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REMOTE SENSING AND GIS ENVIRONMENT IN SOIL INDICATORS CLASSIFICATION FOR WATER SUPPLY SYSTEMS

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Abstract- It is commitment experts and researches to select and develop appropriate methods and methodology for saving the water especially is to use all efforts in limitation of drinking water losses. The water is one of the most important factors of human life. The safe and lossless water supply is the human commitment and obligation. For this reason, there is always aspiration to minimize the loss of water during supply through existing systems. It is obvious that it was all the time attempts efficiently to solve the problem of water supply for a different purposes of irrigation, watering and drinking. At the same time it has been concentrated attention how to monitor and to arrange high effectively observation process to assist and evaluate all the track of delivery of the water to use end user system. It demands to find out appropriate approach to achieve expected outcomes in subject indicated above. There are traditional methods for water leaks monitor and discover. But existing traditional methods for this purposes do not satisfying today expectation with the level of accuracy, time consuming and cost efficiency. The cost relates not only to technological and methodological aspects of study. It is highly important to detect and discover the leakage in time to minimize losses of the water. In this study an approach of monitoring and observation of water supply systems by use of Remote Sensing method has been offered. Advantage of this method is achievement of rapid and cost-effective assessment of water supply systems conditions. In the meantime, soil indicators identification is studied and classified for monitoring and observation of water supply systems.

Keywords: Water Supply, Soil Indicators, Remote Sensing, Space Image, Space Image Processing, Field Data Collection and Integration.

I. INTRODUCTION

Water leakage is one of the common problems for many areas around the world [1-3]. There is no doubt that monitoring and observation of such problem is a complicated for the reason indicated below. People involved for solving problem in water leakage in communication systems have offered several technology and techniques which concerns application of radar technique, geophones, gas filling, and many others. It can be pointed out a variety of methods and techniques such as acoustics, radioactive, electromagnetic, ground penetrating radar and linear polarization resistance have been applied many years for water pipeline leakage observation and detection [4].

Remote sensing method uses for a wide range of applications including water management with performance successful executions in water leakage monitoring and detection. Studies demonstrates promising and attractive results from its use for indicated purposes and aims. Application of remote sensing technology and techniques for water leakage detection are time and cost effective compared with traditional, intrusive methods.

The use of vegetation is the convenient tool in classification. It has wide areas of applications. For this reason, vegetation indices (VI) are the instrument as a key segment of satellite image used for satellite information processing. There are five main categories according to equation or the use of each index, within the processing stage which include [5]:

- broadband indices;
- narrowband indices (hyperspectral);
- leaf pigment indices;
- stress indices, and
- water stress indices.

The VI classification depends of the electromagnetic parameters used in equation for calculation (broadband and narrowband indices). The fact is that it is necessary to identify spectrum band in definition and classification of water leakage. For this reason selected spectral band leak gives a best reflectance to a ratio of near infrared (NIR) to red reflectance.

Multispectral remote sensing imagery is using with high-resolution imaging sensors where necessary and required (with spatial resolution from 1 m up to 5 m) in the visible, NIR and thermal infrared wavelengths. It has been discovered that airborne multispectral imaging (less than 1 m which available to achieve) is a useful tool in the detection of irrigation canal leakage in distribution networks [6]. It is important to state that based on analysis of the processed image data from red, NIR and thermal bands is highly consistent with the observations from field investigation.

Actually, space technology applications needed to be integrated processed space image with field measurements which impacts to achieve high accuracy information. The use of space information from individual bands, particularly from the thermal band, allows detect leakage from irrigation canals. The NDVI image, which combines the data from the red and the NIR bands successfully operates for detecting and correcting errors observed on the thermal imagery.

There is no doubt that it is difficult to accomplish challenging of expectations in water leakage monitoring and observation with application of existing traditional methods limits for the reason of required more time for detection and the cost in significantly high. At the same time it is require to indicate that in some cases part of the water network systems locate in inaccessible areas, away from the main road network and urban areas as the consequence makes difficult to access the area observation for collection appropriate information for assessment of circumstances and condition of the system.

This paper presents the results of monitoring of water supply system by use of advances of space science technology. For detection and classification of water leakage it is offered to use indicators such as soil conditions and vegetation as the instrument during space data processing.

II. AREAS EXPECTED TO BE STUDIED

We are talking about Azerbaijan. Azerbaijan lining from the southeastern part of the Caucasus, reaching to the Caspian Sea, between Iran and the Russian Federation (Dagestan). The country is in the border of Europe and Asia, as the Caucasus Mountains are the conventional border between the two continents. So, the northeast half of Azerbaijan is in Europe and the southwest half is in Asia.

The Yuxari-Garabakh Channel exports main water from the Mingachevir Reservoir (artificially constructed lake) on the upper Kura to the Araz River. The Samur-Absheron Channel redirects water from the Samur River on Azerbaijan's northern border to the Absheron Peninsula. The Mingachevir Reservoir, with an area of 605 square kilometers that makes it the largest body of water in Azerbaijan, was formed by damming the Kura in western Azerbaijan. The waters of the reservoir provide hydroelectric power and irrigation of the Kura-Araz plain. Most of the country's rivers are not navigable.

Samur-Absheron channel is an irrigation channel in Azerbaijan flowing from Russia-Azerbaijan border to the Jeyranbatan reservoir supplying Baku city with drinking water, capital of Azerbaijan.

Samur-Absheron channel starts near the Qaleysuvar Mountain in Khachmaz Rayon one of the districts of Azerbaijan and flows to the south until it discharges into the Jeyranbatan reservoir maintaining with water as one more water source. Its length is 195 km (121 mi). The first section (Samur-Devechi) of the channel which ends intersecting Atachay River is 110 km (68 mi) and was built in 1940 for irrigation purposes.

The second 85 km (53 mi) section starts from Atachay and ends at Jeyranbatan reservoir. Its construction was completed in 1956. Until 1953, the channel was named Joseph Stalin channel. In the recent years, the channel was extended for 72 km (45 mi) from Jeyranbatan reservoir to deep into Absheron Peninsula and was called Main Absheron Channel. Samur-Absheron channel has over 350 hydro-technical structures and two pumping stations handling the flow of water. One of them is located in Hacı Zeynalabdin settlement near Sumgayit. It was previously called "Nasosny" (translated as "pumping station" in Russian language). According to information from 1986, the irrigation basin of the channel was 100,000 ha (1,000 km^2). The channel also provides drinking water to Baku and Sumgayit.

III. METHODOLOGY

The method of data collection with further processing is described in Figure 1. This offered method for monitoring and detection of leakages in irrigation water supply systems is based on comparability of two types of processed data. The first type of data (Space image 1 in the Figure 1) plays the role of benchmark of information reflecting characters and features of the monitored area before any consequences of selected area. Those consequences mainly factored as vegetation and soil contamination in our used method. There is a standard method of data processing applied for space data interpretation based on Remote Sensing (RS) [7].

The same stages of data processing is the subject for the Space image 2 where selected area has been monitored and has implemented data processing with the same factors of both vegetation and soil contamination. It is required to analyze both Space image 1 and Space image 2 in order to detect any possible changes during executed monitoring and observation of the irrigation water supply system. The lack of any dynamic changes is an evidence of the lack of leakage of the system.

Obviously, it is necessary to implement the verification of data outcomes to make sure that observation has been performed correctly. This stage is the final before making any decision about conditions of irrigation water supply system. IKONOS high-resolution satellite images were used for the detection of the water supply channel system. The IKONOS space images are used for different periods in order to be able to detect any changes in space images based on different characteristics: Brightness, Greenness and Wetness. An accuracy of the investigation is dependent of the spatial resolution of chosen space images. In the meantime selected method of data verification also effects the precision of the investigations outcomes.

Figure 2 demonstrates typical picture of selected space image of IKONOS satellite with spatial resolution about 1 m. There is a stage of merging space image into the topographical map. This step of data processing is highly important from the point of view of quality of integration of space and topographical map data. There are several ways of implementation; one of the popular way is to use field data reconnaissance into space data. The further step is to develop Geographical Information System based on data collected from different sources [8, 9].

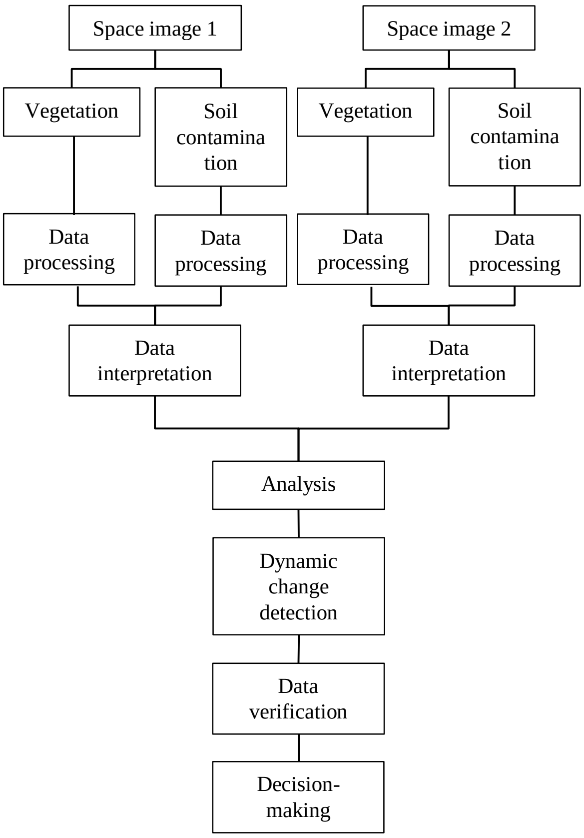

Figure 1. Dynamic change detection method

Figure 2. IKONOS satellite image used for the detection of the leakage of water supply

IV. DISCUSSION AND REMARKS

Remote sensing method is the technology which can be effectively used for the detection of the water supply system for monitoring and detection of water leakages which are important subjects in various needs. This approach in preliminary outcomes is found out successful application for observation and detection leakage in pipeline, irrigation cannels and any other water supplying system. The use of remote sensing method basicly bases on differences of spectrometric reflectance from Earth affected and non-affected areas. Detection of dynamic differences is the fundamental measurement which has nature of reliability and high accuracy.

It is necessary to select suitable satellite image resolution in order to be able effectively to monitor water system. There is no doubt that the problem demands to find out appropriate specific satellite images with required spatial resolution for monitoring and observation of the water systems leakage.

It is necessary to note that offered technology makes available to conduct monitoring process on the permanent base which makes possible to study and fix dynamic changes in the investigated area. At the same time it opens opportunity to conduct ground based geophysical measurement to maintain a competent system for monitoring existing water network systems. It contents mainly related to the soil parameters as electrical resistance tomography and ground penetrating radar. It is all the information required for development of Geographical Information System valuable data source for state authorities.

An approach makes possible to study dynamic changes of the picture in study area and excellent way for electronic archiving of information, which can be play a significant role in future studies. Undoubtedly, it is a high accuracy instrument adding more features of factors of classification into the geographic system made possible to achieve flexible for use information sources.

V. CONCLUSIONS

The method was evaluated in the selected areas of irrigation water system of Azerbaijan. As it has been indicated above, the use of traditional method are not suitable for water leakage monitoring and detection from point of time and cost. The method and study of the problem in this paper demonstrates how rapidly, cost-effectively method can be used for definitions leaks and/or seepage in any kind of water supply systems.

It has been described stage of the process - image acquisition, image processing, and field reconnaissance which bases of fundamental options of satellite image processing with further classification and identification of locations water supply system leaks.

This study demonstrates space image use advantages promising best results of detection of irrigation canal leakage in distribution networks. In the meantime there is results of investigation of selection appropriate space images from red, NIR, and thermal spectral bands for monitoring with further integration field measurements. The use of high-resolution space images made possible to increase of accuracy of investigations.

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BIOGRAPHIES

Bahar N. Aliyeva was born in Terter, Azerbaijan, 1983. She took her B.Sc. and M.Sc. degrees from Geological and Exploitation Department, Azerbaijan State Oil Academy (Baku, Azerbaijan) in 2004 and 2006, respectively. At the present time, she is Ph.D. student of Institute of Physics, Azerbaijan National Academy of Sciences (Baku, Azerbaijan). Currently, she works as Geotechnical Engine in engineering company Encotec Company, Baku, Azerbaijan. She is an author of 7 scientific papers published in famous research Journals around the world.

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 100 scientific papers.