

Detection of Water pipelines and leakage using Remote Sensing Technique

Noora Mubarak Al Breiki

202070581

April 2021

Table of Contents

Table of Contents	2
Water leakage detection by using GIS, remote sensing, field spectroscopy.....	3
Areas of Cyprus	3
Multispectral Approach Assessment for Detection of losses by Airborne Remote Sensing	5
Detection of Water Pipes and Leakages in Rural Water Supply Networks Using Remote Sensing Techniques.....	7
Reference list	9

Water leakage detection by using GIS, remote sensing, field spectroscopy

Areas of Cyprus

Water leakage is a major issue in the diverse areas throughout the world. Physical loss of water from pipes, fittings and joints are the results of leakage. Soil type, materials and technology used in network building, quality of water are the factors for water leakage. In current years, several techniques are invented to detect water leakage. These are “acoustics, radioactive, ground-penetrating radar, and electromagnetic and linear polarization resistance”. Remote sensing and GIS are the other cost-effective and quick technique used to detect water leakage commonly. “Image-based outcomes” are generated through field spectroscopy, which further helps in the validation process (Agapiou, Alexakis, & Themistocleous, 2016).

Recent studies, which were held in Cyprus, portrays that “spatial resolution” plays a major role in detecting leakage areas and mapping through remote sensing data. An important rural pipeline from the “Choirokoitia to the Frenaros area” of Cyprus was the case study area of this report. This pipeline is 500 mm in diameter, and the length is over 65 km. From that study, it was observed that two severe leakages were detected in different portions of the pipe from 2007 to 2010. To see and map the water leakage areas, “a single high-resolution image and additional multi-temporal satellite image” are used. The article shows how the spatial resolutions can have crucial part to influence the values for analysing the boundaries and safety measures to map the data sensing and validation process.

Several steps were performed to detect the water leakage in the Pyla case study. These are Extensive zone of doubtful area define, rectify the image through radiometric and geometric analysis, NDVI index measurement in the interested areas, threshold values determination through NDVI value and mask the areas within these boundaries and lastly, determine the areas with probable water leakage problems. “Avgorou” case study also done to define areas with leakage problems by using an alternative methodology. PCA analysis is also done to justify this hypothesis of leakage because it integrates the “whole spectral bands of the image”.

In the first study, the NDVI index was calculated and applied for detecting potential leakage problems. Threshold values are also determined from field spectrometric analysis to define water leakage areas. Later in the second case study, “multi-temporal “SPOT 5 images

are used to detect the overall pipeline's total leakage. NDVI index was done for both images. After this, the NDVI difference was measured. Threshold values were also determined and Ground spectroradiometers used in order to collect all the necessary information needed for both the case studies in order to apply image base analysis (Hadjimitsis, Agapiou, & Themistocleous, 2013).

After collecting the satellite images, geometric correction and digitalization process have to do for operating this process successfully. Not geometrically rectified images should be avoided. If the collected "multi-temporal images" are not proper or errors of digitization are higher than an extensive buffer area have to select. This methodology can only apply to the urban semi-urban environment because of their heterogeneous environment.

Multispectral Approach Assessment for Detection of losses by Airborne Remote Sensing

Every drop of water wasted has a detrimental result. The pipeline distributes water to various sections of urban and rural areas. Unattended leakage of the pipelines leads to wastage of several litres of water. Manual assessment of channels is laborious and strenuous, also leading to a room full of errors. Remote sensing helps to characterize and monitors soil moisture close to the land surface. Thus, airborne remote sensing is a more efficient way to detect pipe leakages. Airborne (TIR) have the advantage of providing precise data under ideal conditions with subtle geothermal changes in the pipelines. A robust water leakage and water detection system comes into play when TIR and VIS-NIR are combined together with NDVI systems giving a complete idea of the vegetation.

A survey was conducted in Esparron-de-Verdon, province of southeastern France, where a highly moisturized area was located near the pipeline, and similarly, a few more sites were excavated as a result. Airborne measurements were done in extensive areas, which belong to the water network infrastructure (Chatelard, Krapez, Barillot, & Déliot, 2018). This infrastructure provided by SCP (Société du Canal de Provence – France). ONERA's aerial platform (BUSARD) instrumented with two active spectral VNIR and SWIR cameras (Hypex) and a microbolometer infrared camera (FLIR A325 or FLIR A655sc 7.5-12 μ m). They also developed a database. Relevant physical parameters like soil, temperature, spectral reflectance and vegetation brightness are extracted from that developed database. Soil moisture was measured through a portable FDR probe. After processing with the “Correlator3D software”, TIR camera produces “ortho-images and ortho- mosaics”. The result of this study showed that vegetation was absent or dormant in February. OSAVI map generates quite low values. Calibrated radiance images were generated through the attenuation of the atmosphere. Due to early detection, the secondary pipes were attached to the mainline. Soil moisture is determined by this method. A high water index (WI) value gives blue colour in the image, which denotes the most elevated soil moisture. C/N deal, which was 6 or 6.1 calculated by processing this triangle method. TIR image provides the primary information about soil moisture. T-VI scatter plot improves this result slightly—the curvature of the reflectance through CAI, which was in between 2.0 μ m and 2.2 μ m. Infrared cameras have detected water leak and water spreading areas (Agapiou, Alexakis, & Themistocleous, 2016). Moreover, it is

significant to understand the soil moisture and scatter plots to measure the soil plotting. It can be said that completing the task can be significant to understand the water index and measuring the results effectively.

It can be concluded by saying this technology helps in completing the tasks before big damages and increases the performance level. Application of the "triangle method" by combining is produced thermally. The vegetation index image gives the best result to detect the losses in a water transmission system. The application of this method could be implemented in urban areas also in future. The high cost of advanced technology is undoubtedly a concern but is worth every penny.

Detection of Water Pipes and Leakages in Rural Water Supply Networks Using Remote Sensing Techniques

The article shows that water is a crucial element for every living organism. It has widespread usage, and wastage is not an option anymore. Rural areas have a shortage of water, and pipelines travelling long distances are the only option to reduce this daily storage. Due to long and extensive usage, these pipes are prone to damage resulting in leakage. Water loss due to leakage is a significant physical loss of water. Manually assessing these damages can be time-consuming and not to mention laborious.

Remote sensing has emerged as an effective tool for systematic analysis and preservation of natural resources like soil, water, etc. It deals with acquiring knowledge about an object's characteristics without being in touch with the thing (Hadjimitsis, Agapiou, & Themistocleous, 2013). This same concept is applied in studying leakages in water pipelines. Satellite imaging is not effective enough to get the exact location of the damages along the channel, but it is possible with remote sensing.

Studies have shown Airborne remote sensing is very effective in detecting leakages in irrigation canals by using an imaging sensor and thermal infrared wavelengths. Other remote sensing techniques are also available, which can be used to detect hidden pipelines buried deep. These buried pipelines can have archaeological significance as well. Cases studies in Cyprus show that remote sensing techniques provide good results in detecting water leakages.

To further understand the effects of remote sensing, two new technologies have been applied. For the "Lakatameia" waterpipe study project, spectroradiometric measurements via electromagnetic radiation were used, and different data were collected according to altitudes. The help of the spectral signatures recorded differences in the spatial sizes. These spatial signatures were able to detect dry and wet zones before and after leakages with proper imaging. Thus, remote sensing is effective for damage detection on both bare soil and vegetation.

To the "Frenaros - Choirokoitia" case study, Landsat 7 ETM+ medium resolution images were recorded. Various algorithms and datasets have been prepared to understand imaging. However, using medium resolution satellite images did not give any significant results. The infrared spectrum failed to detect any significant water leak.

The tree pattern gives the impression of the water pipes. These impressions of leakage are used for the detection of water pipes, which are buried. IKNOS image has the ability to improvise the visible impression of the buried water pipe (Hadjimitsis, Agapiou, & Themistocleous, 2013) .

To conclude, we can say remotes sensing has bridged the gap to understand and detect water pipe leaks and their location. Remote sensing uses a "time-series satellite image" to access the trouble areas of a water network. In future, the advanced researches on this topic can investigate many methods of geophysical importance, which can give an improvised system for detecting water pipe networks, such as "electrical resistance tomography and ground-penetrating radar". After getting this result, it can be combined into Geographical information. Thus, advanced technologies are paving the way to a better and resourceful future.

Reference list

Agapiou, A., Alexakis, D. D., & Themistocleous, K. (2016). Water leakage detection using remote sensing, field spectroscopy and GIS in semiarid areas of Cyprus. *Urban Water Journal* , 13 (3), 221-231. Retrieved on 12 April 2021, from <https://www.tandfonline.com/doi/abs/10.1080/1573062X.2014.975726>

Chatelard, C., Krapez, J. C., Barillot, P., & Déliot. (2018). Multispectral approach assessment for detection of losses in water transmission systems by airborne remote sensing. *EPiC Series in Engineering* , 408-418. . Retrieved on 12 April 2021, from https://www.waditech.eu/kdocs/1915763/180312_ONERA_HIC2018_full_paper.pdf

Hadjimitsis, D. G., Agapiou, A., & Themistocleous, K. (2013). Detection of water pipes and leakages in rural water supply networks using remote sensing techniques. *Remote Sensing of Environment-Integrated Approaches* , 155-180. . Retrieved on 12 April 2021, from <https://www.intechopen.com/books/remote-sensing-of-environment-integrated-approaches/detection-of-water-pipes-and-leakages-in-rural-water-supply-networks-using-remote-sensing-techniques>