The Application of Air Quality Models on Environment Impact Assessment

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Foreword

Models are useful tools to utilize when estimating environmental impacts from development projects and setting up proper mitigation policies of the Environment Impact Assessment. Especially with regard to air quality, models are indispensable tools for evaluation. Thus, the selection and application of proper models is one of the most important factors for making reliable and accurate assessments.

The purpose of this study is to develop effective impact assessment guidelines by applying regional characteristics based intensive analysis tools on air-quality emphasized projects and screening analysis tools on non-air quality emphasized projects.

Effective impact assessments such as simplified assessment tools, screening methods on non-air quality emphasized projects and applications of advanced air quality models considering the non-steady state of meteorology and topography on air quality emphasized projects can contribute to air quality assessments.

I hope that related research with this study can continue for the sustainable development of air quality assessments of Environment Impact Assessment.

I would like to thank the authors, NanKyoung Moon, YoungSoo Lee, YoungHyun Kang and YoungHa Kim, for their hard work. I also wish to express my sincere thanks to the reviewers for their helpful comments and suggestions on this study.

Suh Sung Yoon
President
Korea Environment Institute
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Chapter 1. Introduction

Air quality models are tools to utilize for a better comprehension of the complicated phenomena in the atmosphere. For instance, it is necessary to quantitatively evaluate the impacts of a source to its surroundings; it is also informative when estimating the effects of a source control plan in order to develop cost effective measures during the EIA.

Atmospheric dispersion models can be classified into 4 categories: statistical model, physical model, Gaussian model and the numerical model. The statistical model can be useful where the Gaussian and numerical model may be inappropriate due to the difficulty of quantifying physical and chemical factors. The physical model is applicable when evaluating impacts from pollution sources in small area by using wind tunnel experiments.

Because the Gaussian model estimates the dispersion phenomenon of air pollutants, under the hypothesis that pollutant concentrations accomplish normal distribution (Gaussian distribution) according to the distance from its plume central axis, this model possesses limited accuracy. However, the Gaussian model has been widely utilized on Environment Impact Assessment (EIA) for its convenience.

On the other hand, the numerical model simulates three-dimensional dispersion and photochemical reactions of air pollutant on every time level and as a result, complex atmospheric-phenomena can be estimated. However, the specialization of atmospheric science and chemistry is required when handling this model.

As an aside, the uniform model and its method have been applied for most projects on the EIA. Considering regional and project characteristics are very important for air quality modeling; it is necessary to obtain accurate estimates of environmental impact and setting up proper mitigation plan.

The purpose of this study is to develop effective environment
assessment guidelines by applying regional characteristics based intensive analysis tools on air-quality emphasized projects and screening analysis tools on non-air-quality emphasized projects.

The contents can be classified into the following three categories:
First, investigations of current air quality assessments on Preliminary Environment Review System (PERS) and EIA are conducted. Assessment contents for the PERS and EIA, such as site-suitability analysis and implementation of mitigation are discussed.

Second, characteristics of several models such as the Gaussian Plume Model, Gaussian Puff Model, and Eulerian Model. Reasonable application models that can effectively analyze impact assessments are selected. From the investigation, generalized model selection criteria are proposed which take into account the regional and project characteristics.

Third, simplified evaluation methods are proposed for the efficiency of the assessments on non-air-quality emphasized projects. A uniform level of assessments has been applied to all EIA reports, regardless of the characteristics of each project. Due to this reason, unnecessary labor and budgets have been invested. Therefore, we must select all items that can be waived to advance the air quality modeling process. Also, the screening method for non-air quality emphasized projects and construction projects are investigated.
Chapter 2. Current Application of Air Quality Models

1. Projects for Area and Point Sources

Table 1 represents the application status of models for recent projects such as housing, industrial complexes, power plants and harbor construction. A total of 85 projects were selected for analysis. As shown in table 1, ISC3 accounts for 92.1 percent of air quality models, and ISCST3 which occupies 80 percent. Therefore, the ISCST3 is a common model to apply for air quality projects.

Table 1. Analysis result of the model application status for area and point source project.

<table>
<thead>
<tr>
<th>Project type</th>
<th>ISCST3</th>
<th>ISCLT3</th>
<th>PEM-2</th>
<th>CDM-2</th>
<th>SCREEN3</th>
<th>K-SCREEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction of Road</td>
<td>9</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Housing Development</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Industrial Complex</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Power Plant</td>
<td>10</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Construction of Golf Course</td>
<td>10</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Development of Mountainous Areas</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Excavation Works</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Construction of Harbor</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Incinerating Facility</td>
<td>10</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>84</td>
<td>11</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Fraction</td>
<td>0.815</td>
<td>0.106</td>
<td>0.009</td>
<td>0.009</td>
<td>0.048</td>
<td>0.009</td>
</tr>
</tbody>
</table>

2. Projects for Line Sources
Table 2 represents similar results to table 1 with the exception of projects for line sources. CALINE3 and CALINE4 are the main models for line source projects, generally. As shown in table 2, CALINE3 account for approximately 75 percent of air quality models for line source projects, and Classification-Equivalence models are applied mostly in cases involving the tunnel effect.

However, it is necessary to investigate the application of CALINE3 and CALINE4 because of their limitations.

<table>
<thead>
<tr>
<th>Project type</th>
<th>CALINE3</th>
<th>CALINE4</th>
<th>Classification-Equivalence Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction of Road</td>
<td>8</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Housing Development</td>
<td>6</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Industrial Complex</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Power Plant</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Construction of Golf Course</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Development of Mountainous Areas</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Excavation Works</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Construction of Harbor</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Incinerating Facility</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>22</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Fraction</td>
<td>0.758</td>
<td>0.103</td>
<td>0.138</td>
</tr>
</tbody>
</table>
Chapter 3. The Application of Improved Air Quality Models

1. The Application for Each Stage of Assessment

It is difficult to resolve the different characteristics of the Preliminary Environment Review System (PERS) and Environment Impact Assessment (EIA) from current reports, although each PERS and EIA has different goals. The most important factor being that its contents are not sufficient to judge site-suitability, the goal for PERS.

In order to clarify the contents of PERS and EIA, site-suitability should mainly be discussed in the PERS. The development of the mitigation plan, on the other hand, should be a main consideration of the EIA. Model application methods are fairly similar, but the secondary pollutant assessment, which has not been conducted yet, is required for both systems.

However, secondary pollutant assessment is properly applied only on large-point source projects such as industry complexes, power plants, oil storage, and VOC emitting projects.

The modeling system that considers three dimensional meteorological fields and photochemical reactions should be developed continuously for assessments of secondary pollutants. Also, several pre-processes such as CAPSS processing tools for air quality model input forms are necessary.

2. The Application considering Regional and Project Characteristics

Projects for Area Sources
ISCST3 is the most common dispersion model for both area and point source projects as shown in Chapter 2. However, in order to better
consider the effects of actual topography in air quality modeling, it is necessary to develop a more appropriate model. With this in mind, the AERMOD (The American Meteorological Society [AMS/EPA Regulatory MODel]) is recommended.

The AERMOD modeling system is composed of a main model (AERMOD) with two preprocessors - a meteorological preprocessor (AERMET) and a terrain preprocessor (AERMAP). AERMET calculates hourly boundary layer parameters for use by AERMOD, including friction velocity, Monin-obukhov length, convective velocity scale, temperature scale, convective boundary layer height, stable boundary layer height, and surface heat flux. In addition, AERMAT transmits all observed meteorological parameters to AERMOD including wind direction, speed, and temperature.

AERMOD was introduced in 1996 as a replacement for the ISCST3 model for regulatory permitting. It is applicable to rural and urban areas, flat and complex terrains, surface and elevated releases, and multiple sources. Relative to ISCST3, AERMOD currently contains new and improved algorithms for:

- Dispersion in both the convective and stable boundary layers;
- Plume rise and buoyancy;
- Plume penetration into elevated inversion;
- Treatment of elevated, near-surface, and surface level sources;
- Computation of vertical profiles of wind, turbulence, and temperature; and,
- ‘Continuous’ treatment of receptors on all types of terrain from the surface up to and above the plume height.

Although, the AERMOD model was developed as a regulatory model to compensate for the weak points of meteorology and terrain, there has been no attempt from the EIA in Korea. Therefore, the theoretical characteristics and applicability of the AERMOD are investigated in this study.

Figure 1 shows the comparison of regression between ISCST3 and AERMOD for two cases. Topography is not considered in case (a) and topography is considered in case (b). The AERMOD presents clear
differences between cases (a) and (b). ISCST3, on the other hand, shows almost identical results for both case (a) and (b). This means that ARMOD calculates the effects of topography through the hill option. Therefore, AERMOD can act as a replacement for ISCST3 in most projects, especially on complex terrains.

Figure 1. The comparison of regression analysis between ISCST3 and AERMOD. (No consideration of topography (a), Consideration of topography (b))

Projects for Point Sources
Since AERMOD does not possess lake breeze models to assess shoreline fumigation conditions nor coastal and over-water interactions such as thermal internal boundary layer development, AERMOD is not any more fitting to apply on large point source projects normally located in coastal areas. To overcome this limitation of the AERMOD model, CALPUFF is recommended.

The CALPUFF air dispersion model is a Lagrangian non-steady-state modeling system that includes a meteorological model (CALMET) and a post-preprocessor, CALPOST. Collectively, the “CALPUFF air dispersion modeling system” was developed through an effort
sponsored by the California Air Resources Board (CARB). It was
designed to incorporate a more advanced understanding of plume
transport, dispersion, and chemical transformation than was available in
existing air dispersion models. Although the CAPLUFF air dispersion
model was originally designed as a large-scale air dispersion model used
to predict dispersion and transport of pollutants over large distances
(100 to 200 kilometers or more), it was also suited for predictions of near-
field plume dispersion. Like AERMOD, CALPUFF is not yet endorsed as
an official regulatory air dispersion model, although the USEPA
recommends its use for many applications; an official promulgation of
CALPUFF is expected by May 2003. Because of its pending
promulgation and historical application for assessing air quality,
CALPUFF is a suitable air dispersion model used for conducting risk
assessments.

A critical component of the CALPUFF air dispersion model is the
meteorological wind field that is generated by CALMET. The wind field
represents a three-dimensional grid of meteorological data (e.g., wind
speed, wind direction, temperature, turbulence parameters, etc.) that
varies with time. The CALPUFF air dispersion model uses the wind
fields to track the transport and dispersion of a plume from its source.
The path of the plume or puff is tracked for multiple hours until, the
puff is diluted via puff splitting - to an insignificant level. Since
emissions from a source are continuous, there is a near continuous
supply of puffs to track. Additional features of CALPUFF include the
ability to incorporate chemical transformation, deposition, elevated
terrain, and building downwash into the air dispersion model.

There are multiple user selectable options in the CALPUFF and
CALMET models as well as the CALPOST post-processor. Regulatory
guidelines for selecting certain options are provided, although due to the
uniqueness of modeling required for a risk assessment, selection of user
options should be carefully reviewed with the regulating agency.

Therefore, the CALPUFF model can be a proper model used in large-
point source projects on coastal or complex terrain area.

Figure 2 presents a comparison of horizontal distribution results
between CALPUFF and ISCST3. The results of the CALPUFF shows the
effect of three dimensional wind fields and topography with
COMPLEX1 algorithm compared to the ISCST3 which shows the
limitation of the Gaussian plume model. Therefore, CALPUFF can be a
replacement for ISCST3 on complex terrain with coastal and mountainous area.

**Figure 2. The comparison of horizontal distribution result between CALPUFF(a) and ISCST3(b)**
Assessment of Secondary Air Pollutants

In order to estimate secondary air pollutants such as ozone, particulate matter (PM) and secondary PM, numerical air quality models such as U.S.EPA-MODEL3/CMAQ and CAMx are necessary. Three dimensional meteorological fields and emissions are required to run numerical air quality models.

U.S.EPA-MODEL3/CMAQ and CAMx are reviewed for numerical air quality models; MM5 and RAMS are reviewed for meteorological models in the following.

- **Models-3/CMAQ Model**
  The Community Multi-scale Air Quality (CMAQ) modeling system is designed to approach air quality as a whole by including state-of-the-science capabilities for modeling multiple air quality issues, such as tropospheric ozone, fine particles, toxics, acid deposition, and visibility degradation. In this manner, the development of CMAQ involves scientific expertise from each of these areas. It combines the capabilities to enable a community modeling practice. CMAQ is also designed to function with multi-scale capabilities so that separate models are not needed for urban and regional air quality modeling.

  The target grid resolutions and domain sizes for CMAQ range spatially and temporally over several orders. With the temporal flexibility of the model, simulations can evaluate long-term (annual to multi-year) pollutant climatologies as well as short-term (weeks to months) transport from localized sources. With the model's ability to handle a large range of spatial scales, CMAQ can be used for urban and regional model simulations. Owing to CMAQ, a modeling system that addresses multiple pollutants and different spatial scales, it forms a "one-atmosphere" perspective that combines all the efforts of the scientific community. Improvements will be made to the CMAQ modeling system as the technology further develops in the scientific community.

  To implement the multi-scale capabilities of the CMAQ, several issues, such as scalable atmospheric dynamics and generalized coordinates that depend on desired model resolutions, are addressed. Meteorological models may assume hydrostatic conditions for large regional scales, where the atmosphere is assumed to have a balance of vertical pressure and gravitational forces with no net vertical acceleration on larger scales. However, on smaller scales such as urban scales, this assumption cannot
be made. A set of governing equations for compressible non-hydrostatic atmospheres is available to better resolve atmospheric dynamics on smaller scales. These non-hydrostatic equations are appropriate for finer regional scale and urban scale meteorology. Because the CMAQ is designed to handle scale dependent meteorological formulations and a large amount of flexibility, CMAQ's governing equations are expressed in a generalized coordinate system. This approach ensures consistency between CMAQ and the meteorological modeling system. The generalized coordinate system determines the necessary grid and coordinates transformations, and it can accommodate various vertical coordinates and map projections.

The CMAQ modeling system simulates various chemical and physical processes that are thought to be important for understanding atmospheric trace gas transformations and distributions. The CMAQ modeling system contains three types of modeling components: a meteorological modeling system for the description of atmospheric states and motions, emission models for man-made and natural emissions that are injected into the atmosphere and a chemistry-transport modeling system for simulating chemical transformation and fate. The emissions model and CMAQ science codes are available from the Community Modeling and Analysis System (CMAS) center.

The CMAQ modeling system consists of several processors and the chemical-transport model:

⊙ Meteorology-chemistry interface processor (MCIP)
⊙ Photolysis rate processor (JPROC)
⊙ Initial conditions processor (ICON)
⊙ Boundary conditions processor (BCON)
⊙ CMAQ chemical-transport model (CCTM)

The CMAQ system is designed to have a flexible community modeling structure based on modular components. The CCTM includes the following major processes:

⊙ Horizontal advection
⊙ Vertical advection
⊙ Mass conservation adjustments for advection processes
⊙ Horizontal diffusion
⊙ Vertical diffusion
Emissions injection
Deposition
Gas-phase chemical reactions
Aqueous-phase reactions and cloud mixing
Aerosol dynamics, thermodynamics, and chemistry
Plume chemistry effects
Photolytic rate computation
Process analysis

-CAMx (Comprehensive Air Quality Model with Extensions)
The Comprehensive Air quality Model with extensions (CAMx) is an Eulerian photochemical dispersion model that allows for an integrated "one-atmosphere" assessment of gaseous and particulate air pollution (ozone, PM2.5, PM10, air toxics, mercury) over many scales ranging from sub-urban to continental. It is designed to unify all of the technical features required of "state-of-the-science" air quality models into a single computationally efficient, easy to use, and publicly available model. The model code has a highly modular and well-documented structure that eases the insertion of new or alternate algorithms and features. The input/output file formats are based on the Urban Airshed Model. It is compatible with many other existing pre- and post-processing tools.

CAMx can perform simulations on three types of cartesian map projections: Universal Transverse Mercator, Rotated Polar Stereographic, and Lambert Conic Conformal. CAMx also offers the option of operating on a curvi-linear geodetic latitude/longitude grid system. Furthermore, the vertical grid structure is defined externally, so that layer interface heights may be specified as any arbitrary function of space and/or time. This flexibility in defining horizontal and vertical grid structures allows CAMx to match the grid of any meteorological model that is used to provide environmental input fields.

-MM5
The Fifth-Generation NCAR / Penn State Mesoscale Model is the latest model in a series that developed from a mesoscale model used by Anthes at Penn State in the early '70s that was later documented by Anthes and Warner (1978). Since that time, it has undergone many changes designed to broaden its applications. These include (i) a multiple-nest capability, (ii) nonhydrostatic dynamics, and (iii) a four-dimensional data assimilation (Newtonian nudging) capability, (iv)
increased number of physics options, and (v) portability to a wider range of computer platforms, including OpenMP and MPI systems. The MM5 is introduced in order to acquaint the user with some concepts as used in this modeling system.

Terrestrial and isobaric meteorological data is horizontally interpolated (programs TERRAIN and REGRID) from a latitude-longitude grid to a mesoscale, rectangular domain on either a Mercator, Lambert Conformal, or Polar Stereographic projection. Since the interpolation of the meteorological data does not necessarily provide much mesoscale detail, the interpolated data may be enhanced (program LITTLE_R/RAWINS) with observations from the standard network of surface and rawinsonde stations using a successive-scan Cressman or multiquadric technique. Program INTERPF then performs the vertical interpolation from pressure levels to the $\sigma$-coordinate of the MM5 model. Alternatively, program 3DVAR may be used to ingest data on model $\sigma$-levels. After a MM5 model integration, program INTERPB can be used to interpolate data from $\sigma$-levels back to pressure levels, while program NESTDOWN can be used to interpolate model level data to a finer grid to prepare for new model integration. Graphic programs (RIP and GRAPH) may be used to view modeling system output data on both pressure and $\sigma$-levels.

- RAMS

The Regional Atmospheric Modeling System (RAMS) was developed at Colorado State University and MRC/ASTER. RAMS is a multipurpose, numerical prediction model designed to simulate atmospheric circulations spanning from the hemisphere down to large eddy simulations (LES) of the planetary boundary layer. Its most frequent applications are to simulate atmospheric phenomena on the mesoscale (horizontal scales from 2 km to 2000 km) level, to support basic research ranging from operational weather forecasting to air quality regulation. The predecessor codes of RAMS were developed initially to perform research into modeling physics - graphically driven weather systems and simulating convective clouds, meso-scale convective systems, cirrus clouds, and precipitating weather systems in general. Since the early versions, the use of RAMS has increased greatly, with more than 100 RAMS installations in more than 30 different countries.

The RAMS concept was born in the early 1980's at Colorado State University. There existed three models at the Department of Atmospheric Science that had a great deal of overlap, the CSU
cloud/mesoscale mode (Tripoli and Cotton, 1982), a hydrostatic version of the cloud model (Tremback, 1990), and the sea breeze model described by Mahrer and Pielke (1977). The sea breeze model and the cloud/mesoscale model had development histories dating back to the early 1970s. It was decided to merge these three models into a unified system. The cloud model and the hydrostatic version were merged in 1983, forming the first version of RAMS.

RAMS contains a number of options which makes it amenable for use in a wide range of applications. It is designed so that the code contains a variety of structures and features ranging from hydrostatic to non-hydrostatic codes, resolution ranging from less than a meter to the order of a hundred kilometers, domains from a few kilometers to an entire hemisphere, and a suite of physical options. This allows for an easy selection of appropriate options for a different spatial scale or different locations. RAMS is well suited for parallelization since it does not use physical/numerical routines that are global. Pressure, for example, is solved locally either using the hydrostatic approximation or non-hydrostatically using a time-split compressible approximation. Advection is calculated using local finite difference operators rather than using non-local spectral methods. The advantage of the non-global character of finite-difference schemes can be bolstered for parallelization with good computational accuracy.

Projects for Line Sources

Even though CALIN4 is the upgraded version of CALINE3, CALINE4 is not easy to handle because it requires delicate input data such as the standard deviation of wind, the concentration of NO, NO₂, O₃, and the coefficient of photochemical reactions.

If we consider the difficulty of input data construction for CALINE4 into account, CALINE3 may be recommended to estimate NO₂ concentrations under the current state of affairs.

3. Screening Assessment

In this chapter, the application of simplified assessments on non-air quality emphasized projects is discussed for effective environmental
assessment.

- Non-air quality emphasized projects that can be applied simplified assessment

Table 3 represents the status of air quality assessment from current EIA reports. According to the data, unnecessary air quality impact assessments have been conducted, even for non-air quality emphasized projects. From this analysis, new guideline to categorize non-air quality emphasized projects that can be waived air quality assessment and applicable project types are summarized in Table 4.

Table 3. The status of air quality impact assessment from EIA

<table>
<thead>
<tr>
<th>Group</th>
<th>Project Type</th>
<th>Literature number</th>
<th>Air quality impact assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>α</td>
</tr>
<tr>
<td>Urban Development</td>
<td>Construction of Canal</td>
<td>2</td>
<td>2 0</td>
</tr>
<tr>
<td></td>
<td>Construction of School</td>
<td>4</td>
<td>3 1</td>
</tr>
<tr>
<td></td>
<td>Construction of Sewage Disposal Plant</td>
<td>5</td>
<td>0 5</td>
</tr>
<tr>
<td></td>
<td>Sewage sludge Incineration Facilities</td>
<td>1</td>
<td>1 0</td>
</tr>
<tr>
<td>Development of Energy</td>
<td>Power transmission Line</td>
<td>5</td>
<td>0 5</td>
</tr>
<tr>
<td></td>
<td>Out door Substation</td>
<td>3</td>
<td>0 3</td>
</tr>
<tr>
<td></td>
<td>Submarine Mining Industry</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Construction of Harbors</td>
<td>Harbor Facilities</td>
<td>4</td>
<td>0 4</td>
</tr>
<tr>
<td>Development of Water Resources</td>
<td>Dam, Reservoir</td>
<td>5</td>
<td>1 4</td>
</tr>
<tr>
<td>Construction of Railroads (including urban railroads)</td>
<td>Railroad, City Railroad</td>
<td>5</td>
<td>4 1</td>
</tr>
<tr>
<td>Utilization and Development of Rivers</td>
<td>River Works</td>
<td>1</td>
<td>0 1</td>
</tr>
<tr>
<td>Reclamation Works and Forest or Land Clearing</td>
<td>Reclamation, Filling-Up</td>
<td>5</td>
<td>2 3</td>
</tr>
<tr>
<td>Works</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>Development of Tourist Complex</td>
<td>Tourist Industry</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Development of Mountainous Areas</td>
<td>Public Cemetery</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Grassland</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Forest road</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Development of Gymnastic Facilities</td>
<td>Golf Course</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Installation of Waste and excreta disposal Facilities</td>
<td>Night-soil Treatment</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Construction of Military Facilities</td>
<td>Installation of Training Base</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Excavation Works</td>
<td>Aggregate picking</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>
Table 4. List of project types that can be waived air quality assessment for Use Process

<table>
<thead>
<tr>
<th>Group</th>
<th>Project Type</th>
</tr>
</thead>
</table>
| Urban Development            | • Construction of Canal  
                              | • Construction of School  
                              | • Construction of sewage disposal plant |
| Development of Energy        | • Submarine Mining Industry  
                              | • Power transmission line, outdoor substation |
| Construction of Harbors      | • Harbor Facilities |
| Development of Water Resources | • Dam, Reservoir |
| Construction of Railroads    | • Railroad, City Railroad, High-Speed Railroad, Cable Railway |
| (including urban railroads)  |              |
| Utilization and Development of Rivers | • River Works |
| Reclamation Works and Forest or Land Clearing Works | • Filling-Up, Reclamation |
| Development of Tourist Complexes | • Tourist Industry, Resort, Hot Spring Development, City Park, Natural Park |
| Development of Mountainous areas | • Public Cemetery  
                              | • Grassland  
                              | • Forest road |
| Development of Gymnastic Facilities | • Gymnastic Facilities, Cycling Race, Youth discipline Facilities & district |
| Installation of Waste and excreta disposal Facilities | • Night-soil Treatment |
| Construction of Military Facilities | • National Defense Facilities, Navy Base Installations, Military Air Base |
| Excavation Works             | • River, Forest, Coastal Quartz Sand, Coastal Sand |

Construction Process
Since the uniform mitigation in construction processes are applicable regardless of the estimation results, simplified assessments such as screening methods can be effective for the EIA.

When the concentration with respect to the distance from the project area is simulated using Screen3, which estimates conservative
concentrations, ordinary assessments using advanced models such as ISCST3, AERMOD and CALPUFF are not necessary. The concentrations of housing can be estimated and proper mitigation and monitoring plans can be set up. This method can be used in all types of projects.

If the result is of national and provincial standard values, ordinary assessments using advanced models should be conducted.
Chapter 4. Conclusion

The study results are summarized in the three categories as follows:

First, each of the Preliminary Environment Review System (PERS) and Environment Impact Assessment (EIA) has different goals. However, it is difficult to resolve the different characteristics of PERS and EIA from actual reports. In order to clarify the content of PERS and EIA, site-suitability should mainly be discussed in PERS. The development of mitigation plans, on the other hand, should be a main consideration in the EIA. There are not many differences in application methods, but the secondary pollutant assessment, which has not yet been conducted, is required of both systems.

Second, in order to better understand the effects of topography in air quality modeling, AERMOD (The American Meteorological Society [AMS/EPA Regulatory MODel]) should take precedence over ISCST3. AERMOD presents advantages in the form of a steady-state, Gaussian plume model. It is apparent that AERMOD is more valuable compared to the ISCST3 when various scientific components are estimated. AERMOD considers non-Gaussian plumes in the convective condition and accounts for a dispersion rate that is a continuous function of meteorology. In contrast, ISCST3 assumes that the dispersion rate is constant with height, and the plume is always Gaussian in form. Therefore, AERMOD is recommended with complex terrain areas.

However, AERMOD has neither a lake breeze model to assess shoreline fumigation conditions nor coastal and over-water interactions such as thermal internal boundary layer development. This prevents the application of AERMOD over coastline areas with large point sources. An appropriate model that overcomes the limitation of AERMOD is CALPUFF. CALPUFF is an integrated puff model capable of modeling instantaneous or continuous releases over distances ranging from hundreds of meters to hundreds of kilometers. In practice, the effect of a large point source could range over hundreds of kilometers. CALPUFF possesses a meteorological preprocessor which produces a gridded three-dimensional flow fields for wind speed, wind direction, temperature, mixing layer height, and atmospheric turbulence, using available surface and upper air measurements. Also, CALPUFF includes
a complex terrain algorithms (Complex 1) to account for the effects of elevated terrain in ground level concentrations, and a shoreline model to account for the formation of thermal internal boundary layers due to land-water temperature differences. Therefore, CALPUFF is recommended over coastline areas and complex terrains with large point sources.

Third, screening methods are required in construction and use processes to improve the efficiency of assessments. Currently, items that can be waived in the air quality modeling process are selected in the EIA. We can save the labor involved in modeling processes, by virtue of improving efficiency in selection, which can be applied to construction processes as well as use processes. However, if the result of concentrations from the screening method is greater than the national or provincial standard value, then advanced modeling should be conducted as the next step.
Reference


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