ESTIMATION OF POTENTIAL STREAM BEDS USING DEM:
CASE STUDY KAHRAMANMARAS CITY

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Abstract
Cooperation of using Geographic Information System (GIS) and photogrammetric aspects have an influential affect on geographical and geological applications since long. Developing analysis techniques are useful for determining dried stream beds in order to detect possible mineral deposits. In this paper, GIS analysis on the Digital Elevation Model (DEM) data such as calculating height, slope, and aspects is performed in the selected region, and also satellite image is used for creating 3D model of the site area. Kahramanmaras city is selected as the site area for the analyze. In the result of the study, site area is classified with two different model for estimating higher and lower potential dried stream beds with using GIS analysis. The land cover and land use map results are also combined with the 3D model of the region for geovisualization of potential dried stream beds. In the site area, field work is also done for collecting some sample geological samples. Also, these sample points assisted for the study of 3D model of the potential dried stream beds results. In the conclusion section, the results are discussed for evaluating potential mineral deposits in the region. Usage of these land cover and land use maps are predicted for the decision-making process of geological engineers.

Keywords: 3D Modelling, Geographical Information Systems, Digital Elevation Model
INTRODUCTION

Depending on the advances in high technology devices, the demand for Rare Earth Elements (REE) is raising continuously for a couple of decades. The REE production can be divided into three eras. Monazite place era (till 1950’s), Mountain Pass (carbonatite) era (till 1980’s) and Bayan Obo (carbonatite) era (recent). Although, the mass production for Light Rare Earth Elements (LREE), (lanthanum (La), cerium (Ce), praseodymium (Pr), neodymium (Nd), samarium (Sm), europium (Eu) and gadolinium (Gd)) are related with large carbonatite complexes. Also, the Heavy Rare Earth Elements (HREE) (yttrium (Y),erbium (Er), holmium (Ho), erbium (Er), thulium (Tm), ytterbium (Yb), lutetium (Lu)) production heavily relies on placer and ion exchange deposits. The primary exploration technique is taking examples from stream beds which are related with old metamorphic or acidic magmatic rocks. Stream bed sampling is an easy way to find out heavy mineral deposits, (HREE, magnetite, zircon or gold). However, the cost for geochemical analysis and other field work expenses can be cut down with the use of remote sensing techniques. These techniques can assist for detecting potential dried stream beds. In the case of streams are able to carry REE inside, and especially on the stream meanders (the way of the water changes in sudden) and HREE remain on these side of stream meanders mostly. In field surveys, geologists collect random samples especially inside corner of these stream meanders. Because, depending on the velocity decreasing on these corners and being heavier than flowing water, HREE stand on stream bed beyond continuing within flowing water any more.

Firstly, geologists do reconnaissance about possible placers all around the fields before going to field works. Moreover, they mostly peruse thematic geological maps (land cover maps) if the maps of study area are produced before. Besides, geological maps, other auxiliary data aid for making decisions about field. After researches on the middle scaled maps, for producing larger scaled maps of the field and detecting geological important side, the field work is needed. These field works take a lot of time, also cost big amount for extended fields and areas. These field works include collecting samples from the side areas with a team, who continue collecting samples with ground surveys aided GPS in order to list of sample points’ coordinates. Furthermore, after field works, analysis of samples would take more time and cost big amounts again. Reducing total amount of the costs for these investigations and also for time-saved researches; remote sensing technologies are advantageous sufficiently. As well to exploration field works of geological studies, remote sensing technologies give adequate results for several stages of geological studies with using image processing methods on satellite images. These techniques vary and consist of image processing and surface analysis. Using DEM data and obtaining 3-D model of the area can lead the classification step for an approach to potential stream beds. This study investigates about 3-D model of the area and surface analysis on the model in order to investigating of the potential stream beds for future geological field surveys.

RELATED WORKS

Throughout the years, the mineral deposit has significant researches about The morphology of streams are playing crucial role for exploring mineral deposits. Defining topography in highly manner and quantitative analysis on the surface models are some of the approaches. According to S. Trevisani et al., slope index is valuable and can be used for identification the channel profile in generally in the case of preparatory for geostatistical calculations that is used more channel bed roughness [1].

Additionally, slope analysis, there are several surface analysis methods for producing surface models. Obtaining high-resolution topographical model aid to evaluating the stream beds, as well. S. Trevisani et al. claimed that, directional variograms in the flow way and local changes showed that, has significant role for identifying morphologic situations like steps, pools and clusters of large boulders [1].

Researches and applications are increasing by time on these field of surveys and sectors invariably. Also, scientific studies are continuing to produce robust results about the subject day by day.

DATA AND METHODS

In the study satellite image and Digital Elevation Model (DEM) are used for the processes as data. Satellite image acquisition date is 3th March 2017. Spatial resolution of SPOT 7 image is 1.5 meter. As DEM data ASTER GDEM is used for the study. It is estimated 20-meter accuracy for vertical axis at %95 confidence and 30-meter accuracy for horizontal axis at %95 confidence for ASTER GDEM [2]. In the study, 3-D model is obtained at first. Then, different surface analysis techniques are performed for weighted overlay analysis model. In surface analysis, calculating slope, obtaining aspect and hill shades of the selected area are main analysis. After these operations, potential stream beds are obtained on the model. Moreover, the classification step is applied of showing three different classes for potential stream beds according to multi-criteria analysis on the model.
Digital Elevation Model

A digital elevation model (DEM) can be defined as a two-dimensional discrete function of elevation of the topographic surveys. DEM is a less costly and objective method than traditional terrestrial methods and visualization methods in terms of land component detection. It is a valuable resource for landscape characterization and soil mapping [3].

Digital elevation modelling emerged in photogrammetry in 1950s. And, digital elevation models (DEMs), two-dimensional discrete functions of elevation, became main source of information on topography. Currently, digital terrain modeling is used to solve various multiscale problems of geomorphology, hydrology, remote sensing, soil science, geology, geophysics, geobotany, glaciology, oceanology, climatology, planetology, and other disciplines [4].

With the developing technology, many new methods have emerged for creating DEMs. High resolution DEMs can be obtained due to progress in GNSS, LIDAR surveys and Structure from motion (SFM) techniques. In addition, quasi-global DEMs can be also produced using satellite images such as ASTER GDEM and SRTM1. In this paper, ASTER GDEM data is used to analysis of topographic surface [2]. ASTER GDEM was developed by Ministry of Economy, Trade and Industry (METI) of Japan and the United States National Aeronautics and Space Administration (NASA).

APPLICATION

Aim of the Study

One of the most important reasons why geologists work on the field is the search for new mineral deposits. The technological developments in recent years lead to a big demand for REE (Rare Earth Elements) due to their usage on electronic devices. Therefore, a working field in Kahramanmaras - Göksun province, Gücüksu district is chosen. The study area is a suitable environment for a placer type deposition for HREE (Heavy Rare Earth Elements) due to the presence of a Late Cretaceous, syncollisional-I type Esence granitoid [5]. The samples gathered form the study field which includes distal zones of altered granite body show a significant enrichment in some of the HREE such as Yttrium (45-63 ppm), Ytterbium (5.5-7.1 ppm) and Erbium (5.5-7 ppm). Compared to some other REE enrichments in Turkey (i.e. Isparta Gölcük Volcano) [6], [7], [8]. It is clearly observed that HREE are enriched by ~2.5 times. In contrast, geochemical analyzes have revealed that LREE such as La and Ce are very low in concentration (app. 6 times low concentration). Considering the geology, geomorphology and geochemical analysis of the study area, it is highly probable that placer or ion absorption type HREE deposition occurred. Remote sensing data will be helpful for determining possible deposition zones, especially in recent or old stream beds.

Three Dimensional (3D) Model

Three Dimensional (3D) model is produced with using satellite image and DEM data. ArcMap toolbox is used for this application. Geovisualization of Land Use and Land Cover (LULC) is more obvious on the 3D model. Also, with this separability of the model is superior than 2D raster image. Besides, surface analysis and classification step, LULC classes seem more apparently on the 3D model. In the figure 1 the East aspect of the 3D model is shown. South facade of the model is shown in the figure 1 below.

Figure 1. (on the left) East and (on the right) South aspects of 3D model of the site area
With using 3D model, surface analysis is performed for the site area in order to estimating specifications of the surface. Slope, hill shade, profile, aspect and curvature analysis are completed and collocated for estimation. These kind of quantitative analysis enable evaluation of the earth surfaces with obtaining topography knowledge in high resolution.

RESULTS AND DISCUSSION

On the study area, it is expected that there are several dried main channels and small streams near hills and above the urban area. It is known that, these stream beds carry many kind of minerals from placer on the Earth. The important side is these minerals stay in which points on the streams. Generally, the heavy minerals stay behind when the stream velocity changes due to topography and surface changes on the stream beds. Especially, inside corner points of the meanders are important for collecting geological samples. Geologist can easily and effectively use LULC maps, geological maps as well. In the result of the surface analysis and classification, they can save more energy and cost from long duration of the traditional methods that using theodolites and collecting sample points from the fields randomly.

According to these aims, significant surface analysis is performed as slope, aspect, hill shade, curvature, profile on the same area. Slope and hill shade analysis maps are shown in figure 2 below. For all surface analysis, maps are produced as base-maps for geologists. Furthermore, for these kind of studies, using more accurate DEM data or elevation data can give more proper results with reducing the bias on the calculations of the models.

In the result of the study, two different model are obtained with using overlay weighted analysis. As input to the modeler, chosen surface analysis are used. In the Model I surface analysis are used in equal weighted for overlay weighted analysis. As a result, 5 different classes is obtained. These class have meanings about sudden and considerable changes on the topography. This means, the minerals of the stream is able to stay on the critical points. Geologist can use these model maps as a guide for choosing sample points on the field. In model II, different weights are given to the modeler as surface analysis input. Furthermore, in the end of the results of model II has 4 classes are obtained for decision makings of potential stream beds with minerals. Model I and model II is shown in figure 3 below.
Especially, when the low class number and the high class number is near on the maps, there is a sudden and significant change on the topography in the regions. That pixel means, if they also infer a dried river on the field, possible mineral deposit points can be detected. In the future studies, these maps are aimed to be used for collecting geological samples and evaluating the results in scientifically. If the samples contain, wanted HREE and LREE on the site areas, the field studies can gain more effective and cost-saved way, as well.

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REFERENCES


BIOGRAPHY

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Cengizhan İpbüker was born in Istanbul-Turkey in 1959. He completed his primary and high school education in Istanbul and received his B.Sc. degree from the Istanbul Technical University, Civil Engineering Faculty, Geodesy and Photogrammetry Department in 1985. After participating in some national engineering projects by private sector, he has started working as research assistant in ITU Geodesy and Photogrammetry Engineering Department Cartography Division in 1990. He received his M.Sc. degree in 1994 and his Ph.D. degree in 1999. He has been working as Professor in the same department since 2009. He is married with two children.

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