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GIS를 활용한 유역의 하천 형태학적 특성 추출에 관한 연구

A Study on an Extraction of the Geometric Characteristics of the Pyongchang River basin by Using Geographic Information System

함 창 학*
Hahm, Chang-Hahk

要 旨

水文學 解析에 있어서 기본자료로 사용되는 유역의 河川 形態學的 特性은 매우 다양하고 광범위 하다. 지금까지의 하천 형태학적 특성의 추출 방법은 手作業에 의존하는 전통적 방법이어서 많은 시간과 경비가 필요하였다. 최근들어 컴퓨터 및 주변기기의 발달로 지형과 밀접한 관련이 있는 수문학에 GIS가 도입되어 유역과 유출분석을 위한 응용연구가 활발히 진행되고 있다. 본 연구에서는 GIS를 활용하여 國際水文開發計劃(IHP)의 代表流域인 南漢江의 平昌江流域을 대상으로 GIS를 활용한 空間分析을 시도하므로써 수문학적으로 참고가 되는 하천 형태학적 특성을 추출하고 수작업에 의한 결과와 비교하여 GIS의 적용 타당성을 검토하고자 한다. 이를 위하여 평창강유역을 포함하는 1:50,000 地形圖 4도엽을 스캐닝하고 벡터라이징하여 DEM을 생성하였고 이것을 ARC/INFO의 GRID 모듈을 이용하여 유역경계를 추출하였다. 또한 추출된 자료로 부터 지표 유출량 산정을 위한 유역의 하천 형태학적 특성 인자들을 정량화하여 기존의 자료들과 비교 검토하였다.

ABSTRACT

odel). One of important tasks for hydrological analysis is the division of watershed. It can be an essential factor amThe main objective of this study is to extract of the geometric characteristics of the Pyongchang River basin, headwaters of the South Han River. A GIS is capable of extracting various hydrological factors from DEM(digital elevation mong various geometric characteristics of watershed. In this study, watershed itself and other geometric factors of watershed are extracted from DEM by using a GIS technique. The manual process of tasks to obtain geometric characteristics of watershed is automated by using the function of ARC/INFO software as a GIS package. Scanned data is used for this study and it is converted to DEM data. Various forms of representation of spatial data are handled in main modules and a GRID module of ARC/INFO.

A GRID module is used on a stream in order to define watershed boundary, so it would be possible to obtain the watersheds. Also, a flowdirection, stream networks and others are generated. The results show that GIS can aid watershed management and research and surveillance. Also the geometric characteristics as parameters of watershed can be quantified by a using GIS technique. Resonable results can be obtained as compared with conventional graphic methods.

* 인하공업전문대학 항공측량과 조교수

1. Introduction

As GIS software matures in functionality, speed, and flexibility, issues of the use and suitability of GIS the extraction of the geometric characteristics. This study is about the extraction of geometric characteristics data to manage water resources more effectively. GIS technique is applied to extract spatial information from an experimental watershed, and analysis is carried out to evaluate the results which will be used for management of water resources.

Besides being applied for the extraction of geometric characteristics factors such as physiographic factor, soil, landuse and characteristics of watershed. GIS can be used to reduce the time and manpower needed in the tedious manual task of collecting such data. ARC/INFO was used with DEM to extract and quantify the geometric characteristics and topographic characteristics of streams. It is anticipated that the result of this study will be used for the implementation of the database of a water information system and will contribute to the management of water resources.

2. Scope and Major Objectives

An experimental area was selected as the Pyongchang River basin one of the headwaters of South Han River, South Korea. 4 sheets of 1:50,000 topographic maps were scanned then contours were vectorized to get a TIN. DEM was then formed to formulate the stream line. The flowdirection was determined using the fact that water flows toward the steepest direction and the stream network and watershed boundary was induced from the determined flow direction. Also various cell sizes was tested by comparing computed streamlines and actual stream features on the topographic maps.

Using the computed stream network, stream orde r was found by Strahler method and various geometric characteristics factors were determined such as contributing drainage area(CDA), average basin slope(BS), main channel length(MCL), basin perimeter(BP), total stream length(TSL), number of first streams(FOS) with contributing drainage area.

The results were then compared with results obtained by conventional graphic method and evaluated. It is hoped that the geometric characteristics of Pyongchang River basin extracted by the GIS method presented in this paper will be useful in decision makings of the management and operation of water resources.

3. Method

The study area, Pyongchang River basin which is one of the representative basins of the International Hydrological Program(IHP), is comprised mostly of mountainous areas and starts from Mt. Kebang (1,577 meters) and is located at E 128 15 45 - E 128 31 30, N 37 24 34 - N 37 43 55. The geometric characteristics factors extracted by conventional graphic method is as follows. The CDA is about 523.79 km2, MCL is 51.85 km, the TSL of tributary and main water is 712.77 km and the BS by Hortons method is 0.333 radian. 4 sheets of 1:50,000 topographic maps published by the National Geography Institute of South Korea was scanned and contour lines, spot height symbols and streams were vectorized. The input data used is as in table 3.1. Themes selected are contour lines, spot height symbols, stream network and administrative boundaries. Watershed was extracted with reference to administrative boundaries and contour lines.

Table 3.2 shows the layers of the digital maps used and Fig.3.1 shows the components of the software used.

Table 3.1 Input data of Pyongchang River basin

type of map	sheet number	scale	administ-ration
topographic map	NJ52-10-10	1 : 50,000	national geography institute
	NJ52-10-11		
	NJ52-10-17		
	NJ52-10-18		

Table 3.2 Digital basemap of Pyongchang River basin

layer	data source	scale	data type	attribute data
contour line	topo-graphic map	1: 50,000	line	elevation
spot height			point	elevation
stream nerwork			line	river name
water shed			polygon	water shed
administration			polygon	administ-ration name

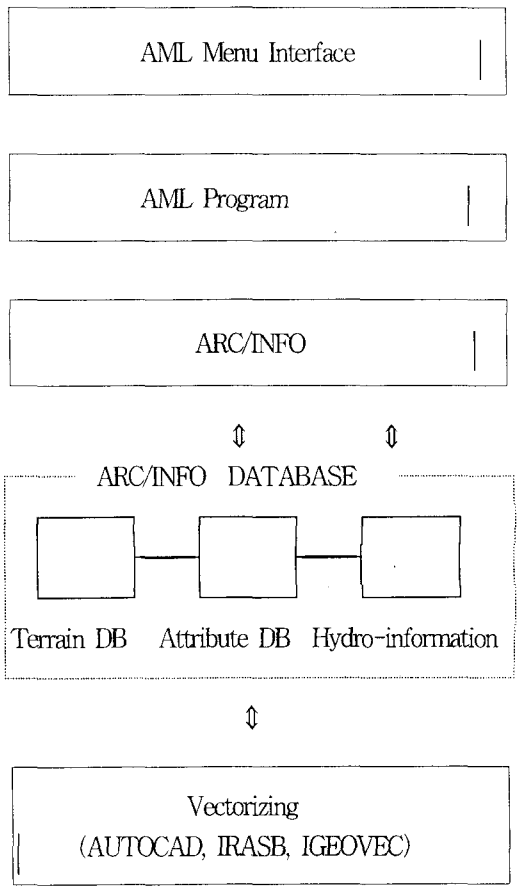

Fig.3.1 Components map of software

GIS can be effectively applied to spatial analysis tasks which requires repetitive manual observations. The spatial analysis of watersheds leads to extraction of input data for runoff model and information for watershed management.

In this study, watershed parameters such as average slope of watershed, topographic analysis of watershed, 3 dimensional perspective display were extracted from DEM using GRID analysis of ARC/INFO. The extracted spatial information was quantified by using various formula for hydrologic and topographic analysis. The result was compared with values of conventional methods and evaluated for the applicability of GIS for this purpose.

The area and perimeter values of conventional graphic method and GIS method is shown in Table 3.3. The difference in area was quite small which was about 3.12 km2 and the main channel length was about 0.53 km. The difference in the perimeter of the watershed is due to the size of the cell which determines the DEM of the basin area. Also the fact that dry rivers which are not shown on topographic maps but were taken into account in

GIS analysis, could contribute to the difference in the TSL of the river. This could lead to the fact that the difference in type of river, MCL and TSL will increase with the increase of map scale.

Table 3.3 Comparison of geometric factors of study area between graphical method and GIS technique

geometric characteristics factor	(1:50,000)	
	conventional graphic method	GIS method
Contributing Drainage Area (km^2)	523.79	520.67
Basin Perimeter (km)	118.84	148.82
Main Channel Length (km)	51.85	52.38
Total Stream Length (km)	712.77	1,549.74
Stream order	5	7
average Basin Slope (°)	19.079	20.375
Basin Relief (km)	1.220	1.190
Main Channel Slope (°)	3.140	3.410
effective Basin Width(km)	14.74	14.95
Slope Ratio	0.165	0.167
Shape Factor	0.412	0.427
Form Ratio	0.068	0.068
Main Channel Sinuosity Ratio	1.448	1.495
Rotundity of Basin	0.323	0.335
Elongation Ratio	1.761	1.729
Drainage Frequency	0.629	0.789
number of First Order Stream	365	413
Relate Relief	0.010	0.008
Stream Density	1.350	2.959
Constant of Channel Maintenance	0.741	0.338
Ruggdeness Number	1.647	3.521
Compactness Ratio	1.459	1.853
Compactness	0.685	0.545
Main Channel Slope Proportion	29.261	28.370

4. Conclusion

The extraction of basic data needed for a comprehensive water resources management of basins involves tedious manual tasks with topographic maps. This study has addressed this problem by applying the various spatial analysis of GIS to the database established for the Pyonchang River basin. Also the various topographic and hydrologic information is extracted and quantified.

As a result of applying GIS method for the extraction and analysis of geometric characteristics of large scale basin, the following conclusions can be made.

As a result of implementation of DEM of Pyongchang River basin from 1:50,000 topographic maps and comparing various parameters extracted by conventional graphic method and by GIS method from DEM, the difference in area of river basin showed 3.12 km2 for the 1:50,000 scale which indicates acceptable reliability of the GIS method.

The stream channel do topographic maps and the GIS extracted streams showed some differences and this can be evaluated by the review of the topographic maps which had been used for the computation of geometric characteristics.

To evaluate and analyse the difference showed

between the GIS method and conventional graphic method it is advised that detail topographic study of the area be carried out by interpretation of aerial photos and remotely sensed space imageries.

Further studies will be carried out to form a database with the extracted geometric characteristics for the computation of runoff and a comprehensive management of water resources. It is also hoped that there will be activities carried out for the development of a water resources management specific GIS software.

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