A study on Design of GIS Based Water Quality Linkage System

Sung Joo Lee, Kye Hyun Kim, and Geon Hwi Lee

***Abstract*—The Basin of the Yeong-San River has been seriously damaged by reckless development during the past half century. The demand for management in the basin has increased, but the system for prediction and management is not sufficient. Therefore, the aim of this study is to design a GIS-based water quality linkage system using the most suitable simulation, HSPF (Hydrological Simulation Program-Fortran) in this basin of South Korea. To achieve this, the system applied linkages of the water quality model and GIS such as loose Coupling, tight coupling, and embedded coupling. Also, the major function of the system was designed as a modular unit. In future studies, a water quality linkage system will be developed based on this design and will be expected to contribute to improving conditions by simulating of the basin.**

***Index Terms*—GIS, HSPF model, Design of system.**

I. Introduction

The Basin of the Yeong-San River has been seriously damaged by reckless development during the past half century. The study area is the basin of the Yeong-san River. A basin is a large or deep bowl that you use for holding liquids, or for mixing or storing food. The Yeong-san River is one of the major rivers in South Korea. Thus, basins are characterized by different pollution levels. Therefore, this module applies the HSPF model, created by the US EPA, to predict a unique basin. HSPF is suitable, especially for huge areas of study. Because the HSPF model is a semi-distribution model, it allows for fast calculation and has a simulated suspended load and hydrologic responses based on natural laws. Meanwhile, the results of the HSPF model are comprised of ASCII and binary code. Therefore, users might have difficulty managing spatial queries. However, GIS can solve this problem and make it possible to perform highly difficult analyses through a linkage of GIS and the water quality model. In this study, GIS based on this module was designed for the management of basins. In order to support this study, the modules was compared and used to analyze the linkage of GIS and the water quality model. Also, the function of the module was gradually designed and will be applied to future systems.

II. Methods and Materials

A. Definition of Linkage Method

The linkages of GIS and the water quality model were classified into three types: Loose Coupling, Tight Coupling, and Embedded coupling (Fig. 1) [1].

The technique of loose Coupling was extracted by using GIS for the required data in the water quality model, which exists outside the system. The method of extraction used functions of export and import, which are common types of functions in the GIS and water quality models. The means of export is diverted from the original format to exchange format. Import is diverted from the exchange format to the original format. However, this method required additional operations for the creation and selection of a common format between GIS and the water quality model by the user.

Also, tight coupling is found separately to exist in GIS and the water quality model. However, data interchange is used to develop a common interface between GIS and the water quality model. This data interchange is done with something like a macro and the C language. This method uses a common interface, which does not require user intervention. However, the developer was required to have an understanding of the structure of GIS and the model. Also, this process takes a lot of time and incurs many costs.

The technique of Embedded Coupling was used to put the function of the water quality model into GIS using the macro language of GIS and another computer language. This method was not needed for the work of the interface between GIS and the water quality model. However, the operation of the insert model was found to have required too much time and to have incurred to many costs. Therefore, if there is already a good water quality model, Loose Coupling or tight coupling is more efficient.

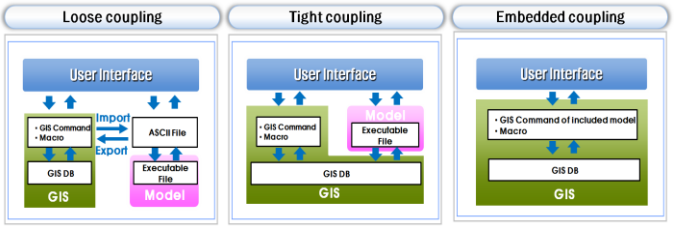

Fig. 1. The linkages of GIS and the water quality model

This study applied loose Coupling, because loose Coupling is the most commonly used system worldwide and can modify a set of items that are needed by the user. When the system was developed, the technique of loose coupling was found to be the most efficient system [2].

B. Design of Linkage System

The design of the module was performed gradually, with an interpretation of the input data, model operation,

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interpretation of the output data, and display of the results. Fig. 2 shows a conceptual diagram of system design [3].

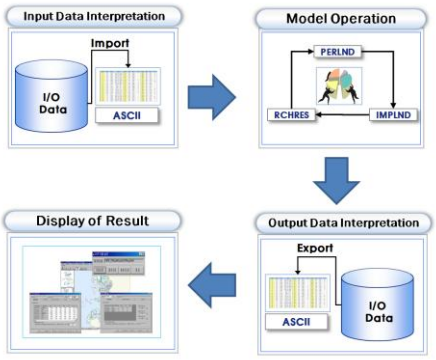

Fig. 2. The conceptual diagram of system design

The step of interpretation of the input data was read by the UCI (User Control Input) in ASCII type as model input data [4]. The items of the input data were selected as Items of interest to users, such as the flow factor of the PERLND module in the HSPF model. This system can be modified. The step of model operation was operated outside the system's HSPF model. When the model was operated outside the program, the system generally used the function of "process start" as an asynchronous function. However, if the system used an asynchronous function, system errors could easily occur, as there are restrictions on the model structure. To solve this problem, the system will use the "Diagnostics Process" as an synchronous function. The definition of an asynchronous function is that the operation is completely shut down and then returned to the control. In contrast, the definition of a synchronous function is that the functions occur at the same time. The step of interpretation of the output data was the authorized basin code from the output data for relational joining. The basin code is connected to the shape and the properties of the basin. The step of result display is expressed in 11 kinds of items, such as T-N, T-P, BOD, and so on. The result item was displayed on the map of the system using the ramp function.

C. Definition of Linkage Environment

The linkage environment used Visual Basic.net as the development language, which is language from Microsoft, and used ArcObjects 9.3.1 from ESRI as a component (Fig. 3). ArcObjects has materialized functions and an interface for a geographic information system. Also, it is connected to the HSPF model using the Technique of loose coupling.

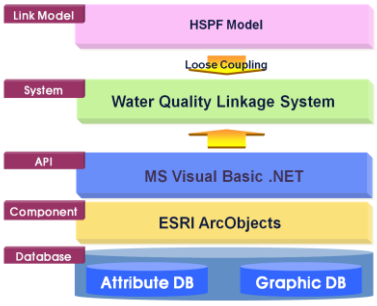

Fig. 3. The linkage environment

III. Result and Conclusion

This study was performed to design a system for the linkage of GIS and the water quality model. To achieve this, the system analyzed linkages of the water quality model and GIS. The major function of the system was the design of a module unit. Also, the environment of the linkage was defined. In future research, a linkage system will be built based on the proposed design. If a linkage system is developed to reflect the analysis of demand, it is expected that the system will promote ecological environment basin management.

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