# KorFate MODEL: REGIONAL-SCALE FATE ESTIMATION OF ORGANIC POLLUTANTS IN NORTH EAST ASIA

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**Abstract**
Urbanization and land use are two important factors for the optimization of the multimedia model at the specific region. Thus, the Korfate model is developed for the regional-scale estimation in North East Asia. Several large cities are located at this area with the increase in rice farming areas. The model divided the soil media into 3 parts. Forest area considered as a typical vegetation property, and cultivated land had dual characteristics as a reservoir and soil. Urban area acted as a type of drainage system of chemicals. Results showed that it needs more parameterized work to improve the accuracy. The concept for this approach however is believed to be feasible and optimal for the proper fate estimation of organic pollutants in North East Asia.

## Introduction

Multimedia model is a useful tool to estimate the integrated pattern of chemical fate in each environmental media. For this reason, a variety of models have been developed for local, regional and global level estimation. Among them, regional level models, such as ChemCAN and ChemFrance, are known to be useful to assess national scale chemical fate in specific region. Those models however were optimized to their regional climate and environmental conditions. Thus, the use of these models is limited to direct application to North East Asia region where has some unique environmental and cultural characteristics. North East Asia is industrialized very rapidly with the different climate and land use, such as monsoon and large areas of paddy fields. During the farming season, paddy fields contain a lot of water to grow rice. Thus, cultivated land could play an important role as a small reservoir in the chemical fate, while most of urban area is covered with asphalt that blocks the penetration of chemicals.
Here, our objective of this research is to develop a regional-scale optimized model for the North East Asia region, and estimate the potential effects of urbanization and land use on chemical fate using the model.

## Materials and Methods

KorFate model is developed based on an Excel program using VBA macro. This model is designed as one type of unsteady state one-box model. It is consisted of 6 compartments, such as Air, Water, Sediment, Urban area, Cultivated land and Forest.

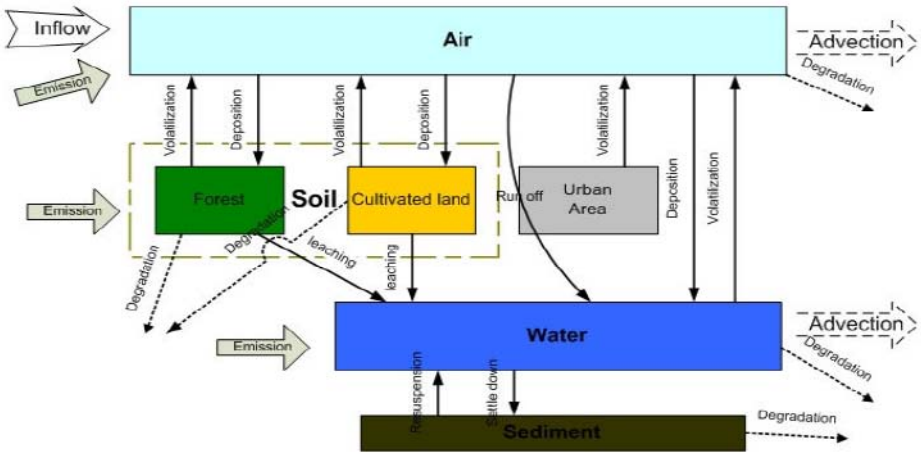


**Fig 1. Diagram of KorFate model**

This model considered that environmental fate is divided to intra-media and inter-media processes. Intra-media process contains inflow, outflow, degradation and leaching. Inter-media process includes volatilization, deposition, runoff and settle down to sediment.
Mass balance of each environmental media is calculated using the functions as followed.

$$\frac{dMi}{dT} = input - output = E_i + \sum (T_{ji} - T_{ij}) + \sum (F_{input} - F_{outflow}) - DE_i$$

**Table 1. Mass balance functions of each environmental media**

| | Functions in each media |
|---|---|
| Air | $\frac{dM_a}{dT} = E_a + F_i + V_{fa} + V_{ca} + V_{ua} + V_{wa} - D_{af} - D_{ac} - D_{au} - D_{aw} - F_o - DE_a$ |
| Water | $\frac{dM_w}{dT} = E_w + F_i + L_{fw} + L_{cw} + RU_{uw} + D_{aw} + R_{sw} - S_{ws} - F_o - DE_w$ |
| Forest | $\frac{dM_f}{dT} = E_f + D_{af} - V_{fa} - L_{fw} - D_f$ |
| Cultivated land | $\frac{dM_c}{dT} = E_c + D_{ac} - V_{ca} - L_{cw} - D_c$ |
| Urban area | $\frac{dM_u}{dT} = E_u + D_{au} - V_{ua} - RU_{uw}$ |
| Sediment | $\frac{dM_s}{dT} = S_{ws} - R_{sw} - D_s$ |

T : Transport mass between media i and j(mol/hour), F : Flow mass (mol/hour), E ; Emission mass(mol/hour), DE : Degradation mass(mol/hour), V : Volatilization(mol/hour), D : Deposition(mol/hour), R : Resuspension(mol/hour), S : Settle down(mol/hour), RU : Runoff(mol/hour)
*f*: Forest, *c* : Cultivated land, *u* : Urban area, *w* : Water, *s* : Sediment, a: Air

Basic static data related to land use were collected form the Yearbook of Construction and Transportation. Characteristic environmental parameters, for example, the settling rate of SS, were obtained form NIER research papers and other references[1,2,3].

**Results and Discussion**

The Korfate model is developed for the regional-scale estimation in North East Asia. Several large cities are located at this area with the increase in rice farming areas. Soil is a major transit pathway of the inflow chemicals. Thus, urbanization and land use could affect to the distribution of chemicals in environment. In order to estimate the effect of land use on the organic pollutant fate, the model divides the soil media into 3 compartments. Forest includes mountain, pasture, orchid, park and dry field that considered as typical vegetation properties. The most of soil in Korean peninsula is weathering products of granite, that the soil pH is a little bit acidic and soil depth in forest area is relatively shallow, compare to other regions. It means that water capacity of forest is low and leaching is a key factor to remove chemicals in this medium.
Cultivated land includes a paddy field. In Korea, mean depth of paddy fields water is 4.5cm. Thus, paddy fields acts as a shallow reservoir during spring to autumn. The bank around a rice field also prevents soil loss by runoff[4]. Thus, cultivated land has unique characteristics as a reservoir and soil. The Korfate model adjusts the leaching rate and mass of cultivated lands to consider this dual modes of paddy fields.

The most of urban areas were covered with asphalt or concretes as a pavement. It implies that most of incoming chemicals to urban area are removed by runoff because of block effect of pavement and drainage system. Urban area acts as a type of drainage system of chemicals.
For estimate this model, 2,2'3,4,4',5,5'-HeptachloroBiphenyl(PCB-180) is simulated. The result shown that run off is a key factor to remove PCB-180 in soil. But simulation results from forest soil and cultivated land showed very similar pattern and also overestimated in air. It means that it needs more parameterized work to improve the accuracy.
However, the concept for this approach is believed to be feasible and optimal for the proper fate estimation of organic pollutants in North East Asia.

**References**

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