Emergency Management and Resiliency Planning Program (EMRP) and the

Electronic Visualization Laboratory (EVL)

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Midwest Comprehensive Visualization Dashboards: The Image of an Overburdened Community

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Abstract

In preparation for the proximity to hazards dashboard PHD upgrade dealing with environmental justice issues in Chicago, and as part of the community-based participatory design approach, we are adding new exposure sources of concern for communities and improving the interface's functionality. A preliminary analysis of this information revealed that most asphalt plants and rail yard support facilities are primarily in Chicago's southwest side. These rail yard support facilities require elevated truck traffic levels to accommodate the high volume of containers passing trough the intermodal terminals. In addition, the prevailing wind direction and the location of all these sources are likely to enhance the environmental burden on some downwind communities in the SW.

1.0 Introduction

The UIC School of Public Health (UIC-SPH), in collaboration with the Electronic Visualization Laboratory (EVL) and the College of Urban and Public Affairs (CUPPA), is presenting a series of Midwest Comprehensive Visualization Dashboards (MCVD) focusing on environmental justice issues in this region.

One of the underlying objectives of these MCVD is to enhance the visual communication of the distribution of environmental burdens (and benefits) in the overall study area, which is currently Chicago. Based on our interaction with community groups for the last four years, we established that the distribution of environmental burdens needs to be expressed at least in an ordinal scale of measurement, and the relative magnitude of the burden (or benefit) should be associated with a recognizable geographic unit. Integrating this information into the the dashboards provides an effective tool for identifying environmental disparities.

The first two MCVD (EJ.1 and EJ.2) identified that several categories of hazardous sources in Chicago are likely to be concentrated near neighborhood public schools in communities with a predominantly Latinx student population.[1,2] The proximity to hazards dashboard (PHD; i.e., MCVD EJ.3) was the latest interface design dealing with environmental justice issues at a hyper local level.[3]

In preparation of the PHD upgrade, and as part of the community-based participatory design (CBPD) approach, we are adding new exposure sources of concern for the community and improving the functionality of the interface as a tool for substantiating environmental disparities. Preliminary analysis and visualization of this information, which is part of our data integration phase, revealed disparities that we deemed necessary to communicate to the public. The sections that follow present these findings in a static map form.

2.0 The UIC community-based participatory design (CBPD) approach

As part of the adopted iterative CBPD approach (see Figure 1), MCVD were created based on the selected categories of hazard sources deemed to pose a threat to the communities of Chicago.[1,2] To improve further the interfaces, a community engagement and input period was implemented. During this period presentations and focus group meetings were conducted organized by the Southwest Environmental Alliance (SEA) and policy decision making entities of Chicago (e.g., 7/28/21: 25th Ward CBO Stakeholders meeting; 9/14/21: Latino Caucus of Chicago; etc.). The outcome of this interaction was the visualization interface PHD.[3]

This approach relies on an iterative community-based participatory design (CBPD, see Figure 1) to develop representations of data that community members can understand leading to findings which substantiate their EJ claims and demonstrate the underlying issues. Policymakers benefit from such interfaces since they make visible EJ issues (e.g., rail-yards in the SW section of Chicago) requiring an equitable resolution. As we pointed out, this is an iterative approach (see feedback loop in Figure 1). The purpose of this interaction period was to engage the local stakeholders in discussions about the sources, the dashboard and the information it conveys. The dynamic nature of this approach created revisions of the previous dashbaords[1,2,3] as well as the current PHD interface which aims to address specific needs of community groups dealing with environmental justice issues (e.g., permit of new facilities). The underlying theoretical background of this approach and the technical details of the resulting proximity to hazards visualization interface are starting to be published.[4,5,6]

The community-based participatory design (CBPD) approach for the MCVD interfaces creation is feasible thanks to the UIC library portal INDIGO which "collects, disseminates, and provides persistent and reliable access to the research and scholarship of faculty, staff, and students at the University of Illinois at Chicago." (i.e., indigo.uic.edu). This portal established an easy to access communication link between the MCVD and the end-users (see Figure 1 above). The various versions of the supporting documentation archive the evolution of this effort and the changes instigated by the CBPD approach; which, by nature, is dynamic.

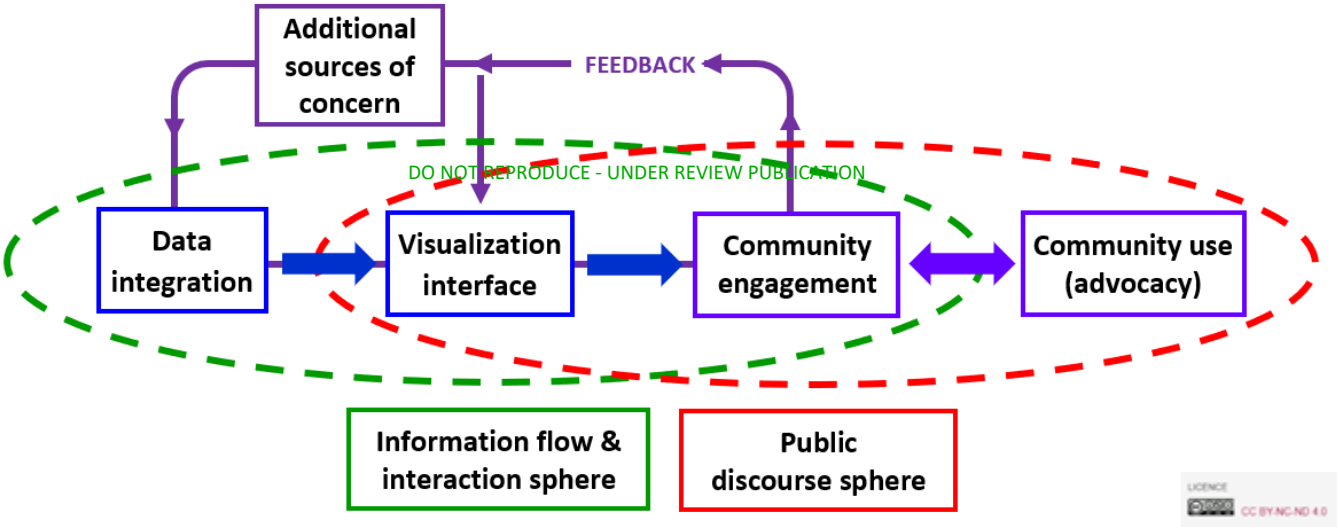


Figure 1. Schematic of the UIC community-based participatory design (CBPD) approach for developing environmental justice dashboards (Figure from forthcoming publication).

3.0 Emission Sources of Concern

The ongoing CBPD interaction for the PHD upgrade identified the need to incorporate a more detailed list of exposure sources of concern for the community and to improve the functionality of the interface. Preliminary analysis and visualization of this information, which is part of our data integration phase (see Figure 1), revealed significant environmental burden disparities related to:

- Rail yards and the depot and container storage facilities serving them.
- Asphalt plants (related to paving mixture, block, shingle, and coating materials mfg., and distribution).

The high concentration of intermodal rail yards in the Southwest (SW) side of Chicago was demonstrated by the UIC team in a previous MCVD.[3] This is part of a legacy issue and the fact that:

"Chicago is the largest US rail gateway and there is another major rail center located in East St. Louis. Rail's importance to both Chicago and the state is highlighted by the fact that over 1,300 freight, passenger and commuter trains pass through the Chicago region every day and, in 2011, Illinois ranked first in the nation in terms of rail freight volume at 490.4 million tons." (Source: Illinois Department of Transportation)

3.1 Operations and facilities serving the rail yards.

In the upcoming version of the PHD we added the depot services and container storage facilities for the intermodal rail yards. The main reason is the heavy-duty truck traffic associated with their operations. For different reasons, the Chicago Metropolitan Agency for Planning (CMAP) also included depots in their visualization (see Figure 2, yellow circles). The adjacent map adds one more dimension to the burden we describe in this study. As seen from Figure 2 the intermodal terminals in the SW exceed, in terms of lift 2015 volumes, all the other rail yard terminals in the city (not region). Two of them recorded more than 450,000 lifts in 2015. A lift involves moving a container to or from a rail car with heavy-duty forklifts, handlers, and cranes with diesel engines. In addition to the yard emissions, many of these containers will be transported by trucks (rail-to-truck service) to other destinations, thus increasing local traffic. These trucks are known as "Drayage trucks" (diesel-fueled large trucks with a gross vehicle weight of 33,000 pounds or greater). In addition, these elevated lift volumes increase the demand for nearby depot services and storage facilities. In the following section, we will present the 2018 lift volumes from the same source as an indicator of truck activity (i.e., burden).

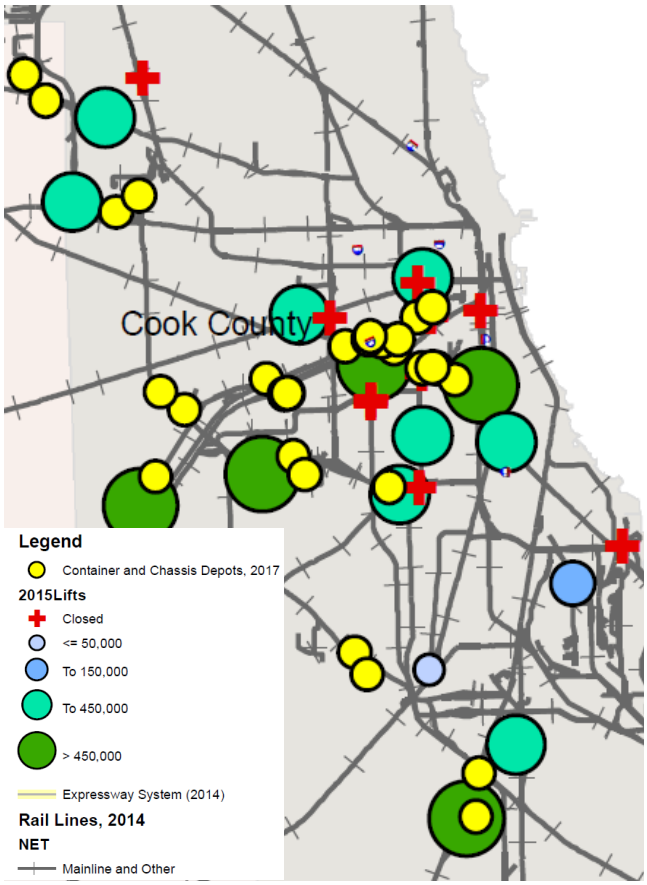


Figure 2. Intermodal Facilities and Volumes, Chicago Region, 2015. (Source: CMAP)

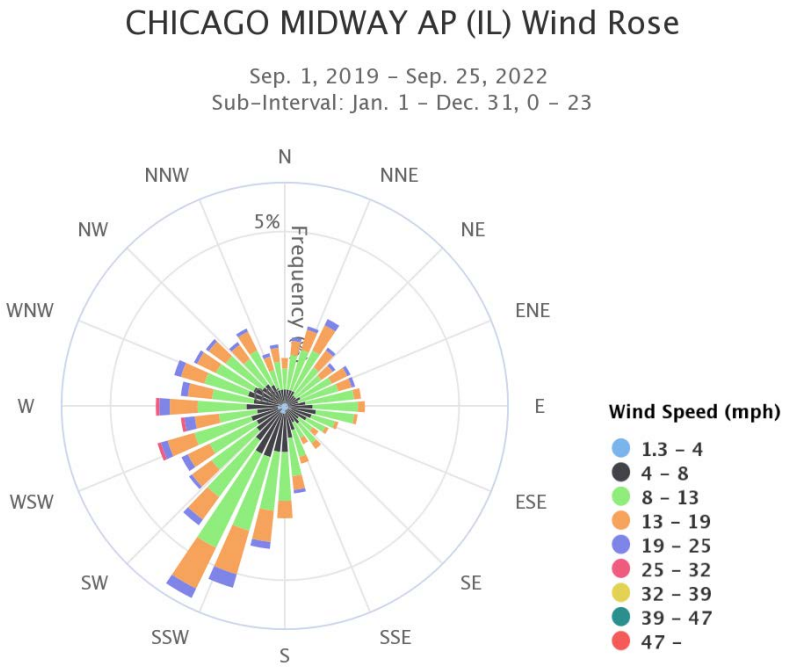
The locations for the facilities servicing the intermodal rail yards were acquired from the Intermodal Association of Chicago site; the addresses were verified with a Google maps search. Drayage truck services companies were not included.

3.2 Asphalt plants

These are construction material supply companies active in producing asphalt paving mixtures, block, shingle, and coating materials and their distribution. We retrieved the names and locations of asphalt plants from the Illinois EPA Bureau of Land (BOL) portal. A Google maps search verified the addresses used to create the maps, and residents were involved for additional site confirmation. The primary concern of the residents in the SW is the asphalt-producing facilities. These facilities were de-listed from the EPA category list of major sources emitting Hazardous Air Pollutants (HAP). The 2002 decision quotes that "no asphalt concrete manufacturing facility has the potential to emit HAP approaching major source levels."[7] They are, however, regulated by state agencies and require a permit to operate. The main reason for including them as sources of concern in the PHD upgrade is the potential (under certain conditions) to cause "acrid, noxious odors". In most cases, odor complaints are difficult to substantiate since the odor is a challenging to quantify air quality parameter. This limitation does not mean odor issues (and complaints) should be ignored. A case in point is an asphalt plant at Chelmsford, Massachusetts. Residents and the local EPA identified that it had been violating its permit due to "acrid, noxious odors that smelled like burning tires, caused throat irritation and respiratory issues for nearby residents and woke some from their sleep."[8]

3.3 Wind direction

We will introduce in this analysis the prevailing wind direction close to the SW section of the city (data from Midway airport station). This is a major factor for dissipating mobile and point source emissions. A wind rose covering the 2019-2022 period will be used. "Wind roses are graphical charts that characterize the speed and direction of winds at a location. Presented in a circular format, the length of each "spoke" around the circle indicates the amount of time that the wind blows from a particular direction. Colors along the spokes indicate categories of wind speed." The source for this information is the Climate.gov portal. From the adjacent wind rose graph we can conclude that in the SW the prevailing low speed direction is from SSW.



3.4 Limitations and quality assurance safeguards

The number of these facilities is likely not accurate since it depends on how current the information is at the source (e.g., BOL or Google map listing). Also, as noted in the BOL portal: "The source of this information is from the regulated community and may contain errors or inaccuracies. It is intended to be used for informational purposes only." For the purpose of this study, which is the spatial distribution of the sources and the order of magnitude of disparities between areas, minor inaccuracies do not pose a problem.

The most reliable (reference) information is related to the intermodal rail yards. These sites occupy many acres of land and a few have been operational for over a century (e.g., Chicago Junction Railway Co., now the NS Ashland Avenue Yard). We use as well the information from the Chicago Metropolitan Agency for Planning (CMAP) indirectly to corroborate, for example, Figure 2, the findings of this study.

4.0 Overburdened communities

Overburdened communities are those where environmental burdens (EB) and socioeconomic disparities (SD) act cumulatively to create harmful conditions. The 2021 Executive Order (EO) 140081 and the Justice40 Initiative bring to the forefront the plight of these communities and the need to ameliorate their conditions. Assuming stationary emission sources, S_i, of the same pollutant, e.g., Sulfur Dioxide (SO2), within an area k where SD prevail, a simple way to demonstrate the overburdened concept, EB_k, is to express is as the sum of all these sources:

$$EB_k = S_1 + S_2 + S_3 + \ldots + S_i + \ldots + S_n + S_{n+1}$$

Even if each individual source S_i is far under the regulatory threshold, the sum of all these sources has the potential to pose, under certain conditions (e.g., spatial density of sources and wind direction), a threat to vulnerable communities. A major regulatory challenge emerges when a new facility (emission source), n+1, applies for a permit. In addition, environmental justice (EJ) concerns are raised since the k^{th} community is likely to be burdened by a disproportional number of sources if n is relatively high.

Sulfur Dioxide (SO2) is an interesting pollutant associated with asphalt plants and odor. One facility in the SW reported SO2 emissions reaching 12.3% of the permitted limit for SO2 in pounds per hour (based on the self-reported test results; summer 2021). Suppose we assume the other facilities in the community emit the same percentage of the limit. In that case, it will take approximately eight (n = 8) facilities to reach it and the n+1 to "violate" it. This example underlines the importance of EB as a relative cumulative magnitude. It partially explains as well a large number of odor complaints in the SW section of the city[9] since the regulatory EPA limit is not directly related to odor.

As we stated above, the concept of an overburdened community does not rely only on its SD position and requires considering EB. The SD position of a community is easily verified (e.g., with median household income and race composition thresholds). The EB concept is a relative term with no EB threshold limit above which this distinction applies. Suppose the comparison includes the 77 Chicago Community Areas (CCAs). In that case, the SW is the most overburdened section of the city in terms of the selected two EB sources: the vast majority of CCAs have zero asphalt plants and intermodal rail yard serving facilities. As we will show in the next section, a defining factor in their nonrandom -unequal- distribution is the industrial corridors and proximity to major highways. For a worst-case scenario assessment, we will set aside the EJ principles and the intermodal rail yards (in the final analysis, they are a legacy issue). The comparison will be made based on the the distribution of the asphalt plants and rail yard serving facilities within CCAs that are located near industrial corridors.

Figure 3 demonstrates that even if CCAs with industrial corridors (IC) are used as a comparison group, the southwest community areas with industrial corridors (CCAs-IC) are far more overloaded with asphalt plants and storage/maintenance facilities serving the rail yards than any other CCAs-IC in the city. As seen from this Figure, the South Lawndale (Little Village), New City, McKinley Park, and Pilsen (Lower West Side) CCAs-IC are almost one order of magnitude different from the other CCAs-IC. South Lawndale CCA-IC is probably at the top. The prevailing low-speed wind direction is from the SSW (the monthly summer trend -not shown- is more indicative). This implies that emissions associated with these sources are likely to dissipate slower and remain in the communities longer. Worth noticing as well is that the residential sectors of the South Lawndale, Lower West Side, McKinley Park, and Bridgeport CCAs are located downwind from multiple sources of emissions.

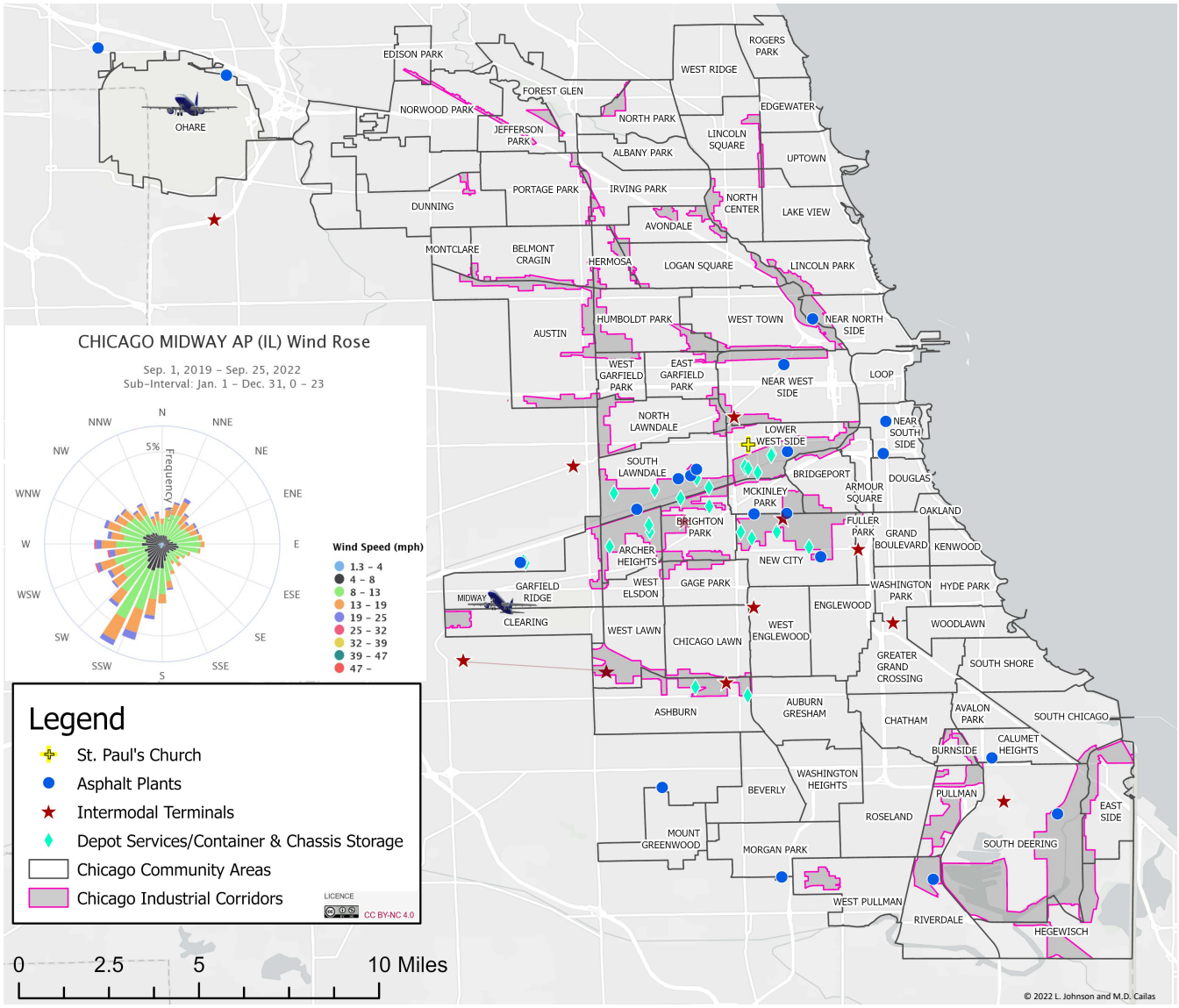


Figure 3. The distribution of the selected emission sources within Chicago and wind direction rose (one intermodal terminal, CSX Bedford Park, with a gate entrance near Harlem Avenue is connected to a rail service line area reaching S. Pulaski road; see line connecting the two stars).

Table 1. Intermodal rail yards in and close to SW Chicago communities

Name of rail yard	Annual Lifts (2018)	Percent of total
NS Landers	444,352	5.4%
CSX 59th Street	310,165	3.8%
BNSF Cicero (not in a CCAs)	457,026	5.6%
CSX Bedford Park (with West Lawn section)	895,983	10.9%
BNSF Corwith	850,686	10.3%
NS 47th	630,513	7.7%
UP Global I	336,729	4.1%
Total (selected Rail yards in or close to SW)	3,925,454	47.8%
Total for Chicago Region	8,220,476	

Source: Chicago Intermodal Facility Lift Counts and Regional TEU Estimate. Prepared by the Chicago Metropolitan Agency for Planning, November, 2019.

The lift volumes in Table 1 justify the high density of rail yard serving facilities in this city section (see Figure 3; green diamonds). For example, the BNSF Corwith terminal (located next to the residential area of Brighton Park) has a volume of 2,330 lifts per day (assuming 365 days of 24/7 operations) and a proportional diesel engine activity (e.g., forklifts and handlers). In addition, even if 5% of this lift volume is served by drayage trucks, this will require a traffic volume estimate of 116 trucks per day for transportation: a low-end, probably, truck volume estimation. Nevertheless, it is indicative of the reality in the SW caused by one only source.

The total lift number reported by the CMAP is regional (not within Chicago city limits). 47.8% of this regional volume number is associated with terminals in the SW. In the CMAP report the NS Ashland Avenue yard is not included.

4.1 Epilogue: a closer look at the SW

The following figure presents a section of the SW with multiple industrial corridors and the two major highways. It is a unique in the city and This is the figure -in an interactive mode- we started using in our community-based participatory design (CBPD) approach meetings for upgrading the PHD. To provide better context we are adding a wind direction rose graph from data collected at the "next door" Midway airport weather station.

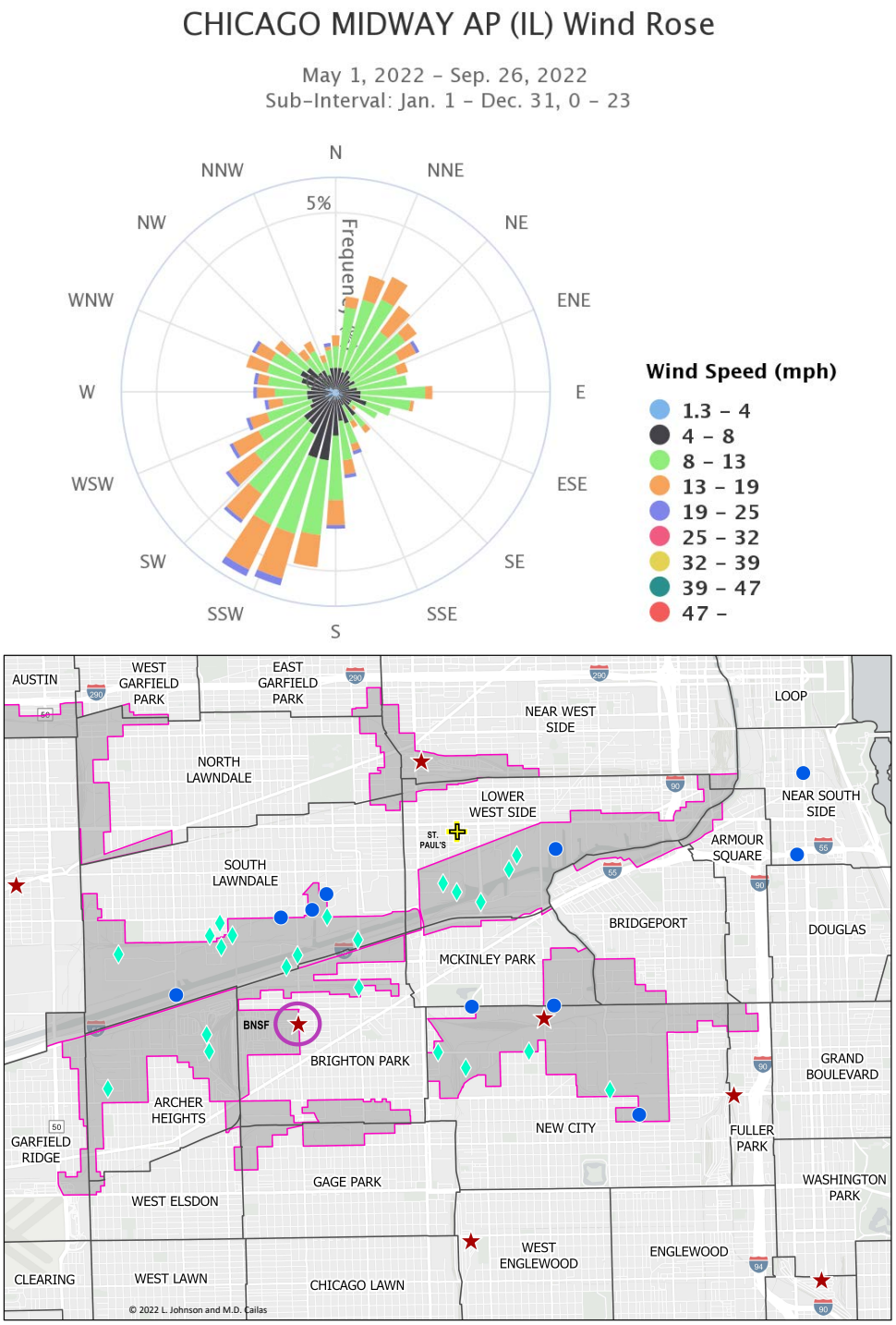


Figure 4. Section of Chicago's Southwest with its four -unique in spatial density- sources of environmental burdens: rail yards, rail yard support facilities, asphalt plants, and industrial corridors (i.e., landscape burden).

This figure clearly demonstrates the link between the high lift volume of the BSNF terminal and the high number of rail yard service facilities (see Figure 4, green diamonds in the industrial corridors). It also reveals the cause of the high truck volume in this area, a common complaint from residents. BNSF is just one of the six facilities in the SW (see Figure 3), accommodating 10% of the regional lift volume. Envisioning all the other intermodal rail yards, the rail yard storage and service facilities, and the required diesel engine activities for their operation will suffice to draw a bleak picture of an overburdened community. Unfortunately, the picture is unfinished since these are not the only EB sources in this part of the city.

The recent 2022-2026 EPA Strategic Plan Draft provides a thorough statement of the underlying issues that overburdened communities face and the challenges to resolving them:

> *"Many of the problems that need to be addressed have been well-known but unsolved for decades. Communities that have multiple industrial and energy facilities and are saturated with legacy pollution want to see EPA realign its enforcement in a way that provides action, accountability, and guidance for taking cumulative impacts and risks into account, even if they cannot be measured with precision. Permitting and rulemaking have typically not reflected the reality of overburdened communities, which means that it is often easier to site an eighth facility in a community that already has seven than in a community that has none. Since permitting is primarily implemented by other governmental partners with delegated authority from EPA, the work of integrating environmental justice and external civil rights considerations throughout all EPA programs and activities will require commitment, relationship building, and trust from partner agencies."* (Source: US EPA[10])

For overburdened communities in Southwest Chicago, their concerns, especially for children, can only be addressed using a cumulative impact framework for assessing the addition of one more facility near their children's schools.

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ACKNOWLEDGEMENTS

The authors would like to acknowledge the participation of the Southwest Environmental Alliance group for making the community-based participatory design approach feasible. Many thanks to the Director of Marketing and Communication, Mr. Rob Schroeder of the UIC-SPH, for his efforts to make this work known to the public. The authors would also like to express their gratitude to Ms. Sandra De Groote of the University of Illinois at Chicago Library for assisting us with the electronic filing and dissemination of this dashboard. Finally, we would all like to thank Mr. Justin Kerr publisher of McKinley Park News for his interest in our work and his help to disseminate reliable informations.

DISCLAIMER

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