embraces a wide area of activities and involvement of a large of engineering features solutions. It demands of use different instruments and tools of engineering to meet requirements of the standards and regulations required for project execution. It is being used in engineering from the stage of tender package developments up to the project execution and as built document archiving. The content of such developments can be included the spatial (layouts, drawings) and non-spatial (specifications, cost estimates etc.) aspects of information in a construction project. With regard to this approach, it is necessary to collect required information in the early stage of engineering activities. It is obvious that an accuracy and detailed data will create a good environment for the success of the engineering works in any stage of implementations. It became easy and useful to use advance of computer technology to integrate recent advances of high technology in a wide areas of engineering applications. In this integration, the drawings can be drafted using a computer-aided drafting (CAD) program (AutoCAD) and construction schedule would be prepared using Project Management Software. In the meantime, the use of space technology advances opens a large success in engineering developments that is being a key instrument in project implementation and management processes.

Keywords: Engineering, Engineering Management, Space Data, Remote Sensing, Geographical Information System, Data Processing.

I. INTRODUCTION

Engineering in industry has a huge number of implementations beginning from different types of engineering disciplines involvement up to all required documentations like drawings as built layouts and financial issues and legislations. At the same time, it is necessary to monitor progresses of project executions permanently and add all available data into the appropriate achieved folder for the future. There is no doubt that before any engineering activities where is intending to construct any engineering facilities collection of required information is highly important.

It has to be considered all engineering features on site that makes available successfully integrate existing and forthcoming communication and other necessary engineering structures into unit system. It is especially valuable action when the volume and scale of project is enough big. At the same time, any engineering activities on site demand execution of control of works. The project managers for planning which a serious disadvantage for the decision is making purpose as the spatial aspects fail to provide the required information are still using the traditional approach for scheduling and progress control techniques such as bar charts and the critical path method.

There is pressure on the project managers to shorten the delivery times and thus the current scheduling and progress-reporting practices are in need of substantial improvements in quality and efficiency. Application of methods remote sensing with further development of geographical information system (GIS) can be successfully applied for elimination of such disadvantages. GIS and project management software's with visualization was recognized as one of the most important tools for achieving this goal.

GIS is not a tool for presentation of data. A GIS does in fact create high quality maps that communicate considerable amounts of information in an efficient and attention-getting manner. GIS is both a database system with specific capabilities for spatially referenced data, as well as a set of operations for working with the data.

II. REMOTE SENSING AND GIS APPLICATIONS

Advances in information systems, satellites imaging systems and improvement software technologies and consequently data processing led to opportunities for a new level of information products from remote sensing data. The integration of these new products into existing response systems can provide a huge range of analysis tools and information products that were not possible in the past. For instance, with the higher resolution of the space imagery and change detection of the linear infrastructure situational awareness and damage and assessment by impact of the variety of reasons can be implemented rapidly and accurately.

All this presented information sources can be valuable in the response, recovery and rehabilitation phases of the preparedness management issue. Remote sensing methods and technology as well as the tremendous contemporary expansion of multilateral environmental treaties grew out of separate but parallel developments in the 1960s and 70s. For most of this period scientists and decision - makers on both sides had little contact; remote sensing scientists were unaware of the data needs of the treaty community, and treaty staff and contracting parties were often ignorant of what remote sensing technologies were available.

Using remotes sensing methods and integration of data received from the all available information sources can be merged topographically. It creates an opportunity to develop the GIS, which can be successfully used for a wide area of applications. Using the rapid development of tools such as remote sensing methods and GIS technologies bridging the gaps between data collection, modeling and flood prediction is becoming more feasible. Created database on the base of mentioned methods are a good opportunities for natural disaster management in particularly for river flood damage reduce.

Geographical information System (GIS) is an instrument for integration appropriate data into the geographical system. The data can be provided by using remote sensing methods throughout satellite images. This instrument allows gathering, storing, analyzing, editing, sharing information, and successfully using in wide required areas. In the meantime, GIS is a tool creating an environment for interactive quires, analyze the spatial information, and edit data, developed maps, and present outcomes of all these operations. GIS technology is being used in diverse application areas related civil engineering, such as:

- Engineering management
- Land survey management systems
- Environmental problems
- Hydrologic systems development
- Infrastructure management systems
- Irrigation and drainage system design and construction
- Transportation, and
- Other areas of engineering management

Some applications of GIS related construction can be found out in the literature where has used a GIS technology to construction contractor prequalification [1]. In the developed an integrated GIS that aids managers in activities related to onsite soil condition [2]. In the work presented the system, Material Plan, which integrated GIS, based cost estimates with construction scheduling to automate planning tasks required for materials layout [3].

The studies of investigated the roles of internet, based GIS in E, commerce systems and used of GIS capability to integrate, to manage, and to analyze spatial information, in the integrated GIS with visualization techniques for planning, visualizing of dam construction processes [4, 5]. The main goals of presented paper are following:

1- Remote sensing and GIS as a tool data collection in project design

2- Remote sensing and GIS in project management processes, and

3- Remote sensing and GIS application in engineering facility construction.

III. ADVANCE OF TECHNOLOGIES APPLICATION

Advances in geospatial sensors, data analysis methods and communication technology present a new opportunity for users to increase productivity, reduce costs, facilitate innovation and create virtual collaborative environments for addressing the challenges of security improvement and risk reduction. Sensor developments include a new generation of high-resolution commercial satellites that will provide unique levels of accuracy in spatial, spectral and temporal attributes.

Today the use of remote sensing (RS) methods and GIS technology is one of the interesting computer-based technologies and it is the initial stage of application their potential and capability in engineering. This technology supports the interaction of multiple participants such that they can approach problems in a more comprehensive and systematic way. One of the main benefits expected from the application of GIS to contractor prequalification is the creation of a comprehensive database.

This database can provide a wide range of construction users with a mechanism for rapid retrieval and manipulation capability to satisfy their need of spatial and descriptive information required in the process [6]. Specialists in engineering always are looking for a tool for collection appropriate right data and efficient storage for easily access in needed case, analysis and presentation of geographic data. These efforts have apparently been the result of increasing demands by users for the data and information of a spatial nature.

For solution indicated problems, the use of RS and GIS developments is an excellent instrument. This approach of use such a system goes beyond description where includes analysis, modeling, and prediction. RS and GIS is the means contenting organized collection of computer hardware, application software, geographic data, and personnel designed to efficiently capture, store, update, manipulate, analyze, and display all forms of geographic referenced information.

The next level is the most complicated part of engineering developments. It is necessary to monitor all the process and progress of engineering activities during project implementation phase. A suitability and efficiency of the quality, human resources, timing and financial management issues will depend of how monitoring of engineering works will develop.

IV. RS AND GIS IN ENGINEERING FACILITIES DESIGN AND CONSTRUCTION PROCESSES

This paper consists of construction of shipyard starting from tender, project design and project management stages. It is intended for a newly established shipyard, located on the coast of the Caspian Sea, 25 km distance from Baku, Azerbaijan. The 62 ha yard was specifically designed for the construction of specialized vessels and merchant ships to include:

- Subsea vessels
- Anchor handling tug/supply vessels
- Multi-purpose offshore support vessels
- Tankers and cargo vessels

Operating at full capacity in this first phase, the Baku shipyard is able to perform 80-100 repairs and conversions per year and is expected to achieve an average annual steel output of 25000 tons. The yard also houses:

- 15000 dry weight ton floating dry dock
- 300 ton Goliath crane
- An automatic panel line
- An enclosed blasting and painting facility
- A trolley transfer system

During the geological investigation, topography survey, newly benchmarked installation processes and reclamation and compaction activities, highly skilled experts provided the Baku shipyard project with third party supervision, commissioning services and presented itself as a professional inspection, verification, and testing and certification company. This approach of project execution for this particular project helped to minimize risks related to the quality of works in order to achieve successful and punctual completion.

- Seismic circumstances of the construction
- area - 8 bal
- Average yearly temperature - 14.1 °C
- Partly hot days temperature - +42 °C
- Partly cold days temperature - -15 °C
- The main wind stream - northern
- The main wind stream velocity - 25m/san-40m/san
- Average yearly wind velocity - 6.7 m/san
- Average atmosphere rainfall - 110mm
- Average yearly evaporation - 1344mm
- Average yearly humidity - 68-71%

It is necessary to consider number of aspects of key elements before any engineering and construction activities. In general, it covers a wide reasons and impact needed to be undertaken in the beginning stage of design process. The scale of a big engineering facilities influences up to social consequences making important to collect appropriate data for minimizing and forecasting of risk in the areas as well as other aspects of design and construction phases as reflected below:

- Geohazard studies
- Environmental monitoring
- Geographic Information Systems (GIS) applications
- General risk assessment
- Environmental Impact Assessment (EIA) studies
- Environmental Management and Monitoring Plan (EMMP) and other related plans
- Social Impact Assessment (SIA) studies

The objective of the research has also been undertaken for identification of the most sensitive zones, considering for construction and based on collected data development of Geographic Information System (GIS). Sensitive zones have been discovered using the field observation guided by existing and available information and application of Global Positioning System (GPS) technology. The spatially-referenced database is satisfied the need for accurate and easily accessible construction area. Field crew has been collected GPS point data at the area and around the area of public roads, railways and rivers within the studied sensitivity area.

The GPS gathered data during the fieldwork were entered into the GIS. The GIS was used to generate statistical, spatial and thematic data. A comprehensive set of spatially referenced risk and dangerous zones information has been generated. The steps of research achievements are following:

- Research-all pertinent and relevant existing data in the study area were collected and reviewed.
- Field Investigation- field crew using GPS units, collected latitude and longitude readings at the pipeline crossing of public roads, railways and rivers within the study area.
- GIS Development- GPS data collected by the field crew has been used for development of pipeline system layers based on GIS.

Outcomes, GIS has been developed with reflection of generation of the statistical, spatial, and thematic data. In the meantime hard-copy maps and digital GIS files were produced. The final product of the investigations was the unique database specifications as the digital base maps layers. This was done to ensure a seamless integration of the GIS map into the larger construction area database.

A. Methodology

At the first stage of investigation, it was necessary to collect of the existing information regarding the construction area for further understanding of the status. This information has been undertaken for GIS development for the selected area. In the next stage, the maps were used for identification of the existing configurations in the investigated area. Based on this the present status of the systems and field investigation protocol were developed.

B. Field Methodology

The field components of the study as the presence of features as any communication systems or other facilities existing in the selected area like crossing with roads, railway, rivers as well as pump stations have been involved. For researchers involved for studying such a processes, the witness post contains same useful information as the operator name and an emergency contact phone number which can be accessed and touched in case of necessity as an additional information as convenience of use.

Field staff was experienced in the use of GPS and GIS systems were employed to collect data throughout study area. These field crews were directed to collect GPS point data at system and features, existing in the area crossing of public roads, rivers and railway within the study area.

C. GIS Development

The further stage after the GPS data, digital photographs, and other documentation were collected based on each field investigations and transferred into Microsoft Excel spreadsheet, a method was applied for data projection and conversion and subsequent GIS development.

D. Data Projection and Conversion

The deliverable of the digital data for this project must be seamlessly integrated with the existing data. This required that all digital data generated for this project be based on a Gauss Kruger coordinate system, Zone 8 using Pulkovo 1942 as the reference datum. Therefore, all data brought into project GIS were converted to Gauss Kruger.

It is necessary to mention that an environmental aspect for any engineering activities has a great importance. It relates of government demands as well as social consequences. As a tool to improve environmental cooperation, remote sensing has great promise. Just as remotely sensed images raised awareness of ozone depletion, images of receding glaciers and polar ice caps may also have a similar effect on the publics' awareness of global warning and its willingness to accept stricter measures that would limit greenhouse gas emissions.

Many challenges still exist in technical, institutional and political domains but there are signs such as the organization of Global Monitoring for Environment and Security in Europe that the critical integration of remote sensing technology and international environmental policy is beginning to take place. There are a number of factors may affect the adoption of remote sensing data for treaty negotiation, compliance monitoring, national reporting, and monitoring of environmental trends of interest to MEAs. It can be considered as a problems and constraints include as following:

- Data gaps - availability of right data at the right time
- land cover/Land use applications
- Lack of systematic archiving of remote sensing images
- Regional disparities in data access and in the skills needed to interpret imagery
- Data costs, which are still significant, particularly for high - resolution imagery
- Costs of ground-trothing, remote sensing is seldom sufficient in its own right, but needs to be combined with selective ground - trothing
- Sovereignty concerns
- Most applications are still experimental, and costs of scaling up are significant
- Current lack of an international institution to coordinate among space agencies, value added companies and MEAs for technology and applications development.

It is required to evaluate existing condition of the site before any engineering works where is intending execution of industrial facilities. The sketch demonstrates empty site with a lack of engineering features as shown (Figure 1). It is the site where was planned construction one of the important plant of Azerbaijan not far from the Baku city.

Figure 1. Layout of the selected industrial site

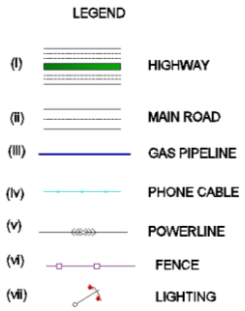
This sketch was integrated into the space image with a high spatial resolution 1m. It is desirable to summarize as more as possible data into this system for further processing. The site contents almost a few engineering elements (Figure 2). There is an advantage that all collected data from different sources geodetic, space image site data including data gathers from social and public sources integrated into coordinate system accessible for positioning identification. This approach is important not only in the stage of project design during any available data collection, as well as highly useful when project completed and all data has been archived. It makes easily to select and use at any needed case which is the vital consequence of used technology for project execution.

Figure 2. High spatial resolution space image for 2009

An investigation based on space data by means of RS methods and developed GIS technology opens an opportunity comparatively easy to integrate existing engineering facilities into the system constructed structure. An actual conduction of the site after almost completed plant with the main engineering facilities (Figure 3(a)).

All involved engineering elements to this data are reflected as legend below as Figure 3(b). From this view can be easily discovered advantages and comforts of merging data with use of RS methods and GIS technology applications.

(a)



(b)

Figure 3. (a) IKONOS space image processed with engineering features of industrial site, (b) Legend of processed space data

V. CONCLUSIONS

Analyzing above mentioned aspects it can be concluded with the following results and outcomes:

- An increasing of classified layers of the developed GIS based on RS methods will be created an environment of comprehensive application of data within this system.
- RS and GIS technology has an advantage in engineering management for engineering planning, time, human and financial management issues. GIS can provide with powerful information, not just how things are, but how they will be in the future based on changes.
- RS and GIS usage for engineering management system given as an example demonstrates of flexibility of use of GIS technology in the wide area. Integration of collected information with needed other investigated or monitored fields can be successfully adopted into common targets for further developments.

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BIOGRAPHIES

Arif M. Hashimov was born in Shahbuz, Nakhchivan, Azerbaijan on September 28, 1949. He is a Professor of Power Engineering (1993), Chief Editor of Scientific Journal of "Power Engineering Problems" from 2000 Director of Institute of Physics of Azerbaijan National Academy of Sciences (Baku, Azerbaijan) from 2002 up to 2009, and Academician and the First Vice-President of Azerbaijan National Academy of Sciences from 2007 up to 2013. He is laureate of Azerbaijan State Prize (1978), Honored Scientist of Azerbaijan (2005), Cochairman of International Conferences on "Technical and Physical Problems of Power Engineering" (ICTPE) and Editor in Chief of International Journal on "Technical and Physical Problems of Engineering" (IJTPE). His research areas are theory of non-linear electrical chains with distributed parameters, neutral earthing and ferroresonant processes, alternative energy sources, high voltage physics and techniques, electrical physics. His publications are 280 articles and patents and 5 monographs.

Nargiz A. Babayeva was born in Baku, Azerbaijan on December 06, 1989. She received B.Sc. degree in Architecture Completed Courses from Azerbaijan Architecture and Construction University, Baku, Azerbaijan. Currently she is a Master degree student in the indicated area at Azerbaijan State Academy of Fine Art, Baku, Azerbaijan. She has been employed as a Junior Engineer for a company providing engineering services for the international companies operating in Baku, Azerbaijan.

Namig Rahimov was born in Baku, Azerbaijan, in May 1948. He has a high degree in Mine Engineering with specialization in Geodesy received from Azerbaijan State Oil Academy, Baku, Azerbaijan. He has the experience more than 45 years in the indicated area as the leading of many complicated projects in Geodesy. Currently, he is working in Encotec Company, Baku, Azerbaijan providing geodetic and topographic services within the scale of different projects.

Rustam B. Rustamov was born in Ali Bayramli, Azerbaijan, on May 25, 1955. He is an independent expert on Space Science and Technology. In the past, he was in charging of the Azerbaijan National Aerospace Agency activities as an Acting Director General. He has mainly specialized in space instrumentation and remote sensing and GIS technology. He has graduated Ph.D. at the Russian Physical-Technical Institute, S. Petersburg, Russia. He was invited for the work at the European Space Agency within the Framework of the United Nations Program on Space Applications at the European Space Research and Technology Center, the Netherlands. He has appointed for the United Nations Office for Outer Space Affairs Action Teams (member, Vienna, Austria), United Nations Economical and Social Commission for Asia and the Pacific (national focal point, Thailand), International Astronautically Federation (Federation's contact, France), Resent Advances in Space Technologies International Conference Program Committee (member, Turkey). He is an author of 11 books published by the European and United States famous publishers and more than 70 scientific papers.