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[**Combining community resiliency and energy efficiency retrofits**](https://scholarship.libraries.rutgers.edu/esploro/outputs/journalArticle/Combining-community-resiliency-and-energy-efficiency/991031549899404646?institution=01RUT_INST)

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by **Jennifer Senick (Author)**, **Clinton J. Andrews (Author)**, **Handi Chandra Putra (Author)**, **Ioanna Tsoulou (Author)** and **MaryAnn Sorensen Allacci (Author)**

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[**Comparison of real-time instruments and gravimetric method when measuring particulate matter in a residential building**](https://scholarship.libraries.rutgers.edu/esploro/outputs/journalArticle/Comparison-of-real-time-instruments-and-gravimetric/991031549948804646?institution=01RUT_INST)

by **Zuocheng Wang (Author)**, **Leonardo Calderόn (Author)**, **Allison P. Patton (Author)**, **MaryAnn Sorensen Allacci (Author)**, **Jennifer Senick (Author)**, **Richard Wener (Author)**, **Clinton J. Andrews (Author)** and **Gediminas Mainelis (Author)**

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by **Allison P. Patton (Author)**, **Leonardo Calderόn (Author)**, **Youyou Xiong (Author)**, **Zuocheng Wang (Author)**, **Jennifer Senick (Author)**, **MaryAnn Sorensen Allacci (Author)**, **Deborah Plotnik (Author)**, **Richard Wener (Author)**, **Clinton J. Andrews (Author)** and **Uta Krogmann (Author)***... (11 authors)*

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[**An examination of policy options for achieving greenhouse gas emissions reductions in New Jersey**](https://scholarship.libraries.rutgers.edu/esploro/outputs/report/An-examination-of-policy-options-for/991031549874404646?institution=01RUT_INST)

by **Gabriel Pacyniak (Author)**, **Noah Kaufman (Author)**, **James Bradbury (Author)**, **Andrew Veysey (Author)**, **Hampden Macbeth (Author)**, **Matthew Goetz (Author)**, **Marjorie B. Kaplan (Author)**, **Jeanne Herb (Author)**, **Jennifer Senick (Author)** and **Tanya Abrahamian (Author)***... (11 authors)*

Rutgers University

2017

This report explores policy options for the State of New Jersey in advancing statutory limits to reduce greenhouse gas emissions. Recognizing that it has been a decade since the passage of the New Jersey Global Warming Response Act (N.J.S.A. 26:2C-37), this report examines five critical issues with respect to attainment of the statewide limits: Whether the limits are still appropriate limits reflecting scientific consensus; The status of New Jersey's current greenhouse gas emissions in relation to such limits; The status of New Jersey's legal and policy framework for addressing greenhouse gas emissions; Leading mitigation policies in other states that could be applicable to New Jersey; and What policies offer opportunities to improve conditions in communities that currently bear disproportionate environmental burdens in New Jersey that are likely to be exacerbated by a changing climate.

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[**An agent-based model of building occupant behavior during load shedding**](https://scholarship.libraries.rutgers.edu/esploro/outputs/journalArticle/An-agent-based-model-of-building-occupant/991031654714904646?institution=01RUT_INST)

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Building simulation, Vol.10(6), pp.845-859

12/2017

Load shedding enjoys increasing popularity as a way to reduce power consumption in buildings during hours of peak demand on the electricity grid. This practice has well known cost saving and reliability benefits for the grid, and the contracts utilities sign with their “interruptible” customers often pass on substantial electricity cost savings to participants. Less well-studied are the impacts of load shedding on building occupants, hence this study investigates those impacts on occupant comfort and adaptive behaviors. It documents experience in two office buildings located near Philadelphia (USA) that vary in terms of controllability and the set of adaptive actions available to occupants. An agent-based model (ABM) framework generalizes the case-study insights in a “what-if” format to support operational decision making by building managers and tenants. The framework, implemented in EnergyPlus and NetLogo, simulates occupants that have heterogeneous thermal and lighting preferences. The simulated occupants pursue local adaptive actions such as adjusting clothing or using portable fans when central building controls are not responsive, and experience organizational constraints, including a corporate dress code and miscommunication with building managers. The model predicts occupant decisions to act fairly well but has limited ability to predict which specific adaptive actions occupants will select.

[**Designing Buildings for Real Occupants: An Agent-Based Approach**](https://scholarship.libraries.rutgers.edu/esploro/outputs/journalArticle/Designing-Buildings-for-Real-Occupants-An/991031654651604646?institution=01RUT_INST)

by **Clinton J Andrews**, **Daniel Yi**, **Uta Krogmann**, **Jennifer A Senick** and **Richard E Wener**

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11/2011

[**Synthetic Populations of Building Office Occupants and Behaviors**](https://scholarship.libraries.rutgers.edu/esploro/outputs/bookChapter/Synthetic-Populations-of-Building-Office-Occupants/991031654027504646?institution=01RUT_INST)

by **Jennifer A Senick**, **Clinton J Andrews**, **Handi Chandra Putra**, **Ioanna Tsoulou** and **MaryAnn Sorensen Allacci**

Building Performance Evaluation, pp.63-72

Springer International Publishing

08/31/2017

The goal of this chapter is to convey a novel approach to overcoming the limitations of case study research of building occupant behavior in workplace settings by pooling samples and creating a synthetic population of building occupants and behaviors. Synthetic populations can be used by researchers and designers of buildings to develop more accurate models of performance and behavior (Andrews et al. 2016). In the example presented here, three disparate field studies of workplace settings are combined into a larger database that is enhanced through the generation of a statistically similar synthetic data set.

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[**Using synthetic population data for prospective modeling of occupant behavior during design**](https://scholarship.libraries.rutgers.edu/esploro/outputs/journalArticle/Using-synthetic-population-data-for-prospective/991031654036104646?institution=01RUT_INST)

by **Clinton. J Andrews**, **MaryAnn Sorensen Allacci**, **Jennifer Senick**, **Handi Chandra Putra** and **Ioanna Tsoulou**

Energy and buildings, Vol.126(C), pp.415-423

08/15/2016

•Design work precedes building occupancy but designers should still consider occupant behavior.•The transferability of occupant behavior data depends on incorporation of key contextual factors.•Creating a synthetic set of generic building occupants captures aspects of context, is feasible and helpful in design practice, and is available now for commercial buildings. This paper addresses the challenge of incorporating occupant behavior into building performance simulation models used during the design process—that is, before the actual occupants are known. It proposes the use of synthetic population data, an approach that is novel in building performance modeling although common in urban planning and public health. A simpler approach embodied in the ASHRAE Fundamentals volume is to report standard distributions of values for behavioral variables, assuming that parameters vary independently of one another when in fact many co-vary or are interdependent. An alternative approach calibrates models of occupant behavior against actual occupants in specific existing buildings, but this raises questions of transferability. Needed is a database of “generic” occupants that designers can use prospectively during the design process. This paper documents a process of combining disparate field studies of commercial buildings into a larger occupant behavior database and generating a statistically similar synthetic data set that can be shared without compromising confidentiality requirements associated with field studies. The synthetic data set successfully incorporates much of the covariance structure of the underlying field data and supports multivariate modeling. Its scope and structure necessarily serve the needs of the associated modeling framework. Cooperative and systematic sharing of data by field researchers is crucial for building large enough data sets to serve as a behaviorally-robust basis for building design.

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[**Summertime thermal conditions and senior resident behaviors in public housing: A case study in Elizabeth, NJ, USA**](https://scholarship.libraries.rutgers.edu/esploro/outputs/journalArticle/Summertime-thermal-conditions-and-senior-resident/991031654936804646?institution=01RUT_INST)

by **Ioanna Tsoulou**, **Clinton J Andrews**, **Ruikang He**, **Gediminas Mainelis** and **Jennifer Senick**

Building and environment, Vol.168, p.106411

01/15/2020

As heat waves become more extreme, there is a growing concern for the health of elderly city dwellers who have poor living conditions and limited access to resources. Much research has documented socioeconomic links to heat vulnerability, but limited studies have investigated the detailed living conditions of vulnerable populations, despite increasing requests from local communities. In this paper, we examine the summertime thermal performance of 24 senior apartments within 3 public housing sites (2 conventional multifamily and 1 LEED-rated building), and the seniors' adaptive responses in Elizabeth, NJ, USA. Time-series data were collected from sensors, interviews and observations on the thermal environment and behavior, from May–October 2017. Our multi-level, occupant-centric approach utilizes the indoor heat index as a proxy for heat stress, against site and building characteristics, and environmental and personal variables. Panel regressions show thermal variations among sites/apartments and illustrate the significant effect of actions, such as window opening and air conditioner use. Results also show how the seniors' adaptive responses vary by site; residents with central air-conditioning use it, while residents from the two older sites engage in a wider range of adaptive actions, and in some cases achieve similar indoor heat indexes as apartments from the green building. Indoor heat stress experienced by low-income seniors can be greatly reduced through cost-effective strategies that target individual behaviors and outdoor amenities. This implies the need for integrated solutions to the heat waves problem across scales; including changes to residents' habits, building envelopes, building operations, and outdoor spaces. [Display omitted] •A summer-long study of indoor thermal performance and occupant behaviors in senior public housing sites is conducted.•The multi-level approach examines indoor heat against environmental, site, apartment, personal and behavioral variables.•Behaviors and site have the strongest effect over the indoor heat index.•Behaviors vary significantly across sites with different outdoor amenities and building envelopes.•Heat adaptation strategies should jointly consider the residents' habits, building modifications and outdoor alterations.

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[**Distinguishing between green building occupants' reasoned and unplanned behaviours**](https://scholarship.libraries.rutgers.edu/esploro/outputs/journalArticle/Distinguishing-between-green-building-occupants-reasoned/991031654660304646?institution=01RUT_INST)

by **Elizabeth L Hewitt**, **Clinton J Andrews**, **Jennifer A Senick**, **Richard E Wener**, **Uta Krogmann** and **MaryAnn Sorensen Allacci**

Building research and information : the international journal of research, development and demonstration, Vol.44(2), pp.119-134

02/17/2016

Several frameworks incorporate social and psychological elements of environmentally significant behaviour, and most assume cognitive and deliberate decision-making. Household energy consumption behaviours, however, span a spectrum from reasoned and deliberate to unplanned and automatic. The aim of this paper is to advance knowledge of reasoned and unplanned behaviours in the context of pro-environmental action. Using results of a survey administered to occupants of an urban residential green building, this study explores five household consumption behaviours and tests the hypothesis that unplanned behaviours will be poorly predicted by a reasoned, values-based behavioural framework. Using path analyses, variables in a values-based framework are used to predict surveyed behaviours. Findings indicate that behaviours hypothesized to be unplanned were not well predicted by the values-based framework. The framework successfully predicted what was hypothesized to be a fully reasoned behaviour. Three potential reasons are discussed for the lack of prediction of some behaviours. A deeper understanding of how unplanned, automatic or habitual behaviours intervene in conservation intentions can help policy-makers and building designers better respond to influences of occupant behaviour on building performance.

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[**Relative importance of electricity sources and construction practices in residential buildings: A Swiss-US comparison of energy related life-cycle impacts**](https://scholarship.libraries.rutgers.edu/esploro/outputs/journalArticle/Relative-importance-of-electricity-sources-and/991031654808404646?institution=01RUT_INST)

by **Martín Mosteiro-Romero**, **Uta Krogmann**, **Holger Wallbaum**, **York Ostermeyer**, **Jennifer S Senick** and **Clinton J Andrews**

Energy and buildings, Vol.68(PARTA), pp.620-631

01/2014

•We performed life cycle assessments of low energy homes in the US and Switzerland.•We assessed the effect of rating and construction practices on energy-related impacts.•The Swiss home performed better than the US building regarding all selected impacts.•The regional electricity mix had the greatest influence on the selected impacts.•Building life time and removal of the Swiss basement were less important. Comparisons of buildings in similar climates built in accordance with different regional construction practices and building rating systems can provide useful insights in sustainable design practices. The objectives of this study were: (1) to perform energy related life cycle assessments of a typical LEED-H (Leadership in Energy and Environmental Design for Homes) single-family home in New Jersey (US), and a typical Minergie-P single-family home in Chur, Switzerland; and (2) to assess the effect of rating systems and construction practices on the buildings’ environmental impacts. Inventory data was obtained from the Ecoinvent 2.2 database with a replacement of the Western European electricity mix with the US or New Jersey electricity mix for the New Jersey home. The Swiss building performed better regarding non-renewable energy consumption, Global Warming Potential and Acidification Potential mainly due to the geothermal heat pump and the Swiss electricity mix while there was less of a difference regarding Ozone Layer Depletion Potential and Eutrophication Potential. The influence of electricity sources exceeded the effects of longer building life time or the removal of the Swiss basement. Regional building practices, local codes and environmental policies should take the electricity mix into account because it is so important.

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[**Energy-Efficient Reuse of Existing Commercial Buildings**](https://scholarship.libraries.rutgers.edu/esploro/outputs/journalArticle/Energy-Efficient-Reuse-of-Existing-Commercial-Buildings/991031653885504646?institution=01RUT_INST)

by **Clinton J Andrews**, **David Hattis**, **David Listokin**, **Jennifer A Senick**, **Gabriel B Sherman** and **Jennifer Souder**

Journal of the American Planning Association, Vol.82(2), pp.113-133

04/02/2016

Problem, research strategy, and findings: Increased demand for urban living, financial incentives for redevelopment, and conducive planning regulations are leading to significant commercial building reuse. This trend represents an opportunity to upgrade the energy performance of the existing building stock in older, more walkable downtowns and to achieve preservation goals. Some advocates of building reuse resist imposing the cost of energy improvements on associated projects, while many energy efficiency advocates do not distinguish how the opportunities and constraints differ between new and existing buildings. Building code officials experience this tension when reviewing improvements to existing buildings, and many find that sections of the widely adopted International Energy Conservation Code are pragmatically unenforceable. In this study we examine the existing-building energy challenge using a mixed-methods approach within one region as well as a national-level analysis of governmental data. We characterize promising regulatory strategies including exempting historic buildings (which is the status quo), exempting smaller buildings and less energy-intensive occupancies and systems, and creating simple lookup tables that provide succinct guidance to redevelopers and code officials. Takeaway for practice: Code officials enforce longstanding life-safety codes more assiduously than they do the newer energy codes, and these codes need revisions to make them more cost effective and enforceable. A better understanding and implementation of building energy codes can have positive implications for both energy performance and downtown revitalization. Success depends on better managing interdependencies among the national policy objective of energy efficiency, the ubiquitous local planning objective of downtown revitalization, and the bureaucratic challenges of regulating construction in existing buildings. Planners should bring code officials into adaptive reuse projects early.

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[**Distinguishing between reasoned and unplanned behaviours carried out by occupants of a green building**](https://scholarship.libraries.rutgers.edu/esploro/outputs/journalArticle/Distinguishing-between-reasoned-and-unplanned-behaviours/991031550124804646?institution=01RUT_INST)

by **Elizabeth L. Hewitt (Author)**, **Clinton J. Andrews (Author)**, **Jennifer Senick (Author)**, **Richard Wener (Author)**, **Uta Krogmann (Author)** and **MaryAnn Sorensen Allacci (Author)**

Building Research & Information, Vol.44(2), pp.119-134

2015

[**Understanding Apartment End-Use Water Consumption in Two Green Residential Multistory Buildings**](https://scholarship.libraries.rutgers.edu/esploro/outputs/journalArticle/Understanding-Apartment-End-Use-Water-Consumption-in/991031654018804646?institution=01RUT_INST)

by **F Jordán-Cuebas**, **U Krogmann**, **C. J Andrews**, **J. A Senick**, **E. L Hewitt**, **R. E Wener**, **M Sorensen Allacci** and **D Plotnik**

Journal of water resources planning and management, Vol.144(4), p.4018009

04/01/2018

AbstractThe objective of this study was to gain a better understanding of the drivers of indoor water consumption in urban multistory residential buildings, to more accurately predict residential water demand, and to identify water saving opportunities. Water meters were installed at each end-use fixture in 15 apartments within two economically diverse green high-rise buildings. Infrared motion loggers recorded occupant presence. Interviews provided sociodemographic data and data about water consuming activities. The average apartment water consumption was 184  L/[capita  (cap)·d] in Building #1 and 260  L/(cap·d) in Building #2. A principal component analysis determined that tenant presence in kitchen, kitchen faucet water consumption, cooking frequency, bathroom faucet water consumption, bathtub water consumption, percentage of tenants going to work/school, percentage of children, and percentage of seniors were major contributors to the variability in total per capita water consumption. A water end-use model taking these drivers into account demonstrated that preferences in bathtub and shower consumption exceeded the effects of dish washing and toilet leaks. When considered in relation to overall water consumption in the city, the tenant per capita water consumption in both buildings was similar.

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[**Application of three different data streams to study building deficiencies, indoor air quality, and residents’ health**](https://scholarship.libraries.rutgers.edu/esploro/outputs/acceptedManuscript/Application-of-three-different-data-streams/991031550245504646?institution=01RUT_INST)

by **Nirmala Thomas (Author)**, **Leonardo Calderόn (Author)**, **Jennifer Senick (Author)**, **MaryAnn Sorensen Allacci (Author)**, **Deborah Plotnik (Author)**, **Mengyang Guo (Author)**, **Yi Yu (Author)**, **Jie Gong (Author)**, **Clinton J. Andrews (Author)** and **Gediminas Mainelis (Author)**

Building and Environment, Vol.154, pp.281-295

2019

[**Airborne Particulate Matter in Two Multi-Family Green Buildings: Concentrations and Effect of Ventilation and Occupant Behavior**](https://scholarship.libraries.rutgers.edu/esploro/outputs/journalArticle/Airborne-Particulate-Matter-in-Two-Multi-Family/991031654587404646?institution=01RUT_INST)

by **Allison P Patton**, **Leonardo Calderon**, **Youyou Xiong**, **Zuocheng Wang**, **Jennifer Senick**, **MaryAnn Sorensen Allacci**, **Deborah Plotnik**, **Richard Wener**, **Clinton J Andrews** and **Uta Krogmann***... (11 authors)*

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01/20/2016

There are limited data on air quality parameters, including airborne particulate matter (PM) in residential green buildings, which are increasing in prevalence. Exposure to PM is associated with cardiovascular and pulmonary diseases, and since Americans spend almost 90% of their time indoors, residential exposures may substantially contribute to overall airborne PM exposure. Our objectives were to: (1) measure various PM fractions longitudinally in apartments in multi-family green buildings with natural (Building E) and mechanical (Building L) ventilation; (2) compare indoor and outdoor PM mass concentrations and their ratios (I/O) in these buildings, taking into account the effects of occupant behavior; and (3) evaluate the effect of green building designs and operations on indoor PM. We evaluated effects of ventilation, occupant behaviors, and overall building design on PM mass concentrations and I/O. Median PMTOTAL was higher in Building E (56 µg/m³) than in Building L (37 µg/m³); I/O was higher in Building E (1.3-2.0) than in Building L (0.5-0.8) for all particle size fractions. Our data show that the building design and occupant behaviors that either produce or dilute indoor PM (e.g., ventilation systems, combustion sources, and window operation) are important factors affecting residents' exposure to PM in residential green buildings.

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[**Investigation of indoor air quality determinants in a field study using three different data streams**](https://scholarship.libraries.rutgers.edu/esploro/outputs/journalArticle/Investigation-of-indoor-air-quality-determinants/991031653884704646?institution=01RUT_INST)

by **Nirmala M Thomas**, **Leonardo Calderón**, **Jennifer Senick**, **MaryAnn Sorensen-Allacci**, **Deborah Plotnik**, **Mengyang Guo**, **Yi Yu**, **Jie Gong**, **Clinton J Andrews** and **Gediminas Mainelis**

Building and environment, Vol.154, pp.281-295

05/2019

Indoor air quality (IAQ) is determined by indoor and outdoor sources and conditions, building characteristics, and occupant behavior. In the field study context where the researcher lacks full control of observational conditions, it is difficult to compare and integrate these determinants because they require such different types and sources of data. This pilot-level project investigated the potential to overcome these limitations by integrating traditional IAQ measurement techniques with questionnaires and analysis of building deficiencies using 3D infrared thermography imaging in two residential multi-apartment buildings. Of the building deficiencies detected by the 3D thermography, missing insulation (MI) correlated best with the IAQ measurements and questionnaire data. Apartments missing more than 5% of insulation in their exterior wall (n = 6) had a significantly higher number concentration of ultrafine airborne particles (diameter < 300 nm) (p = 0.013) and their indoor/outdoor ratio (p = 0.029) compared to apartments where less than 5% of insulation was missing (n = 14). The correlation was driven by apartments where no smoking or use candles or incense was reported. Ultrafine particle concentrations in apartments with combustion sources were higher regardless of the levels of MI. Corner apartments had a higher fraction of MI compared to non-corner apartments (p = 0.002); higher levels of MI were detected in apartments where a resident had an asthma attack in the past 12 months. Our data suggest that integration of different data streams produces a more informative IAQ investigation. This pilot-level study should be performed on a larger scale to examine its wider applicability in the IAQ field. •Building deficiencies detected by spatially resolved infrared thermography imaging.•Missing insulation correlated with IAQ measurements and questionnaire data.•Ultrafine particle concentration positively correlated with missing insulation levels.•Indoor combustion sources positively correlated with airborne particle presence.•Asthma attacks associated with high levels of missing insulation and indoor combustion sources.

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[**Estimating Lung Deposition of Fungal Spores Using Actual Airborne Spore Concentrations and Physiological Data**](https://scholarship.libraries.rutgers.edu/esploro/outputs/journalArticle/Estimating-Lung-Deposition-of-Fungal-Spores/991031654818104646?institution=01RUT_INST)

by **Lynn E Secondo**, **Jessica A Sagona**, **Leonardo Calderón**, **Zuocheng Wang**, **Deborah Plotnik**, **Jennifer Senick**, **MaryAnn Sorensen-Allacci**, **Richard Wener**, **Clinton J Andrews** and **Gediminas Mainelis**

Environmental science & technology, Vol.55(3), pp.1852-1863

02/02/2021

Exposure to bioaerosols has been implicated in adverse respiratory symptoms, infectious diseases, and bioterrorism. Although these particles have been measured within residential and occupational settings in multiple studies, the deposition of bioaerosol particles within the human respiratory system has been only minimally explored. This paper uses real-world environmental measurement data of total fungal spores using Air-o-Cell cassettes in 16 different apartments and residents’ physiological data in those apartments to predict respiratory deposition of the spores. The airborne spore concentrations were measured during the spring, summer, and fall. The respiratory deposition of five most prevalent spore generaAscospores, Aspergillus, Basidiospores, Cladosporium, and Myxomyceteswas predicted using three empirical models: the Multiple Path Particle Dosimetry model, using both the Yeh and age-specific versions, and the Bioaerosol Adaptation of the International Committee on Radiological Protection’s Lung deposition model. The predicted total deposited number of spores was highest for Ascospores and Cladosporium. While the majority of spores deposit were in the extrathoracic region, there is a significant deposition for both Aspergillus and Cladosporium in the alveolar region, potentially leading to the development of aspergillosis or allergic asthma. Although the dose–response relationship is unknown, the estimate of the actual spore deposition could be the first step in determining such a relationship.

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[**Presence and variability of culturable bioaerosols in three multi‐family apartment buildings with different ventilation systems in the Northeastern US**](https://scholarship.libraries.rutgers.edu/esploro/outputs/journalArticle/Presence-and-variability-of-culturable-bioaerosols/991031617249404646?institution=01RUT_INST)

by **Nirmala T Myers (Author)**, **Leonardo Calderón (Author)**, **Brian Pavilonis (Author)**, **Zuocheng Wang (Author)**, **Youyou Xiong (Author)**, **MaryAnn Sorensen-Allacci (Author)**, **Deborah Plotnik (Author)**, **Jennifer Senick (Author)**, **Jie Gong (Author)** and **Uta Krogmann (Author)***... (12 authors)*

Indoor air, Vol.31(2), pp.502-523

03/01/2021

Bioaerosol concentrations in residential buildings located in the Northeastern US have not been widely studied. Here, in 2011‐2015, we studied the presence and seasonal variability of culturable fungi and bacteria in three multi‐family apartment buildings and correlated the bioaerosol concentrations with building ventilation system types and environmental parameters. A total of 409 indoor and 86 outdoor samples were taken. Eighty‐five percent of investigated apartments had indoor‐outdoor (I/O) ratios of culturable