Atlanta Roadside Emissions Exposure Study

Methodology & Project Overview

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Project Overview

The transportation system is a significant source of unhealthy atmospheric pollutants in the Atlanta region. Research indicates that elevated air pollution is measurable up to several hundred meters from traffic. Factors like traffic volume, topography and weather all impact where that pollution spreads and how it affects neighborhoods in our region. The growth of vehicle travel in the Atlanta region and increasing population density make it more important than ever to understand the link between transportation and air pollution. By evaluating how pollution disperses after it leaves the tailpipe, we can take steps to reduce exposure and improve public health.

The principle goal of the Atlanta Roadside Emissions Exposure Study (AREES) project is to understand how local-scale air quality is impacted by changes to the transportation system. By focusing on local emissions exposure at a human scale, planners can make more informed decisions about how roadway projects will impact health in their communities.

To accomplish this goal, the Atlanta Regional Commission (ARC) established a research team consisting of staff from ARC and the Georgia Environmental Protection Division (EPD). This team worked to determine the best tools and methodologies to develop a regionally applicable dispersion modeling methodology. The development of the AREES tool took the better part of three years and involved partnership and communication with the research team and staff from Georgia Tech, U.S. EPA, CDC, the University of New Mexico and the University of North Carolina.

To determine the concentration of transportation-related pollution in the regional atmosphere, the research team tied the ARC travel model to both a vehicle emissions model and a dispersion model. For the purpose of this study, the research team focused on fine particulate matter ($PM_{2.5}$) due to its well documented impact on human health and its relative stability in the atmosphere.

The resulting output emission concentration data can be crafted into an emissions exposure performance measure for use in transportation project evaluation, scenario planning and decision-making. Tying census and land-use data into the AREES outputs allows planners to evaluate a variety of additional topics such as: health risks among vulnerable populations, environmental justice, and siting of sensitive land uses.

The methodology used for AREES is replicable in other regions with the ability to model transportation and emissions. ARC management felt it was important to help disseminate the AREES methodology. The research team selected freely available and open-source tools and methodologies to calculate near-road transportation emission concentrations.

The information provided in this report is meant to demonstrate the development of the AREES methodology. In addition, later chapters are committed to showing sample results and case studies of how the data can be used to inform transportation planning decision-making. Future papers will focus on analyzing the impacts of transportation emissions on factors like social equity and health impacts.

Purpose

Current general best practices by Metropolitan Planning Organizations (MPOs), like ARC, handle air quality on a regional scale as mandated by federal air quality regulations in the Clean Air Act. Harmful emissions from the transportation sector are modeled as part of the requirements for transportation conformity. Total regional emissions are tested against pre-established motor vehicle emissions budgets presented in the State Implementation Plan (SIP). Regional total emissions, however, do not provide communities specific enough information to make decisions based on air quality impacts. An entire region can meet its transportation conformity goals, but pockets of the region may still face an added burden of emissions exposure due to localized conditions. The AREES project was conceived with that need in mind.

As stated, the principle goal of the AREES project is to understand how local-scale air quality is impacted by changes to the transportation system. AREES is meant to function as a tool for planners to evaluate the local air quality impact of changes to the transportation system, including: roadway widenings, new roadways, transit expansion, transit service changes, etc. With the increased federal emphasis on performance based planning, AREES provides a highly localized air pollution exposure tool to produce project level measures that reflect on public health impacts associated with changes to the transportation system. ARC implemented a transportation emissions exposure-based performance measure using AREES for the first time in the development of the Atlanta Region's Plan[1], adopted by the ARC Board in February, 2016.

The results of the AREES project can be used to evaluate existing transportation-induced concentrations of $PM_{2.5}$ throughout the region on a neighborhood scale. This information can be used to help determine appropriate land uses in areas with high concentrations of pollution from nearby roadways. ARC has developed an online interactive mapping interface[2] to help provide easy access to the data for the community.

One specific application related to land-use siting of the AREES project could be the siting of schools. Research emphasizes that the siting of schools, especially where children use playgrounds at recess, should be more sensitive to their exposure of pollution for the roadways nearby. The United States Environmental Protection Agency (EPA) produced guidelines for siting schools away from major roadways[3]. Some states, like California[4] have environmental guidelines that discourage building schools near major roadways. AREES results can help local governments make better-informed decisions on siting schools and other important land-uses in relation to transportation emissions.

[1] http://atlantaregionsplan.com/
[2] http://atlregional.github.io/dispersion/
[3] http://www.epa.gov/sites/production/files/2015-06/documents/school_siting_guidelines-2.pdf
[4] http://www.arb.ca.gov/ch/handbook.pdf

Methodology

Atmospheric dispersion models are typically run to understand the dispersion of emissions within a few kilometer area around a single pollution source. These models typically run over a small domain and include few emission source inputs. The AREES project expands this methodology out to a 20-county regional geography of 16,585 km^2 with approximately 25,000 roadway segments as illustrated in Figure 1. This distinction provides the principle challenge in developing a methodology for the AREES project that balances computation time and accuracy.

Figure 1 – AREES Project Domain and Source Emission Roadway Links

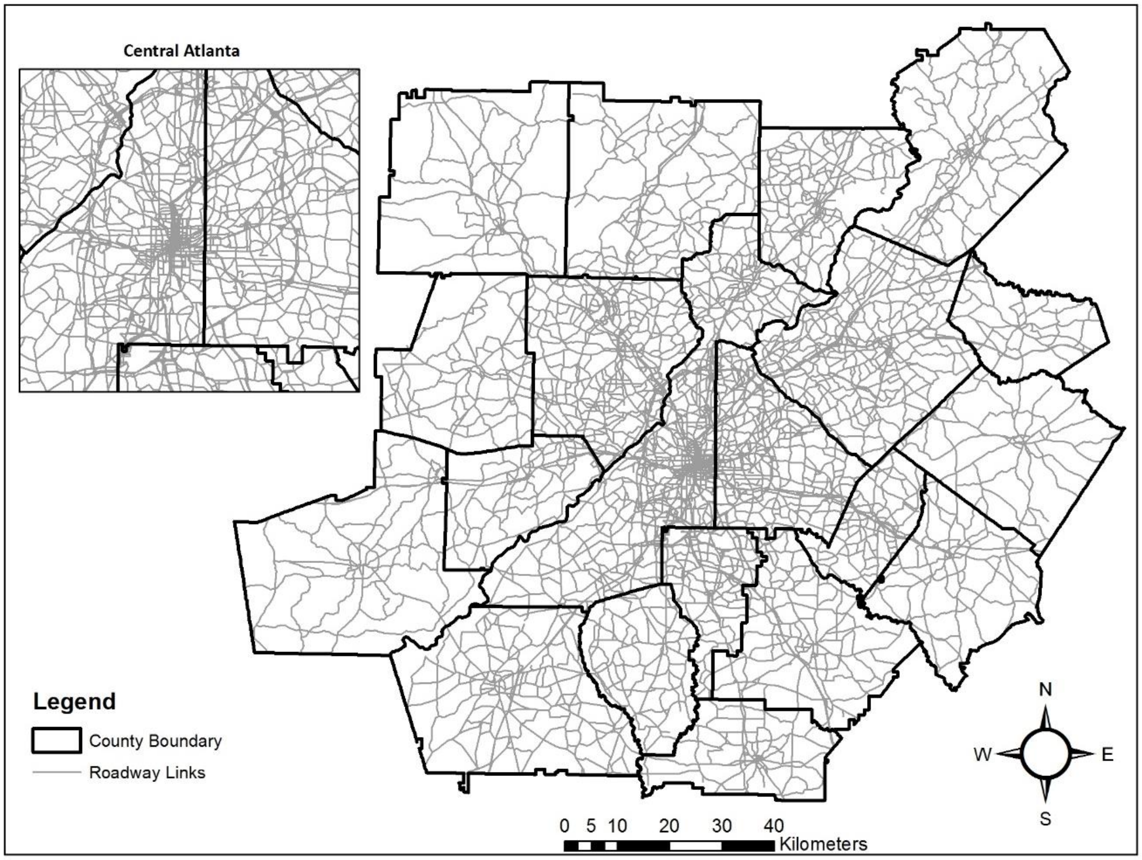
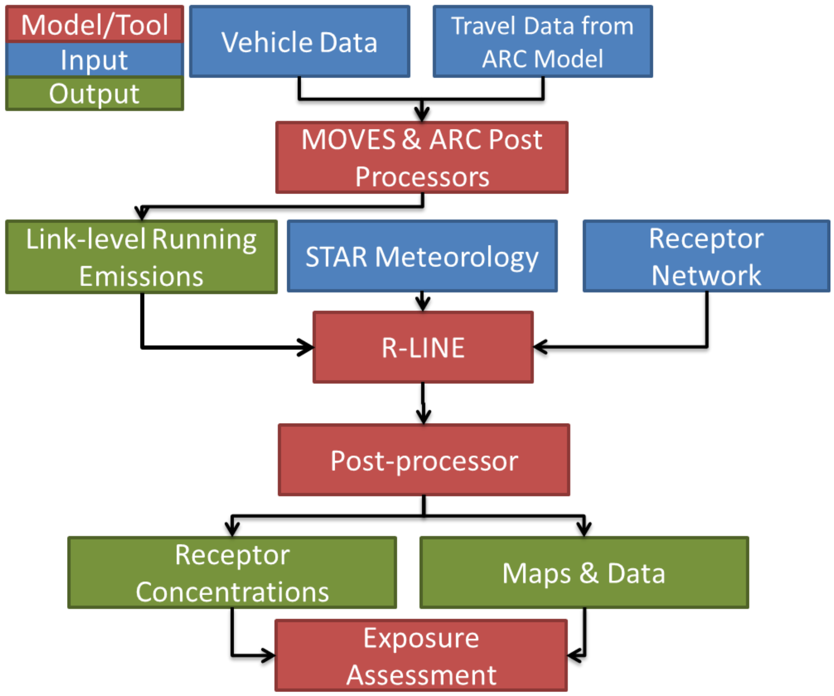


Figure 2 outlines the methodology established to meet the modeling needs for the AREES project. The process can be divided into three separate steps. First, regional traffic is modeled by ARC's travel demand model. These data, which includes information about traffic volumes and speeds, along with information about the Atlanta region's vehicle fleet and composition are then fed into the EPA-developed MOVES[5] emissions model to produce link-level emission values. Finally, the emission data is fed into the R-LINE[6] dispersion model to determine concentrations of annual average $PM_{2.5}$ pollution (in $\mu g/m^3$). The following subsections will go into more detail on the three main components of the AREES methodology.

[5] http://www.epa.gov/otaq/models/moves/
[6] https://www.cmascenter.org/r-line/

Figure 2 – AREES Modeling Flow Chart



ARC Travel Demand Model

ARC maintains a state of the practice travel demand model. For the preliminary proof-of-concept work, the research team used the ARC's 4-step travel demand model. This model generates information on a stick link network for a 20-county area of metropolitan Atlanta that corresponds to the Atlanta $PM_{2.5}$ nonattainment area.

Since the start of the AREES project, ARC developed a newer travel model, the Activity-Based Model. This model includes finer grain data about travel in the Atlanta region, a more comprehensive network of roads and more advanced algorithms to microsimulate regional population and travel. Final work presented in this document focuses on model output from the 2015 Atlanta Region's Plan model networks developed in the Activity-Based Model.

ARC has a long history of developing travel models and processing model outputs for use in emissions modeling for the Atlanta ozone and $PM_{2.5}$ nonattainment areas. Travel demand model output is post-processed for use in emissions modeling, which is the second step of the process.

MOVES Emissions Model

During the development of the AREES methodology, EPA updated their emissions model from MOVES2010 to MOVES2014. Preliminary work was completed using MOVES2010. For the final iteration of the project the research team used the MOVES2014 emissions model to determine the mass rate of $PM_{2.5}$ emitted by regional roadways. MOVES inputs are a mix of travel demand model output, default inputs, and locally collected data. Table 1 outlines the Atlanta region's inputs and their sources.

Table 1 – MOVES Inputs & Data Sources for the Atlanta Region

MOVES Input	Data Source
Vehicle Age Distribution	Local Data
Annualized Fuel Data	Local Data
Inspection & Maintenance Program Details	Local Data
Average Speed Distribution	Travel Model Output
Hourly VMT Distribution	Travel Model Output
Annualized Meteorology	Local Data
Fraction of VHT on Ramps	Travel Model Output
VMT Distribution by Road Type	Travel Model Output
Vehicle Population by Classification	Local Data
Monthly VMT Distribution	MOVES Defaults
Daily VMT Distribution	MOVES Defaults
Vehicle Starts	Travel Model Output

Like with travel modeling, ARC has a long history of running emissions models, like MOVES. Since the Atlanta area has historically been in nonattainment for the annual $PM_{2.5}$ standard the research team decided to focus on annual $PM_{2.5}$ concentrations for the study. MOVES was run to produce annual average $PM_{2.5}$ emissions. That is, annualized MOVES inputs are used to produce an average daily mass of emissions by transportation link for use in dispersion modeling in step 3.

R-LINE Dispersion Model

Metropolitan Planning Organizations, like ARC, generally have lots of experience in building travel models and using emissions models. On the other hand, state air agencies, like EPD have experience using dispersion models, making the partnership of ARC and EPD vital to the success of this project. This section outlines, to greater detail, the work required to incorporate an emissions dispersion model into the process. While all three of these models are tied together, the dispersion component of the AREES project took the most time to develop and refine.

The research team reviewed and tested several dispersion models and methodologies before deciding on R-LINE for this project. Initial tests used AERMOD in volume source mode. The research team selected R-LINE for the project after making comparisons between R-LINE and AERMOD and considering input compatibility, ease of scripting and speed of model runs. R-LINE requires a few major inputs: geospatial emissions sources, meteorology data and a receptor network.

Source Emissions

Table 2 illustrates key inputs required by the R-LINE model and the research team's sources of those data. For a full description, see the R-LINE user guide. Source emissions for R-LINE are prepared as roadway link-based mass rates in grams/meter/second of $PM_{2.5}$. These data were prepared from the output of the travel model and emissions model post-processing. All coordinates are provided in the SEMAP_LCC_6370 projected coordinate system using a Lambert Conformal Conic projection with standard parallels at 33° and 45° to match photochemical and dispersion modeling currently undertaken at EPD.

Table 2 – Key R-LINE Source Emission Inputs

Input	Input Explanation	Research Team Notes
X_b, Y_b, Z_b	Coordinates of the beginning of each link segment	No information on z coordinates exists in the ARC travel model, so value was set to 1
X_e, Y_e, Z_e	Coordinates of the end of each link segment	See above
dCL	Distance from roadway centerline to lane of traffic	Set to 0
Sigmaz0	Initial σ_z – Represents initial dispersion of plume	Set to 2.05
#lanes	Number of lanes of traffic	Set to 1. Emissions from all lanes were aggregated on each facility to represent one lane
Emis	$PM_{2.5}$ Emission rate in g/m/s	Postprocessed from travel model and MOVES emission runs output

Meteorology Data

The second major input required is meteorological conditions. For these runs the research team used 2011 AERMET meteorology from the Atlanta airport. This meteorology file is commonly developed by state air agencies for use in AERMOD dispersion modeling. The same file readily feeds into the R-LINE dispersion model.

Standard practice for dispersion modeling is to provide at least one full year of meteorology and emission inputs to determine annual average pollutant concentrations. When the domain of the project along with a full year of meteorology was considered, an initial estimate of R-LINE runtime for a 20-county area of metro Atlanta for this exercise on a small ARC server was over one year. To shorten this runtime, the research team altered meteorology based on a methodology developed by US EPA[7] and modified by Dr. Shih Ying Chang at UNC, called the Stability Array (STAR) approach.

The STAR approach reduces the 8,760 hours of meteorology in a year down to around 100 hours by applying weights to representative meteorological hours observed in a region. This is accomplished by grouping meteorology based on the following categories:

- Monin-Obukhov length in five categories: unstable, slightly unstable, neutral, slightly stable and stable
- Wind Direction in four categories: north, east, south and west
- Wind Speeds in five categories: <1 m/s, 1-2 m/s, 2-4 m/s, 4-7 m/s and >7 m/s

When this technique was applied to the 2011 Atlanta AERMET data, the resulting file contained 77 hours of meteorology – some combinations of the above parameters were not observed in Atlanta in 2011. A small domain comparison between running R-LINE with full meteorology or STAR meteorology found an R^2 value of 0.98 between the two methodologies.

[7] https://www3.epa.gov/scram001/metobsdata_procaccprogs.htm

Receptor Network

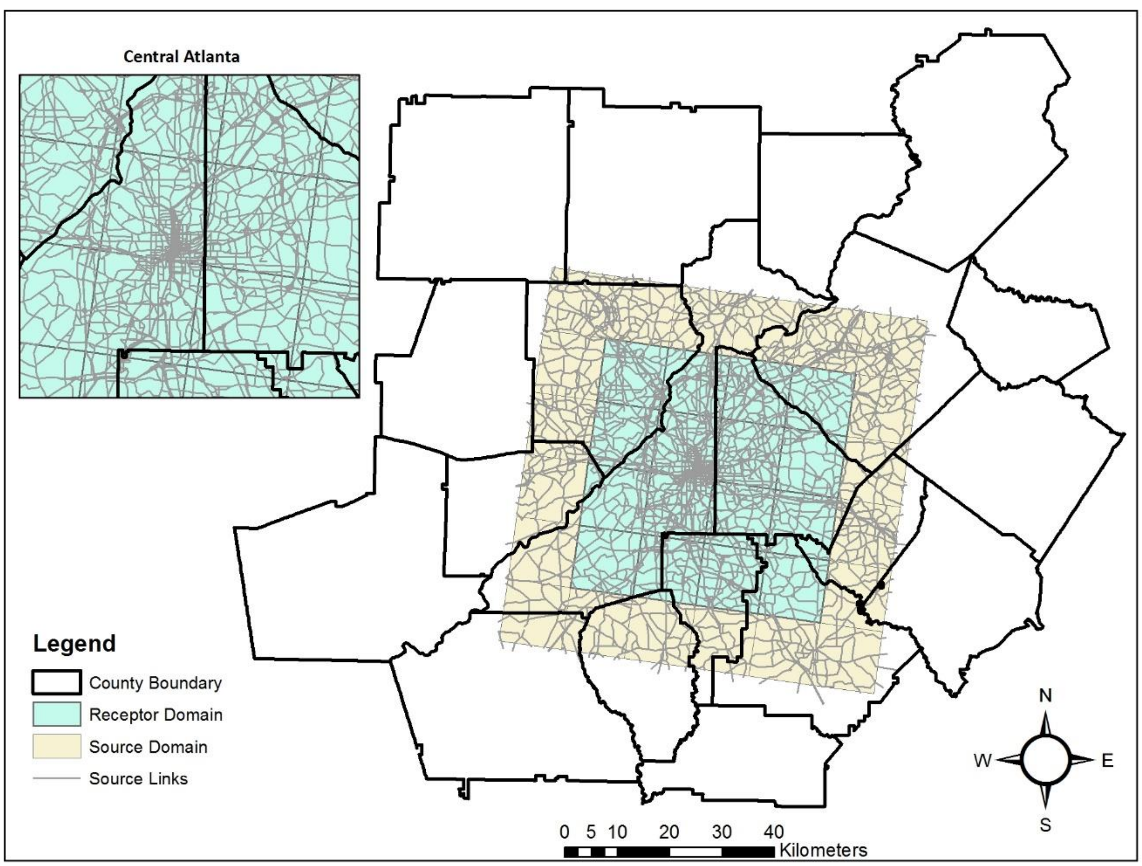
Dispersion models require a receptor network to calculate emissions from sources at set locations. For this project, the research team settled on a receptor grid of 200m distributed throughout the region. This spacing results in a network of 486,000 receptors. Similar to the source links, coordinates are displayed in a Lambert Conformal Conic projection.

Model Domain

Typically, dispersion models run with a single domain of sources and receptors. Running R-LINE in this fashion would calculate the contribution of every source to every receptor in the region. When in reality, the pollution contribution of a roadway spikes nearby and quickly falls off over the distance of a few kilometers.

To reduce runtime and remove extraneous calculations the research team decided to reduce the domain of each individual R-LINE run. Using 12km x 12km SEMAP grids, established for photochemical modeling by EPD as a base geometry, a series of tests determined the optimal receptor domain of each R-LINE run was a square grid 48km x 48km with source links included within a domain of 72 km x 72 km (see Figure 3 for an illustration).

Figure 3 – Illustrative R-LINE Run Domain Network of Receptors and Sources



This step reduces the number of calculations and greatly reduces runtime at the expense of a small degree of accuracy. In this methodology, the central grid illustrated above, now has 57,600 receptors and 14,093 source links. Runtime on a 7 core processor was reduced to approximately 70 hours.

This methodology also decouples the need to run the entire region with every test. New transportation projects can be evaluated by running the set of grids that are most relevant to the project. Figure 4 illustrates the final set of receptor grids for the Atlanta region. Final counts of receptors and source links as well as runtime estimates are provided in Table 3. Total runtime for the entire Atlanta region is 231 hours (9.6 days) on one 7-core desktop machine.

Figure 4 – Final Regional Network of Receptor Grids used for AREES

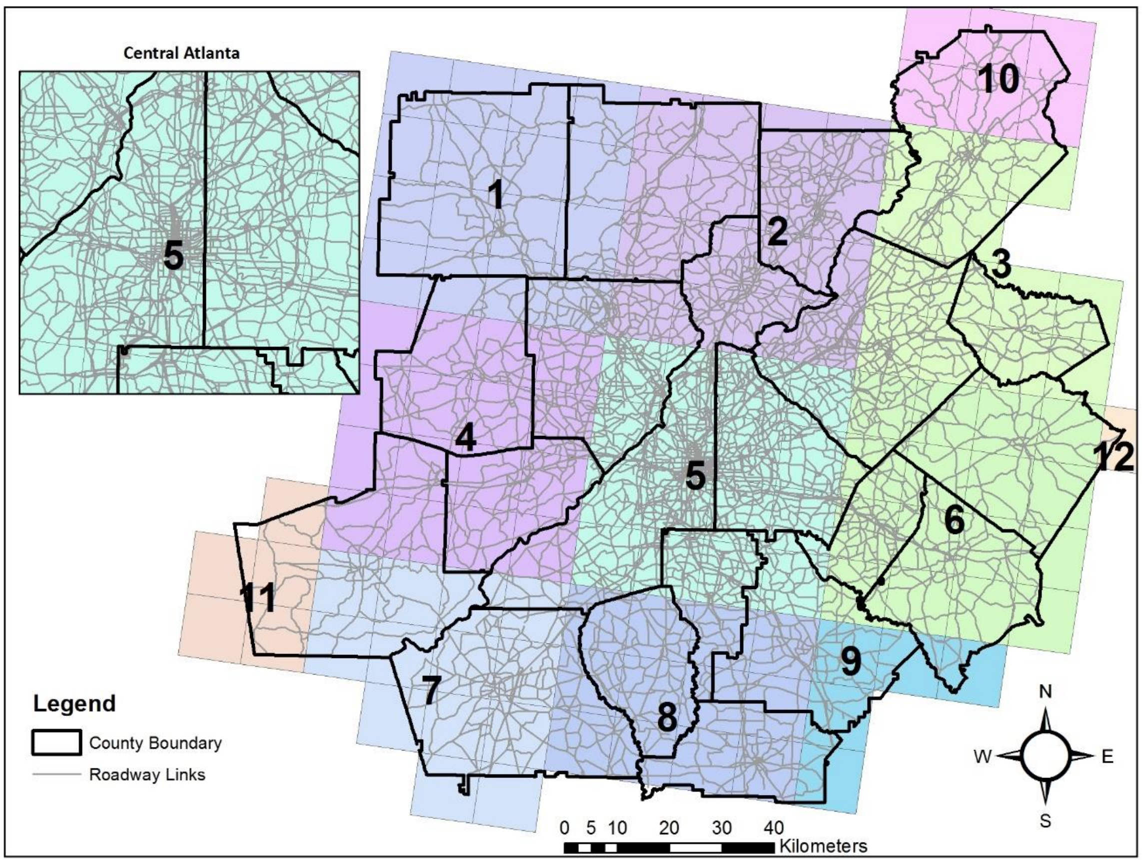


Table 3 – Summary of Receptor Grid Attributes and Runtime

Grid #	Receptors	Sources*	Percent of Total Calculations	Runtime (hours)**
1	57,600	3,604	8%	19
2	57,600	7,527	17%	40
3	46,800	4,725	9%	19
4	57,600	5,102	11%	28
5	57,600	14,093	31%	70
6	57,600	4,800	11%	28
7	46,800	2,374	4%	10
8	43,200	3,752	6%	11
9	18,000	1,291	1%	2
10	21,600	1,484	1%	3
11	18,000	760	1%	1
12	3,600	218	<1%	<1
Sum	486,000	49,730	100%	231

*Sources on the edge of each receptor grid are used in multiple grids
**Intel Core i7-4770 CPU @ 3.40 GHz with 16 GB RAM using 7 processors for each run

Post-Processing the RLINE Output

The research team developed Python scripts to batch the R-LINE runs and distribute tasks to multiple CPUs. As mentioned, each receptor grid network can be isolated and run independent of the rest of the region or work can be distributed over multiple computers grid by grid.

The research team developed a post-processor to apply the STAR Meteorology weights to post-process the R-LINE results to calculate annual average $PM_{2.5}$ concentrations at each receptor in the region. The resulting receptor network can be stitched together in GIS, or a variety of other software, to display pollution concentrations. This step represents the last part of the main modeling methodology of AREES.

R-LINE Validation and Correction

The research team met with a group housed at Georgia Tech (GT), led by Dr. Ted Russell[8], to evaluate the accuracy of the AREES results and to determine if a correction factor was necessary. In order to validate the results from the model runs, the GT team took the output from R-LINE and compared it to existing $PM_{2.5}$ monitor data in the Atlanta region.

The mobile source apportionment (the share of pollution attributable to automobile sources of $PM_{2.5}$) was determined to be generally acceptable; however the R-LINE dispersion model was likely overestimating concentrations very near to major roadways. This assessment was based on an analysis of other dispersion model results and monitor comparisons. GT staff developed a correction equation for the research team to apply to AREES output to adjust the final R-LINE results. This equation is applied to all AREES output. The steps GT staff used to reach the adjustment equation are explained below.

[8] http://russellgroup.ce.gatech.edu/node/4

Table 4 compares the first set of AREES results (using MOVES2010 and the trip-based model) and regional $PM_{2.5}$ monitor data. AREES results displayed here used 2011 STAR meteorology with 2010 travel model output and are compared to 2011 $PM_{2.5}$ monitor data. Since transportation is not the only source of $PM_{2.5}$ the percent of total monitor emissions is expected to be well below 100%.

Table 4 – 2010 AREES Results Compared to Regional $PM_{2.5}$ Monitors

Monitor	AREES Receptor Grid #	2011 AREES $PM_{2.5}$ Concentration (µg/m^3)	2011 Monitor $PM_{2.5}$ Concentration (µg/m^3)	AREES Percent of Monitor Total
Kennesaw	1	3.23	11.5	28%
Powder Springs	4	2.69	11.3	24%
Doraville	5	7.04	11.6	61%
E. Rivers	5	7.05	11.7	60%
Yorkville	4	0.30	10.7	3%
Gwinnett	3	6.38	11.0	58%
Fire Station #8	5	5.77	13.1	44%
Forest Park	5	4.91	12.7	39%
S. DeKalb	5	4.57	12.0	38%

When AREES estimates were recalculated using 2015 travel data, the Activity-Based Travel Model and the latest version of the MOVES model, new data were provided by Dr. Russell's group to again evaluate if AREES results were reasonable and what could be done to adjust them to better match real-world observations.

As stated, the GT team determined that the R-LINE values were likely overestimating near-road emissions. The team looked at 2015 monitor data in the region to develop a regression equation to adjust R-LINE values to match monitored values. To accomplish this they assumed the Yorkville monitor, which is located at the far northwest corner of the region, most closely matched background $PM_{2.5}$ concentrations. Table 5 below outlines the modeled results compared to 2015 monitored concentrations used for the R-LINE adjustment regression.

Table 5 – 2015 AREES Results Compared to Regional $PM_{2.5}$ Monitors

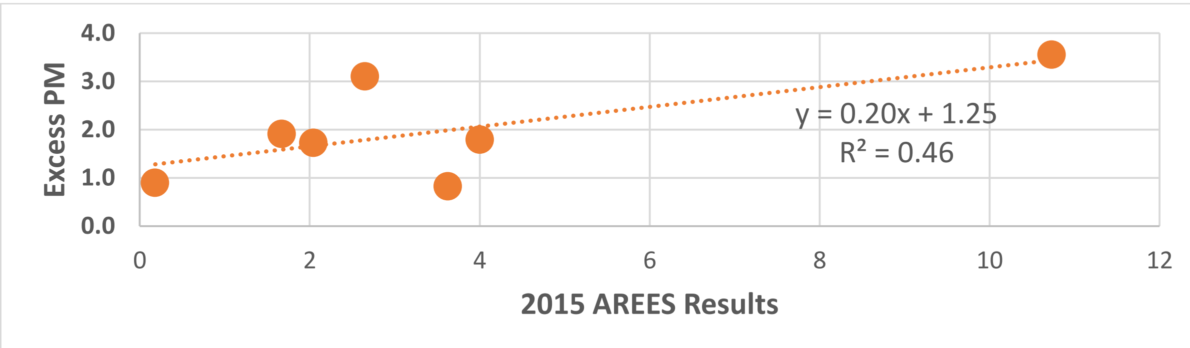
Monitor	2015 AREES $PM_{2.5}$ Concentration (µg/m^3)	2015 Monitor $PM_{2.5}$ Concentration (µg/m^3)	AREES Percent of Monitor Total
Kennesaw	1.67	9.42	18%
Yorkville	0.18	8.41	2%
Gwinnett	4.00	9.30	43%
Fire Station #8	2.65	10.62	25%
JST	3.62	8.34	43%
S. DeKalb	2.05	9.24	22%
Georgia Tech	10.73	11.07	97%

Chemical mass balance (CMB) data was not available for the 2015 monitors. Averaging recent year CMB data shows that Yorkville's background concentration should be 0.9 µg/m^3. This value was input into the following equation to determine a value of excess $PM_{2.5}$ - where excess $PM_{2.5}$ is the pollution concentration above background levels found in the region.

$$\Delta PM_{2.5,i} = PM_{2.5,i} - (PM_{2.5,Yorkville} - PM_{2.5,Yorkville}^{mobile})$$

Plotting AREES output against the values for excess $PM_{2.5}$ allows you to develop a regression equation that corrects the AREES output for near-road bias (see Figure 5).

Figure 5 – 2015 AREES Rescaling Regression



The resulting regression equation was applied to rescale the AREES results. The GT team also tried a logarithmic variation of the equation but R^2 values were not as high as with a straight linear adjustment. All R-LINE outputs are corrected using the following equation:

$$Rescaled\ AREES\ Value = 0.2 \times RLINE\ Output + 1.25$$

Results

AREES is meant to be continuously updated to reflect the latest travel demand and emissions model assumptions to aid in transportation project selection, regional performance measures and regional land use policy. Following is a snapshot of the results from the 2015 Atlanta Region's Plan model runs.

The final output of the post-processed R-LINE runs is a set of 486,000 receptors with an annual average $PM_{2.5}$ concentration. Figure 6 illustrates this output with the receptor as the centroid of a 200m x 200m grid – i.e. with no interpolation. The domain was clipped to the 20-county geography. Looking at the map, it becomes very obvious where freeways crisscross the region, as well as some of the major arterials and state roadways. A histogram of output concentrations is displayed in Figure 7.

Figure 6 – Annual Average $PM_{2.5}$ Concentrations from Automobile Sources

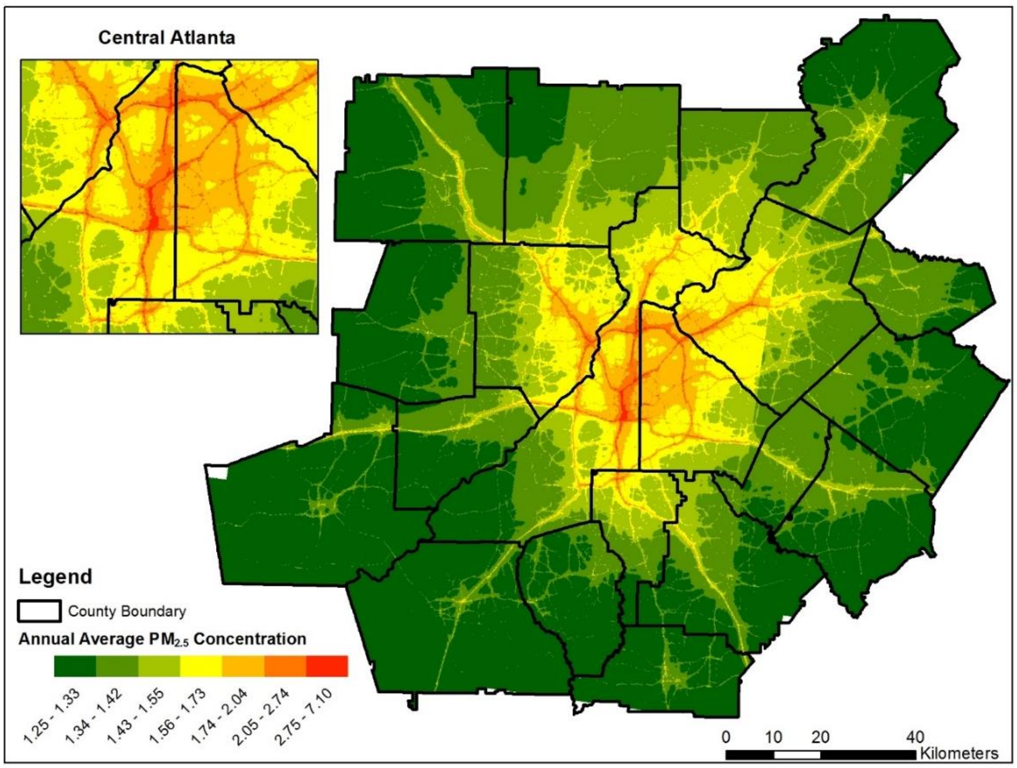
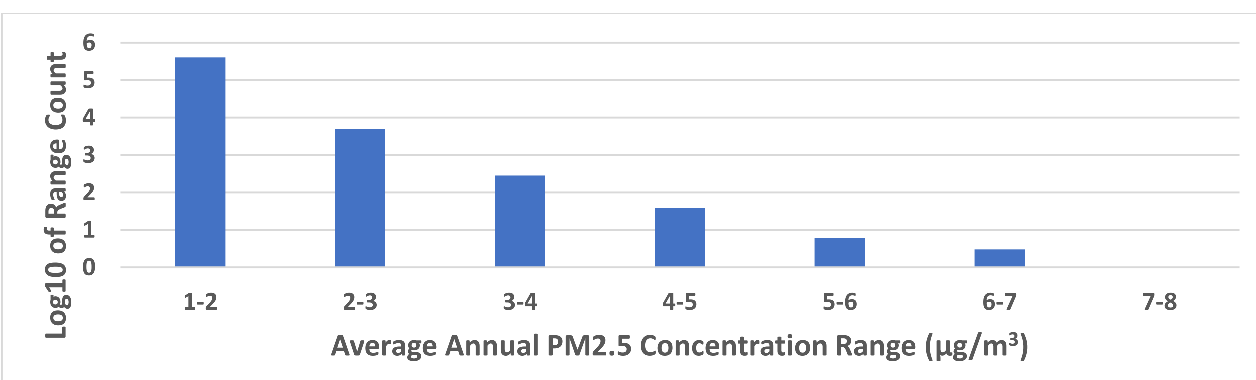


Figure 7 – Logarithmic Histogram of Modeled $PM_{2.5}$ Concentration



Project Evaluation Scenario Testing

In addition to regional runs, the project team evaluated emissions from two small domain test transportation projects. These scenarios were designed to test the sensitivity of the AREES methodology to evaluate annual average $PM_{2.5}$ concentration changes associated with roadway capacity increases. The projects were not selected based on inclusion in current Atlanta Region's Plan documentation, and include:

1) Widening of 10th Street in Atlanta from Howell Mill Road to Monroe Blvd. One additional lane was added to the transportation model in each direction of travel.
2) Widening of I-75 from I-285 to the Downtown Connector interchange in northwest Atlanta. One additional lane was added to the transportation model in each direction of travel.

These two projects function as bookends to the types of capacity expansion found in the Atlanta Region's Plan. The 10th street corridor is a small widening of a local facility through Midtown, while the interstate widening is a massive project spanning miles and impacting a major interstate.

Figures 8 and 9 map the changes in annual average $PM_{2.5}$ concentration in and around the city of Atlanta due to these infrastructure changes. In Figure 8 within a 500m buffer of the I-75 widening project the average change in annual $PM_{2.5}$ concentration is 0.05 $\mu g/m^3$, which corresponds to a 1.1% increase over the base scenario. The maximum increase measured is 0.30 $\mu g/m^3$, or a 4% increase over the base scenario.

The spatial distributions of emissions in the city changes due to the travel model reassigning trips onto I-75 due to the increased capacity. The redistribution of trips results in a reduction of modeled emissions in some areas and an increase in others not adjacent to the project limits.

In Figure 9 within a 500m buffer of the 10th Street widening project the average change in annual $PM_{2.5}$ concentration is 0.02 $\mu g/m^3$, which corresponds to a 0.33% increase over the base scenario. The maximum increase measured is 0.09 $\mu g/m^3$, or a 1.4% increase over the base scenario. Similar to what was observed with the I-75 scenario, there is redistribution in trips accounting for fluctuations in modeled $PM_{2.5}$ concentrations throughout the study area.

Sensitive land uses cited within these buffers, and especially closer than 500m to the project limits, would expect an increase in exposure to $PM_{2.5}$. The magnitude of the increase is highly dependent on the exact distance from the expanded roadway facility.

Figure 8 – Change in Annual Average $PM_{2.5}$ Concentrations from Widening I-75

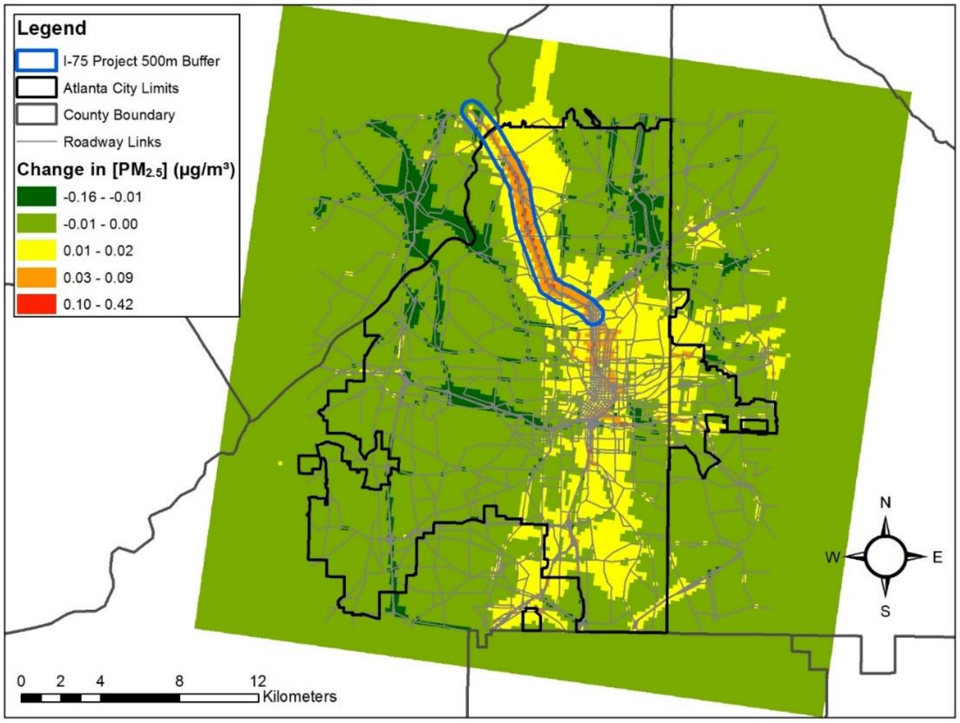
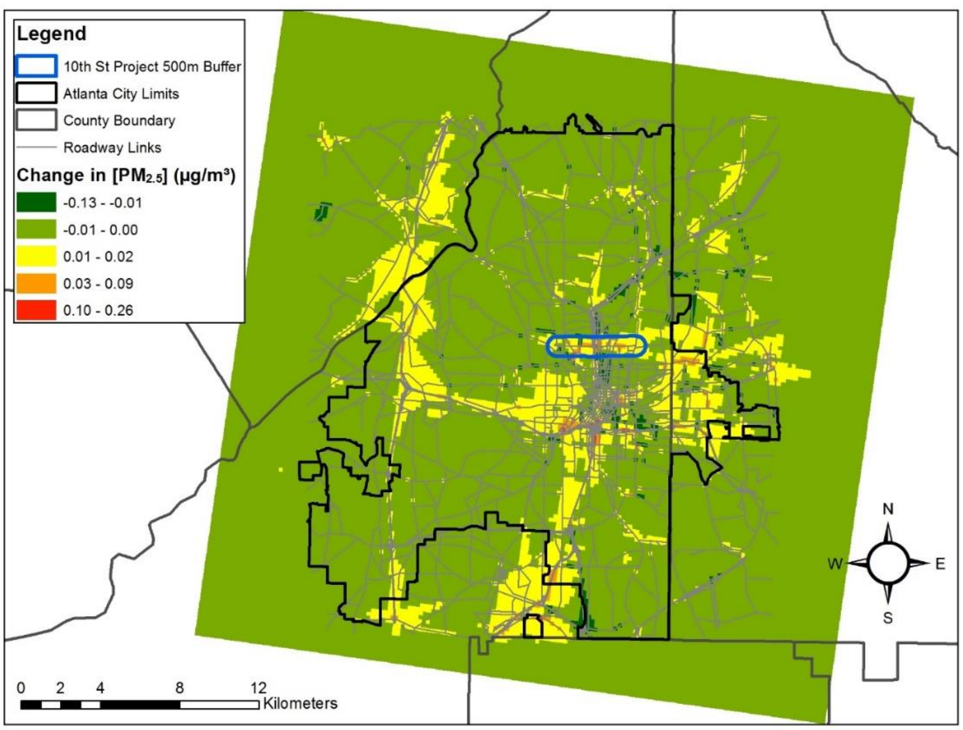


Figure 9 – Change in Annual Average $PM_{2.5}$ Concentrations from Widening 10th Street



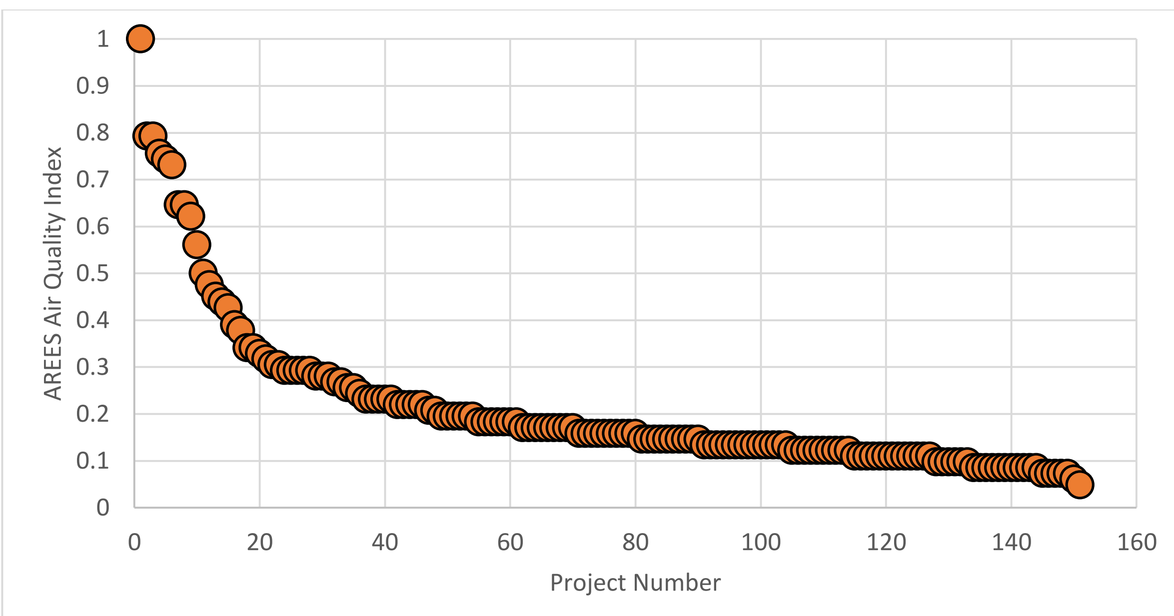
The Atlanta Region's Plan Transportation Project Evaluation

During the development of the Atlanta Region's Plan ARC staff evaluated all of the existing and proposed transportation projects using a host of performance measures. Typical measures used by ARC, for example, relate to congestion, accessibility, social equity and air quality impacts.

In the past, the air quality performance measure was evaluated as a mass of emissions from the links of the project. For the Atlanta Region's Plan update, air quality was broken into two separate measures, one based on current conditions (called the needs assessment) and one based on future performance. The needs assessment measure was determined by looking at the AREES-derived average annual concentration of $PM_{2.5}$ along the project corridor. See the Atlanta Region's Plan technical appendix for methodologies and measures;[9] ARC also created a publically accessible performance measure visualization tool to help compare transportation projects.[10]

Figure 10 shows the distribution of AREES needs assessment index scores for projects in the Atlanta Region's Plan. The project with the highest average concentration is set to a value of 1. All other projects' average concentration is then scaled to that value. Figures 11 and 12 show the correlation between projects' AREES score and the facilities' current levels of congestion and travel time reliability based on acquired real-world data. Overall, as expected, there is a positive correlation ($R \approx 0.5$) between facilities that are congested/unreliable and the nearby annual average concentration of $PM_{2.5}$. Projects that reduce congestion and improve a corridor's reliability should also help to reduce transportation emissions on most corridors.

Figure 10 – Distribution of Atlanta Region's Plan Current Air Quality Measure



[9] http://documents.atlantaregional.com/The-Atlanta-Region-s-Plan/rtp/appendices.pdf
[10] http://atlregional.github.io/proj-eval/#

Figure 11 – Atlanta Region's Plan AREES Air Quality Index Compared to the Congestion Index

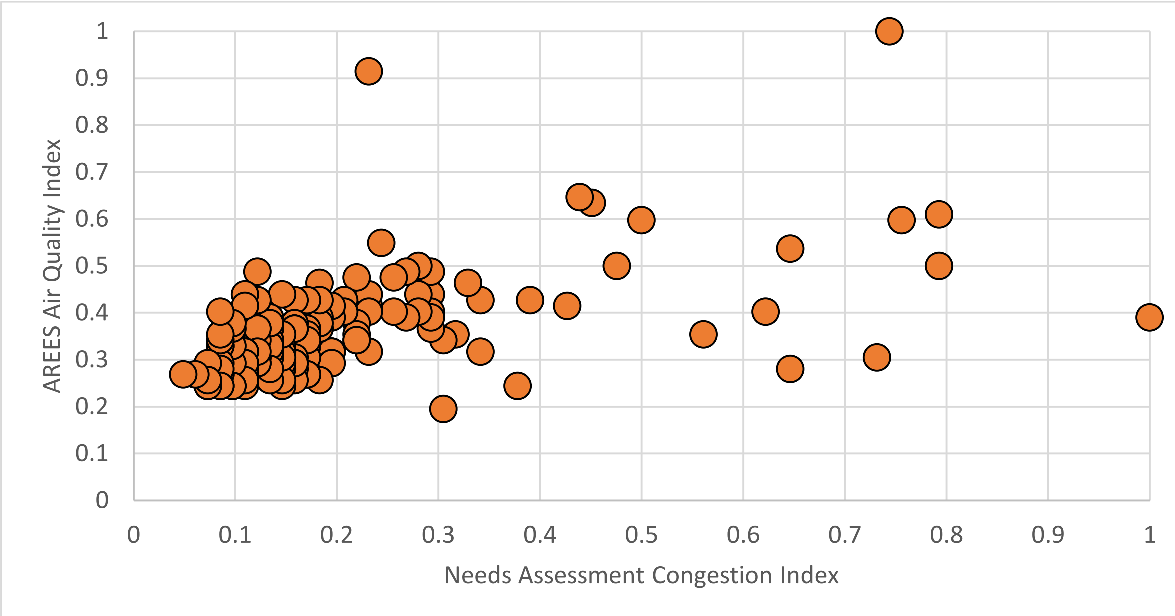
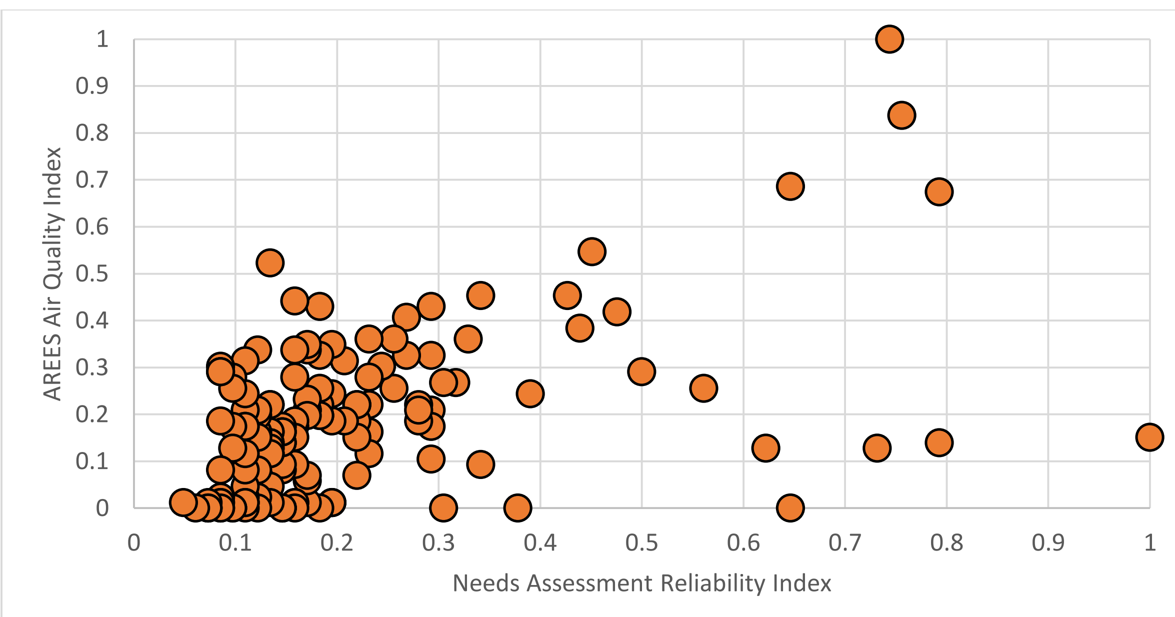


Figure 12 – Atlanta Region's Plan AREES Air Quality Index Compared to the Reliability Index



Future Work

The information provided in this report is meant to demonstrate the methodology of developing the AREES tool and some existing output datasets ARC staff have already utilized for planning purposes. The AREES project was designed to be flexible and replicable. As of early 2016, ARC staff have analyzed two separate travel/emission models as part of two separate Regional Transportation Plans. Future revisions to the AREES methodologies will increase the accuracy of results and refine the inputs based on advances in travel and emissions modeling.

Future white papers produced by ARC staff will include more detailed information about how to use the results of the AREES model. Further projects based on the results could include anything from a social equity analysis of emissions exposure to public health assessments tying transportation emissions to health factors.

Data Requests & Support

ARC staff are happy to make available raw data, shapefiles, model coding and limited staff resources to support the development of research projects based on the AREES data with the goal of improving air quality-influencing decision-making and protecting public health in the Atlanta region. Please contact the paper's author with any follow-up questions or data requests.

AREES information is housed primarily on the ARC website at http://www.atlantaregional.com/arees. Public online mapping is housed on ARC's github site at http://atlregional.github.io/dispersion/.