

Ohio Journal of
Environmental
Health

1st Quarter 2026

Bayesian Network Modeling
of Socio-Environmental
Variables Supporting Health
Policy Deliberation

Also in this issue...

- **President's Message**
- **District Director's Message**



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President's Message

Courtney Myers, MPH, REHS
Stark County Health Department

Dear OEHA Members,

As I reflect on the past year and a half serving as your President, I am filled with pride in what we have accomplished together and confidence in the strong future ahead for the Ohio Environmental Health



Association (OEHA). Because of your engagement, volunteerism, and professional dedication, OEHA remains a respected and influential voice for environmental health across Ohio.

A Strong and Active Association

OEHA continues to demonstrate its value where it matters most—advocacy, professional development, and member support. Over the past 18 months, we have remained highly engaged in legislative activity affecting our profession, working closely with our lobbyist and legislative partners to ensure environmental health professionals have a seat at the table.

Your membership and support make this possible. Simply put, OEHA's advocacy strength is directly tied to the strength of our membership. Because of you, our lobbyist continues to actively defend and advance environmental health priorities at the Statehouse. At a time when public health programs face increasing scrutiny and resource challenges, this unified voice has never been more important.

Throughout multiple legislative cycles, OEHA

has:

- Provided testimony on key legislation affecting solid waste, food safety, lead prevention, sewage treatment, and credentialing
- Engaged directly with bill sponsors and state agencies
- Mobilized our technical committees to provide rapid, science-based feedback
- Maintained a consistent presence in policy discussions that impact your daily work

These efforts ensure that environmental health remains visible, credible, and protected in Ohio.

Investing in Our Members

While advocacy is critical, OEHA's foundation has always been service to our members. Over the past year, we have continued expanding opportunities that help you grow professionally and succeed in your roles.

Our Annual Education Conference and District Fall Conferences once again delivered high-quality continuing education opportunities and meaningful networking. These events remain one of the most tangible benefits of OEHA membership, helping professionals across the state maintain credentials and stay current in an evolving field.

We have also continued to prioritize workforce development. Through leadership programming and targeted trainings, OEHA is intentionally building the next generation of environmental health leaders. The Environmental Health Leaders Professional Course continues to

receive strong participation and positive feedback, reinforcing the importance of investing in emerging professionals.

Looking ahead, OEHA remains committed to:

- Offering accessible, high-quality CEU opportunities
- Supporting members in advocating for their professional roles locally and statewide
- Preparing Registered Environmental Health Specialists in Training (RESITs) for success on the NEHA credentialing exam
- Strengthening leadership pathways within the profession

These efforts are essential not only for individual career growth but for the long-term stability of Ohio’s environmental health workforce.

The Power of Volunteer Leadership

None of OEHA’s progress happens by accident. I have been continually impressed by the depth of expertise and dedication

demonstrated by our Board of Directors, Technical Committees, District leadership, and volunteers.

Over the past year and a half, this tremendous Board has navigated leadership transitions, complex legislation, conference planning, and organizational improvements with professionalism and focus. Their willingness to step forward—often on very short timelines—speaks volumes about the strength of this association.

To every committee chair, district officer, presenter, and volunteer who contributed their time and expertise: thank you. OEHA is stronger because of you.

Why OEHA Matters—Now More Than Ever

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In this environment, a strong professional association is not optional—it is essential.

OEHA provides:

- A unified voice in legislative and regulatory matters
- Credible technical expertise for policymakers
- Professional development and leadership growth
- A statewide network of peers who understand the work you do every day

Membership is more than a line on a résumé—it is an investment in the future of our profession. I encourage each of you to continue sharing the value of OEHA with your colleagues, especially those newer to the field. Our collective strength depends on continued engagement and growth.

Looking Ahead with Confidence

As I move toward the latter part of my presidential term, I do so with tremendous optimism. OEHA is financially stable, operationally strong, and strategically engaged. Most importantly, the association is in excellent

hands moving forward.

I am especially confident in the leadership of our incoming President, Justin Rechichar. Justin brings thoughtful leadership, strong institutional knowledge, and a clear commitment to advancing environmental health in Ohio. I look forward to supporting him and the Board as OEHA continues to build on its momentum.

In Closing

Serving as your President has been one of the greatest professional honors of my career. Thank you for your trust, your engagement, and—most importantly—your daily work protecting the health of Ohio’s communities.

OEHA will continue to advocate, educate, and support you. Together, we are ensuring that environmental health remains strong, visible, and essential across our state.

In Service,
Courtney Myers, MPH, REHS
President, Ohio Environmental Health
Association



Environmental Protection Agency

Recognizing Ohio's Newest Registered Environmental Health Specialists

In this section we recognize and congratulate those individuals who successfully met the standards to earn the title REHS in the State of Ohio from January 1, 2025—December 31, 2025.

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- Cory Tibbits
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Bayesian Network Modeling of Socio-Environmental Variables Supporting Health Policy Deliberation

Nicholas V. Scott¹, Sarah E. Jensen², Hannah A. Lower², and Tania Nur²

¹Apogee Engineering, LLC

²Franklin County Public Health, Environmental Health

Abstract - Environmental health agencies face the critical challenge of understanding the interplay between air pollution and global socio-environmental quantifiers that capture land, water, and overall environmental health while operating under constrained budgets. Traditional analytical methods often fall short in capturing the complexity of these relationships. This study has two objectives. First, it investigates whether Bayesian belief network analysis can uncover crude structural dependencies and interactions between an array of environmental variables, offering a more holistic approach to data interpretation. Second, it demonstrates what crude statistical inferences are possible given network estimation and how this can impact decision-making. Using data from the Centers for Disease Control and Prevention's tracking network (2005–2019), thirteen variables were examined across 80+ Ohio zip codes, including land quality and air toxicity metrics for carbon tetrachloride, formaldehyde, benzene, acetaldehyde, and naphthalene. The Chow-Liu algorithm revealed land quality as a key parental node, with air toxicity variables acting as dependent children. A semi-inverse relationship emerged: higher land quality correlated with lower concentrations of formaldehyde and acetaldehyde, suggesting that land quality may serve as a coarse structural predictor of air pollution levels. To assess the possibility of basic predictive capability, hard instantiation simulations were conducted. Improvements and degradations in air quality variables were shown to occur when hard evidence was provided to the land quality variable at the lowest and highest state intervals. Notably, carbon tetrachloride levels remained largely

unaffected, indicating potential data biases and highlighting other unique high mutual information-based pathways. These findings highlight the policy relevance of land quality as a leverage point for mitigating air pollution and demonstrate how inference supported by Bayesian belief networks can support policy deliberation.

Keywords: Bayesian belief networks, correlation, air toxicity, land quality, Chow-Liu algorithm, pollutants, concentration, cancer

1. Introduction

Environmental health departments and organizations throughout the United States, such as the Centers for Disease Control and Prevention (CDC), are often tasked with understanding the complex relationship between air toxicity and other socio-environmental metrics under the constraint of tight budgets dictated by environmental public health policies. This area receives focus because comprehension of such relationships impacts how health departments distribute resources to combat the issues of clean air and water that affect many communities. The state of Ohio is one such place that actively addresses this issue through many avenues, including the use of data analysis of measured and processed environmental variables¹. Of particular importance now is not only the political issue of clean land, water, and air but also the more fundamental aspect of how global parameterizations of these variables, which quantify overall environmental health, reflect more granular measurements of air toxicity affecting communities. A clear and valuable approach to addressing this issue, paving the

way toward improved environmental health, is through analysis of acquired data that seeks to go beyond simple classical methods of correlation between select environmental variables toward understanding systems of such variables as a gestalt.

Machine learning and artificial intelligence have been shown to be powerful tools for processing data and have therefore been used in various areas of environmental health for addressing complex issues. For instance, machine learning has been used to estimate global abundance of ground-level airborne particulate matter (PM_{2.5}) for epidemiological studies while simultaneously relating these estimates to risks surrounding aberrations in mental health². With increasing focus on concatenating global variables that influence local variables at the community level, machine learning has been leveraged to understand the highly nonlinear complex relationships existing between the two areas. Further substantiation of the utility of machine learning methods has come from other researchers who have used it

for robust prediction of air pollution levels over fine spatiotemporal scales. Ren et al. used an array of machine learning methods for air pollution prediction that were compared to traditional linear regression results³. Their results demonstrated that machine learning provided more interpretable and practical results than linear regression with respect to improving the accuracy in modeling the relationship of air pollution to human exposure. Wang et al. used random forest algorithms to forecast community health status by analyzing various health factors such as disease prevalence, resource allocation, patient outcomes, and risk prediction⁴. Their study emphasized the potential of machine learning to make informed state predictions that impact community health management and disease prevention. These research examples substantiate the strong opinion in the community that machine learning is an overall potent tool for environmental health management. This is due to its ability to perform multidimensional analysis of complex multivariable systems that require robust

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Data supporting such nontraditional analyses are available from online databases created and maintained by the CDC ⁶. These multivariate datasets allow for the investigation of two data analytical areas of interest. The first area falls within the scope of latent space data clustering and addresses the issue of understanding the structural relationship of measured and recorded environmental variables comprising a data array. If a BBN is applied to the multivariate data, does the data admit a global parent variable that is related to children variables, establishing a binding cause-and-effect latent network structure? The second data analytical issue focuses on demonstrating how statistical inferences can be provided by the network. If the network is deemed credible, what sort of expected state-level changes within children environmental variables can be estimated from predetermined parent variable state-level changes? Determining what crude statistically simulated inferential changes are possible allows for gaining insight into a methodology for estimating how environmental children variable changes are affected by changes prescribed in causal, parental variables. Such understanding and insight could provide health administrators, who are concerned with influencing broad environmental policy, with perspective on how granular measurements of air toxicity are potentially influenced by large-scale environmental quantifiers which are of great concern to them. BBN analysis allows for addressing these queries.

The purpose of this work is twofold. First, it is to demonstrate first-order network learning from pre-processed CDC data, providing a sense of the directional, latent space information clustering provided via BBN estimation. Second, it is to show what type of statistical inferences can be provided by the

network, allowing health administrators a glimpse into the power of Bayesian statistical tools that could potentially support the policy formation and deliberation process. It is clearly stressed that the statistical inferences provided by the BBN here cannot and should not be taken as support for any type of institutional policy change. The results shown are to be taken only as a demonstration of the type of statistical analyses that could be used to support rigorous environmental deliberations. It is the methodology that is the fulcrum of this work, demonstrating how the approach allows environmental health professionals the ability to reason soundly about policy using statistical inference rather than through the use of suppositions backed by no quantifiable reasoning.

2. Data Structure and Methodology

A thirteen-variable dataset was used in this statistical analysis, obtained from the CDC's data portal website, which allows open-source data for public use ⁶. The thirteen variables selected were: 1) overall environmental quality, 2) environmental land quality, 3) environmental water quality, 4) air concentration for naphthalene, 5) air concentration for formaldehyde, 6) air concentration for carbon tetrachloride, 7) air concentration for benzene, 8) air concentration for acetaldehyde, 9) mean cancer estimates due to airborne naphthalene, 10) mean cancer estimates due to airborne formaldehyde, 11) mean cancer estimates due to airborne carbon tetrachloride, 12) mean cancer estimates due to airborne benzene, and 13) mean cancer estimates due to airborne acetaldehyde. Each variable was sparsely sampled over yearly time scales using eighty-eight zip codes where contemporaneous, yearly data samples across the zip codes were not always present. For each of the thirteen variables, the number of data samples for each zip code over the time interval of 2005-2019

varied, and not all zip codes possessed data samples for a particular year. For each variable, samples more than two standard deviations from the mean were removed. The paucity of data samples produced a substantial level of uncertainty in the data array, and it was for this reason that a Bayesian rather than a frequentist approach was taken. The thirteen variables were treated as random processes that emit mean data values from an array of zip codes over the 15-year time scale, whose covariance structure is parameterized via the application of a BBN. The amalgamation of mean data samples over space and time was necessary to suppress noise. In addition, the veracity of mean data values obtained from the preprocessing performed by the CDC was relied upon.

Table 1 shows the mean and standard deviation of the mean data values for the 13 variables across all zip codes and the 15-year time span as well as the minimum and maximum values achieved. The mean data samples for the thirteen variables were transformed into a $m \times n$ feature matrix with dimensions of 88×13 , where the n dimension designates the

environmental variable. The m observations are the mean variable values over the time range spanning 2005-2019 for the 88 zip codes spread over the state of Ohio and arranged in numerical order.

The data obtained from the CDC data portal was compiled from the National Air Toxics Assessment (NATA) run by the United States Environmental Protection Agency (EPA), which is a comprehensive evaluation of air toxins in the nation from 2005 to 2017. The Air Toxics Screening Assessment (AirToxScreen), which began in 2017, provided data from 2017-2019. This compiled data was created for the purpose of gaining insight into which pollutants are potential targets for risk reduction activities. The data was also used to identify spatial locations of interest for further investigation, providing a starting point for local assessment and monitoring by programs and communities. With respect to cancer risk, the EPA calculated annual average cancer risk estimates to quantify the estimated lifetime probability of cancer from exposure to selected pollutants assessed in a geographic area. The EPA defined cancer risk as the probability of contracting cancer over the

Variable	Mean (arbitrary units)	Standard Deviation (arbitrary units)	Min, Max Value
Overall Environmental Quality	1.22	0.40	0.00, 2.14
Environmental Land Quality	0.43	0.50	-1.50, 1.50
Environmental Water Quality	0.31	0.37	-1.50, 1.50
Air Conc. Naphthalene	0.02	0.01	0.00, 0.04
Air Conc. Formaldehyde	1.08	0.15	0.05, 1.60
Air Conc. Carbon Tetrachloride	0.51	0.01	0.50, 0.55
Air Conc. Benzene	0.41	0.1	0.25, 0.75
Air Conc. Acetaldehyde	1.03	0.12	0.85, 1.40
Mean Cancer Naphthalene	0.64	0.17	0.40, 1.30
Mean Cancer Formaldehyde	13.5	1.3	11.2, 19.9
Mean Cancer Carbon Tetrachloride	2.97	0.03	2.95, 3.20
Mean Cancer Benzene	3.00	0.62	1.95, 4.75
Mean Cancer Acetaldehyde	2.16	0.26	1.80, 2.95

Table 1: Mean, standard deviation, and minimum and maximum values for the thirteen variables used in the BBN analysis. The statistics reflect the behavior of data samples emanating from all 88 zip codes over a 15-year time span.

course of a lifetime, assuming 70 years of continuous exposure. Annual average air concentration estimates were calculated by the EPA from outdoor air⁷. For the 2005-2017 NATA and the 2017-2019 AirToxScreen, cancer risks and air concentrations were calculated at the census tract level. The overall uncertainties and accuracy of the assessments varied from location to location and from pollutant to pollutant, limiting the statistical inferences that can be made. All inferences and results therefore are not to be taken as absolutes but only provide and illustrate crude trends.

BBNs are probabilistic graphical models utilizing edges and nodes to model the joint probability distribution existing between a system of random variables⁸. They allow for statistical inferences to be made at random variable nodes when evidence is provided to one or more network nodes. Prior to statistical inference, network nodes along with nodal states need to be defined, followed by structural learning, which derives the directed acyclic graph (DAG) associated with the BBN. This step is concerned with extracting the BBN topology from the data. Once the network is induced from data feature information, parameter learning can be performed, which provides conditional probabilities relating different nodes⁹. The defined nodes and conditional probabilities in turn allow for statistical inference where the effects of evidence at one or more random variable nodes are propagated throughout the BBN to estimate their impact on other nodes.

BBN analysis was performed on the mean feature matrix using the software package Bayes Server manufactured by Bayes Server Ltd., which automates much of the statistical analysis, including Bayesian network structural learning and parameter learning.

The Chow-Liu structural learning algorithm was implemented on the feature matrix, which

is a global structural learning method that creates a single root initial network structure as the beginning of the network learning process⁹. The Chow-Liu algorithm assumes that a tree structural model is appropriate for the data and seeks a skeletal structure consisting of a low number of dominant parental nodes that provide sub-dominant children nodes. A tree network grows iteratively in complexity using a structural model that contains a multivariate probability distribution expressed as a product of conditional probability distributions associated with the nodes. The tree structure that best approximates the real distribution is found by minimizing the difference between the real data-based distribution and the tree approximation. This in turn is accomplished by minimizing the mutual information between any two pairs of nodal variables¹⁰. The best network structure is selected based on a score measuring how well the model represents the data. The direction of links is found using higher-order dependency tests. Parameter learning provides numerical values to the nodal-edge structure, allowing for statistical inference between nodes. The Chow-Liu algorithm also uses a relevance tree algorithm, allowing for exact statistical inference rather than approximate inference¹⁰.

All Bayesian network algorithms possess a structural learning bias native to the algorithmic structure used in the data processing. An estimated BBN in this sense is not unique to the data. For instance, the Peter-Clark algorithm was also applied in the structural learning of the feature matrix data and created a very different network structure⁹. The Chow-Liu network results were focused on because the structural bias it introduces is important in addressing the data analytical issue surrounding this work. This issue is whether, within the confines of the chosen algorithm, certain nodes have more causal power than others. In other words, does the application of the tree-like structural model

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of the Chow-Liu BBN model suggest that certain variables are parental nodes as opposed to children nodes? The results below provide evidence that some socio-environmental variables can be taken as parental nodes, being weakly related to air pollution-based children nodes.

3. Results

The major purpose of this analysis is to demonstrate latent space directional nodal clustering of the feature matrix data using an assumed BBN model. Using the estimated BBN model, the types of possible statistical inferences given the network is performed demonstrating how a BBN model can facilitate the guidance of health policy. Such policy facilitation and inferential estimation can be lucidly accomplished if a BBN is created such that socioeconomic variables are modeled as causal nodes influencing measurement-based children variables quantifying air pollution. This type of structure is shown to be latently embedded within the data.

Model results represent the optimal mean estimates of covariance structure existing between the thirteen nodes. Figure 1 shows a BBN layout similar to the Sugiyama layout for all thirteen variables where no nodal evidential instantiations are implemented. Shown in green are nodes provided with parental nodal status before BBN structural learning is performed. Shown in blue are nodes provided with children nodal status before BBN structural learning is performed. The BBN layout shows that all the nodes assigned children nodal status before structural learning appear as actual children nodal variables in the BBN. The BBN layout also shows that two of the three nodes assigned parental nodal status before structural learning appear as parental nodes. Structural learning is successful in extracting a parent-children latent structure in the multivariate data array, where two of the socio-demographic variables appear

in parental nodal positions relative to measured air-quality variables. The air toxin concentrations, air toxin cancer risks, and environmental health variables possessed normal and Poisson statistical distributions, an expected occurrence due to the high number of latent independent processes driving the variables as well as the discrete low observation count.

The variable ENV-All is an overall environmental quality index encapsulating the factors of socio-demographics and air, water, and land quality, providing a crude summation of overall environmental health for Ohio counties. The variable ENV-All attempts to quantify areas with an increased burden of environmental impacts, enabling counties to assess the drivers of poor environmental quality. It does not offer a measure of environmental quality at spatial and temporal scales that can inform individual-level adverse health outcomes. It is therefore a global variable of interest to many health administrators who work with health policy and have a need to understand large-scale environmental health changes. The variables ENV-Land and ENV-Water are also overall environmental quality indices for land and water, respectively, across Ohio counties. Given the high amounts of uncertainty in the data variable array, the Chow-Liu algorithm is able to demonstrate that the environmental variables parameterizing overall environmental health, ENV-All, and environmental land quality, ENV-Land, are parent variables giving 'birth' to air-toxin children variables.

Mutual information is a way to quantify link strength in a BBN, providing insight into which nodes share the strongest covariance and are the most amenable to covariance-based changes. These values exist on a scale of 0-1 and are shown on the edge arrows in Figure 1. With respect to understanding parental-children

dynamics, the following nodes possessed moderate to strong mutual information link strengths: Env-Land, Acet-cancer, Acet-conc., Form-cancer, and Form-conc. The mutual information values for these nodes, which occupy the upper bifurcation pathway in the BBN, ranged from 0.24–0.69, suggesting that this pathway possesses moderately strong cause-and-effect relationships. If crude statistical inferences regarding trends can be made using the relationships in the environmental variable array, the variables occupying the upper pathway in the BBN layout represent the best candidates for performing this analysis. In other words, based on all the data spanning more than a decade from 2005-2019 and across 88 zip codes in Ohio, the BBN suggests that if any parental-children ties between socioeconomic and observed air toxicity variables exist, they most likely exist among these five variables. The air toxicity values parameterizing mean cancer estimates for benzene, air concentration

for benzene, mean cancer estimates for naphthalene, and air concentration for naphthalene share moderate mutual information levels in the network at approximately 0.48. Though these nodes exist in the upper bifurcation, they are not robustly connected to the previously mentioned nodes. The mutual information value of 0.15 exists between the nodes for air concentration for formaldehyde and mean cancer estimates for benzene. Statistical inference is therefore very uncertain in this region of the network.

Other qualitative aspects are apparent in the BBN. The air concentration and cancer risk estimates for each air toxin appear next to each other in the BBN layout, suggesting their mutual information relationship. This is consistent with the idea that each member of an air toxin couple quantifies the same air toxin variable, albeit in different ways. The air toxin naphthalene, parameterized using concentration

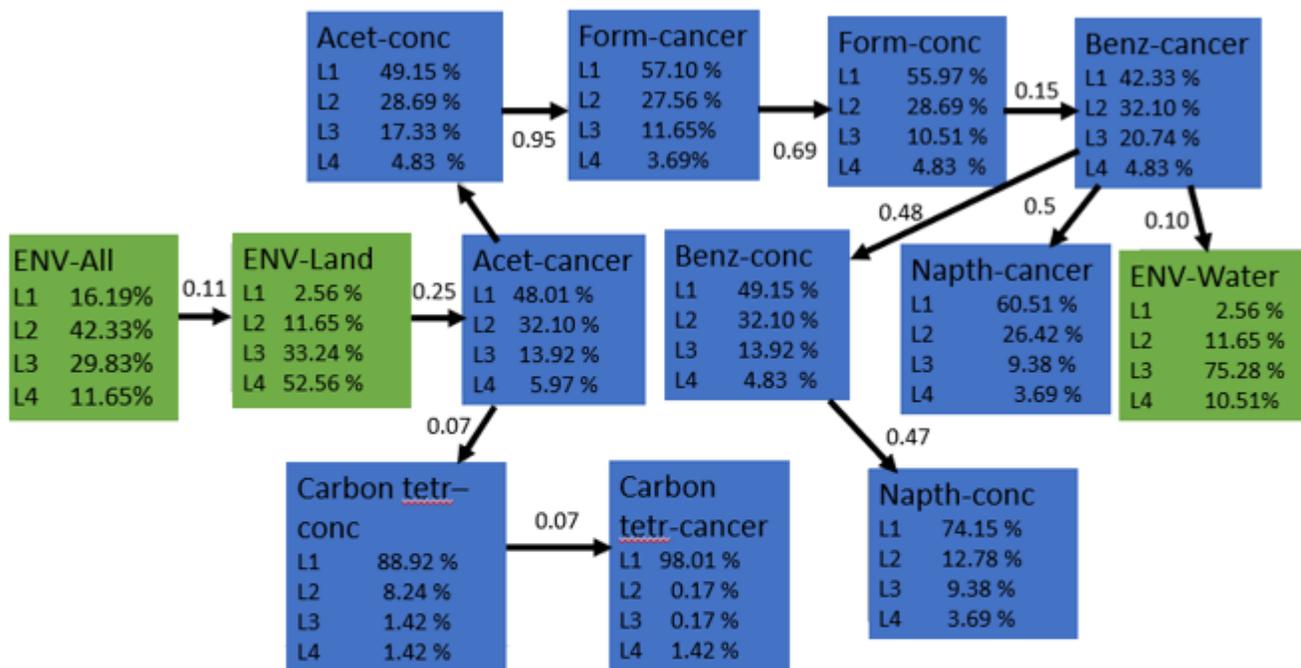


Figure 1: Sugiya-like BBN network layout for 13 environmental variables estimated using the Chow-Liu algorithm. Each node contains a discrete marginal probability distribution with low state levels near the top and high state levels near the bottom. Arrow edges with numbers delineate mutual information connections. Green and blue nodes are assumed parental and children node status labels respectively before nodal structural learning. State level partitions are equal partitions over the minimum and maximum values for a node shown in Table 1.



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and cancer risk, appears furthest from the parental node ENV-Land, suggesting that this air toxin has the weakest mutual information relationship with the parental node. The lower bifurcation is characterized by very weak mutual information values, suggesting that global inferences using ENV-Land for affecting changes in mean cancer and air concentration estimates for carbon tetrachloride cannot be made. The variable ENV-Water appears as a node on the right in the BBN layout and has a very weak mutual information value with the node quantifying mean cancer estimates for benzene. This demonstrates that this variable has a very weak relationship to the other variables and is not a parental node as presupposed. More data is needed to understand these aspects of the BBN.

BBNs are a powerful tool for statistical inference, providing statistical insight into the thirteen-variable relationship. Statistical inference simulations were performed only as a way of demonstrating what is possible with the tool, and not as a method for demonstrating

definitive statistical results. Instantiations in the BBN allowed a crude sense of how changes produced in one variable via hard evidence affect other variables. Figure 2 shows the same BBN as in Figure 1 but where the ENV-Land variable had a hard evidential instantiation at the lowest interval, L1, which ranged over [-1.5, -0.859] and where the complete state intervals had a range of [-1.5 to 1.5]. (Here the units are arbitrary). This instantiation caused pronounced changes in the highest state interval, L4, of the variables Acet-cancer, Acet-conc., Form-cancer, and Form-conc., which appear along the upper pathway after the bifurcation at the Acet-cancer node. The hard instantiation produced a 41% change in the Acet-cancer node, a 31% change in the Acet-conc. node, a 23% change in Form-cancer node, and a 22% change in the Form-conc. node at level L4.

Figure 3 shows the same BBN as in Figure 1 but where the ENV-Land variable had a hard evidential instantiation at the highest interval, L4, which ranged over [0.522, 1.5]. This

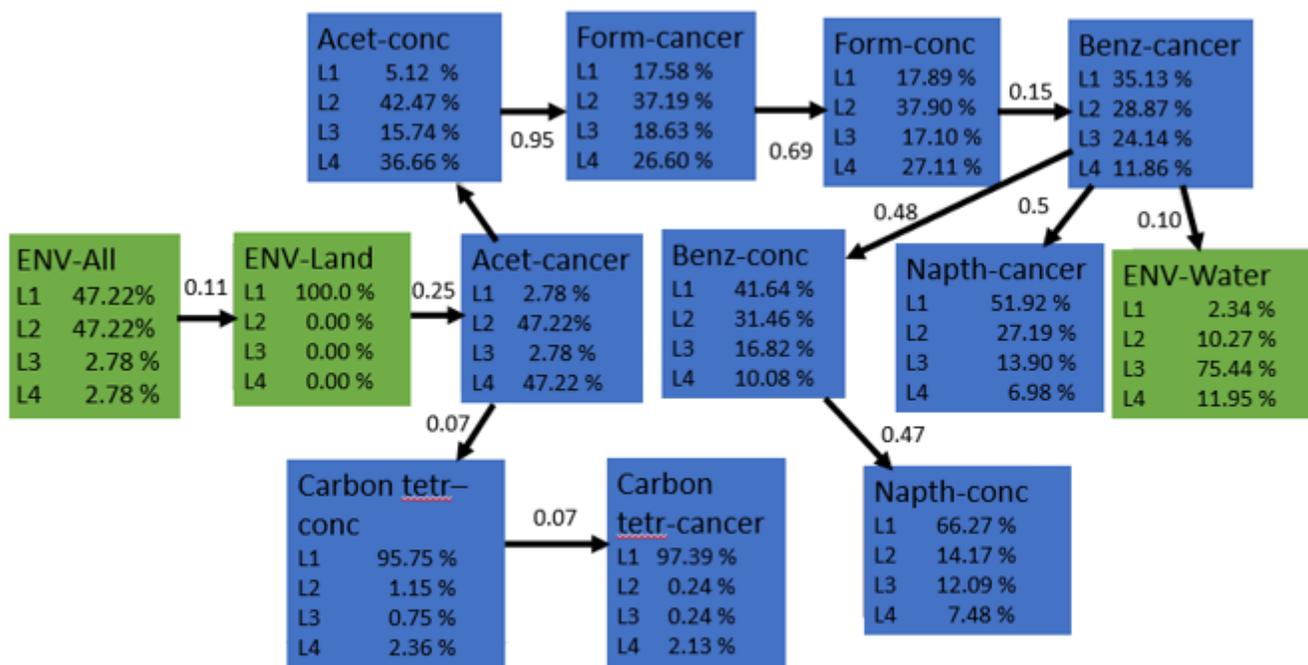


Figure 2: Sugiyama-like BBN layout of the BBN shown in Figure 1 where an instantiation was made at the lowest state level, L1 in ENV-All. Nodal structural details delineated in Figure 1.

instantiation caused pronounced changes in the lowest state interval, L1, of the variables Acet-cancer, Acet-conc., Form-cancer, and Form-conc. The hard instantiation produced a 26% change in the Acet-cancer node, a 25% change in the Acet-conc. node, a 23% change in Form-cancer node, and a 23% change in the Form-conc. node. The reasons why these children nodes underwent these changes are unknown. The distillation of the structure within the data by the BBN, however, suggests how the variables are possibly related and crudely shows expected statistical changes in air toxicity based on projected changes in the socioeconomic environmental parental variable of Env-Land.

Environmental health departments possess a structure characterized by information flow from low-level field technicians and scientists, responsible for the measurement and accrual of information closely affecting people, to higher-level administrators responsible for initialization and implementation of broad health policy. Information also flows in the

opposite direction, where health policy-based logistics are delivered to field personnel responsible for interacting with the public in a variety of venues. This departmental structure is akin to the parental-children relationship of environmental variables demonstrated here in the BBN. If a crude association is made where parental nodes are associated with high-level administrators and children nodes with field technicians, the BBN may be viewed as a tool pertinent to environmental health departments' mission of improving environmental health policy. An example of how a BBN can be used in this way is furnished below.

BBN results show a coarse inverse relationship between changes in air toxicity nodes and environmental land quality, which is useful in shaping environmental policy. When environmental land quality experiences high probability values at the lowest nodal state interval L1 for the parental node ENV-Land, air toxicity nodes—embodied in the Acet-cancer, Acet-conc., Form-cancer, and Form-conc. nodes—experience high probability values at

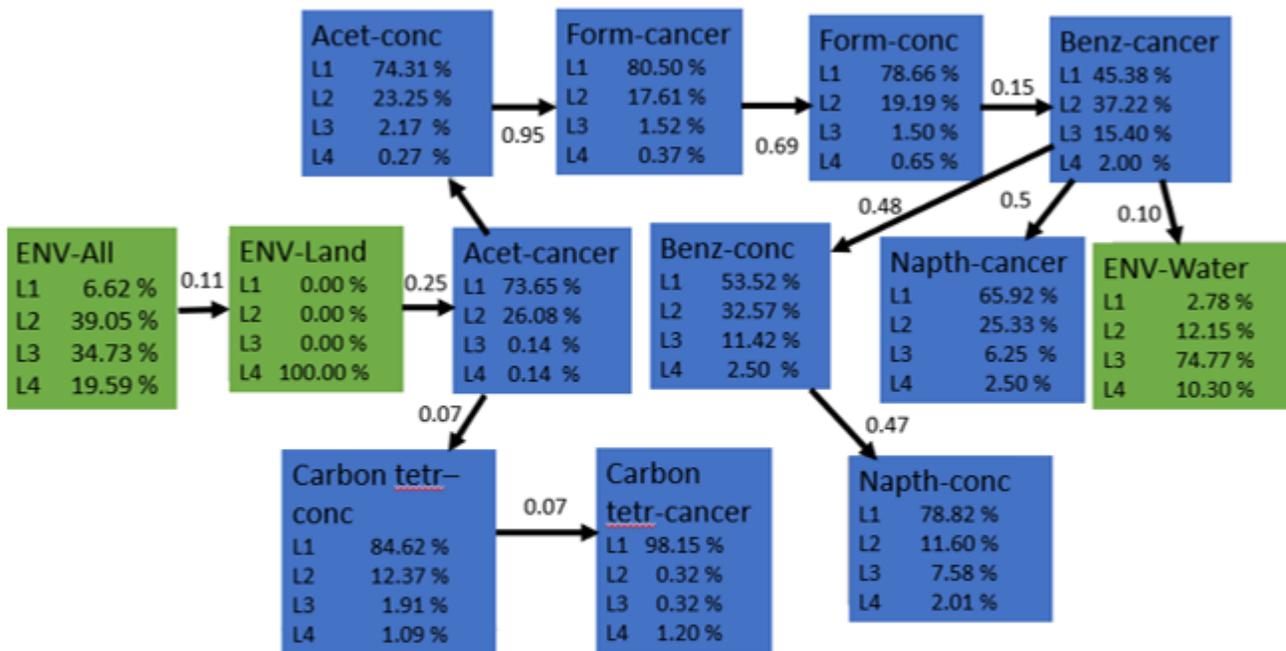


Figure 3: Sugiya-like BBN layout of the BBN shown in Figure 1 where an instantiation was made at the highest state level, L4 in ENV-All. Nodal structural details delineated in Figure 1.

the highest nodal state interval L4. These state changes in children variables are much more substantial than when hard instantiations are instituted at the highest nodal state interval L4 of the ENV-Land variable. This is a potentially useful information facet emanating from the BBN for health administrators to be aware of, since it shows the effects of drastic changes in the socio-economic variable of land quality on air toxicity at both very low and high state intervals. The BBN model results can be seen as statistical expected changes and may suggest to health administrators where resources could or possibly should be allocated for the purpose of addressing public health impacts. The physical reasoning why these variables undergo the changes shown in the BBN simulations again is not completely understood. Therefore, no clear or definitive state-based decision making can be made. However, even with this uncertainty, the BBN crudely demonstrates expected change trends between variables sharing mutual information ties and therefore provides insight into how it could be used to properly shape policy. More data with low uncertainty as well as a lot more prior information would be needed for actual state-based decision making, which lies outside the confines of this work.

4. Conclusion

In the state of Ohio, air quality has been a major concern as early as the 1970s and is an

issue of renewed concern given recent disastrous events such as the train derailment in East Palestine, Ohio, in 2023^{11,12}. This accident, responsible for the release of large amounts of toxic chemicals into land, air, and water at levels leading to evacuation orders, stresses the need for understanding the relationship between environmental quality variables, air toxicity concentration levels, and air toxicity related to medical issues such as cancer. This age of artificial intelligence and machine learning allows for unprecedented ways for exploiting publicly available data, providing organizations with the ability to understand the relationship between environmental variables. The sparsely sampled mean data values for the thirteen variables studied here is an example of such data, whose analysis showed a mean directional nodal clustering contingent on the assumptions underlying the machine learning algorithm. The statistical machine learning methodology also demonstrates how numerical data captured by health organizations can be distilled into useful information that can potentially guide environmental health deliberations. While the intent of this work is not to suggest that BBNs alone can direct environmental health policy, it does demonstrate a way for presenting evidence influencing how environmental health issues, such as air toxicity, are treated by health care practitioners.

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Featured District Director's Message: Northwest

Madeline Dyer, MPH, REHS
Toledo-Lucas County Health Department

My name is Madeline Dyer, and it is an honor to serve as the Northwest District Director. I began my professional career at Marion Public Health, where I worked primarily in the Food Program conducting inspections and reviewing plans. After one year, I transitioned to the Wood County Health Department, where I spent three years working within the Sewage and Water Programs. In January 2026, I accepted a position with the Toledo-Lucas County Health Department as a Generalist. Having lived in Northwest Ohio for the majority of my life, I take great pride in serving the communities that have shaped both my personal and professional journey.



I earned my Bachelor of Science in Environmental Science in December 2021 and completed my Master of Public Health in April 2025. My longstanding commitment to environmental stewardship has guided my career path, and I remain deeply dedicated to advancing the environmental health profession. I am particularly passionate about fostering opportunities for individuals to learn about and enter the field, which led to my active involvement in OEHA.

The Ohio Environmental Health Association has played a significant role in my professional development. It is my sincere intention to contribute meaningfully to the organization through dedicated service and leadership. Serving on the Northwest Planning Committee has been a pivotal and rewarding experience,

and I am grateful for the opportunity to collaborate with such a committed and accomplished group of professionals.



I encourage you to join us for the Northwest Fall Educational Conference on October 1–2, 2026, at Kalahari Resorts in Sandusky. The 2026 conference will be held in the Executive Center, a new location compared to recent years. Please visit the Northwest District page on the OEHA website for updates regarding registration, the conference agenda, and additional details. The webpage also highlights district meetings, upcoming events, and employee spotlights.

Respectfully,
Madeline Dyer, MPH, REHS
Northwest District Director
Ohio Environmental Health Association
mdyer@co.lucas.oh.us



Announcements

Have a grant, educational opportunity, move, promotion, or other announcement you would like to share? Please email a member of the publications committee.

Open Positions (For the full current listing [click here](#))

- **Assistant Director, EH**
Wood County Health Department
- **Maintenance Director**
Carriage Court Senior Living
- **Manager of Health & Safety**
Northeast Ohio Regional Sewer District
- **REHS/EHST**
Medina County Health Department
- **Director of Environmental Health**
Portage County Combined General Health District
- **Vector Control Technician**
Hancock Public Health
- **Grants Fiscal Manager**
Mahoning County Board of Health

Educational Opportunities

- **AOHC LEHDS** - April 14 - 15, 2026; Dublin, Ohio
- **AOHC Finance for Health Departments** - April 14 - 15, 2026; Dublin, Ohio
- **OEHA AEC** - April 16-17, 2026; Lewis Center, Ohio
- **Ohio Public Health Conference** - April 27 -29, 2026; Lewis Center, Ohio
- **AOHC Health Commissioner University** - May 11 - 13, 2026; Dublin, Ohio
- **AOHC New Employee Training** - July 8, 2026; Delaware, Ohio
- **2026 AOHC Fall Conference** - September 21-23, 2026; Dublin, Ohio

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<p>Effluent Filters / Filter Alarms & Switches</p> <p>Covers: 12", 15", 18", 20", 24" & 30" Grates: 3", 4", 6", 12", 15", 18", 20" & 24"</p>	<p>Distribution Boxes</p>	<p>Hydro Shield</p> <ul style="list-style-type: none"> • One Hydro Shield fits 3 pipe sizes: 1", 1-1/4" & 1-1/2" or 1", 1-1/2" & 2" • Easy to install, just clip in. • 360 degree equal distribution
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2026 Annual Educational Conference

2026 OEHA Annual Education Conference Agenda

4/16/2026		SESSION TITLE	SPEAKER	ROOM
7:30 – 8:15		Registration		
8:15 – 8:20		VP Welcome	Zoe Tyler, REHSIT	
8:20 – 8:25		President’s Address	Courtney Myers, MPH, REHS	
8:25 – 8:40		OEHA Business Session	Courtney Myers, MPH, REHS	
8:40 – 9:40	General	Conflict De-escalation	Alicia Love	
	REHSIT	REHS credential and Test Information	Stephanie Youst/ Garrett Guillozet	
9:40 – 9:50	ROOM CHANGE			
9:50 -10:50 Concurrent Sessions	Pool/Spa	Beyond inspections- value-added trainings and handouts for pool operators	Shannon Self	
	Solid Waste	Promoting Sustainability in Environmental Health	Danna Lotz	
	Food	Embargo, Cease Use, & Voluntary Destruction	Jason Ahrens	
	REHSIT	Environmental Risk Assessment and Toxicology	Dr. Paul Rosile	
10:50 – 11:00	ROOM CHANGE			
11:00 – 12:00 Concurrent Sessions	Leadership	Leadership Panel	Chad Brown, Renee Diekman, Courtney Myers,Chris Cook, Eric Cherry	
	Vector/Pesticide	Reducing Risk when Using Rodent Control Products	Ernest Schoonover	
	Food	Microbrewing of Alcoholic Beverages	Jason Ahrens	
	REHSIT	Environmental Policy and Law	Carrie Yeager	
12:00 – 1:00	Buffet Lunch			
12:30 – 12:50	Awards and GE Scholarship		Gus Dria REHS	
12:50-1:10	NEHA Updates		Niki Lemin	
1:10 – 1:40	Legislative Update, *REHS class will begin*		Courtney Myers, MPH, REHS	
1:40 – 1:50	Break			
1:50 – 2:50	General	State-to-state differences in Environmental code	Vivian Zeng	
	REHSIT	Epidemiology	TBD	
2:50 – 3:00	ROOM CHANGE			
3:00 – 4:00 Concurrent Sessions	Emergency Preparedness	2025 NATO Parliamentary Assembly	Jennifer Wentzel	
	Body Art/ Tattoo	Sanitation practices/procedures in body art facility	Kevin Barlow	
	Pool/Spa	Fixing the prolem Pool- From a health inspector's Perspective	Megan Mementowski and Tom Fink	
	REHSIT	Food Safety for EHS Part I	TBD	
4:00 – 4:10	ROOM CHANGE			
4:10 – 5:10 Concurrent Sessions	Tattoo	Ink and Pigment in Body Art	Sarah Bandenhop	
	Vector/Pesticide	MCG and GIS utilized for mosquito surveillance.	Natalie Menke, Hocking County	
	Leadership	Leadership presentation	Luke Jacobs	
	REHSIT	Food Safety for EHS Part II	TBD	

2026 Annual Educational Conference

4/17/2026	SESSION TITLE		SPEAKER	ROOM
7:45 – 8:30	Registration			
8:30 – 8:35	OEHA VP Follow-up		Zoe Tyler, REHSIT	
8:35 – 9:35	General	Communication, Behavior and Trust: Understanding the Intersection	Amelia Greiner Safi	
	REHSIT	Water	TBD	
9:35 – 9:45	ROOM CHANGE			
9:45 – 10:45 Concurrent Sessions	Water	Clean Water Ashtabula County Grant: How you can replicate at your HD	Randall Barnes	
	Vector	From Bite to Insight: How Tick Testing Strengthens Public Health Surveillance	Risa Pesapane	
	Food	Liquor Control Compliance and Food Service Requirements	Shaun Powers & Teddy Conn	
	REHSIT	Wastewater	Madeline Dyer	
10:45 – 10:55	ROOM CHANGE			
10:55 – 11:55 Concurrent Sessions	Tattoo	Modern Day Tattooing and the future of the industry	Matthew and Elizabeth Franklin	
	Water/Technology/Solid Waste	Modernizing a Water Well and Septic Program	Scott Morris	
	General	Conflict or Cooperation? It's Up to You!	Suzanne Hrusch/Kevin Brennan	
	REHSIT	Build Environments	TBD	
11:55 – 1:00	Buffet Lunch, Wrap Up Awards, Close of Business, Voting Results, Raffle Prizes & Visit Exhibitors			
1:00 – 1:10	ROOM CHANGE			
1:10 – 2:10 Concurrent Session	Food	Food Safety Violation Data Review to Help Evaluate LCHD's Enhanced Enforcement Program	Traven Wood	
	Leadership	How to be the Best Coach/Leader	Mark Adams	
	water	Nuisance Complaints Confrontations	William Duck	
	REHSIT	Vectors	TBD	
2:10 – 2:20	ROOM CHANGE			
2:20 – 3:20 Concurrent Session	General	Wright Pratt Air Force Base	Emily Tyler	
	Food	Lost Lands - Start to finish production of a 50,000 person multi day music festival	Licking County Health Department	
	General	Asbestos	Wayne Ingram	
	REHSIT	Solid and Hazardous Waste	TBD	
3:20 – 3:30	ROOM CHANGE			
3:30 – 4:30	Solid Waste	Talking Trash- Ohio Waste Characterization Study	Lindsey Grimm	
	REHSIT	Occupational Health and Air Quality	TBD	
4:30 – 4:45	Closing remarks		Zoe Tyler, REHSIT	

OEHA Committees & Chairs

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Sarah Badenhop, REHS
Columbus Public Health

Campground

Mark Janowich, REHS
Erie County Health Department

Food

Scott Whittaker, REHS
Columbus Public Health

Lead

Greg Putka, REHS
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Emily Speck, BSPH, REHS
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Sewage

Eric Cherry, REHS
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Chuck De Jonckheere, REHS
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Archives

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Delaware Public Health District

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Cleveland Department of Public Health

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Website

Garrett Guillozet, MPA, REHS, AEMT
Delaware Public Health District

Auditing

Jennifer Wentzel, MPH, REHS
Public Health - Dayton & Montgomery County

Awards & Recognition

Gus Dria, REHS
Canton City Health Department

George Eagle Scholarship

Traven A. Wood, MS, REHS
Licking County Health Department

Membership

Luke Jacobs, MPH, REHS
Columbus Public Health

Nominations & Elections

Rachel Belford, REHS
Knox Public Health

Public Affairs

Stephan Ruckman, MPH, REHS
Worthington Schools

Publications

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Delaware Public Health District

Concentrated Animal Feed Facility

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Ohio Public Health Partnership

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