

## **Applying GIS and Remote Sensing Techniques in Landscape Planning Studios**

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### **ABSTRACT**

The demand in the Saudi markets for qualified environmental and landscape planners with Geographic Information System (GIS) & Remote Sensing knowledge, has led the Landscape Architecture Department, Faculty of Environmental Design, at King Abdulaziz University (KAU) - Jeddah to start a pilot project applying GIS and Remote Sensing techniques in a fourth year (third year department) landscape planning studio.

Two projects were selected for potential application, the first assesses Ragadan forest in Al-Baha region for potential eco-tourism activities, while the second one document and propose rehabilitation programme for the historical foot and camel trail in Jabal Kara, which forms part of the old craven rout between Makkah and Taif, which Prophet Mohammad (PBUH) used during his Taif visit. Three students were assigned for each project. A series of lectures introduced the students to the potential use of GIS and Remote Sensing in their studio projects, this included: applications of Remote Sensing; types of satellite images, ERDAS IMAGINE software; Introduction to GIS and ArcView software; the use of Global Positioning System (GPS); and Surfer software. The Students were instructed in class and during fieldwork in systems principles and their application in image rectification and samples collection for image classification. Aerial photographs from the King Saudi Geological Survey (KSGS), and Satellite images from King Abdulaziz City for Science and Technology (KACST), were used to

compare changes during the last fifty years, in land use, vegetation cover, and urban growth. Images used included: Aerial Photos, Landsat 5, SPOT PAN, and IKONOS. The process used included: on screen digitizing, generating contour maps; generating slope and aspect analysis, and 3D scenes; image spectral enhancement and classification.

The paper discusses, the studio concept and structure; lecture series and fieldwork; and software and techniques used. A conclusion synthesizes the potential use of GIS and Remote Sensing in landscape planning studio and possible improvements to the process used.

**KEYWORDS:** Environmental Planning, GIS, Remote Sensing; GPS, Eco-Tourism, Cultural and Historical Tourism, Landscape Architecture, Landscape Planning Education.

## **INTRODUCTION**

The market for highly specialized GIS professionals continues to grow at annual rates of ten to fifteen per cent (Farley 2004). This can be even higher in the Saudi market, in which the demand for qualified environmental planners and landscape architects with GIS & Remote Sensing knowledge is raising steadily for the last ten years. This increasing demand has led the authors to design a programme to introduce such skills to the students as an integral part of studio assignment, emphasizing the potential practical application in design and planning projects.

In principle, information systems, especially geographical information systems (GIS), can provide a means for defining, collecting, disseminating, and interpreting needed information while also providing a foundation for the analysis of current problems within the education task. Such skills so vital, as (Çabuk et al., 2004) argue that, the wealth held by the developed countries today depends on the information they have rather than on the natural resources they own

The selected studio was a fourth year (third year department) landscape planning studio. Out of four different projects, two projects were identified as potential fields for applying GIS and Remote Sensing techniques. The other two projects that were running at the same studio, were dealing with urban landscape issues. The first selected project assesses Ragadan forest in Al-Baha region for potential eco-tourism activities, while the second one document and proposes preservation and rehabilitation programme for the historical foot and camel path in Jabal Kara, which forms part of the old craven rout between Makkah and Taif, which Prophet Mohammad (PBUH) used during his Taif visit. Three students were assigned for each project. A series of lectures introduced the students to the potential use of GIS and Remote Sensing in their studio projects. This included: an introduction to Remote Sensing, types of satellite images, applications of Remote Sensing, and an introduction to ERDAS IMAGINE software; Introduction to GIS and its applications in landscape planning, including the use of ArcView software; and an instruction to use GPS for coordinates and mapping. In Addition the use of Surfer software in terrain analysis was explained. The Students were instructed in class and during fieldwork in systems principals and their application in image rectification and samples collection for image classification. Aerial photographs from the Saudi Geological Survey (KSGS), and Satellite images from King Abdulaziz City for Science and Technology (KACST), were used to compare changes during the last fifty years, in land use, vegetation cover, and urban growth.

The main objectives of this paper is to present the experience of this experimental studio; and to evaluate the use of GIS and Remote Sensing application in Landscape Planning studios; and the potential integration in design and planning studios during the five years BLA (Bachelor of Landscape Architecture) program. Furthermore, determining the prerequisite courses, that may influence restructuring the department educational plan. The paper consists of five sections: 1-Introduction. 2- studio structure and concept. 3- lecture series, and fieldwork. 4- software and techniques. 5- a conclusion, synthesizes the potential use of GIS and Remote Sensing in landscape planning studio and possible improvements to the process used.

## **STUDIO STRUCTURE AND CONCEPT**

One of the most effective ways of learning process associated with technical skills is through the problem-solving exercises of Problem-Based Learning (Dias, 2004). The authors noticed that theoretical teaching of GIS and Remote Sensing is not enough to develop the skills needed in professional practice, therefore the studio structure aimed to integrate the lecture series with studio assignment, in order to provide students with the chance to apply the theoretical knowledge, in a simulation of real life application.

Education systems that embrace positive change through the ongoing generation, use, and self-assessment of contextually relevant data are more likely to provide a quality education to students than those that are static (Peters and Hall, 2004). Similarly, this argument support the concept of providing the students with the skills and capacity that allow them to engage in active work after they have completed the university programme, rather than giving them theoretical information. By learning the processes, students will be able to apply the skills learned in different fields of their interest. For Remote Sensing, the data may come from different sources with different characteristics. From the data, students must learn how to select the appropriate data form and extract the necessary information for a specific application. They should be able to decide which image processing techniques they have learned are most appropriate to use with the available data, in order to obtain the most accurate information. In the case of GIS application, students should be able to analyze the various layers using spatial analytical tools and present the results in different ways by using the tools provided by a standard GIS environment.

The rapidly increasing demand for professionals with a background in Remote Sensing and GIS has forced many universities all over the world to restructure their courses and programmes and to introduce new under- and postgraduate programmes (Çabuk et al 2004). Students at the department of landscape architecture at KAAU, have to take three courses related to the information

technology. The first is a faculty requirement, which introduce basic computer skills and general application, the second is, landscape technology III (third year department) that includes a short introduction to Remote Sensing. The third is computer application in landscape architecture (fourth year department) that includes an introduction to GIS. The students don't have the chance to use the advantages of these courses neither in their studios nor in graduate projects. In this experimental studio the authors tried to put the power of GIS and Remote Sensing in the students' hands to understand and use these technical tools in their projects. The evaluation of the out come of this studio may lead to restructuring the information technology courses, sequence and contents.

## **LECTURE SERIES AND FIELDWORK**

(Haubold, 2003) stated that the general problem confronting science education is the inability of students to see or experience the phenomena being taught, which often leads to an inability to learn basic principles and to see the relationship between two or more concepts and their practical relevance to problems in real life. To overcome this problem, series of theoretical lectures are given to the students beside several field trips and lab exercises to fill the gab between the theoretical and real problem. The lecture series covered three main subjects; they are Remote Sensing, GIS and GPS.

Remote Sensing lectures included: introduction to Remote Sensing and its application, specially land cover and vegetation types maps; characteristics of electromagnetic radiation and its interaction with atmosphere, plants and soil; types and characteristics of available satellites and images; image processing including geometric corrections; spectral enhancement and image classification with both supervised and unsupervised methods. GIS lectures included: introduction to GIS and its applications; types of data used with GIS; spatial analyst and 3D analysis extension; raster analysis; surface analysis, concentrating on slope and aspect derivation. GPS lectures included: principals of GPS;

components of GPS; distance measuring; precise timing; position determination and reference datum.

Understanding the changing landscape implies knowledge of the processes and mechanisms that cause them (Antrop and Eetvelde 2004). Several field trips were performed to the locations of the two projects to collect land cover samples for image classification and accuracy assessment and to collect other data needed for the projects.

In the case of Ragadan forest several field trips assessed the students in applying their GPS knowledge in drawing map for the road and track net work existed in the forest, this was important in the first phase, as no accurate map was available at the time. Furthermore, recording vegetation study plots was useful in coordination with IKONOS image as, each plot record of dominant species helped in ratifying image processing, leading to vegetation map of the forest. Students faced difficulties in classifying vegetation cover via the use of ERDAS IMAGINE Software, these difficulties were expected because of the limited practical training they had, thus, several attempts were needed to reach an acceptable result.

In the case of Jabal Kara historical caravan trail, several sectors of the trail were not visible in the field, due to the construction of a vehicles road in the early 1960's. An aerial photo dated to 1953 was used to register the missing sections, in the case of inaccessible sections; the IKONOS image was useful in locating parts of the trail.

The following section describes the techniques used by the students to achieve their design and planning goals.

## **SOFTWARE AND TECHNIQUES**

Several software and techniques were used during the studio period. ERDAS IMAGINE 8.5 was used for image processing (enhancement and classification). ArcView 3.2 was used for spatial and surface analysis. Surfer 8 was used for contour construction and surface analysis. AutoCAD 2004 was

used for on screen digitizing of topographic maps after scanning them. Finally, Adobe Photoshop was used for the final touch of the presentation.

In the case of Ragadan project, several satellite images from KACST were used. These images were Landsat\_5 TM for years 1986, 1991 and 1995, SPOT PAN for year 2000 and IKONOS image for year 2003. Topographic map and Aerial photographs for year 1953 from KSGS were also used.

Firstly, the site characteristics were studied using topographical maps to define the main structural components of the landscapes. Secondly, the topographic map was scanned and the contour lines of 20 m interval for the study area were digitized on screen using AutoCAD 2004. Surfer 8 was used to generate a contour map of 10 m interval and exported as a shape file to be used with ArcView. Thirdly, ArcView 3.2 was used to convert the shape file to TIN, from which the aspect and slope were derived and a 3D scene was constructed. Fourthly, ERDAS IMAGINE 8.5 was used to perform image enhancement and classification as the images were geometrically corrected. The first step was to perform various spectral enhancements on the rectified image. Subsequently, FCC (False Color Composite) was generated from the enhanced layers. Finally classifying the image with the help of the collected field samples.

Another image was constructed by using resolution merge of IKONOS image with Landsat image. The steps of enhancement and classification were repeated on the new image.

## **CONCLUSION**

The effort in this studio by both, instructors and students was higher than a standard fourth year studio. Students found it difficult to understand the need for lectures within the studio time, especially it covers topics not related directly to design and planning. Fieldwork proved to be very demanding for both parties, especially when considering the distance factor. Jabal Kara is 150 km away from campus, the site located in a steep slope. Ragadan forest is 450 km to the south via difficult mountain road.

The general outcome from using GIS and Remote Sensing in the studio was less than the expected. This can be attributed to the use of traditional methods for problem analysis. Indeed, the time factor was critical, as long time was spent in data collection. This limited the time allocated for practical application. Data availability can be critical in future application of GIS and Remote Sensing in design and planning studios. It is recommended in the case of Saudi Arabia, that data should be prepared prior to commencing such exercise. It is highly recommended to establish an archive of digital data in the faculty library to be used by teaching staff and students.

It is been noticed that the format of group work, used in the studio, resulted in a situation where one of the group will take over the GIS and Remote Sensing application. This is natural as some students have a better computer skills and more interest than others. However, this meant that at least half of the students ended by little practical experience in the field. Consequently, it is recommended that, such exercises must be assigned individually, to ensure that all students had the chance to apply theoretical knowledge.

Prerequisites, and computer application courses, can have detrimental influence in the success of such experimental studio. The sequences of related courses need to be adjusted to allow for students to take the computer application course in the fall semester of the third departmental year. This will allow them to be prepared for the landscape planning studio in the spring semester of the same year. The content of the Computer Application, need to be directed more towards practical exercises rather than pure theory, such exercise can be assigned the bulk of course grade, emphasizing in-class assignments, and real life problems. Nevertheless, concurrent lectures integrated within the studio time still need to be a tool for advancing knowledge and reviewing basic Remote Sensing and GIS skills. Students need to be encouraged to read assigned reading materials, in addition to research in applied and scientific journals. Written exams found to be a good incentive.

In addition to the landscape planning studio, students should be encouraged to apply such skills in their graduation projects;



furthermore, for those who are capable and interested, Remote Sensing and GIS application can be the emphasis of their graduation project.

Generally we can state that this experimental studio despite the discussed difficulties was a good first step in integrating GIS and Remote Sensing application in landscape planning studio. Future application will help in preparing graduates of the landscape department to have a competitive edge in the market of professional designers and planners.

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