Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 154 (2016) 645 – 649

Procedia Engineering

www.elsevier.com/locate/procedia

12th International Conference on Hydroinformatics, HIC 2016

Development of future precipitation forecasting program using probability forecast and climate change scenario

Dongwoo Jang[a*], Hyoseon Park[a], Jintak Choi[a]

[a]*Incheon National University, College of Engineering 119 Academy-ro Yeonsu-gu, Incheon, 21999, South Korea*

Abstract

Recently, it is estimated that Korea and other countries will face water shortage, and the water related industries and technologies will be increasingly important. So the cutting-edge IT technology and existing water management infrastructure have been combined to develop the concept of smart water grid, which is widely applied in Korea and overseas. To apply the smart water grid, it is important to calculate the available volume of water resources. It requires the future precipitation forecasting data analysis, and the precipitation forecast of Korea Meteorological Administration and climate change scenario data can be essential elements in calculating short-term and long-term available quantity of water resources. Korea Meteorological Administration is providing the precipitation data for the next 10 days through community and mid-term forecast while providing the precipitation for the next 3 months through the long-term forecast using past normal-year data. It is difficult to estimate the precipitation after 3 months so this research used the climate change scenario data. RCP8.5 scenario was used to provide the precipitation data of 1km*1km resolution, and especially it used the Kriging technique to interpolate and thus provide the missing grid, which was not provided by conventional RCP scenario, considering the latest administrative district.

It used C language based visual studio2013 and the data including the climate change scenario was saved in an Oracle DB so that it can be used through a server of Incheon National University. The Oracle DB contains future RCP scenarios from 2015 to 2050, and a Windows based application was developed so that a user can extract the precipitation data by setting the time frame and location. The extracted result is saved as a text file format in order to facilitate the use.

Keywords: Climate change scenarios; Future precipitation prediction

* Corresponding author. Tel.: +82-32-835-4760
E-mail address: nightray@paran.com

Peer-review under responsibility of the organizing committee of HIC 2016
doi:10.1016/j.proeng.2016.07.564

1. Introduction

According to the National Institute of Meteorological Research (2009), the annual precipitation amount of the Korean Peninsula is expected to increase by 17% in the 21st century compared to 20th century. The increase of precipitation amount in August and September is expected to be large, and the spatial/temporal variability of precipitation amount is expected to be even larger, increasing the possibility of contradictory precipitation phenomena such as drought and heavy rain in certain regions [1]. The process of producing the detailed prediction of climate change in the Korean Peninsula is as follows. The Meteorological Administration and National Institute of Meteorological Research (2011) prepared the 5th evaluation report for IPCC, and to produce the detailed prediction of climate change in the Korean Peninsula, they calculated in 2012 the multi-stage prediction data of climate change in the Korean Peninsula by combining the global climate prediction model, regional climate prediction model and statistical spatial elaboration model [2].

Yeongjongdo Island and Daecheongdo Island, which are the demonstration plants of Smart Water Grid Research Group, were used as subjects for developing the program which provides the future precipitation data. The study allowed comparison by using the average year's data based on the precipitation data for the past 30 years. By comparing the data of future precipitation prediction with the average year's data of the past, the study allowed users easily judge whether the predicted precipitation amount is large or small. The classification of future precipitation data provided is shown in Table 1.

Table 1. Classification of future period and data used

Term	Precipitation data	Period
Short	Meteorological Administration's community prediction (~three days) and mid-term (10 days) prediction	Future 10 days
Medium	Meteorological Administration's long-term prediction	10 days ~ three months
Long	RCP 8.5 scenario supplementing missing data	More than three months

In this study, the precipitation data by RCP 8.5 where the concentrated emission of greenhouse has is maximized are used as the predicted amount of future precipitation. The program used in this study was Visual Studio based on C language.

2. Classification of precipitation prediction data

As precipitation data for providing short/mid/long-term prediction on future precipitation, the average year's observation data of the past, the probability prediction by Meteorological Administration, and the climate change scenarios supplemented with missing grids were used.

As data of daily unit, RCP 8.5 scenario with a grid of 1km×1km was applied with the recent administrative district map. Regarding the research on missing grids in climate change scenarios of coastal areas conducted by Park (2014), the missing grids of island areas were created. Then, the result of studying the optimal spatial interpolation method to supplement data of the missing areas was applied to supplement and use the precipitation data of missing grids [3, 4].

Table 2.

Classification		Classification		Notes
		Area	Unit of providing precipitation	
Short-term prediction	Short-term prediction by the Meteorological Administration	Eup/myeon/dong around the country	Daily unit	Using the community prediction for three days and the mid-term prediction data for ten days
Mid-term prediction	Prediction by the Meteorological Administration (Weekly, monthly)	10 cities/do (provinces) around the country	One week / Below normal compared to an average year	Providing the predicted precipitation amount compared to the average year (for 30 years) in 10 classified areas around the country
			One week / Normal compared to an average year	
			One week / Above normal compared to an average year	
Long-term prediction	RCP 8.5 scenario	Unit of 1km-grid around the country	Daily unit, daily average data	RCP 8.5 scenario supplemented with missing areas based on the recent administrative district

3. Program design and user interface

Based on the present point, the program providing future precipitation data shows the daily precipitation amount during the future period in the area selected by the user. Taking Yeongjongdo Island of Incheon, the demonstration plant area of Smart Water Grid Research Group, as its subject, the program used the prediction of precipitation probability provided by Meteorological Administration to provide the daily precipitation amount for a period less than the future three months. For long-term exceeding three months, the precipitation amount was provided by RCP scenario for each 1km-unit grid and administrative district.

Figure 1 shows the entity-relation model of the program providing precipitation. The climate change scenarios and average year's precipitation data of the past stored in the DB are designed to be extracted based on the location and period set by the user. The data of climate change scenarios in the unit of 1km-grid are linked so that setup in the unit of large region, medium region and standard basin is available by the latitude/longitude coordinate and date. Setup was also made to allow users get data by selecting the observation point based on the unique number of rainfall observatories.

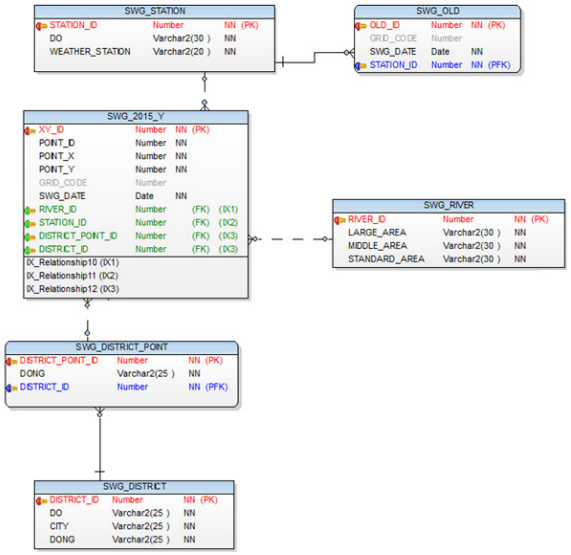

Fig. 1. Entity-relation model of the climate change program

Figure 2 shows the screen of the program developed by this study to provide future precipitation data. For the region of Yeongjongdo Island, Incheon City, the program provides the predicted daily precipitation amount for the future six months from the present point using the prediction by Meteorological Administration, average year's precipitation data of the past, and climate change scenarios.

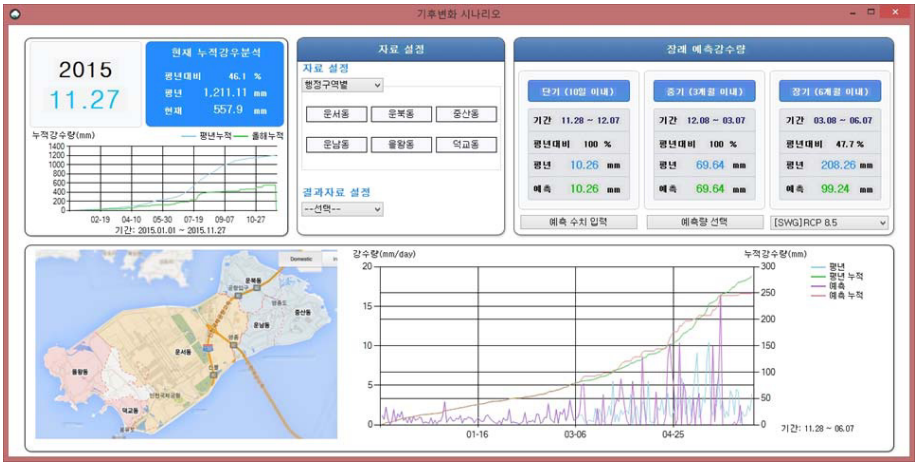

Fig. 2. Screen of program providing future precipitation data

4. Conclusions

As part of the Smart Water Grid Research, this study developed a program providing future precipitation data to be used for evaluating the risk of water shortage. The average year's precipitation amount of the past provided by observatories, the probability of precipitation prediction provided by Meteorological Administration, and RCP 8.5 scenario were used for program development.

The program developed by this study to extract climate change scenarios allows users extract daily precipitation data based on their selection for period and location. The program is especially effective in getting the average precipitation amount in specific areas selected by the user. To extract data within a one-year period, it takes less than 10 seconds, showing capacity of speedy search and display. In case of the program providing future precipitation data for areas around Yeongjongdo Island, the probability prediction of Meteorological Administration, average year's data of the past and climate change scenarios were combined to allow users extract various future precipitation data based on their selection. However, besides the community prediction (three days) provided by Meteorological Administration and the data of 1km-grid unit provided by climate change scenarios, the average year's data of the past provided by observatories and the mid/long-term prediction provided by Meteorological Administration were reflected by the precipitation result of the entire Incheon and metropolitan areas. This made the program have shortcomings of not being able to make detailed predictions on each area. Researches to overcome such shortcomings are expected.

Acknowledgements

This research was supported by a grant (12-TI-C01) from Advanced Water Management Research Program funded by Ministry of Land, Infrastructure and Transport of Korean government

References

[1] National Institute of Meteorological Research, Understanding the climate change Ⅱ – Present and Future of Korean Peninsula's Climate Change, 2009.

[2] Korea Meteorological Administration, 2012. A Report on Climate Change Projection of the Korean Peninsula, 2012.

[3] H.S. Park, G.W. Choi, Applicability Evaluation of RCP Climate Change Scenarios in the Complex Coastal Regions, Journal of Safety and Crisis Management, 2014, 10(2), pp.215-230.

[4] D. W. Jang, H. S. Park and J. T. Choi, Selection of Optimum Spatial Interpolation Method to Complement an Area Missing Precipitation Data of RCP Climate Change Scenario, International Journal of Software Engineering and Its Applications, 9(8), 2015, pp. 179-188.