Development of the GIS-based Population Data Conversion Program, POPCON

Seung-Cheol Jang *, Sung-yeop Kim, Sang-Hun Lee
Korea Atomic Energy Research Institute, 150, Dukjin-dong, Yuseong-gu, Daejeon, 305-353
Corresponding author: scjang@kaeri.re.kr

1. Introduction

One of the important inputs required to develop the input model for level 3 probabilistic safety assessment(PSA) code e.g., MACCS2 [1] [1] or WinMACCS[2], etc., for offsite consequence analysis is sector-specific demographics.

The development of a GIS-based population data processing program is necessary for more efficient automatic computation of sector-specific demographics. The generation of demographics by sector for offsite consequence analysis of domestic nuclear facilities/sites has so far been calculated as area ratio from the population census data of an administrative district (i.e., eup/myeon/dong) using the KOSCA-POP preprocessor [3]. However, the GIS-based population data conversion program (POPCON; POPulation data CONverter) was developed to generate sector-specific demographics efficiently, using GIS-based grid population data that were recently started to provide by the National Geographic Information Institute (NGII). POPCON program has made it possible to calculate sector-wise population data by more accurately and quickly pointwise counting method rather than by relatively inaccurate area ratio method in KOSCA-POP preprocessors for creating MACCS2 input data for offsite consequence analysis.

The developed program can be used as a development tool for various sector-wise population input data for future offsite consequence analysis of nuclear facilities/sites.

2. Development and Results of the POPCON

2.1 Overview of the Current KOSCA-MACCS2

KOSCA-MACCS2 is specialized to enable site-specific consequence analysis for Korean nuclear power plant, based on MACCS2 code. As shown in Figure 1, KOSCA-MACCS2 largely consists of three parts; 1) pre-processing modules, 2) MACCS2 execution (including base and sensitivity case generation module), 3) post-processing module.

KOSCA-MACCS2 has some useful pre-processors to facilitate the generation of domestic site-specific MACCS2 input files as well as a post-processing module (KOSCA-OUTPUT) to convert MACCS2 text

outputs to graphic report forms. As preprocessors, there are the following data conversion modules.

1) KOSCA-POP [3]: preprocessor to automatically convert site-specific sector population and land fraction into MACCS2 input, given the polar-coordinate spatial grid specified by user. Its functionality is similar to SECPOP [4] for MACCS2.
2) KOSCA-METEO [3]: preprocessor to convert site-specific meteorological data for MACCS2 input.
3) KOSCA-FCM [5]: COMIDA2 [2] input file for domestic-specific food chain model (FCM).
4) KOSCA-ECONO [7]: preprocessor to generate domestic-specific economic cost data for MACCS2, similar to economic estimation part of the SECPOP preprocessor.
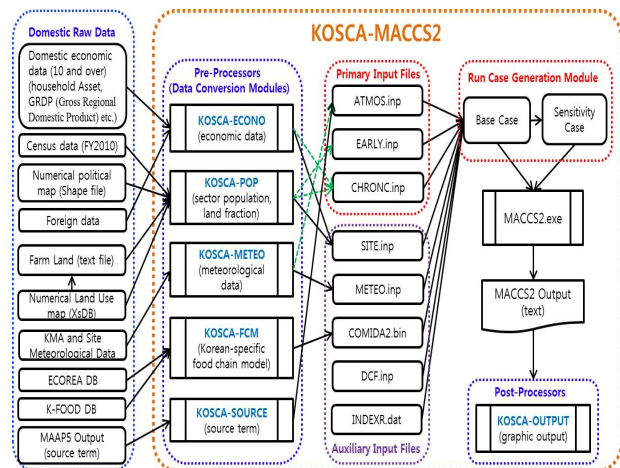

Fig. 1. Overview of KOSCA-MACCS2 code package

2.2 Development of the POPCON

As shown in Fig.1, one of the important function in the KOSCA-POP preprocessor is to generate the population for the sectors defined in a radial field used in MACCS2. Using 2010 census data and the recent digital geographic map of the administrative district, currently the sector population can be calculated by one of three methods below and the results are saved at the 'SITE.inp' file following the population input format defined in MACCS2.

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1) Allocation of population by the ratio of area belonging to the sector. (area-ratio allocation method)
2) Allocation of population to the sector containing center point of administrative district (center point counting method)
3) The use of the pointwise population data (resolution: 1km^2 population data) (pointwise data counting method)

Of the above three methods, if the pointwise calculation method is only high in resolution of the grid population data (approximately 100m x 100m or less), it is the most efficient way in terms of accuracy and applicability. However, the current KOSCA-POP was only capable of low-resolution grid population data (1 km x 1 km non-public data) at the time of development, forcing it to adopt the area calculation method based on the census data. The big problem with the area-ratio allocation method is that non-population areas (e.g., mountain, river, lake areas, etc.) are also allocated a number of people by the proportion of the area. In addition, the current KOSCA-POP was developed based on the administrative district (eup/myeon/dong) numerical map using the Bessel ellipsoid TM central origin coordinate system, so-called Korean 1985 Modified Central Belt [8]. As a result, the national grid population data available in the current KOSCA-POP is also provided in the form of a text file containing the X and Y coordinates according to the Bessel ellipsoid TM central origin coordinate system and the corresponding grid population.

Fortunately, the National Geographic Information Institute (NGII) recently releases a national grid population map of high resolution (100m x 100m) twice a year. However, the GIS population data is provided in the form of a shape file using the GRS80 UTM-K coordinate system, which requires conversion to a coordinate system and text file format for use in KOSCA-POP. To this end, POPCON, a GIS-based population conversion program, was developed with the primary purpose of automatically converting the national grid population data provided by the NGII into input forms used by KOSCA-POP. Considering the fact that the basic coordinate system using GIS information may vary depending on the situation, we further developed the conversion function to various coordinate systems.

The main functions of POPCON are as follows:
1) Converting the nationwide grid population data of the shape file format provided by NGII to the text file format of KOSCA-POP
2) When converting to a text file, select the field separator and the field property (e.g., total population, female, male, population to age interval, etc.)
3) Management of the population data files divided into metropolitan cities or municipalities

4) Converting UTM-K coordinate systems to various user-specified coordinate systems

POPCON's user interface is simply composed of one screen, as shown in Figure 2. It should be noted that if the coordinate system of the recognized GIS-based national grid population data is changed in the future, the POPCON should be revised accordingly. Finally, refer to another paper[9] for the details of POPCON V&V works.
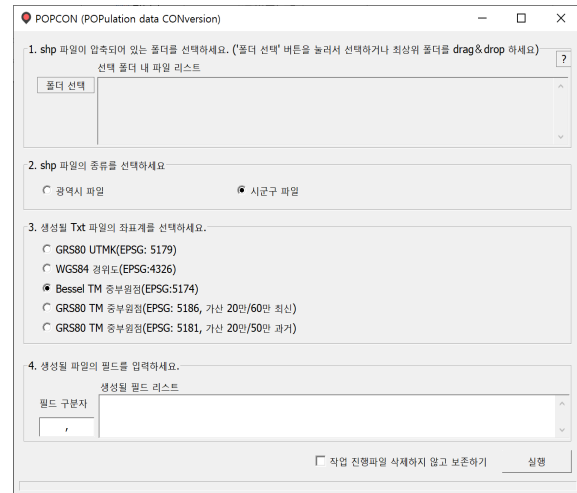

Figure 2. User Interface of the POPCON

2.3 Results of the POPCON Application

After the POPCON conversion to the Daejeon City lattice population data to which the research site belongs, the results of KOSCA-POP's sector-specific population data can be found to be visually error-free, with non-populated areas (e.g., mountains and lakes) calculated as zero as shown in the figure below ([8], [9]).
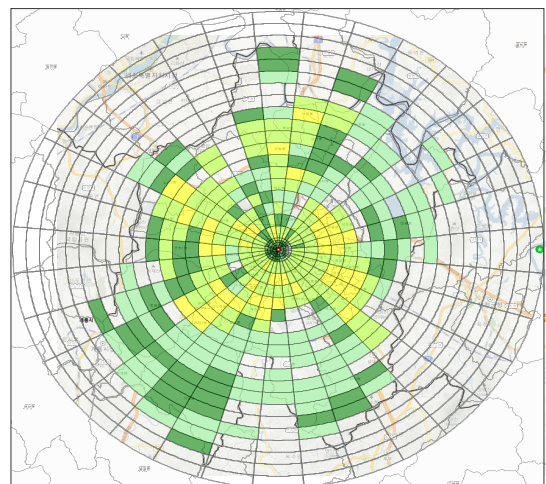

Figure 3. An Illustration of the KOSCA-POP Result with POPCON

3. Conclusions

The GIS-based population data conversion program (POPCON) was developed to generate sector demographics efficiently for off-site consequence analysis from the national grid population data provided by the National Geographic Information Institute (NGII). POPCON program has made it possible to calculate sector-wise population data by more accurately and quickly pointwise counting method rather than by relatively inaccurate area ratio method in KOSCA-POP preprocessors for creating MACCS2 input data for offsite consequence analysis. The POPCON can be used as a development tool for various sector-wise population input data for future offsite consequence analysis of nuclear facilities/sites.

Acknowledgements

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