

Development of a Pre-processor to Convert Source Term and Korean Site-specific Data for MACCS

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3. Summary

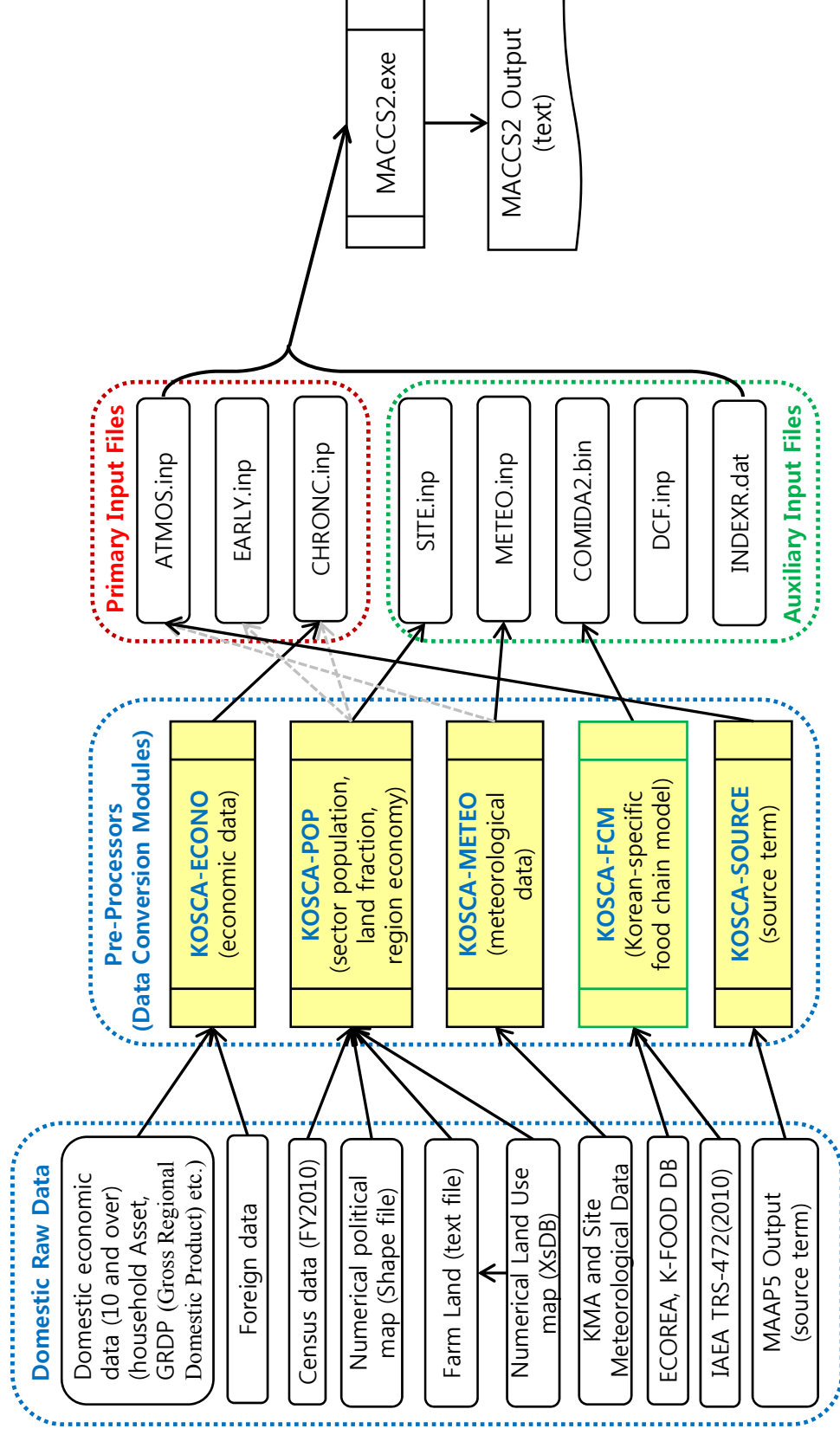
Introduction

Background

- Frequently used tool for Level 2 & 3 PSA in Korea
 - Severe Accident Analysis: **MAAP**
 - Up-to-date **SOARCA level** study using both MELCOR and MAAP
 - Level 3 PSA: **MACCS**
 - In the early stage of domestic Level 3 PSA code development
- Need for data conversion into appropriate **MACCS input** format
 - **Level 2 PSA results**
 - **Source term**: Interfacing Level 2 & 3 PSA
 - **Site-specific data**
 - Population data
 - Land use data
 - Meteorological data
 - Domestic food chain data
 - Economic data

Overview of Pre-Processors

■ KOSCA: Korea Off-Site Consequence Analysis Code Package



Overview of Pre-Processors

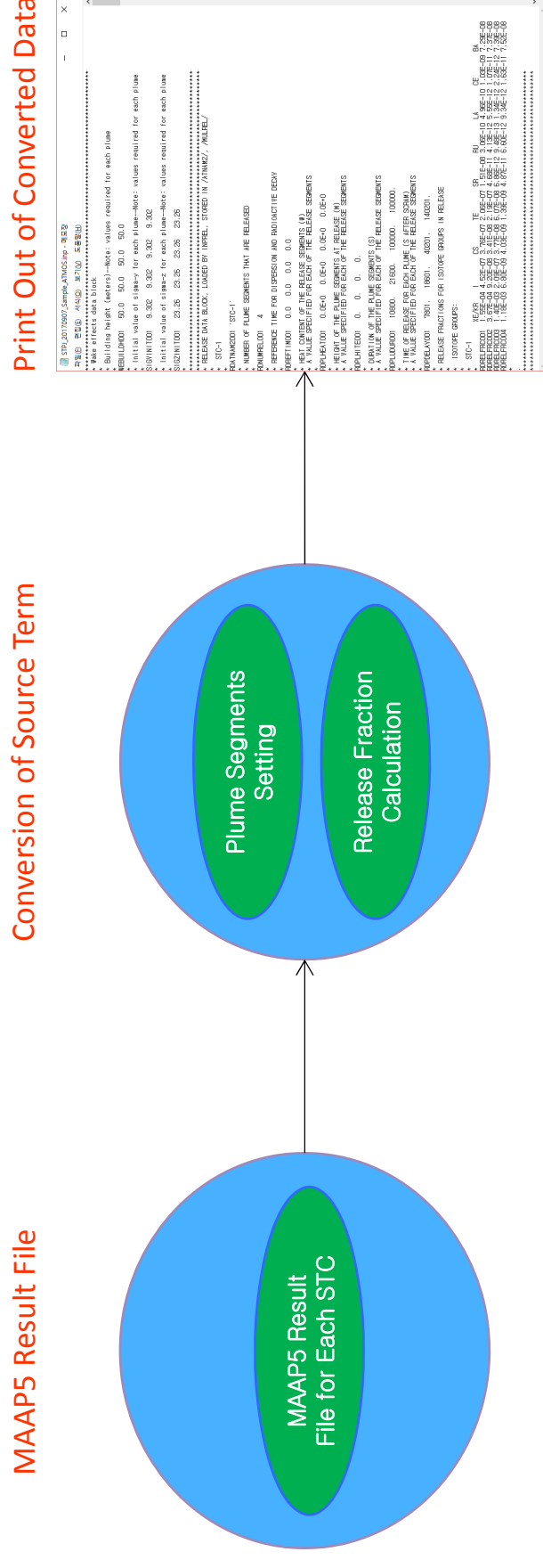
■ Development environment and system requirements

O/S	Windows 7 or above version, 64 bit
H/W	<ul style="list-style-type: none">• CPU: Intel Pentium 4 series (Multicore) or above• RAM: 4 GB or above
Development Environment	Microsoft .Net 3.5 or above
Development Language	C#

Pre-processors to Build MACCS Input

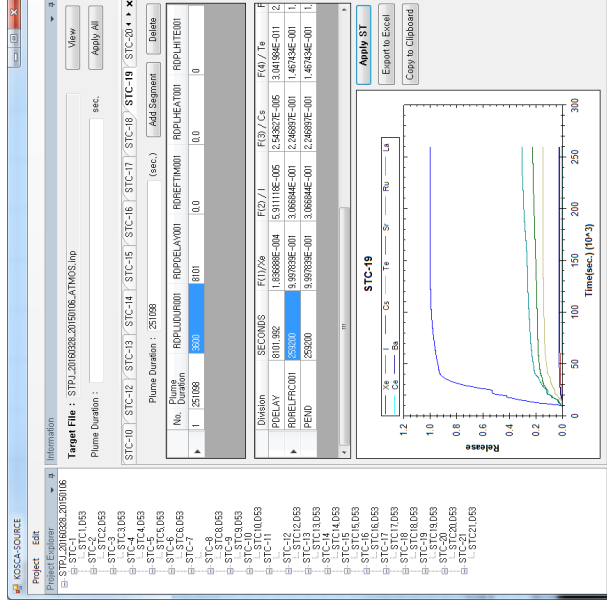
KOSCA-SOURCE

- Schematic summary of the function



KOSCA-SOURCE

- Interfacing L2-L3 PSA
 - Similar to MELMACCS
 - MELCOR output - (**MELMACCS**) - MACCS input
 - MAAP output - (**KOSCA-SOURCE**) - MACCS input
- Making the best use of Level 2 PSA results
 - L2 PSA results: plant-specific source term calculation by using MAAP
- Multiple STCs Editable



The 'Project - New' dialog box contains the following fields and options:

- Project Name : STPJ_20170907_
- Working Folder : [Browse button]
- Num. of STC : [Browse button]
- MAAP5 File Extension : D53
- Buttons: OK, Cancel

The 'Edit - ST MAAP5 File' dialog box contains the following fields and options:

- Project Name : STPJ_20170907_Sample
- Source Term : STC-1
- MAAP5 File : [Browse button]
- Buttons: Clear, OK, Cancel

Below the fields is a table with columns 'S/T No.' and 'File Path'.

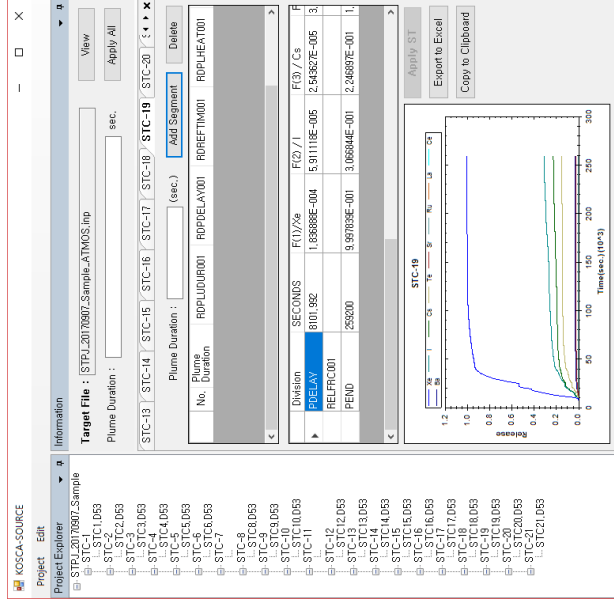
S/T No.	File Path
STC-1	
STC-2	
STC-3	
STC-4	
STC-5	
STC-6	
STC-7	
STC-8	
STC-9	
STC-10	
STC-11	
STC-12	
STC-13	
STC-14	
STC-15	

The 'Variables - Apply All' dialog box contains the following sections and fields:

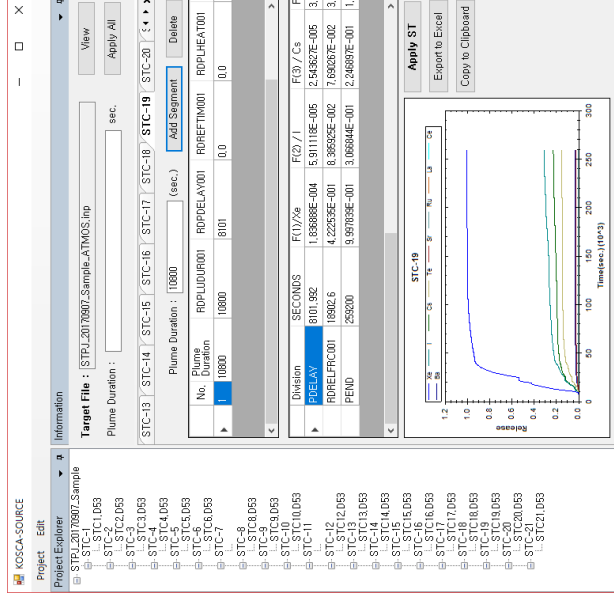
- Wale Effects Data Block**
 - WEDBUILD : 50.0
 - SIGINIT : 9.302
 - SIGZINIT : 23.26
- Release Data Block**
 - RDEFTIM : 0.0
 - RDEHEAT : 0.0
 - RDEPLITE : 0
- Plume Delay**
 - ☒ Use Default of Each Source Term
 - Plume Duration : 10000 (sec.)
- Buttons**
 - OK, Cancel

KOSCA-SOURCE

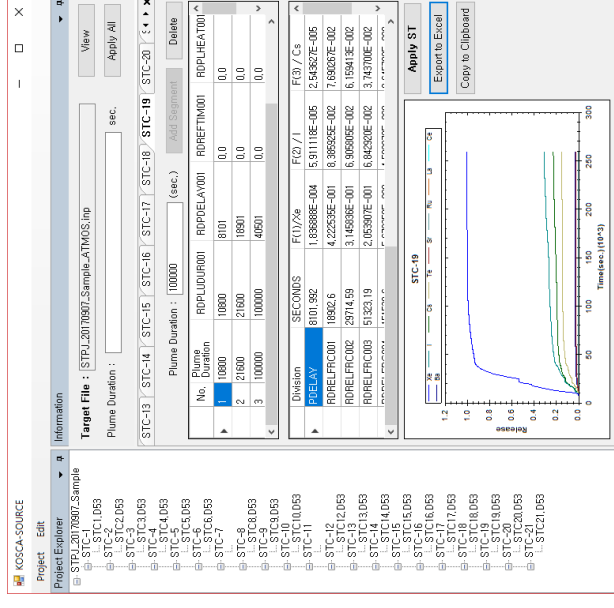
- Time-discretization of plume release
 - Enable semi-dynamic modeling of source release
 - Maximum 4 plume segments



1 plume segment



4 plume segments



KOSCA-SOURCE

■ Limitations of the current version

- Not applicable for particle size distribution yet
- Not importing the information related with plume rise from MAAP
- Only MAAP5 (18 groups) → MACCS2 (9 groups) version compatible
- Maximum 4 plume segments

```

STPL20170907_Sample.ATMOS.inp - 메모장
파일(F) 편집(E) 서식(O) 보기(V) 도움말(H)
*****
* Make effects data block
*****
* Building height (meters)--Note: values required for each plume
WBUILDH001 50.0 50.0 50.0 50.0
*****
* Initial value of sigma-y for each plume--Note: values required for each plume
SIGYINIT001 9.302 9.302 9.302 9.302
*****
* Initial value of sigma-z for each plume--Note: values required for each plume
SIGZINIT001 23.26 23.26 23.26 23.26
*****
*****
* RELEASE DATA BLOCK, LOADED BY INPREL, STORED IN /ATNAM2/, /MULTREL/
*****
* STC-1
*****
PODATNAM2001 'STC-1'
*****
* NUMBER OF PLUME SEGMENTS THAT ARE RELEASED
RONUMREL001 4
*****
* REFERENCE TIME FOR DISPERSION AND RADIOACTIVE DECAY
ROREFTIM001 0.0 0.0 0.0 0.0
*****
* HEAT CONTENT OF THE RELEASE SEGMENTS (H)
* A VALUE SPECIFIED FOR EACH OF THE RELEASE SEGMENTS
ROPLHEAT001 0.0E+0 0.0E+0 0.0E+0 0.0E+0
*****
* HEIGHT OF THE PLUME SEGMENTS AT RELEASE (H)
* A VALUE SPECIFIED FOR EACH OF THE RELEASE SEGMENTS
ROPLHTE001 0. 0. 0. 0.
*****
* DURATION OF THE PLUME SEGMENTS (S)
* A VALUE SPECIFIED FOR EACH OF THE RELEASE SEGMENTS
ROPLDUR001 10800. 21600. 100000. 100000.
*****
* TIME OF RELEASE FOR EACH PLUME (S AFTER SCRAM)
* A VALUE SPECIFIED FOR EACH OF THE RELEASE SEGMENTS
ROPLRELAV001 7801. 18601. 40201. 140201.
*****
* RELEASE FRACTIONS FOR ISOTOPE GROUPS IN RELEASE
*****
* ISOTOPE GROUPS:
*****
* STC-1
*****
ROPLFR001 XE/KR 1 CS 7E-07 3.78E-07 2.06E-07 1.51E-08 RU 3.06E-10 LA 4.95E-10 CE 1.05E-09 BA 7.29E-08
ROPLFR002 3.55E-04 5.02E-04 9.70E-07 3.77E-08 6.07E-08 6.98E-12 8.49E-12 5.34E-12 2.20E-12 7.50E-08
ROPLFR003 3.04E-04 5.02E-04 9.70E-07 3.77E-08 6.07E-08 6.98E-12 8.49E-12 5.34E-12 2.20E-12 7.50E-08
ROPLFR004 1.18E-03 6.80E-09 4.03E-09 1.33E-09 4.87E-11 6.60E-12 9.34E-12 1.69E-11 7.50E-08
*****
*****

```

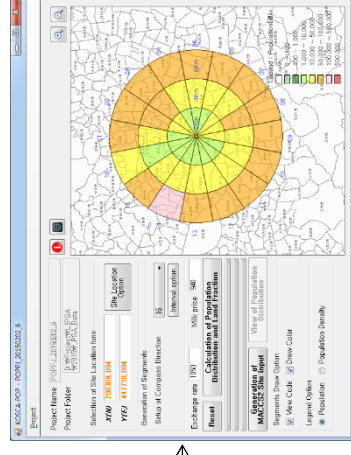
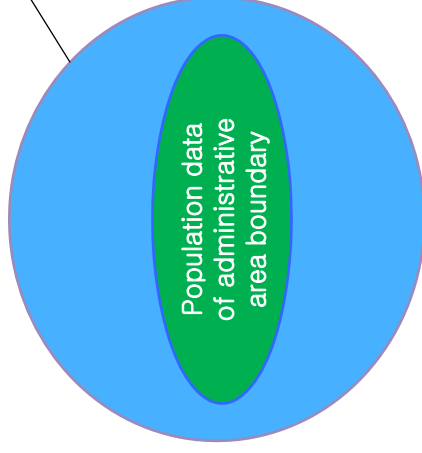
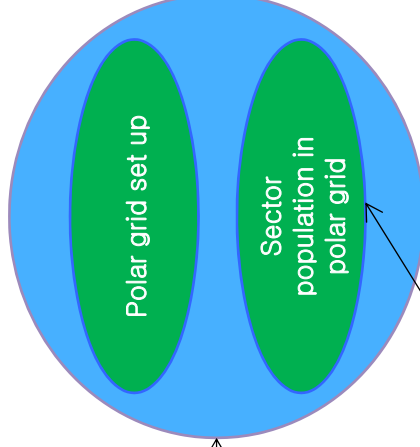
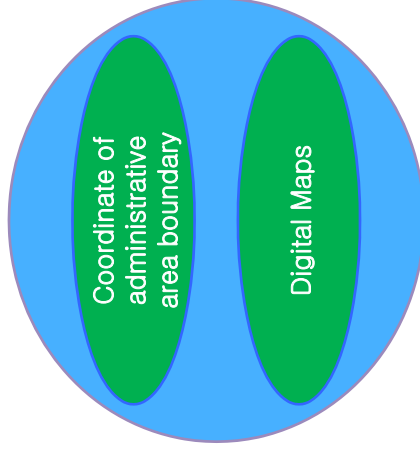
KOSCA-POP

■ Schematic summary of the function

Numerical Map

Polar Grid

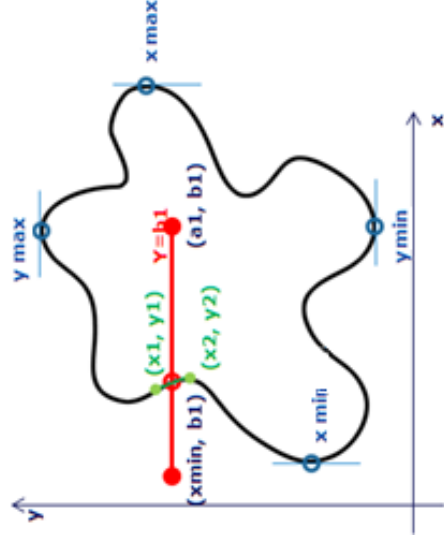
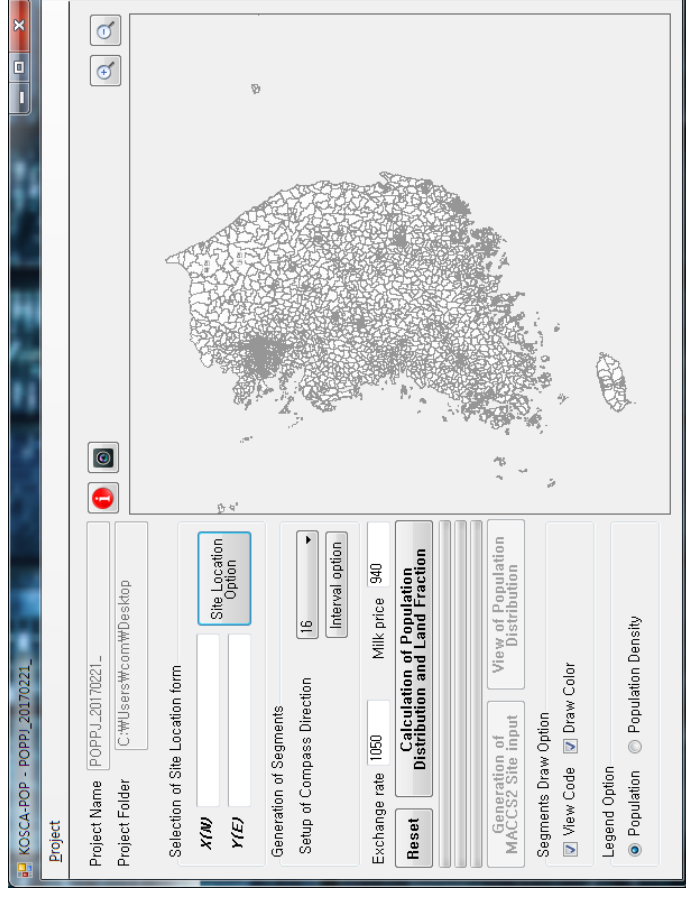
Print Out the Results



KOSCA-POP

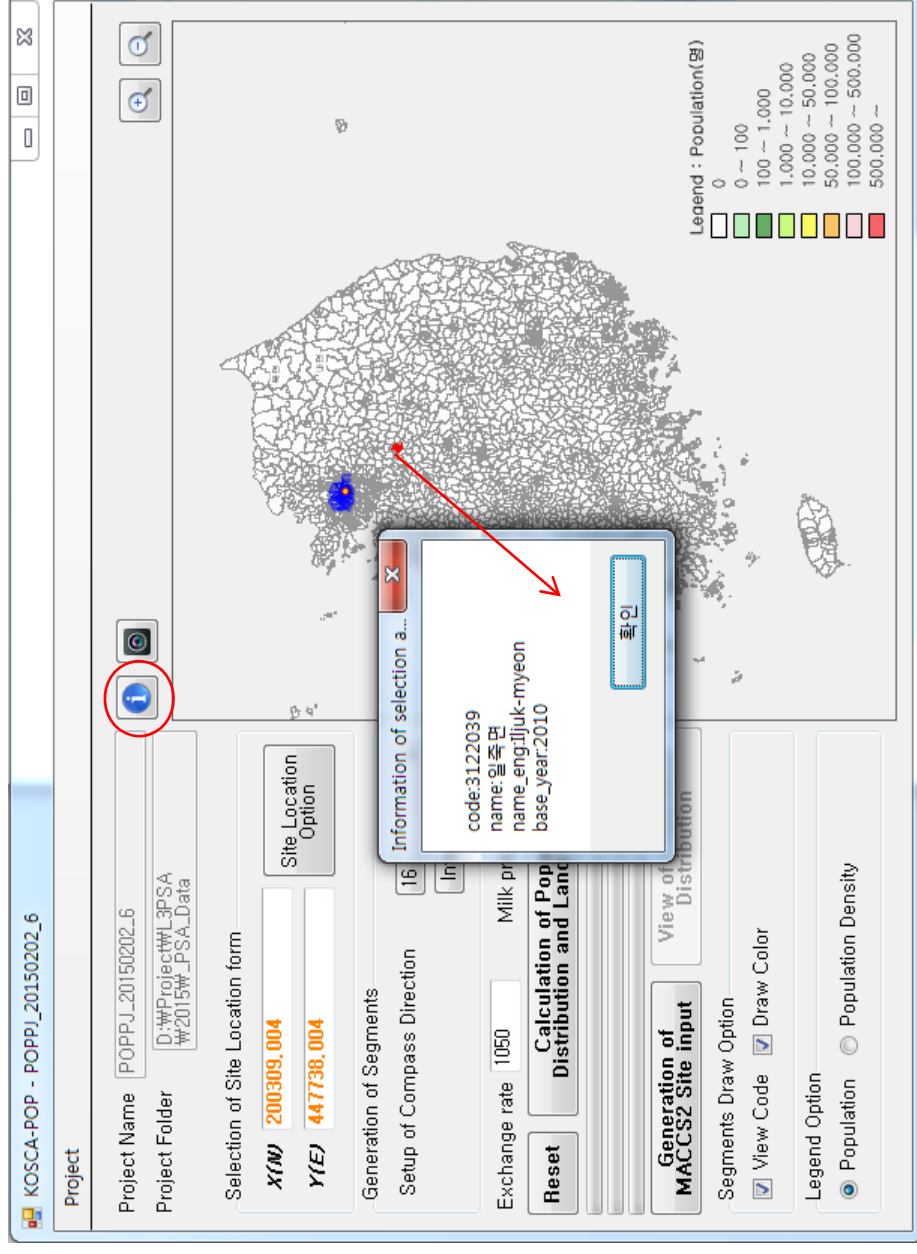
- Calculation of population data
 - Reference data
 - Region and geographic information
 - Population data of basic local government
 - Spatial grid
 - Method
 1. Allocation of population by the ratio of area belonging to the sector
 2. Allocation of population to the sector containing center point of administrative district
 3. The use of the point population data (resolution: 1km2 population data)

- Calculation of land information and economic factors
 - Farmland ratio
 - Farmland asset price
 - Non-farmland asset price



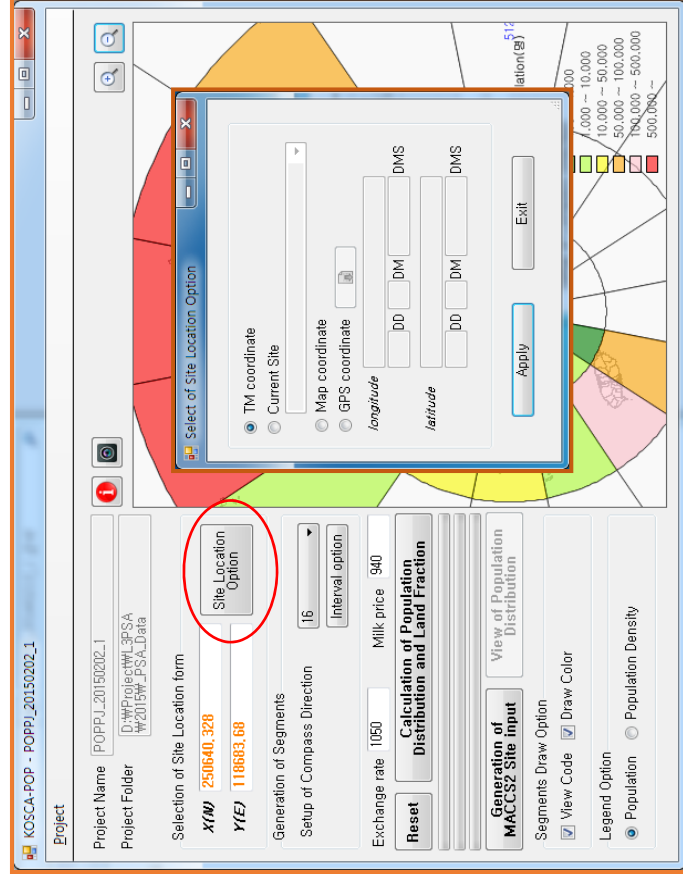
KOSCA-POP

■ Region information

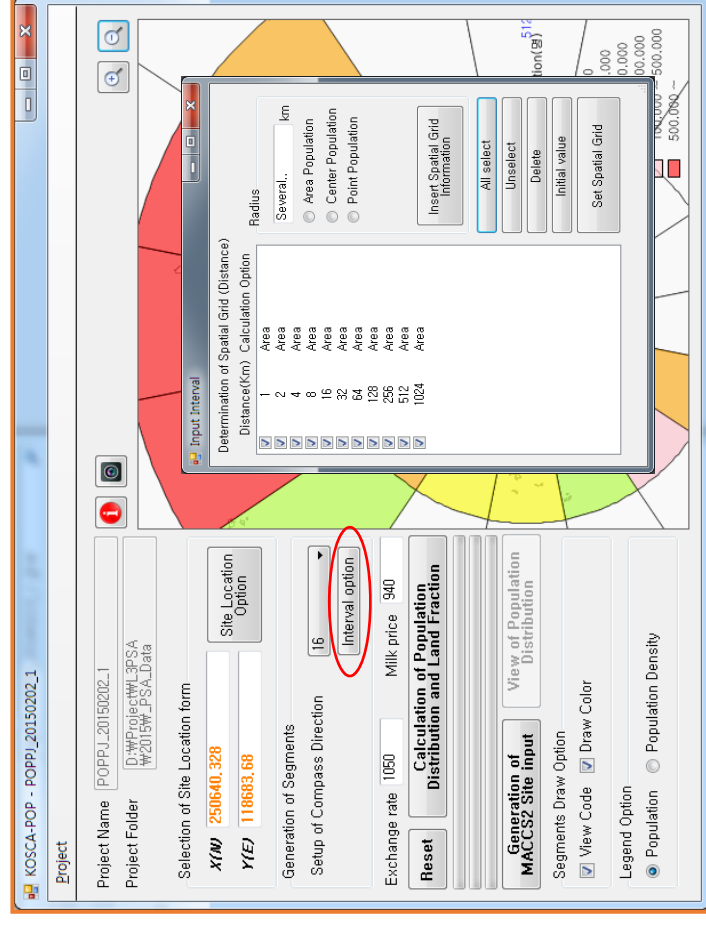


KOSCA-POP

■ Site location option

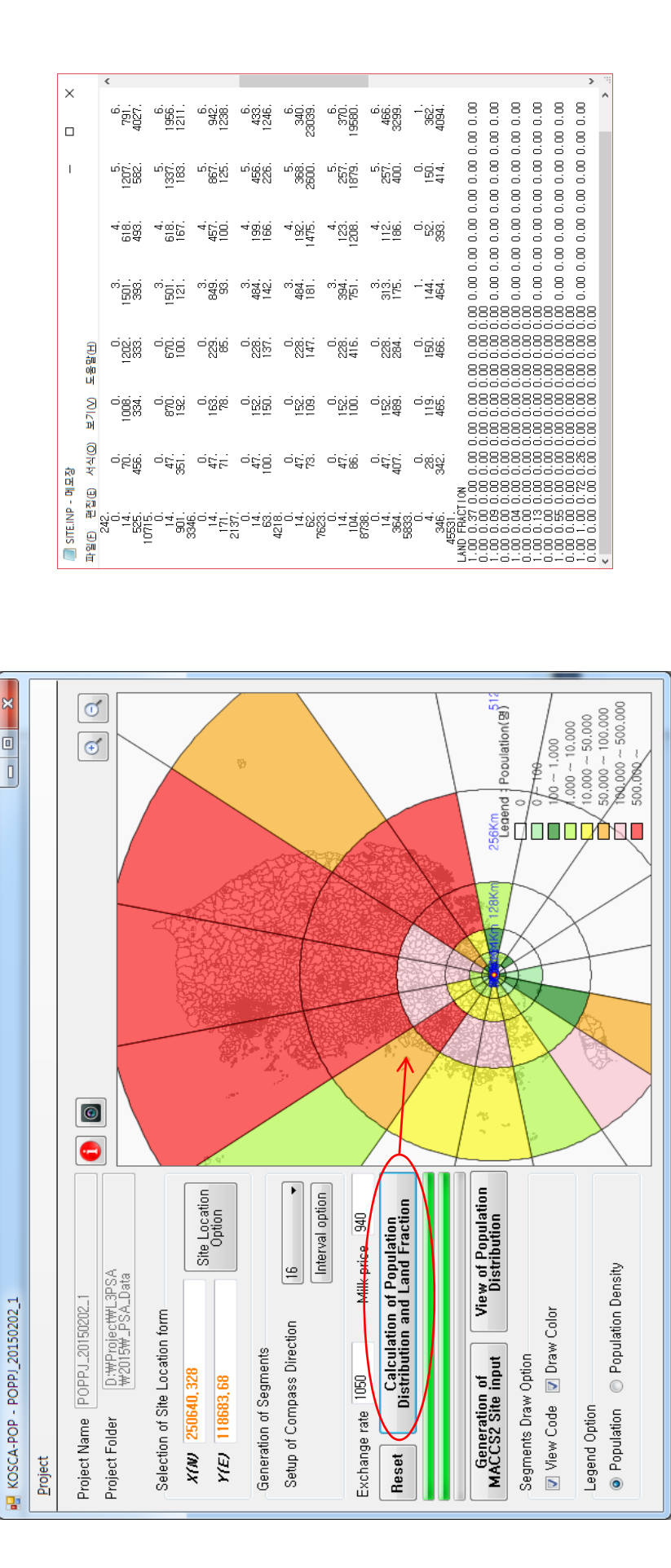


■ Grid interval option



KOSCA-POP

- Output examples



Project Name POPPJ_20150202_1

Project Folder D:\WP\Project\W1_3PSA
W2015W_PSA>Data

Selection of Site Location form

X(Y) 250640.328 **Site Location Option**

Y(E) 118683.68

Generation of Segments

Setup of Compass Direction 16 **Interval option**

Exchange rate 1050 **Mill-price** 940

Reset **Calculation of Population Distribution and Land Fraction**

Generation of MACCS2 Site Input **View of Population Distribution**

Segments Draw Option

☒ View Code ☒ Draw Color

Legend Option

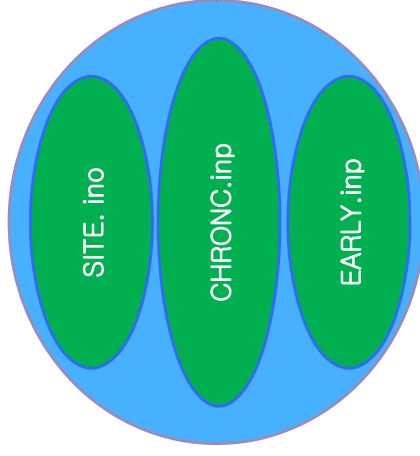
Legend

0 ~ 100
100 ~ 1,000
1,000 ~ 10,000
10,000 ~ 50,000
50,000 ~ 100,000

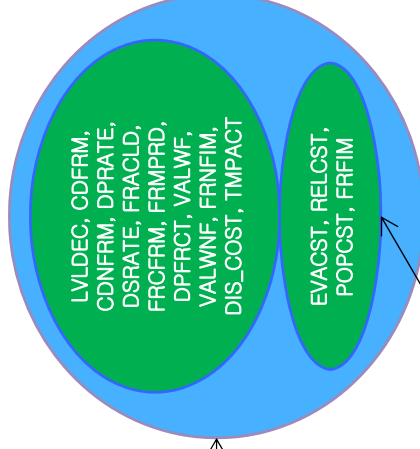
KOSCA-ECONO

■ Schematic summary of the function

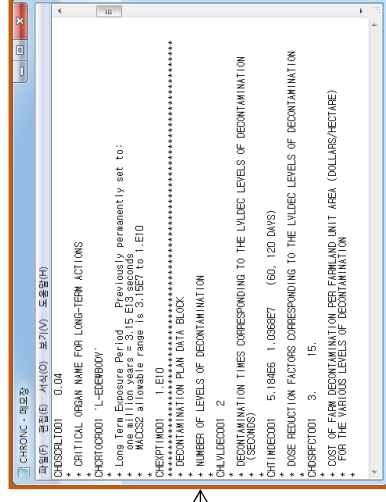
Input Files



Edit and Calculate

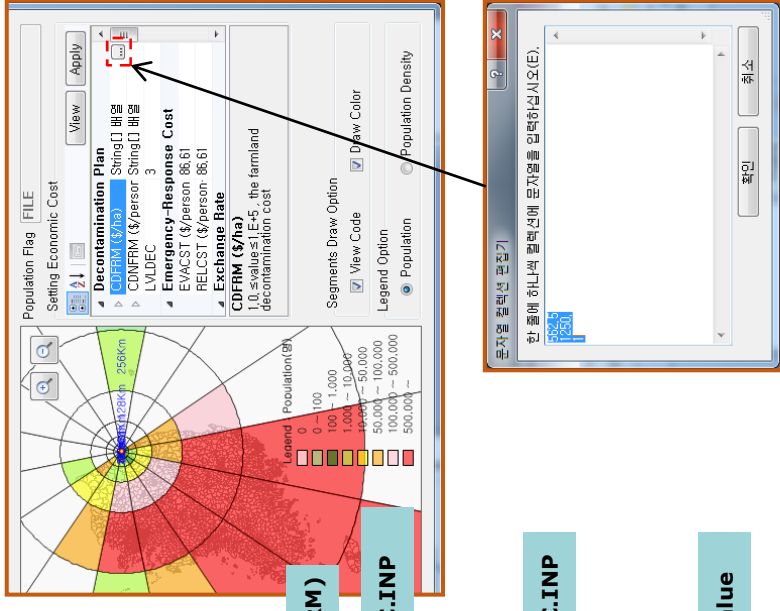
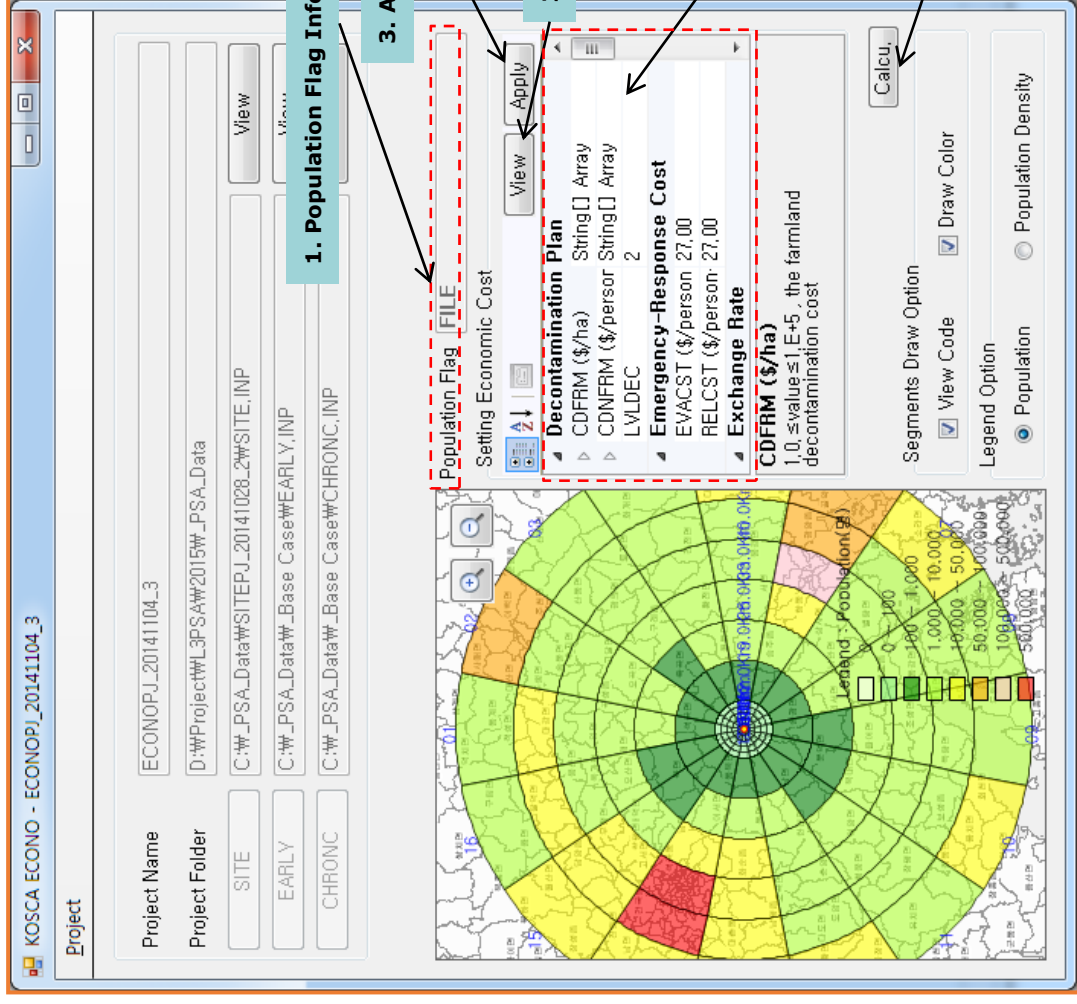


Print Out the Results

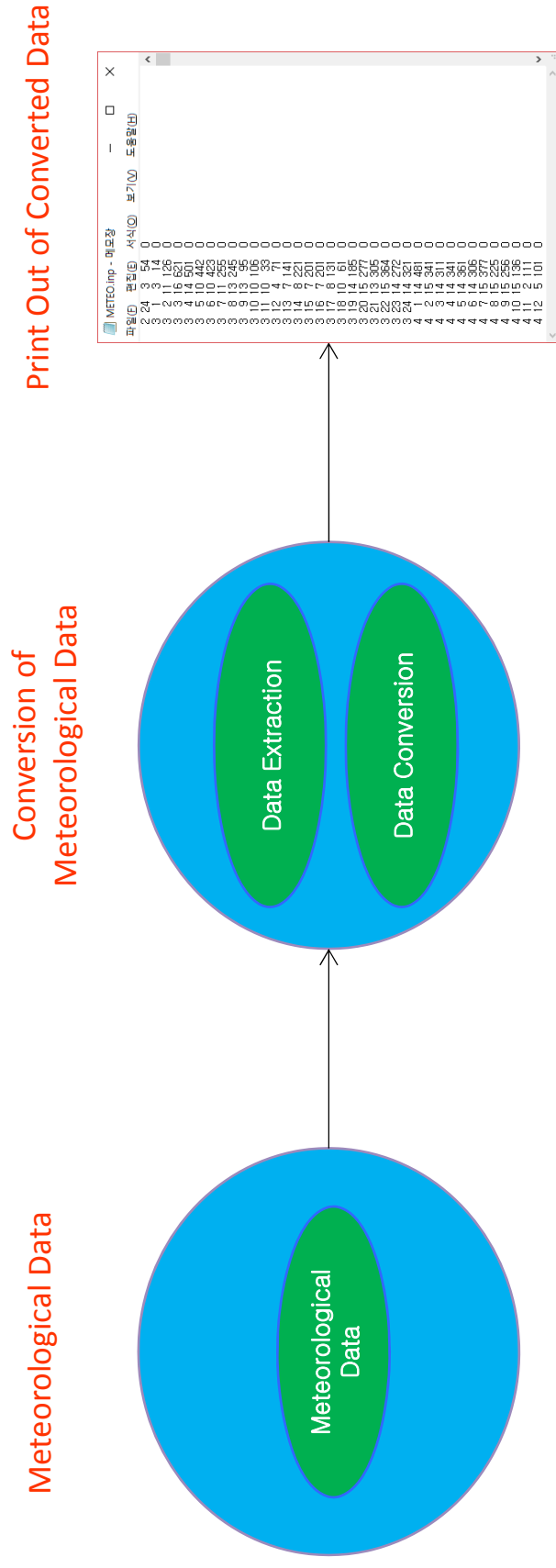


- Domestic data source
 - National Statistical Office
 - Korean Statistical Yearbook
- International data source (regarding decontamination)
 - ExternE
 - UNESCO Chernobyl Forum
 - IAEA Technical Report
 - MACCS2 data

KOSCA-ECONO



■ Schematic summary of the function



KOSCA-METEO

- Raw site meteorological measurement data

- Measurement interval: 10 min
- 3 height level: Ground, 10 m, and 58 m
- Wind direction: Angle
- Atmospheric stability: Temperature gradient between 10 m and 58 m height

Example of raw meteorological data

Time					Ground				10 m				58 m				Atmospheric Stability		
Year	M	D	h	min	Temp.	Humidity	Precipitation	Wind Dir.	Wind Speed	Max. Speed	Temp.	Wind Dir.	Wind Speed	Max. Speed	Temp.	ΔTemp.	10 m	58 m	
2011	04	01	00	10	8.90	50.4	0.0	163.0	1.0	2.1	9.22	166.9	1.1	2.1	9.66	0.9	48.7	48.5	
2011	04	01	00	20	7.95	51.4	0.0	126.9	1.4	2.6	8.88	125.6	1.5	2.5	9.10	0.4	54.6	48.1	
2011	04	01	00	30	8.19	52.8	0.0	259.2	0.7	1.4	8.16	251.4	0.7	1.5	8.29	0.3	34.3	39.7	
2011	04	01	00	40	7.34	47.5	0.0	228.2	1.5	2.4	7.62	227.0	1.7	2.4	7.69	0.1	22.8	17.7	
2011	04	01	00	50	8.03	44.4	0.0	236.3	1.2	2.2	7.53	236.9	1.3	2.1	7.81	0.6	32.6	26.2	
2011	04	01	00	00	7.92	41.9	0.0	228.6	1.7	3.2	8.02	228.2	1.8	3.2	8.23	0.4	26.3	29.4	
2011	04	01	01	10	8.87	34.0	0.0	211.5	2.0	3.0	8.28	213.0	2.1	3.1	8.73	0.9	16.5	13.3	
2011	04	01	01	20	7.71	51.7	0.0	7.6	0.3	1.1	9.03	26.9	0.4	1.1	9.24	0.4	74.2	79.6	
2011	04	01	01	30	7.82	50.1	0.0	236.4	0.9	2.1	8.13	232.8	0.9	2.1	8.40	0.5	23.8	36.3	
2011	04	01	01	40	7.35	53.5	0.0	252.3	0.9	1.8	7.78	260.9	0.9	1.8	8.02	0.5	43.7	48.1	
2011	04	01	01	50	7.10	46.4	0.0	211.8	0.7	1.8	7.54	218.9	0.7	1.9	7.83	0.6	69.5	66.8	
2011	04	01	02	00	7.50	43.1	0.0	198.8	1.6	3.0	7.69	202.4	1.6	2.9	7.98	0.6	46.7	52.2	
2011	04	01	02	10	8.19	36.7	0.0	226.2	1.0	2.2	8.41	232.3	1.0	2.3	8.81	0.8	39.9	42.2	
2011	04	01	02	20	7.41	39.8	0.0	207.7	0.8	1.8	8.25	208.4	0.9	1.8	8.42	0.3	21.6	37.7	
2011	04	01	02	30	7.14	44.3	0.0	217.8	1.1	2.2	7.35	217.3	1.2	2.4	7.61	0.5	69.2	66.9	
2011	04	01	02	40	7.28	39.8	0.0	230.6	0.9	2.0	7.39	232.0	0.9	2.0	7.74	0.7	27.2	31.3	
2011	04	01	02	50	7.21	40.9	0.0	213.4	1.1	2.0	7.38	211.7	1.2	2.0	7.64	0.5	28.4	25.8	
2011	04	01	03	00	7.03	40.7	0.0	227.9	1.0	1.8	7.28	227.6	1.1	2.0	7.55	0.5	23.3	19.1	
2011	04	01	03	10	6.89	41.8	0.0	220.2	2.0	2.9	6.53	221.9	2.1	3.1	6.67	0.3	16.1	11.0	
2011	04	01	03	20	6.97	51.9	0.0	227.0	1.5	2.9	6.66	234.0	1.6	3.0	6.94	0.6	27.8	27.3	

KOSCA-METEO

■ MET data file format of MACCS

Columns	Format	Variable	Information	Range
2-4	I3	ISTRDY	Julian day of the year	1 to 365
6-7	I2	ISTRHR	Hour of the day	1 to 24
9-10	I2	WINDIR	Direction the wind is blowing toward (N to NNW)	1 to 16
11-13	I3	WINDSPD	Wind speed (10ths of meters per second)	1 to 300*
14	I1	ISTAB	Stability Category (Pasquill A through G)	1 to 7**
15-17	I3	RNMN	Accumulated precipitation (100ths of inches)	-1 to 999***

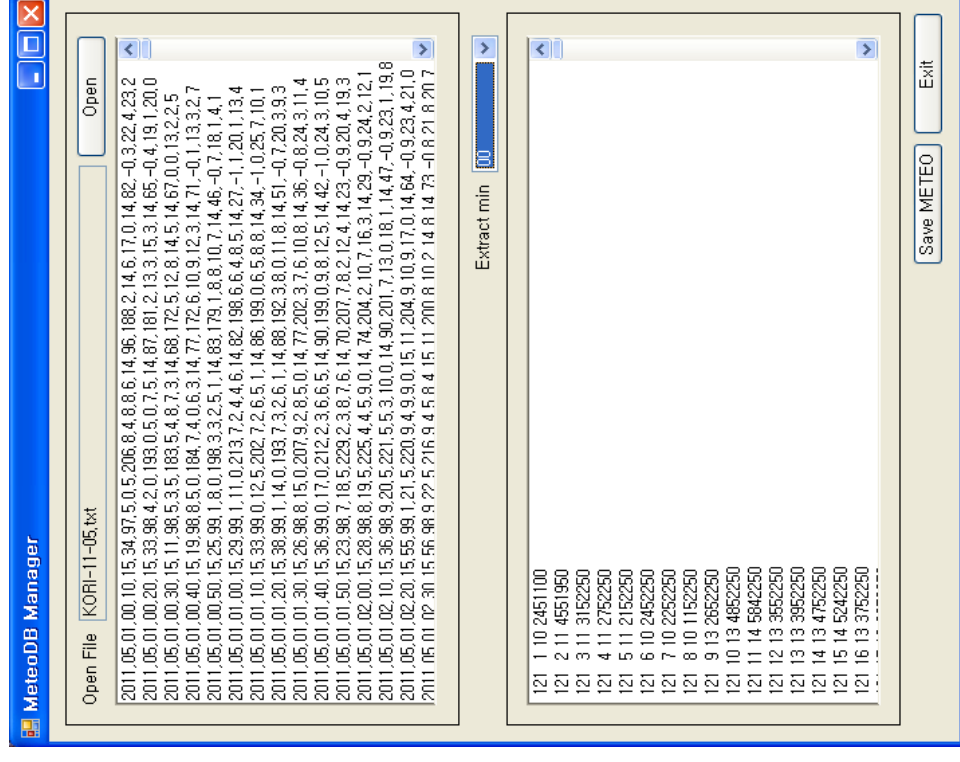
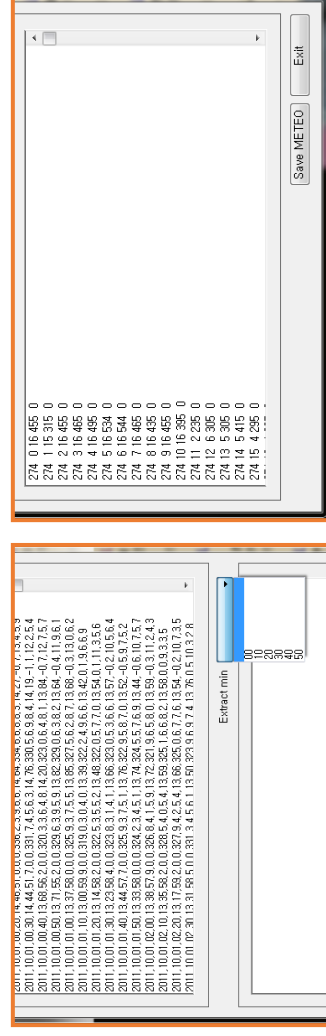
*Table from "Code Manual for MACCS2: Volume 1, User's Guide," NUREG/CR-6613, 1998

■ Conversion of raw site meteorological data into MACCS input format

- "Extract min" option
- Extract and conversion
- Print out text with MACCS MET format

Atmospheric Stability Classification of US NRC Reg. Guide 1.23

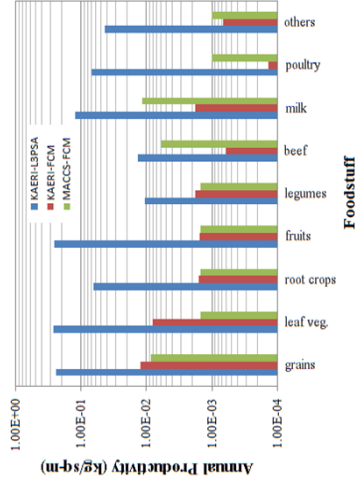
$\Delta T/\Delta z(^{\circ}\text{C}/100\text{m})$	< -1.9	-1.9 ~ -1.7	-1.7 ~ -1.5	-1.5 ~ -0.5	-0.5 ~ 1.5	1.5 ~ 4
Atmospheric Stability	A	B	C	D	E	F



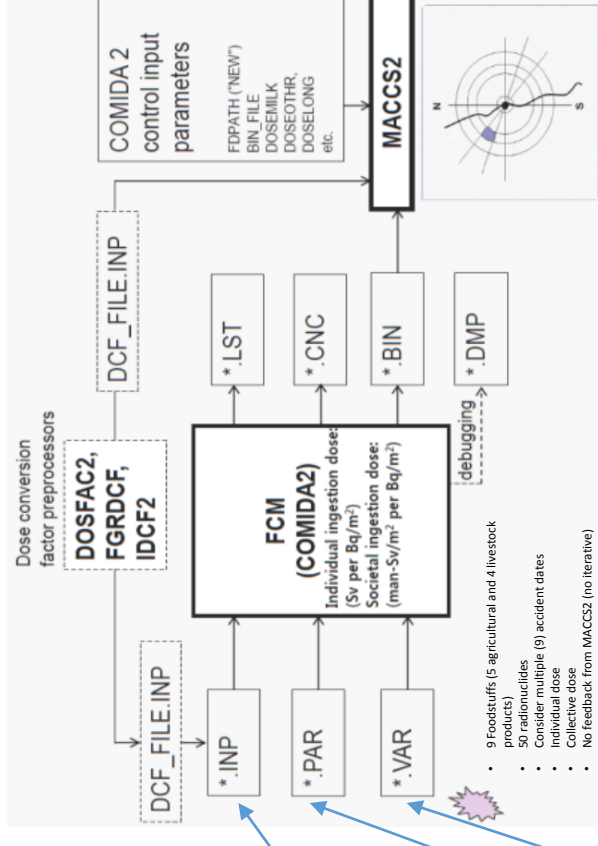
KOSCA-FCM

■ KOSCA-FCM: COMIDA2 input file for domestic food chain model (FCM)

- Scenario file (*.inp)
 - Individual annual consumption rate
 - Annual productivity
 - Processing loss
 - Holdup time between harvest and consumption
 - Domestic data from KOSIS (Korean statistical Information System)



- Crops and animal data file(*.par)
 - Reflecting domestic characteristics
- Nuclide specific data file(*.var)
 - Radionuclide transfer
 - Five radionuclides (I-131, Cs-134, Cs-137, Sr-90, Co-60)
 - Reflecting domestic characteristics



• Individual Dose

$$D_I = A \sum_{k=1}^N \left[\sum_{j=1}^F (GC_k D_{S_k} CR_j) \right]$$

where

N = number of nuclides;
 F = number of foodstuffs;
 GC_k = the ground concentration of nuclide k ;
 D_{S_k} = the COMIDA2 individual dose-to-source ratio for nuclide k ; and
 CR_j = the individual consumption rate for the foodstuff j .

• Societal Dose

$$D_S = A \sum_{k=1}^N \left[\sum_{j=1}^C (GC_k D_{S_k} AP_j) \right]$$

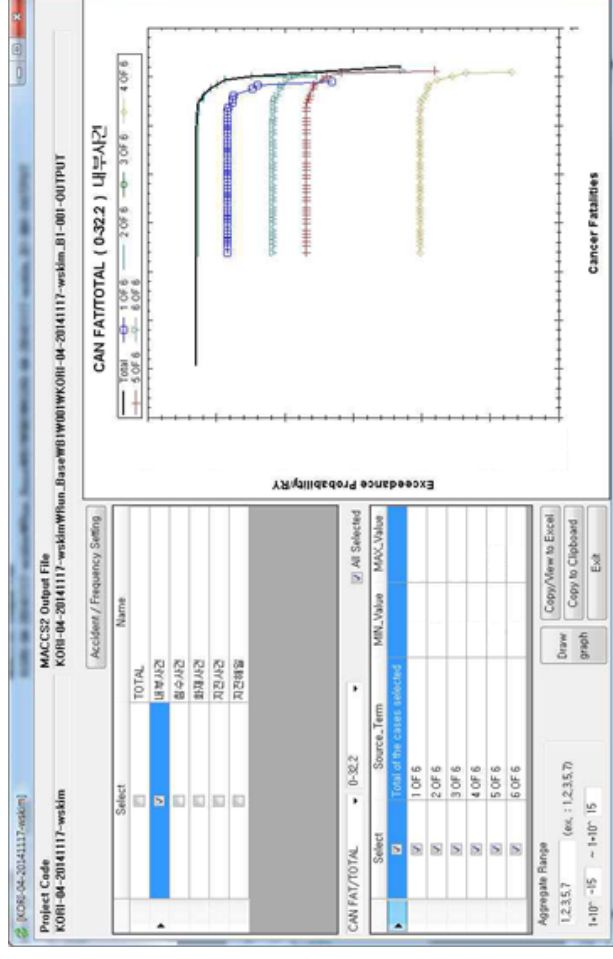
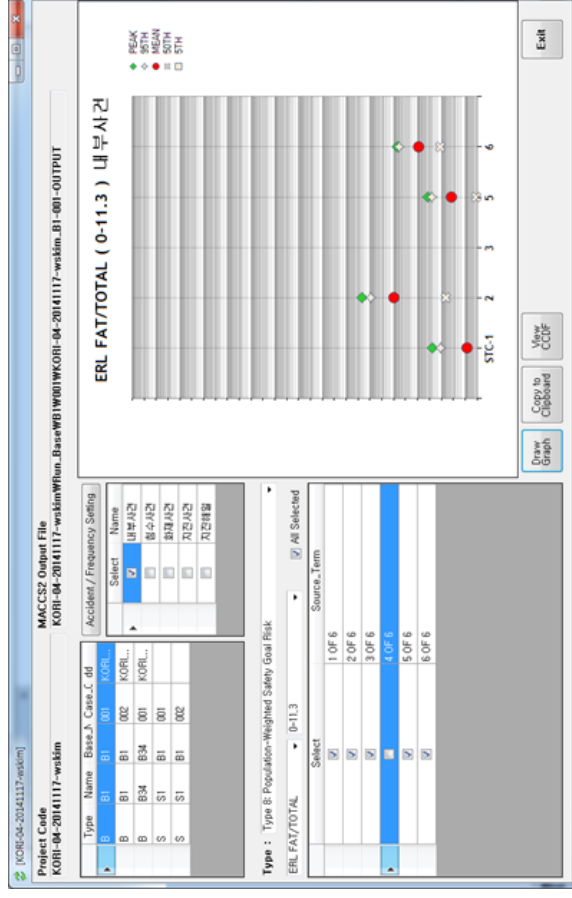
where

N = number of nuclides;
 C = number of crop categories;
 D_{S_k} = the COMIDA2 societal dose-to-source ratio for nuclide k ; and
 AP_j = the agricultural productivity for the crop category j .

*Reference:

- Code Manual for MACCS2: Volume 2, Preprocessor Codes COMIDA2, FGRDCF, IDC2, NUREG/CR-6613 Vol.2, 1998
- "A Development of Domestic Food Chain Model Data for Chronic Effect Estimation of Off-site Consequence Analysis," Seok-Jung HAN, Dong-Kwon KEUM, Seung-Cheol JANG, Transactions of the Korean Nuclear Society Spring Meeting, Jeju, Korea, May 7-8, 2015

KOSCA-OUTPUT



Summary

- **KOSCA-SOURCE**: pre-processor to convert MAAP5 source term output into MACCS2 source term group
- **KOSCA-POP**: pre-processor to automatically convert site-specific sector population and land fraction into MACCS2 input, given the polar-coordinate spatial grid specified by user. Similar to SECPOP for MACCS2
- **KOSCA-ECONO**: pre-processor to generate domestic economic cost data for MACCS2, similar to economic estimation part of the SECPOP pre-processor
- **KOSCA-METEO**: pre-processor to convert site-specific meteorological data for MACCS2 input
- **KOSCA-FCM**: COMIDA2 input file for domestic food chain model (FCM)

Thank you for your attention.