Application of Remote Sensing and GIS to the evaluation of riparian buffer zones

Sung-Ryong Ha*[1],Seung-chul Lee*[2],Chang-hwan Ko*[3],Se-deok Seo*[4], Yun-Won Jo*[5]

*[1] Department of Urban Engineering, ChungbukNationalUniversity,Cheongbuk,Korea
*[2] Department of Urban Engineering, ChungbukNationalUniversity,Cheongbuk,Korea
*[3] Department of Urban Engineering, ChungbukNationalUniversity,Cheongbuk,Korea
*[4] Department of Urban Engineering, ChungbukNationalUniversity,Cheongbuk,Korea
*[5] Department of Satellite Geoinformatics, KyungilUniversity,Kyungbuk,Korea

Abstract: Diffuse pollution has been considering as a major source of the quality deterioration of water resources. The establishment of riparian vegetation strips or buffers along those areas of water bodies is used to reduce the threat of diffuse pollution. Remote sensing offers a means by which critical areas could be identified, so that subsequent action toward the establishment of riparian zones can be taken.

Even though the principal purpose of this research comes from the feasibility of the imagery of KOMPSAT-2 satellite, Landsat TM satellite data, which has 7 bands, are used to characterize the land cover for the study area on the behalf of KOMPSAT-2.

This investigation focuses on the assessment of the existing riparian buffer zones for a portion of the upper Geum river watershed from the viewpoint of pollution mitigation by riparian vegetation strip establishment. Through comparing the delineation of riparian buffer zones developed with the existing zones established by the government, we can find the critical distortion points of the existing riparian buffer zone.

Key words : riparian buffer zone, vegetation, remote sensing, GIS

1. Introduction

Up to Now, The management of main water-source area including riparian buffer zone has been processing with negative method such as development-regulation and maintenance of the status quo. But a problem of inflow pollution into the stream especially main water-source directly needs the new management-plan. The government established a system what prevent inflow pollution into the stream directly without self-purification at main four-rivers with set up the riparian buffer zone to area where same distance from the river and the river-boundary. Riparian buffers are viewed as a solution to water quality problems associated with agricultural production where they are located at the edge of fields adjacent to streams. Anticipated water quality benefits of vegetated riparian buffers include removal of

up to 50 percent of nutrients and pesticides, up to 60 percent of certain pathogens, and up to 75 percent of sediment(USDA-NRCS, 2001).

Korean riparian buffer zone established to same distance from water-boundary only at the water-source area and big rivers. On the other hand, the small stream of up-streams is not established riparian buffer zone even thought inflow pollution into the stream directly. The stream needs riparian buffer zone able to reduce pollution gradually because it is continual space(M. R. Burkart et al., 1996). The present, Korean riparian buffer zone includes agricultural area and Non-vegetation area, so those might affect the pollution of the stream. Therefore, Need investigation to establish depth of buffer zone as the special quality of each streams(Young-Fa Lin et al., 2004).

And need properly management about the elements able to reduce pollution in the riparian buffer zone for get the pollution reducing effect. In the case of korea, not enough the research material what the present condition about configuration and scale of vegetation-distribution and activities in the riparian buffer zone, also lake investigation about how those elements effect to stream-quality and stream-environment.

Apply the skill of remote sensing using the satellite for these analytical plans about the riparian buffer zone(Russell G. Congalton et al., 2002). The remote sensing can observe wide stream area at the same time, repetitive observe the same area, economically collect information for difficult approaching area. Also, the investigation coupling satellite image and GIS is able to make understanding and analyzing about space of riparian buffer zone(s. Narumalani et al., 1996).

The purpose of this paper is to assess the existing riparian buffer zones by using Remote sensing and GIS and to offer the effective distribution of the buffer zone by terrain variables of stream. It is anticipated that information on the spatial distribution of these variables will give managers basin-wide strategies for buffer zone, although information to verify their utility has yet to be gathered.

2. Data and Methods

2.1 Study area

The study area is Dae-Choeng reservoir what a manmade lake has formated as had constructed Dae-Choeng Dam, located between 127° 25′~127° 40′E, 36° 20′~36° 30′N. This Dae-Choeng reservoir is used water-resource, has riparian buffer zone with surrounded 1Km-boundary to spacial measure area, has smaller zone surrounded 500m-boundary where located up-stream from Dam(Fig 1).

Fig 1. Site map showing that there is RBZ(riparian buffer zone) in Daecheong reservoir and choose the specific study area.

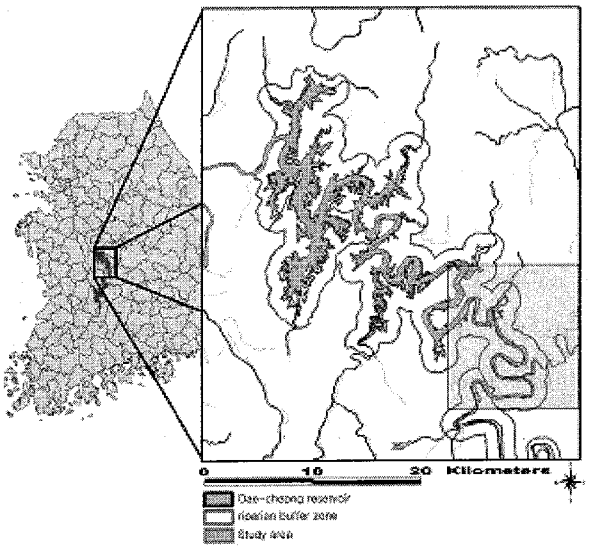

Fig 1. Site map showing that there is RBZ(riparian buffer zone) in Daecheong reservoir and choose the specific study area.

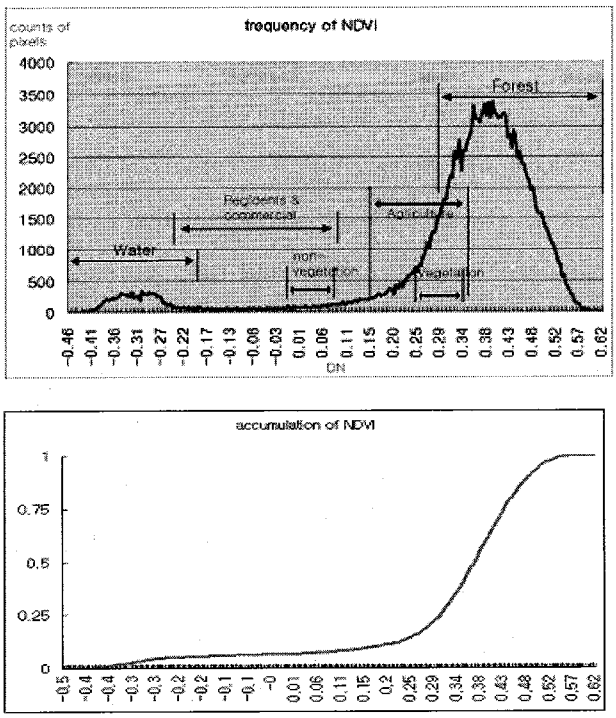

Fig 2. left one showing the range and frequency of NDVI, right one showing the accumulation of NDVI

2.2 Methods

In this study, we used Landsat TM satellite image for analyze vegetation and land-use. Used June image for easily divide vegetation.

Especially, Most of the consistent information describing large areas of forest vegetation, including riparian areas, is produced from Landsat TM imagery because it is the most cost-effective way to inventory large areas (e.g. Congalton et al., 2002).

Analyzed NDVI (Normalized Difference Vegetation Index) with Landsat TM, then analyzed density and distribution of vegetation in the place of study area with that.

NDVI is a commonly used vegetation index that transforms multispectral data into a single image band depicting vegetation distribution.

NDVI = (□ (band4)-□ (band3))/(□ (band4)+ □ (band3))

Compared with offering material at the Ministry of Environment for accuracy of material. And used GIS analysis method for analyze establish plan riparian buffer zone as distribution and flow direction of pollution and geographical features.

3. Results

As a result of NDVI analysis, forest has got the widest range and distribution. Vegetation and forest area have 85% of total area, so can result vegetation is fine. agriculture and vegetation are not divided easily, because we have only one seasonal Landsat TM satellite imagery(Fig 2).

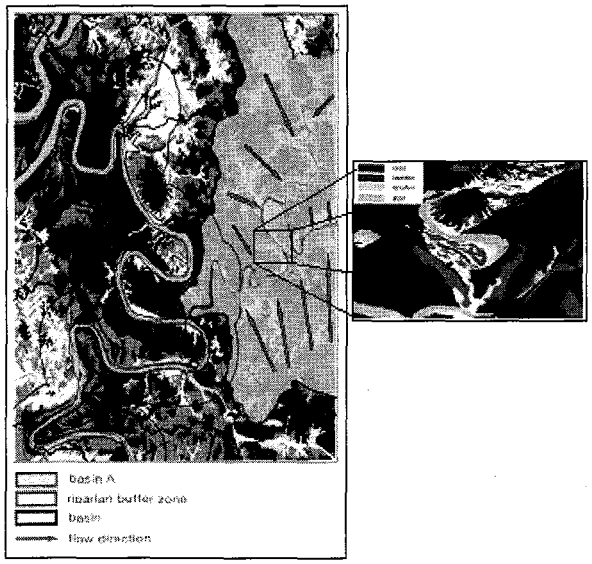

Fig 3. showing that there is no buffer zone in tributary as well as resource of pollutant area is between vegetation and water.

As previously stated, The riparian buffer zone is buffer space where keeping inflow pollution to the stream directly. But formated agriculture area follow the stream adjoins the stream without buffer. Especially, as a result of dimension-analysis about neighboring the agriculture as well as the residential and the non-vegetation area to the stream, those area need establish buffer because are take up 75% of total non-buffer zone(Fig 3).

The basin of a large river is the area of land around it from which streams run down into it. So riparian buffer zone has to established at the end of flow direction to adjoin the stream in the basin. As basis on the boundary of basin, the area where facing the stream needs buffer, but area where the opposite direction not needs buffer zone(Fig 4).

As these specific spatial characters, established the new buffer zones which necessary and unnecessary buffer zone where not directly affect the stream(Fig 5).

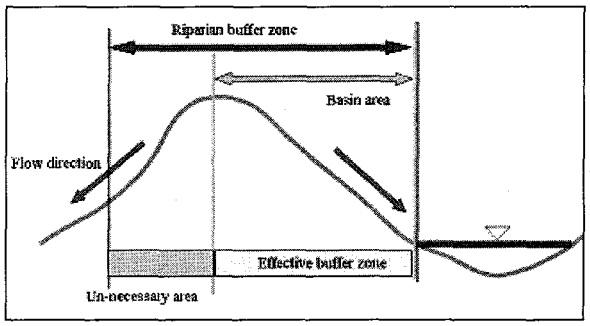

Fig 4. Conception of dividing buffer zone along the flow direction

Fig 5. This map showing that add-necessary is to create new buffer zone in tributary to main stream and unnecessary is unnecessary area in existing RBZ because of basin-wide terrain analysis.

4. Conclusions and Discussion

Remote sensing is necessary to study the area which has large and flexible area such as water stream.

This research provided the assessment of vegetation and land use analyzed by Landsat TM satellite imagery in existing riparian buffer zone, and proposed the effectively substitute method to establish the basin-wide riparian buffer zone in not only the main stream, but also tributary.

Now to conclude, the standards of establishing riparian buffer zone are 1) terrain 2) vegetation and land use in the study area. Even though analysis of vegetation and land is important to reveal the potential of pollution from land to water, It is more essential to consider terrain and hydrological condition than vegetation and land use, when creating riparian buffer zone. as showing that flow direction

This research used to analyze the site with remote sensing and GIS. because we have only one seasonal Landsat TM satellite imagery which has low-resolution to reveal the spatial attribute. however, as long as the high resolution imagery, KOMPSAT-2, is used in this study, it will be able to do more powerful and accurate research like gathering the spatial information of riparian buffer zone with only remote sensing. Using Multi-temporal KOMPSAT-2 imagery will help the monitoring of water space to managers by periods. as well as it could be possible to estimate the variation of water space easily.

Reference

M. R. Burkart, D. E. James, M. D. Tomer. 2004. Hydrologic and terrain variables to aid strategic location of riparian buffers. Journal of soil and water conservation, 59(5), 216-223.

U.S. Department of Agriculture Natural Resources Conservation Service (USDA-NRCS). 2001. Buffer Strips: Common Sense Conservation. http://www.nrcs.usda.gov/feature/buffers/index.html.

Congalton R.G., Birch K., Jones R., Schriever J., 2002. Evaluating remotely sensed techniques for mapping riparian vegetation. Computers and Electronics in Agriculture, 37, 113-126.

Naruimalani S., Zhou Y., Jensen J.R., 1997. Application of remote sensing and geographic information systems to the delineation and analysis of riparian buffer zones. Aquatic Botany 58, 393-409.

Young-Fa Lin, Chao-Yuan Lin, Wen-Chieh Chou, Wen-Tzu Lin, Jing-Shyan Tsai, Cho-Fu Wu, 2004. Modeling of reparian vegetation buffer strip width and placement A case study in Shei Pa National Park, Taiwan. Ecological Engineering 23, 327-339.