NJ Climate Adaptation Alliance

Using Geographic Tools to identify industrial and commercial facilities for which pollution prevention efforts may reduce exposure to hazards associated with climate-related flooding

A Report to the United States Environmental Protection Agency (USEPA), Region 2

February 2017

Please cite this report as: Herb, J., J. Whytlaw, M. Campo. 2017. *Using Geographic Tools to Identify Industrial and Commercial Facilities for which pollution prevention efforts may reduce exposures to hazards associated with climate-related flooding.* New Jersey Climate Adaptation Alliance. New Brunswick, NJ: Rutgers University.

Project Period: 10/1/2014-9/30/2016
USEPA Grant Number (FAIN): 96287714
USEPA Agreement Number: NP96287714-0

Using Geographic Tools to identify industrial and commercial facilities for which pollution prevention efforts may reduce exposure to hazards associated with climate-related flooding

Project Summary: The United States Environmental Protection Agency (EPA) Pollution Prevention Program provided Rutgers University with a grant to use geospatial analytical tools to analyze publicly available state and federal environmental data, along with data regarding current and projected flood hazards and changing climate conditions, to inform state and federal program's operations, local resilience planning and public awareness about potential flood hazards. Rutgers identified active industrial and commercial facilities in New Jersey that may be subject to impacts from flood hazards resulting from changing climate conditions, thus creating potential future exposures in communities where the facilities reside. The data and presentation products from the project can inform federal, state and local environmental program operations (e.g. facility inspections), raise awareness about potential flood hazards in the proximity of industrial and commercial operations, and assimilate data that is useful for enhancing resilience considerations in local hazard mitigation and land use planning processes.

Approach

Almost four years after Hurricane Sandy, the consequences of the storm persist in the minds of local officials, stakeholders, community groups and government agencies working to identify potential exposures to flood hazards and to mitigate and prepare for and mitigate the effects from flood hazards. Following Sandy, the New Jersey Climate Adaptation Alliance, which is facilitated by Rutgers University, undertook an extensive stakeholder engagement process to inform development of public policy recommendations to enhance New Jersey's ability to adapt to changing climate conditions. As part of that stakeholder engagement process, the Alliance worked with the New Jersey Environmental Justice Alliance to host a Climate Justice Roundtable during which residents and community leaders in Newark and other urban communities discussed concerns about the potential for extreme weather events to increase exposures to hazardous materials. Additionally, the Rutgers facilitators also engaged representatives of USEPA-Region 2 programs in a facilitated discussion to better understand opportunities to inform EPA's own efforts using data about industrial and commercial facilities in relationship to current and future flood hazards as well as in relationship to populations that are socially vulnerable to changing climate conditions. Those opportunities provided Rutgers with important insights to inform its ongoing efforts to use available data to inform resilience planning efforts.

Funded by the EPA Pollution Prevention Program, the Rutgers researchers conducted analyses, developed data, and provide insights to inform strategies to integrate the consideration of potential hazards posed by operations of industrial and commercial facilities in flood prone areas as part of climate change preparedness and resilience planning and overall decision-making.

Additionally, the Rutgers project introduced the consideration of potentially flood-prone industrial and commercial facilities in proximity to populations that may be inherently vulnerable to changing climate conditions. EPA provided support to this project in many forms including data access and validation, review of draft outputs, and coordination with other pollution prevention efforts within the region. The New Jersey Department of Environmental Protection (NJDEP) provided access to additional data that are not otherwise available via public portals through a data sharing agreement.

Elements of the project included:

- *Literature Review and Initial Data Assessment* – A review of the academic and scientific literature was conducted at the onset of the project to inform the Rutgers project team's approach to developing an analysis methodology. The literature review (summarized in Appendix A) provides a starting point for understanding the nature of climate hazards that could reasonably be addressed within the scope of the project, approaches to creating a geospatial methodology to identify industrial and commercial facilities that may be vulnerable to climate change impacts and data that could be useful for purposes of geospatial analyses. The literature review affirmed the project scope of focusing on flood hazards as a discrete and manageable climate impact for which data would be readily available and also for which ongoing climate change preparedness and resilience efforts throughout New Jersey would provide a ready platform for application.

- *Spatial Analysis and Visualization Development* - Rutgers developed an analytical methodology to overlay industrial and commercial data with current and projected flood hazard and demographic data. In doing so, Rutgers researchers attempted to develop a systematic way for combining various data sources that would:
    - Provide data to support program operations at state and federal agencies, such as compliance assistance and priorities.
    - Raise awareness among decision makers and the general public about the need to address potential exposures of industrial and commercial facilities as part of climate change preparedness and resilience efforts;
    - Develop access to data to support resilience planning; and
    - Develop data to support engagement of industrial and commercial facility operations in their own resilience planning and emergency operation procedures.

  Appendix B summarizes the detailed methodology used for developing the final set of identified facilities, in addition to describing the spatial data and sources used to conduct exposure assessments and other analyses related to flood hazard impacts on the facilities and surrounding communities. Researchers used these data to generate a series of prototype geospatial analyses with associated narrative content to solicit initial feedback from program staff at EPA and NJDEP. Rutgers researchers revised the analyses based on input from the agencies, and then created publicly available website to communicate the results of the initial analyses using an ESRI Story Map. The link to the Story Map developed for this project is

the following:
http://rutgers.maps.arcgis.com/apps/MapJournal/index.html?appid=17c691be390246c892f9aef1398c37b4.

- *Stakeholder Review of Proposed Data Presentation* – During the course of the project, the Rutgers team considered the most effective presentation of the geospatial analysis conducted. Challenges included presentation of complex data in a way that is understandable to the general public as well as ensuring that the presentation provides an accurate context for the data. After consultation with EPA, the Rutgers team chose to use an ESRI Story Map format. The Story Map format is a web application that allows for the integration of mapping with explanatory text and other graphics. The intent of the Story Map approach is to allow for attractive and accessible presentation of data for interpretation by general audiences. The Rutgers team chose the Story Map format for the pollution prevention project for several reasons:
    - The Story Map approach provides important context for complex and, sometimes, misleading data;
    - The Story Map allows for adherence to Rutgers standards for web applications including use of metadata and platform hosting;
    - The Story Map approach allows for an efficient and structured presentation of the data; and
    - The Story Map approach provides an easily accessible platform to allow the geospatial analytical results to be available through a variety of publicly available websites including the Rutgers www.njadapt.org platform.

  The project team reviewed several alternative Story Maps with federal, state and local users to assess the content narratives, data presentations, and data attribution for their usefulness in assisting different stakeholders with integrating resilience information into hazard mitigation, land use planning, and other planning processes. Following discussions with stakeholder groups, the Rutgers team finalized a series of maps and narrative content based on the preferences of each stakeholder group. The resulting Map Story provided access to resources that each stakeholder group deemed important, in addition to providing examples of data visualizations that demonstrated the flexibility of the data set to be able to respond to the different spatial perspectives and preferred attributes of the stakeholders.

- *Technical Assistance* - The original scope for the project anticipated conducting technical assistance in the form of direct assistance to facilities identified as a result of the geospatial analytical methodology. Initial project design anticipated that technical assistance may involve workshops or trainings focusing on pollution prevention and source reduction practices or even on-site technical assistance. However, following the initial geospatial analysis of data, it became clear to the project team that the application of the initial outcomes may have the greatest impact in providing support to state and local planners including emergency managers and decision-makers as part of their resilience and emergency management efforts rather than in the form of direct pollution prevention and source reduction assistance. For that reason, the nature of technical assistance within the project shifted to outreach to several sets of practitioners to better understand how the geospatial analysis can be used as part of climate change preparedness and resilience efforts. These include engaging the New Jersey State Office of Emergency Management (with participation of the New Jersey Department of Environment Protection), the Office of Emergency Management in the City of Newark, and a wide mix of agency representatives within the City of Jersey City. These engagement opportunities provide an opportunity to present the analytical approach developed during the course of the project and to engage the participants in a dialogue about use of the data as part of ongoing emergency management, and extreme weather and climate change preparedness and resilience efforts. Additionally, engagement was also initiated with the Advisory Committee of the New Jersey Climate Adaptation Alliance (see: http://njadapt.rutgers.edu/about-us/advisory-committee) which represents a diverse cross-section of organizations engaged in climate change preparedness. The purpose of these engagement efforts was intended to better understand:

- The extent to which the generated data would offer distinct value to ongoing efforts related to emergency management, and planning for extreme weather events and climate change and resilience planning;
- The extent to which data regarding industrial and commercial operations was already being considered in ongoing emergency management, and planning for extreme weather events and climate change and resilience planning efforts;
- The nature of technical assistance that is needed for effective use of the generated data, or some version of it, to be integrated into emergency management, and planning for extreme weather events and climate change and resilience planning.

A summary of these engagement efforts is included in Appendix C.

Observations

As a result of the literature review, the researchers proposed different ways to think about the question related to the universe of facilities that were available based on the public and private data. There were several difference that the research team noted in the representation of flood hazards and the commensurate EPA data used to assess potential exposures:

1. There was not a consistent view among Hazard Mitigation Plans at the State or County levels regarding the scope of facilities that should be included to assess hazard exposure for flooding.
2. Popular portrayals of hazardous facilities appeared to focus on displaying the quantity of facilities that are regulated by different environmental programs as opposed to the operating status of the site, thereby identifying the potential to create and build active partnerships for pollution prevention
3. There is conflation of the level of criticality of the facilities, in that there is no consistent view of the term among planning efforts.

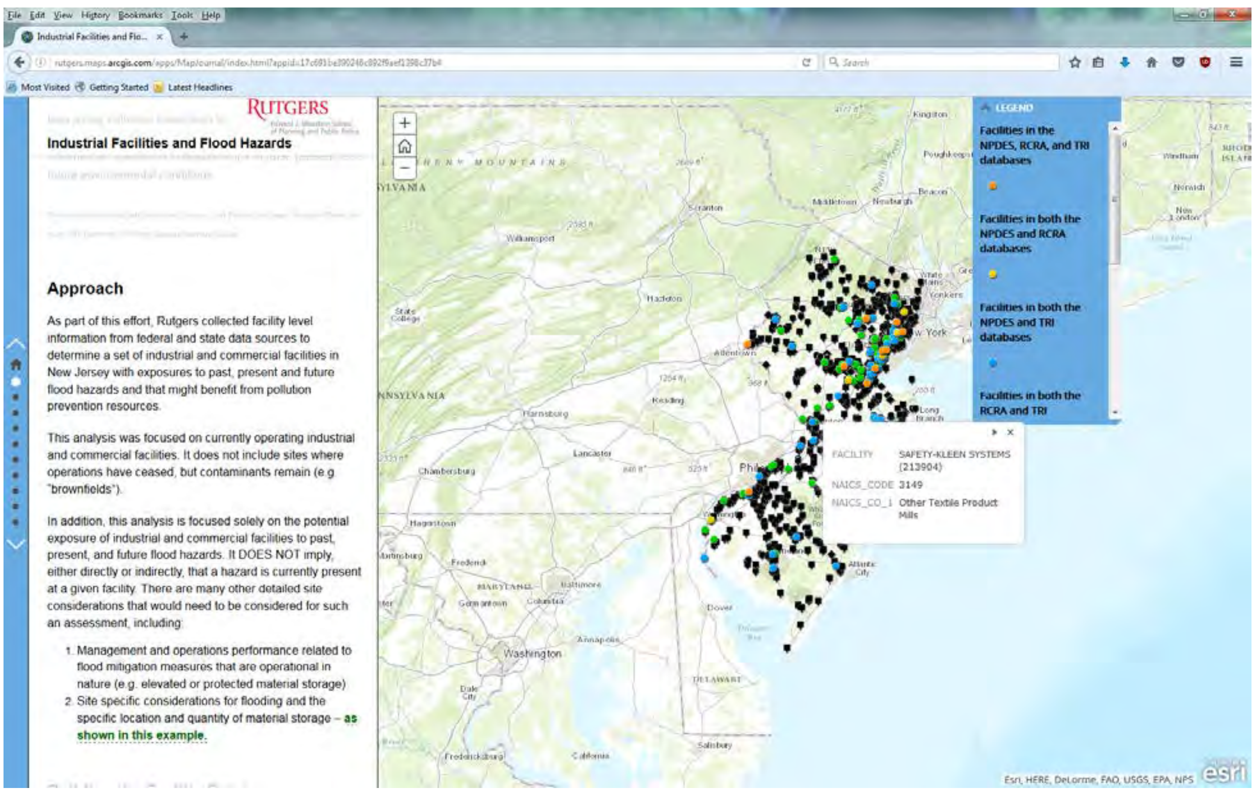

Figure 1: StoryMap depicting facilities with Federal or State Programs for NJ (1,302)

We subsequently developed a data set that would respond to the mandate of the pollution prevention program and would specifically relate to assessing exposure from flood hazards. The goals of compiling the data set were to develop data for active facilities that had not yet been the focus of community outreach efforts and that were potentially not covered under the traditional scope of facilities in the pollution prevent mandate. The resulting analysis and development of the scope of facilities is included in Appendix B and summarized in the Table below.

Table 1: Programs and Facilities Included in the Analysis

	Program Name	Description	Number of Facilities in NJ
Covered Facilities	Toxics Reduction Inventory (TRI) Source: EPA	• Must meet minimum reporting threshold for a limited number of chemicals in specified covered industries (defined by NAICS code) • Releases are estimates, not actual monitored readings	376
	Resource Recovery Act (RCRA) Source: EPA	• Monitoring data for those that handle or transport hazardous materials. • Only "generators" included for this analysis, as opposed to all handlers.	327 174 Matched to TRI
	NJ Toxic Catastrophe Prevention Act (TCPA) Source: NJDEP	• All facilities monitored under state statute for the Toxic Catastrophe Prevention Act. • Locations of Extraordinarily Hazardous Substances (EHS)	48 39 Matched to TRI
	NJ Discharge Prevention Containment and Countermeasure (DPCC) Source: NJDEP	• All facilities monitored under state statute for New Jersey Spill Compensation and Control Act. • Generally, facilities that store 20,000 gallons or more of New Jersey-regulated hazardous substances, excluding petroleum products, or 200,000 gallons of regulated hazardous substances including petroleum products.	252 115 Matched to TRI
	NJ Community Right to Know (RPPR) Source: NJDEP	• All facilities required to report presence of hazardous materials through the state Community Right to Know program through a Release and Pollution Prevention Report (RPPR)	Approx. 10,000 335 Matched to TRI
Additional Facilities	NJ Waster Water Permits (WWP) Source: NJDEP	• All facilities permitted for waste water releases into state water bodies	622 58 Matched to TRI
	National Pollutant Discharge Elimination System (NPDES) Source: EPA	• Federal monitoring reports for facilities permitted to release waste into water bodies	622 All matched to NJ WWP Data

The focal data set for this analysis, consistent with the scope of EPA's pollution prevention program guidelines and the need to identify currently operating industrial and commercial facilities, is the EPA's Toxics Reduction Inventory (TRI). We reviewed facilities identified under the Resource Conservation and Recovery Act (RCRA), New Jersey Toxic Catastrophe Prevention Act (TCPA), New Jersey Discharge Prevention Containment and Countermeasure (DPCC) database, and NJ Right to Know (RPPR) Inventory. Then we added waste water permits based on the recommendations of the interviews in order to create a database that represented active and operating facilities were pollution prevention methods could be useful or beneficial. The table below shows the universe of facilities that were considered for this analysis.

The compilation of the data set above resulted in data that would allow us to link between the different concerns of the stakeholders. We presented initial visualization of the data based on exposure to individual flood hazards and composites of different flood hazards related to past, present, and future flood risks and regulations that present flood risk (See Figure 2).

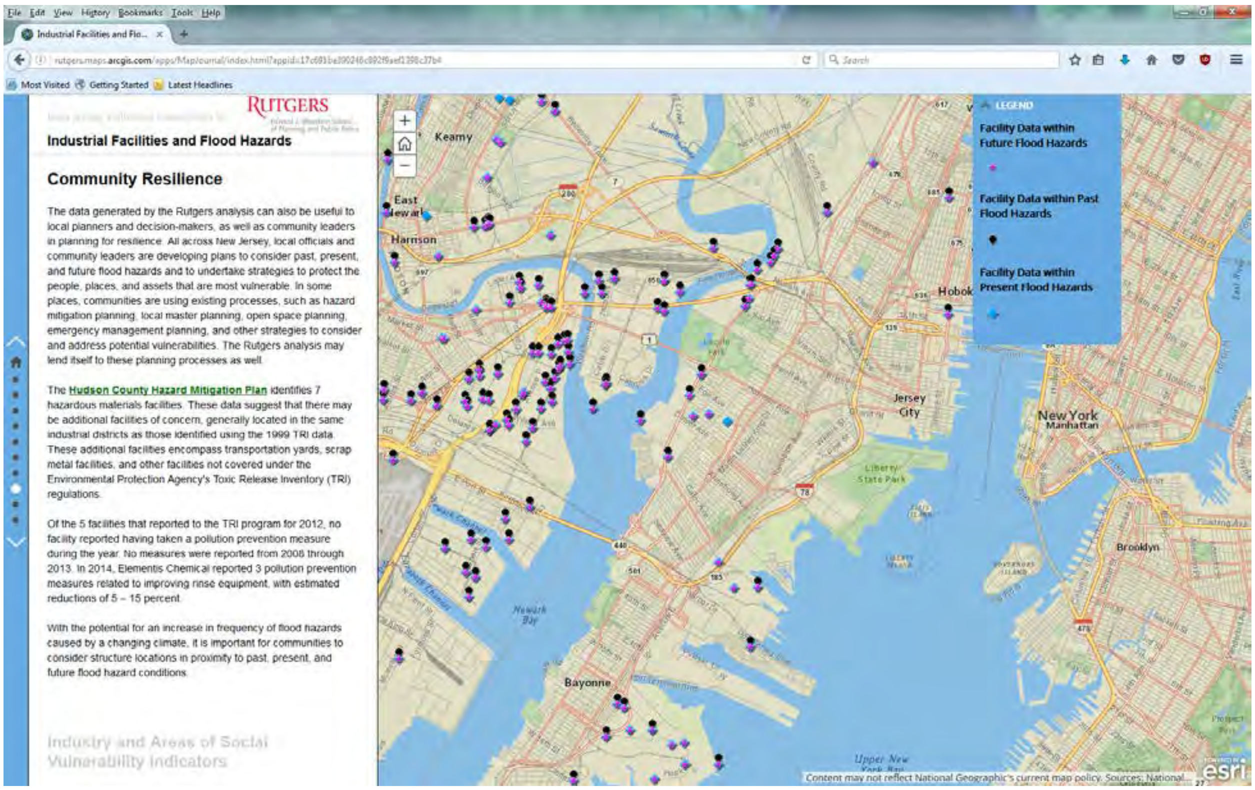

Figure 2: Example of Facilities within Different Temporal Flood Hazard Exposure Layers

Figure 2 demonstrates an important concept that was discussed among the participants in our stakeholder discussions. They perceived that a powerful way to talk about flood risk was related to the capability to discuss impacts from past events and to be able to relate past exposures to current flood zone maps and projected future exposures resulting from sea level rise or changing impacts from coastal storms.

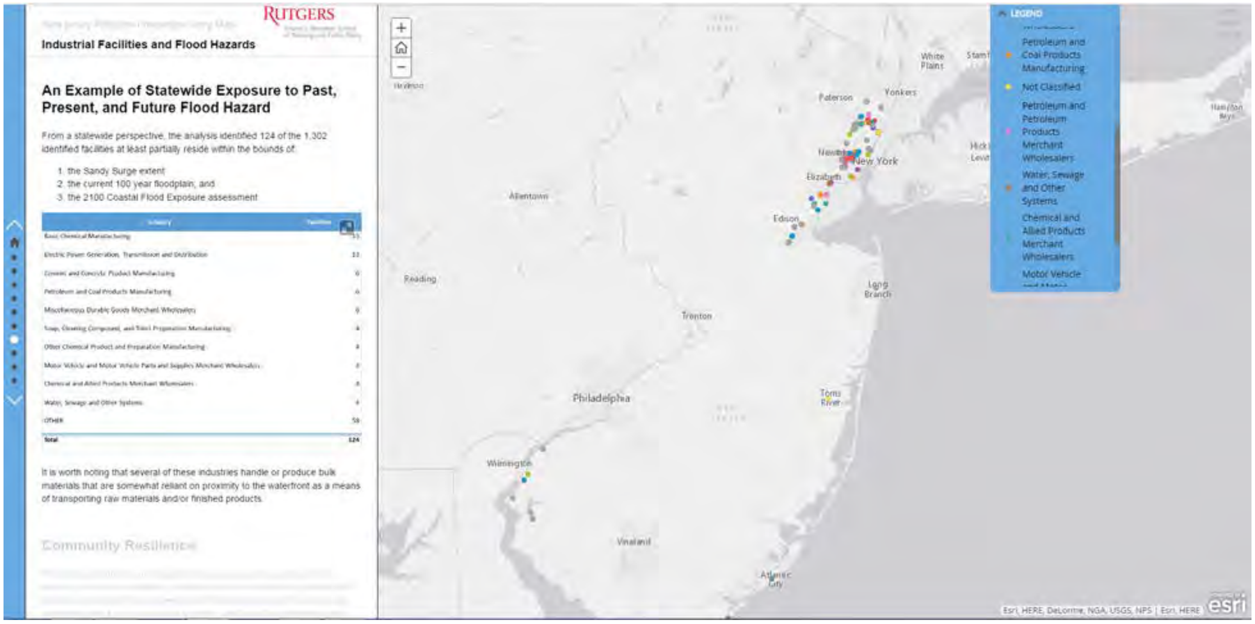

Figure 3: Example of Facilities Classified by Industry within Different Temporal Flood Hazard Exposure Layers

Figure 3 demonstrates another mapping frame that our stakeholders discussed that was applicable at a regional or state level scale. Stakeholders with broader geographic responsibilities felt that it was important to understand the concentrations of industries, if any, for targeting at the regional level.

The Story Map interface provides an interactive way for the user to view and interact with the data while still allowing for additional background and other ancillary information to be provided to enhance the comprehension of the materials by a wider audience. Additionally, the Story Map provides access to other documents (e.g. hazard mitigation plans) for easier reference as well as an assemblage of the outcomes of the analysis that aid in providing a comprehensive view of the extent of the facilities across the state (See Figure 4).

	Program Name	Description	Number of Facilities in NJ
Covered Facilities	Toxics Reduction Inventory (TRI) Source: EPA	• Must meet minimum reporting threshold for a limited number of chemicals in specified covered industries (defined by NAICS code) • Releases are estimates, not actual monitored readings	376
	Resource Recovery Act (RCRA) Source: EPA	• Monitoring data for those that handle or transport hazardous materials. • Only "generators" included for this analysis, as opposed to all handlers.	327 174 Matched to TRI
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Figure 4: The Story Map provides capabilities to link to charts, tables, and documents in addition to maps.

<u>Immediate Applications of Project Outputs</u>

As part of the project outcomes, Rutgers will make this final report and the resultant Story Map available on the two websites of the New Jersey Climate Adaptation Alliance: njadapt.rutgers.edu and www.njadapt.org. With an email list containing more than 1,000 individuals and with more than 45 diverse organizations participating in the Alliance Advisory Committee, it is Rutgers intent to increase awareness about the value of considering the approach and data developed through this project in state, regional and local resilience and adaptation planning.

Additionally, Rutgers intends to seek opportunities to use the data generated under this project to inform place based resilience efforts in which it is involved. For example, additional follow up work with community-based organizations in Newark and with the City of Jersey City are anticipated. Also, a collaborative team at Rutgers is working closely with the New Jersey Coastal Management Program on development of a regional resilience plan in partnership with 15 municipalities in the northern Monmouth County "Two Rivers" region. As part of efforts to assess potential exposures and vulnerabilities posed as a result of current and projected flood hazards within the "Two Rivers" region, Rutgers will offer the data generated as part of this project to inform local planning efforts. Finally, Rutgers hopes to work closely with EPA and other federal agencies and the state Office of Emergency Management to consider effective strategies to integrate the data and methodology developed as a result of this project as part of state and local hazard mitigation planning.

<u>Outcomes and Recommendations</u>

Outcomes and outputs from this project point to the need for a greater focus on integrating consideration of potential hazards posed by the presence of industrial and commercial facilities in flood prone areas into overall planning including emergency management, resilience and climate adaptation planning and hazard mitigation planning. We also heard about the value of a dataset that was formed based on an analytical targeting approach of facilities to narrow down priorities for resilience planning, and technical and compliance assistance. Practitioners that we engaged pointed to the benefits of considering potential industrial and commercial facility exposures from flood hazards as part of planning efforts but a limitation in the availability of tools and data to do so. We heard about the need for delivery of such data to be guided by technical assistance to ensure it is applied in contextually appropriate ways as well as the value of data being assimilated by a "trusted" source.

From its inception, the Rutgers pollution prevention project was challenged in terms of metrics associated with pollution and toxics reduction. The results of the project point to the value of integrating data regarding industrial and commercial facility potential exposures as a result of current and future flood hazards into ongoing state, federal and local planning efforts. The value presented is both as a means to build capacity within those planning efforts to more proactively involve industrial and commercial facilities in hazard mitigation, climate preparedness and resilience planning as well as to provide a vehicle to educate facility operators themselves about the value of risk reduction methods such as pollution prevention.

As discussed elsewhere in this report, over the course of the next 18 months, the Rutgers team will be involved in a variety of projects that provide opportunities to integrate the data developed as a result of the pollution prevention project. Rutgers welcomes the opportunity to work with the U.S. EPA as part of these efforts to track and monitor any impacts of data integration in facility operations, pollution, hazards materials use, and creation of new and meaningful opportunities for direct technical assistance to industrial and commercial facilities.

Other results from the project include increasing awareness about the need for incorporation of specific data regarding industrial and commercial facilities into hazard mitigation, climate adaptation, and resilience planning. Additionally, the project has led to the beginning of a dialogue between the U.S. EPA, Rutgers and statewide environmental groups about strategies to enhance the NGO community's access to data regarding community-based hazards. Outcomes and outputs from this project point to the need for a greater focus on integrating consideration of potential hazards posed by the presence of industrial and commercial facilities in flood prone areas into overall planning including emergency management, resilience and climate adaptation planning and hazard mitigation planning. We also heard about the value of a dataset that was formed based on an analytical targeting approach of facilities to narrow down priorities for resilience planning, and technical and compliance assistance. Practitioners that we engaged pointed to a recognition of the benefits of considering potential industrial and commercial facility exposures from flood hazards as part of planning efforts but a limitation in the availability of tools and data to do so. We heard about the need for delivery of such data to be guided by technical assistance to ensure it is applied in contextually appropriate ways as well as the value of data being assimilated by a "trusted" source.

Outputs from this project include the following:

- An analytical methodology to guide the identification of industrial and commercial facilities that may present exposures as a result of flood hazards and consideration of the proximity of those facilities to population centers;
- A data set generated based on the analytical methodology that has been provided to the U.S. EPA for its own internal planning and programmatic purposes. For example, EPA Region 2 may explore how to integrate the data to inform the agency's "Next Generation" compliance efforts. The data set the data provided allow the user to complete systematic queries that allow for scenario development around past, present, and future flood hazards
- A web-based Story Map that provides the public with access to the results of the analytical method in a format that provides context for the content. The Story Map will be available on the www.njadapt.org platform which has become a standard tool for resilience planning in New Jersey.
- Important insights from the Rutgers engagement of practitioners that can help to inform next steps at EPA and elsewhere about integration of data regarding industrial and commercial facilities in emergency management, climate adaptation, resilience, and hazard mitigation planning.
- Identification of specific opportunities where Rutgers will be working with partners to integrate the data resulting from the pollution prevention project into resilience planning, including: engagement with Jersey City officials, conducting Getting to Resilience (GTR) with several New Jersey cities in partnership with the state Coastal Management Program, and the development of a regional resilience plan with the 15 municipalities in the Two Rivers Region in Monmouth county, New Jersey.
- Several presentations and articles featuring the analytical approach used in the Rutgers pollution prevention project, the resulting data and its value in planning efforts. The method will be presented at the Mid-Atlantic Chapter of URISA (MAC URISA) that is being held in Atlantic City, New Jersey from October 12-14, 2016 and at the Annual Conference for the Association for Collegiate Schools of Planning from November 3-6, 2016.

Based on the activities of the Rutgers pollution prevention project as well as the project team's previous and current involvement in hazard mitigation planning, resilience, environmental planning and community environmental engagement efforts, the following insights and recommendations are offered:

- The Rutgers team clearly heard about the value of data such as those generated under its pollution prevention project and the potential for it to inform various planning efforts including those focused on emergency management, hazard mitigation planning, climate change adaptation and resilience, as well as community capacity building. However, the

Rutgers team also heard a strong need for technical assistance not only in understanding such data but also in applying and deploying data in state and local planning efforts.

- There appears to be strong support for efforts to make data regarding potential exposures of industrial and commercial facilities as a result of flood hazards available and accessible to planners, decision-makers and community leaders. Currently, there is a limited focus on this sector as part of ongoing climate adaptation and resilience planning. More support is needed in additional to guidance and technical assistance from "trusted" sources to identify specific industrial and commercial facilities and operations that may benefit from integration into resilience and climate adaptation planning.
- Some form of assimilation of data to provide the targeting of specific facilities and/or operations provides value to practitioners who may not have the expertise or the resources to undertake such efforts. Practitioners do not necessarily have the expertise or resources to undertake the type of methodological analysis that Rutgers led as part of the pollution prevention project. Such analytical support can facilitate integration and application by practitioners.
- Data such as that generated by Rutgers under the pollution prevention project offers valuable information to inform federal and state agency's own priorities and programming such as compliance assistance, and technical assistance. The U.S. EPA is well positioned to use the Rutgers pollution prevention project-generated data to inform its own programming and to engage other national EPA programs in a dialogue about the value of overlaying current and projected climate data with other data used by the U.S. EPA to set program priorities.
- Within nongovernmental community organizations, there is a strong desire to have greater access to data regarding industrial and commercial facilities and operations including data that relates to flood hazards, community assets, and population centers. Technical assistance is also needed by the NGO community to accurately use data to inform community planning and to aid in capacity building efforts.
- The Hazard Mitigation Planning process seems especially ripe for integration of data regarding industrial and commercial facilities given its proactive role in identification of potential exposures and development of mitigation strategies. The data generated from the Rutgers pollution prevention project provides the U.S. EPA and FEMA an opportunity to undertake pilot projects for use of such data in the Hazard Mitigation Project (HMP) in order to inform future guidance and development of best practices.
- Beyond hazard, resilience, and climate preparedness planning, data regarding potential exposures related to industrial and commercial facilities offers important contributions to overall efforts to plan for and build capacity regarding the health and vitality of communities. Intersected with data such as that presented via EPA's EJSCREEN, the Centers for Disease Control's (CDC) Environmental Public Health Tracking Network, and other tools, data regarding potential exposures of industrial and commercial facilities as a result of flood hazards provide a compelling new perspective. Applying data about potential hazards as a result of changing climate conditions provides an opportunity for an important intersection between community-based resilience and community-based health efforts. The U.S. EPA has a valuable opportunity to apply the data from the

Rutgers pollution prevention project in community based efforts to promote environmentally healthy communities by facilitating consideration of current and future environmental conditions.

Appendix A

Literature Review

New Jersey Industrial and Commercial Facilities in the Face of Climate Change:

Identifying Key Vulnerabilities and Potential Pollution Prevention Opportunities; A Literature Review to inform ongoing project development

Introduction

Climate change is expected to produce future conditions that could threaten industrial and commercial facilities, the communities in which they reside, and the infrastructure on which they depend. The most acute impacts are likely to be related to, or directly caused by, low probability, high intensity weather events. Other potential impacts may be less directly related to extreme weather. Further impacts could be of a more chronic, long-term nature, but not necessarily less important. Measures can be taken to help facilities reduce costs while increasing resilience to these potential events (Galocy, et al., 2000).

This paper discusses potential impacts associated with extreme weather events that could threaten industrial and commercial facilities and/or the communities in which they are located. Other possible impacts are also discussed. Ways to identify vulnerable facilities using publicly accessible data, are described. Some impacts could directly impact the buildings and associated structures, storage areas, and immediate environments of these facilities. Other impacts could be associated with damages to infrastructure on which these facilities depend, such as electricity supply or transportation systems providing critical feedstocks, leading to cascading effects that could be troublesome both economically and environmentally. Corollary impacts on the communities and neighborhoods with which the facilities are directly associated will also be described. Identification of these potential impacts will suggest ways of targeting adaptive measures in a manner analogous to or directly related to typical pollution prevention efforts.

Indirect impacts from either extreme weather events on gradual changes in climate and weather are also discussed. Although some of these impacts are not the sort typically amenable to pollution prevention efforts, some of them, (e.g. replacing feed stocks or supply routes), or modifying processes or the infrastructure on which these processes depend, could be targets for preventative steps resulting from assessments of processes in a manner akin to pollution prevention planning.

It should be noted that, for purposes of this review, certain categories of industrial and commercial operations and facilities have not been included because they are the focus of other climate change impact and adaptation assessment efforts, or are considered likely to have their own internal systems in place to accomplish these assessments. These categories include agricultural operations, hospitals and other health care facilities, utilities, wastewater plants, drinking water plants, landfills, transfer stations, and large, perhaps multinational, industrial and commercial operations.

Expected impacts due to climate change

A number of studies have noted that impacts from climate change will include rising sea levels and associated coastal flooding, greater frequency of extreme precipitation events and associated flooding of both coastal and inland areas, more episodes of extreme heat, and increased frequency of drought (NPCC, 2013), (IPCC, 2014). The ranges of values of these predictions include extremes that could be especially problematic, e.g., there is a 1 in 100 chance that sea level rise in the New York City region could reach 6.9 feet by the year 2100 (Bloomberg, et al., 2014). There is some evidence that impacts from extreme weather events are already increasing globally (Pulhin, et al., 2010). Such damages include those from high winds (Campbell, 2012). There is also evidence that increased numbers of lightning strikes are a factor in some areas (Sander, et al., 2013). Weather and climate-related impacts will augment other existing threats (DOD, 2014).

Impacts on specific facilities and their associated communities will be dependent on geographic, sectoral, and social contexts (Wilbanks, et al., 2007). In this review, types of climate change-related impacts are identified, and the likely effects these could have on industrial and commercial facilities and businesses are discussed. Direct impacts from low probability, high intensity weather events probably present the greatest risk to most facilities. Such weather-related events include flooding, episodes of high heat, droughts and associated water shortages, high winds, and damages to key infrastructure (e.g. electricity supply). Longer-term impacts can stem from extreme weather events as well, but also can include changes in availability of supplies, market demands, and other modifications of business models exacerbated or necessitated by a changing climate.

Damages from flooding

Flooding is widely recognized as a major threat to the New Jersey region (NJCAA, 2014), (NPCC, 2013). Sea level rise projections suggest that existing flood maps are inadequate to characterize the threat in that they do not factor in flood projections based on higher sea levels and do not typically incorporate localized assessments of routes and patterns of storm surges. For this reason, the federal government now requires that federally-funded construction projects should be planned based on the best-available climate science and/or should be designed to withstand flood levels two feet above current projected 100-year flood stages (three feet above for critical buildings), or designed to withstand current projected 500-year floods (Davenport, 2015) (EO, 2015).

A critical threat from flooding is the release of toxic or otherwise dangerous chemicals from chemical use or storage locations that may become inundated by rising waters. Floods are just one reason why dangerous substances might be released from a facility using or storing these substances. Risk Management Plans (RMPs) developed by New Jersey industrial facilities that use extremely hazardous substances (EHS), and the population potentially at risk from a release of an EHS, have been reviewed and a list developed as part of a report on the problem (Patel, et al., 2013). Based on closeness to vulnerable populations, this report states that the most dangerous chemicals are chlorine, hydrofluoric acid, ammonia, hydrochloric acid, ethylene oxide, and titanium tetrachloride. Each of these chemicals has the potential to form a hazardous cloud that could drift downwind. More information on these facilities and a discussion of a general lack of availability of emergency response plans by municipalities and counties to cope with such releases is presented in a further report (McFadden, et al., 2014). A problem with RMPs, however, is that they do not necessarily include all chemicals that present significant risks. For example, failure to include the reactive chemical ammonium nitrate led to a recent serious accident in Texas (Orum, 2013). In addition to facilities that use EHS, facilities that store relatively large quantities of any toxic release inventory (TRI) chemical or that either treat on-site or ship off-site relatively large quantities of such chemicals, or other hazardous wastes, could be vulnerable to flooding. Publicly accessible resources useful for targeting those facilities vulnerable to chemical accidents related to flooding are presented in the Appendix of this report. Additional information that could be useful in identifying specific processes or other facility-specific details that might suggest vulnerability to floods, might be gleaned from reports submitted pursuant to NJDEP's Release and Pollution Prevention Reporting Program (NJDEP, 2015).These reports contain a wealth of information that might be able to shed light on aspects of facility operations that are not available simply by looking at reported releases, such as the presence of exothermic processes that likely require large flows of continuous electricity for cooling and could become unstable if power were lost due to a storm event..

Releases of toxic or otherwise dangerous chemicals listed in the TRI or considered to be EHS are not the only problems resulting from direct impacts of flooding. In the aftermath of Hurricane Katrina in 2005, flood waters were found to have levels of bacteria ten times higher than acceptable levels for sewage and to be high in lead (UGC, 2014). It is possible that the high lead levels in flood waters stemmed from the typically high lead levels in urban soils and dust, a legacy of use of lead in paint and in gasoline. In the flood caused by Hurricane Sandy, spills of fuel oils and gasoline caused serious problems, including damages to sensitive coastal ecosystems and wildlife (NJ.com, 2012). Because fuel oils and gasoline are ubiquitous, storage of these substances in flood-prone spots should be included as a criterion for targeting industrial and commercial facilities for efforts to prevent pollution resulting from flooding. The importance of flood-proofing chemicals, processes, and/or operations, or being prepared to relocate assets in advance of a flood, is the subject of a recent recommendation (UGC, 2014a). This report cataloged a variety of flood-proofing measures including raising fire-protection equipment, critical telecommunications equipment, and toxic materials above likely flood levels, and installing valves on sewer lines to prevent back-up of wastewater during flood conditions.

In addition to releases of problematic substances, flooding can damage structures or make buildings unusable due to water damage or accumulation of debris. Other cascading effects due to flooding could include impacts on workers and their ability to perform both their routine work tasks and special efforts that could be called for in flooding situations.

Identifying populations vulnerable to flooding is the subject of a recent report (Bickers, 2014). Floods can also damage critical infrastructure on which facilities depend, potentially leading to many problems (see discussion on infrastructure below). Therefore, for a variety of reasons, assessment of the location of a facility relative to probable flood levels, and the degree to which flood risks have been taken into account in that facility's resilience planning, should be a key factor in targeting facilities for pollution prevention assistance.

Damages from High Heat Episodes, Droughts, and High Winds

Human health impacts from episodes of high heat are among the predicted impacts of climate change. Therefore, heat stress on workers and other individuals important to facility operations should be considered as potentially serious impacts. Particularly susceptible would be facilities with a significant number of workers involved in outdoor work (Bloomberg, et al., 2014), and those with workers in areas likely to be hit especially hard by episodes of heat stress, including low-income areas that may have, for example, less access to air conditioning (Wilbanks, et al., 2007). High heat episodes will also stress cooling and refrigeration systems. In the European heat wave of 2003, for example, the cold-storage systems of 25% to 30% of food-related establishments proved to be inadequate (Wilbanks, et al., 2007). Droughts could be severe enough to lead to shortages of agricultural products, which could affect facilities that process food or are involved in food services. Water shortages stemming from droughts also could impact facilities that are dependent on high inputs of water. Such high inputs could be necessary for on-site energy production systems, or for other processes such as metal plating, or washing and cleaning. Identification of facilities that have relatively high flows of wastewater could be useful in targeting. Facilities in locations that could be exposed to high winds would also be vulnerable to this variety of extreme weather. To the extent that reports of wind damages in certain neighborhoods are available, facilities in such locations could be targeted.

Damages to Critical Infrastructure

Floods, high heat episodes, droughts, and high winds, some of which could act in concert, all have the capability of doing significant damage to critical infrastructure (NJCAA, 2013), (Gibbs, et al., 2013), (IPCC, 1995), (USEPA, 2013). No industrial or commercial facility operates independently; all are dependent on and operate in conjunction with the communities in which they reside (Shaw, 2012). Climate change-related damages could cascade across infrastructures (Wilbanks, et al., 2012a) especially when these infrastructures are subject to multiple stressors, e.g. high heat coupled with flooding and high winds. Especially vulnerable are infrastructure near coasts and rivers, and those already stressed by age or demand levels higher than those for which they were designed (Wilbanks, et al., 2012a). The disabling or complete failure of infrastructure(s) on which a facility depends could lead to emergency situations for facilities and the communities in which they operate that could be no less threatening than the other damages discussed above. Unfortunately, there do not appear to be publicly-available data that can provide an aggregated picture of the degree to which facilities are dependent on infrastructure in ways that could be either critical to their businesses or that could potentially lead to emergent conditions that could threaten the neighborhoods in which the facilities operate.

However, associations with, nearness to, or vulnerabilities from, important infrastructures can doubtless be inferred for some facilities by comparing what is known about a facility's location and activities with critical infrastructure. Infrastructure that can be considered critical have been identified and are listed in Table 1 below (ASCE, 2013), (PPD-21, 2013), (FEMA, 2009).

Table 1: Infrastructure Potentially Critical to Industrial and Commercial Facilities

Airports
Bridges
Communications systems
Dams
Drinking water supply systems
Energy supply and distribution systems, including electricity, natural gas, and liquid fuels
Hazardous waste transport and disposal systems
Inland waterways
Levees, seawalls
Other facilities providing crucial feed stocks, etc.
Ports
Public transit systems
Railroads
Roads
Solid waste transport and disposal systems
Wastewater systems

Loss of electric power

Of these infrastructures, the most critical for many facilities is likely the system that supplies them with continuous, high-quality electricity. There is little doubt that climate change will put increased stresses on suppliers of electricity. These stresses could lead to increased frequency of power outages (Finley, et al., 2011), (Campbell, 2012), (Wilbanks, 2012). These power outages could be due to high heat episodes leading to spikes in demand, high winds and extreme weather events such as ice storms causing disruption of transmission lines, and shortages of cooling water due to droughts. In recent years industrial and commercial facilities and society in general have become increasingly dependent on continuous electric power (CRO, 2011). Three to six hours without electricity is typically enough to cause most gas stations and refineries to shut down, and aluminum melting furnaces can be expected to suffer irreversible physical damage after four or five hours without power (CRO, 2011). Even drops in voltage (i.e. "brownouts") can affect operations that depend on accurately synchronized production processes, e.g. paper manufacturing facilities (CRO, 2011). Facilities that depend on cooling systems, including food storage, food processing, and the various food service industries and operations are vulnerable to even short durations without power. It is not hard to imagine that some facilities could face emergencies due to loss of cooling due to loss of electric power that could threaten not only their own business but adjacent areas as well. For example, facilities with strongly exothermic processes that have to be continuously cooled to avoid disruption could quickly face an emergency if they do not have sufficient back-up power.

Damages to "linkage infrastructure"

A weather-related accident, e.g., a bridge washing out due to flooding or damage to electricity transmission lines due to high winds, could damage critical infrastructure that links facilities to supplies, markets, and waste disposal systems. In addition to electricity supply as discussed above, other critical supplies include natural gas, liquid fuels, and in some instances coal. For example, with Hurricane Sandy, a pipeline that supplies approximately 15% of the East Coast's gasoline, diesel fuel and fuel oil lost electric power to pumping equipment and was idled (Reuters, 2012). Other important linkage infrastructures include airports, bridges, ports, roads, railroads, and wastewater systems. Another multi-faceted linkage system, communications, could be threatened directly by storm-related damages (e.g., high winds) and threatened indirectly by loss of electric power and could also be critical for some facilities.

Indirect impacts

Indirect impacts, while not likely to pose immediate risks to facilities or their environs, could nevertheless be important and be subject to planning measures consistent with pollution prevention approaches, such as replacements of problematic materials or processes. These indirect impacts could be those resulting from changes in demands and supplies that emerge as the climate changes, such as availabilities of certain agricultural or forest commodities, fisheries, and energy supplies. Companies involved in tourism could also experience significant indirect impacts to their businesses. Companies will typically want to protect not only their physical plants and local operations but also to protect their "value chain," which consists of their suppliers and customers (CSR, 2011). Although generalizations carry with them significant uncertainty, it can be expected that companies with high-tech or otherwise specialized facilities might focus mostly on direct risks from climate change, whereas companies reliant on international supply or marketing chains might be more interested in focusing on indirect impacts (CDP, 2012). Beyond direct business impacts, companies will need to understand how climate change will affect their most vulnerable stakeholders—the poor, citizens of developing countries, and women—who will become more at risk to drought, disease vectors, and the perils of migration (BSR, 2015). Companies could also be subject to increased liabilities due to climate change, for example if at some point culpability is assigned to manufacturers of products that are associated with greenhouse gas emissions (Exponent, 2010).

Other aspects of facilities relevant to assessing both vulnerabilities and prospects of adaptive responses

In addition to the factors such as location and types of chemicals used discussed above, other characteristics of facilities and firms could be useful in identifying those which might be either more vulnerable to climate change impacts or more likely to undertake proactive adaptive responses. These characteristics could be useful in targeting facilities likely to benefit most from pollution prevention outreach efforts.

These characteristics include the degree to which a facility is involved in an industry-wide network. For example, Bui, et al. ((Bui, et al., 2012) found that "information spillover," i.e., dissemination of information obtained by one facility to other similar facilities in its network is frequently effective in developing pollution prevention, regardless of geographic proximity.

Zhu, et al. ((Zhu, et al., 2013) found that the degree to which a facility is inter-connected to other facilities, e.g. with supply chains, energy use, or disposal systems, can influence resilience in the face of disruptions. Interconnected facilities, while they may be more efficient from an environmental or energy perspective, may be less resilient in the face of disruptions because of cascading effects. The same researchers (Zhu, et al., 2014) also found that government-sponsored pollution prevention outreach can be useful in helping facilities develop more mutually beneficial industrial symbioses but that more should be done.

Past performance of a facility regarding pollution prevention could also be important. Harrington (Harrington, 2012) found that facilities with a history of pollution prevention efforts are more likely to take additional pollution prevention steps than facilities without such history. This finding suggests that reviewing chemical and hazardous waste release data and/or pollution prevention plans to identify facilities that have made significant progress in toxics use and release reduction might help in identifying facilities most likely to take steps to adapt to climate change impacts.

Risks of maladaptive responses

Regardless of the types of impacts or the strategies implemented to adapt to them, companies should strive to avoid maladaptive measures. Such measures could include, as an example, measures that a) increase greenhouse gas emissions, b) impart increased risks to vulnerable groups, c) are particularly expensive, d) that reduce incentives for further actions (e.g. desalinization projects or impoundments to increase water supplies), or e) limit choices for future generations (CSR, 2011).

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Attachment: Data Sources for Targeting Facilities Vulnerable to Chemical Accidents Related to Floods		
Name	URL	Comments
Discharge Prevention, Containment, and Countermeasure (DPCC) plans	n/a	DPCC plans show facilities with relatively large storages of problematic substances. These plans are protected pursuant to the Homeland Security program but should be available internally to EPA.
Risk management plans (RMPs)	n/a	Prepared and updated every five years pursuant to the Toxic Catastrophe Prevention Act (TCPA), these plans likely include information relevant to impacts from climate change. Quantities of chemicals and locations are protected pursuant to the Homeland Security program but should be available internally to EPA.
Spill and other chemical release incidents	http://www.nrc.uscg.mil/	U.S. Coast Guard National Response Center database of oil spills, chemical releases & maritime security incidents, organized by calendar year (CY). Spreadsheets representing each CY can be downloaded and searched for NJ incidents and details indicating potentially problematic facilities.
Toxic and reactive highly hazardous chemicals	https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=9761&p_table=standards	U.S. Dept. Labor, OSHA, list of chemicals that are reactive or toxic and threshold quantities. List could be searched by CAS # and compared with facility data from TRI database.
Extraordinarily hazardous substances	http://www.nj.gov/dep/opppc/crtk/andyrppr/RPPR%20Appendix%202005%20F-4%20TCPA%20EHSs.pdf	This 2005 report includes a list of the TCPA extraordinarily hazardous substances as released by facilities covered by DEP's Release and Pollution Prevention Program.
Toxic release inventory (EPA TRI)	http://www2.epa.gov/toxics-release-inventory-tri-program/tri-data-and-tools	Several search systems can be found at this site that provide access to data submitted pursuant to the Toxics Release Inventory, Form R. These systems include TRI Explorer, Envirofacts, myRTK, and TRI.NET. See specific search program descriptions below. Within the TRI data, particularly useful for purposes of identifying facilities vulnerable to chemical spills, etc. from floods, in addition to the location of the facility within a flood zone, are likely to be Part II sections 4.1 (maximum amount of chemical on-site at any time), sections 5.4 through 5.5, which include data on quantities of chemicals

		disposed of on-site, and section 6.2, which includes quantities of chemicals shipped off-site for disposal. Large quantities reported in sections 4.1 and 5.4 through 5.5 could indicate large quantities stored in locations vulnerable to floods. Large quantities reported in 6.2 could suggest vulnerability to transportation-related mishaps resulting from floods.
TRI Explorer (via EPA TRI)	http://iaspub.epa.gov/triexplorer/tri_text.background	According to the site, The TRI Explorer will generate four types of reports: State Fact Sheets - TRI data summarized from 2002 for an individual state or for the entire US; Release Reports - including on- and off-site releases (i.e., off-site releases include transfers off-site to disposal and metals and metal compounds transferred to Publicly Owned Treatment Works (POTWs); Waste Transfer Reports - including amounts transferred off-site for further waste management but not including transfers off-site to disposal; and Waste Quantity Reports - including amounts recycled, burned for energy recovery, quantities treated, and quantities disposed of or otherwise released on- and off-site.
Envirofacts (via EPA TRI)	http://www.epa.gov/enviro/facts/tri/search.html	According to the site, it allows access to basic facility information, all forms submitted to EPA since 1987, aggregate chemical release data for all years reported, and relative risk information. The results display any facility that has reported from 1987 to present, even though the facility may or may not have submitted TRI data in the most recent reporting year. The last year of data displayed represents the last year TRI data was reported. The Envirofacts platform allows searches of other EPA data besides TRI. See separate entry below.

myRTK (via EPA TRI)	http://www2.epa.gov/toxics-release-inventory-tri-program/my-right-know-application	myRTK allows geographic searches based on an online map for facilities that either submitted a TRI report in 2013 or that are covered under other federal environmental permitting programs and are believed to release or handle TRI chemicals in some manner. It provides information on quantities of chemicals released or otherwise managed and compliance history.
TRI.NET (via EPA TRI)	http://www2.epa.gov/toxics-release-inventory-tri-program/trinet	TRI.NET seems to be EPA's most powerful search tool for TRI data. With the application that can be downloaded, one can "select, sort and filter TRI data. You can combine TRI with other data sources, display your results on a map, and export your results into other applications for further analysis." As noted above in the initial Toxics Release Inventory row, certain data elements from Form R are likely to be especially useful in targeting facilities vulnerable to chemical accidents resulting from floods.
DEP data miner (DEP_DM)	http://www.nj.gov/dep/opra/online.html	Although there is a large amount of data available via this site, data that appear useful for targeting facilities that are vulnerable to extreme weather events, such as quantities of reactive chemicals stored on site, or operations for which a power failure could cause an emergency that could lead to a release of hazardous substances or other serious problem, can be found only with a facility-by-facility search. Some of the databases that could be searched for specific facilities and yield potentially useful information are listed separately below.
Community Right to Know (via DEP_DM)	http://datamine2.state.nj.us/dep/DEP_OPRA/index2.html#ctrk	As stated on the website, "due to domestic security concerns, reports must be generated one facility at a time, and in order to generate a report the facility name and street address must be entered as it appears in the program database." The menu selections "Access the Community Right to Know Reports" and "CRTK General Facility Information" lead to a menu which permits identifying a specific facility's name and street address.

DEP regulated facilities (via DEP_DM)	http://datamine2.state.nj.us/DEP_OPRA/OpraMain/categories?category=DEP+Regulated+Facilities	The DEP regulated facilities database allows one to identify the program interest (PI) of specific facilities. The latter can be identified by name or part of a name. The site claims that facilities can also be found by location, but this aspect of the search mechanism does not work well.
Hazardous waste manifests by waste code (via DEP_DM)	http://datamine2.state.nj.us/DEP_OPRA/OpraMain/get_long_report?	Hazardous waste shipments by waste code and date range can be identified. Available data include generating facility, transporter, disposal facility, and quantity. Any hazardous waste can be problematic; hazardous waste with code D001 (ignitability), D002 (corrosivity), D003 (reactivity), D004 (toxicity), or any of the P-series listed wastes (acutely hazardous) could be especially problematic.
DEP Cleanups? Site remediation?		
Hazardous waste codes	https://www.des.umd.edu/hw/rest/manual/codes.html	List of hazardous waste codes and what they represent.
EPA Envirofacts (main site)	http://www.epa.gov/enviro/index.html	Envirofacts permits searches of a number of EPA databases. It is similar in scope to DEP's dataminer, and like that is oriented towards a facility-by-facility approach. It is more user-friendly however. Of greatest potential value are searches of TRI data, as discussed above and RCRA data (see entry below).
RCRA information (via EPA Envirofacts)	http://www.epa.gov/enviro/facts/rcrainfo/search.html	RCRA information can be searched for facilities that have waste management processes that could be vulnerable to floods. These include disposal, storage and treatment processes that include the words "landfill," "land application," "surface impoundment," "waste pile," and "drip pad." The search engine will return a variety of facility-specific information, and will also produce a map showing the facility of interest and neighboring facilities. It will also produce a CSV spreadsheet file that includes all facilities that meet the selection criteria within the selected municipality.

RTK NET	http://www.rtknet.org/	This potentially very useful site provides data from EPA databases including TRI (toxic releases, etc.), RMP (risk management plans prepared by facilities using large amounts of extremely hazardous substances), ERNS (spills and accidents reported to the National Response Center), and BRS (biennial reporting system; data on the generation, shipment, and receipt of hazardous waste). The site is user-friendly and can access data using a wide variety of sorting and organizing criteria. Output detail levels can be varied and could readily be used to identify facilities in specific regions (e.g. flood zones) that are handling hazardous materials, storing wastes, etc. It will produce reports in tab- or comma-delimited ASCII, XML, and text (HTML) format.
Geoweb	http://www.state.nj.us/dep/gis/geowebsplash.htm	This site is NJDEP's public GIS site. It will produce maps with numerous data layers. Some of these could be useful in identifying, for example, known contaminated sites and chromate waste sites in flood zones. The site does not appear useful for a first cut in identifying industrial facilities based on site-specific criteria such as presence of significant quantities of hazardous substances in risk-prone locations. However, it will map all NJEMS sites (sites regulated by NJDEP under one or more regulatory permitting or enforcement programs, or sites that are otherwise of some interest to a NJDEP program). It will provide additional information, including address and NJSPC data for a selected site within a selected data layer, and will produce a CSV format report with the retrieved information. It could thus be used in conjunction with other data sources identified herein to provide details useful for other GIS applications.
NJDEP Release and Pollution Prevention Reports (RPPRs)	n/a	These reports, which are prepared by facilities that meet essentially the same reporting requirements as those that must prepare TRI reports, contain information on facility processes that could be used to identify processes or other situations (e.g. storage) that are at risk from climate change-related impacts in addition to floods, such as power outages. Especially useful could be chemical throughput, storage, and process-specific information found in sections B, C, and D of these reports. Unfortunately, these reports are not available on-line. Individual reports for specific facilities would have to be obtained via an OPRA request.

Appendix B

Geospatial Methodology

(Full data documentation provided to the U.S. EPA on February 1,2016)

General Approach

Rutgers collected facility level information from federal and state data sources to determine a set of industrial and commercial facilities in New Jersey with exposures to past, present and future flood hazards and that might benefit from pollution prevention resources. This analysis was focused on currently operating industrial and commercial facilities. It does not include sites where operations have ceased, but contaminants remain (e.g. “brownfields”). The purpose of compiling these data was to be able to target active operations. In addition, the research team looked to target a "manageable" number of facilities for EPA. Hence, the data compilation is developed around the TRI data set, supplemented my other federal and state data sets. Figure B1 describes the processing and reconciliation of the various facilities under the different programs to develop a database of 1,302 facilities of interest.

In addition, this analysis is focused solely on the potential exposure of industrial and commercial facilities to past, present, and future flood hazards. It DOES NOT imply, either directly or indirectly, that a hazard is currently present at a given facility. Figure B2 illustrates that there are many other detailed site considerations that would need to be considered for such an assessment, including:

1. Management and operations performance related to flood mitigation measures that are operational in nature (e.g. elevated or protected material storage)
2. Site specific considerations for flooding and the specific location and quantity of material storage – as shown in the example below.

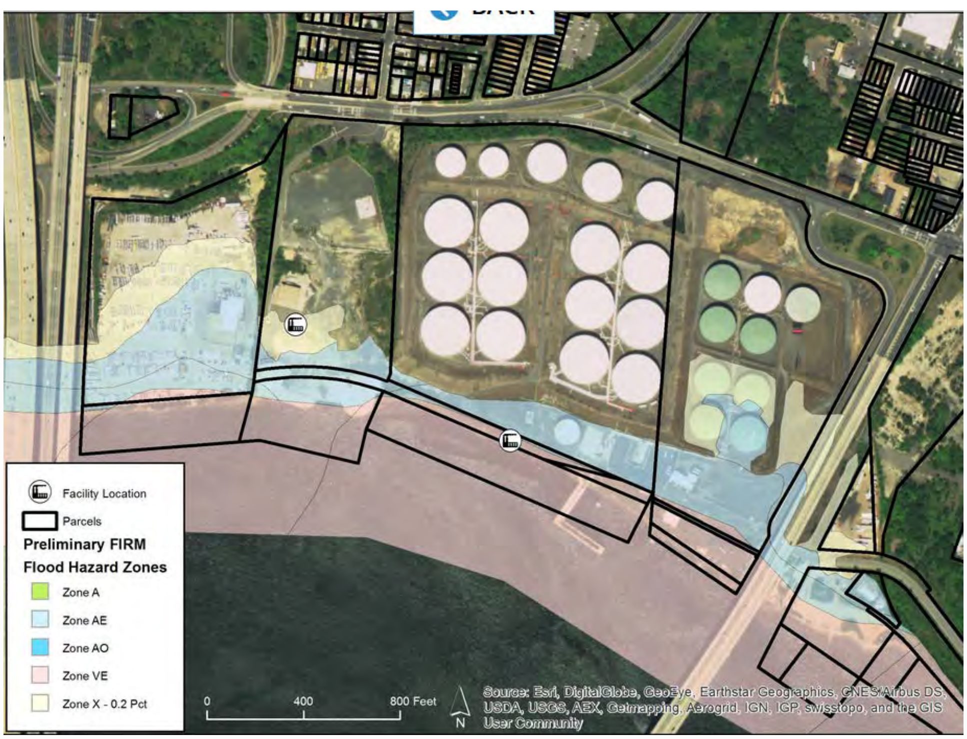

Figure B2: Example of Flood Hazard Exposure Assessment

As displayed in Figure B1, the focal data set for this analysis, consistent with the scope of EPA's pollution prevention program guidelines and the need to identify currently operating industrial and commercial facilities, is the EPA's Toxics Reduction Inventory (TRI). However, there are other facilities that are not covered under the program that may nonetheless benefit from information on leading practices for pollution prevention. These include facilities regulated under additional federal and state regulations in conjunction with, or independent from the federal pollution prevention program. We reviewed facilities identified under the Resource Conservation and Recovery Act (RCRA), New Jersey Toxic Catastrophe Prevention Act (TCPA), New Jersey Discharge Prevention Containment and Countermeasure (DPCC) database, and NJ Right to Know (RPPR) Inventory. The table below shows the universe of covered facilities that were considered for this analysis.

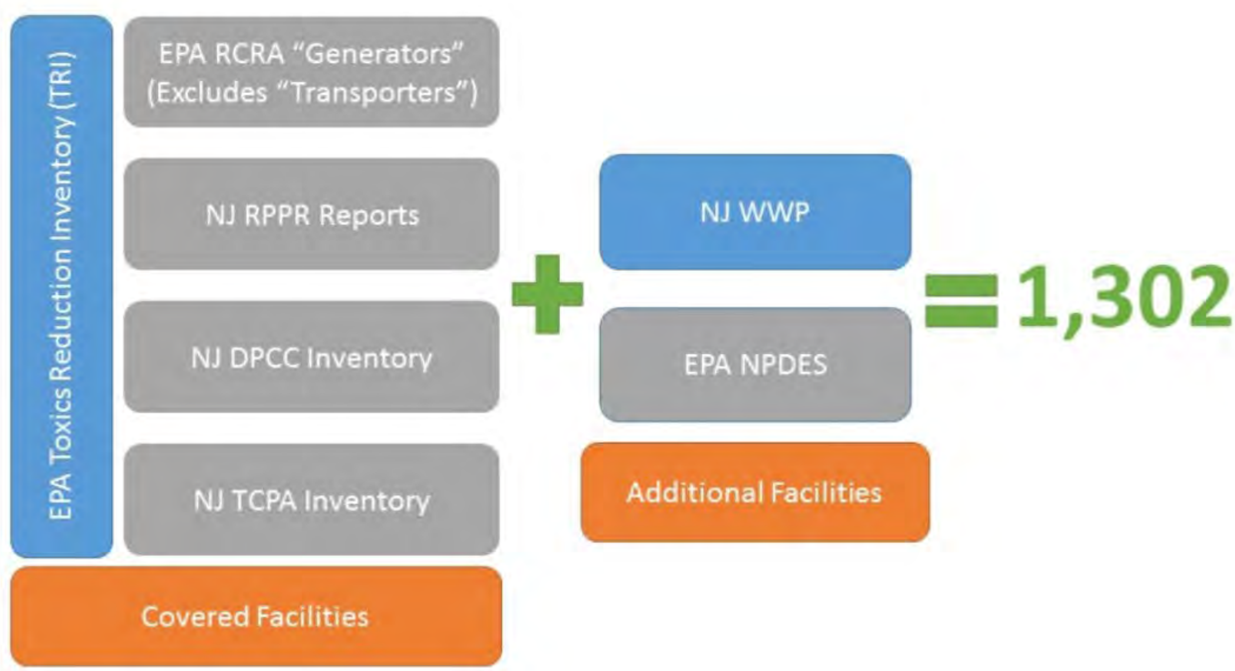

Figure B1: Data Compilation Method

Table 1 displays the results of the data compilation and sources in detail. In addition to those facilities included in traditional environmental pollution prevention programs, we also reviewed added waste water permit data on the recommendations of the interviews in order to create a database that represented active and operating facilities were pollution prevention methods could be useful or beneficial. The team incorporated data from the NJ Waste Water Permit database and supplemented those data with information from the Clean Water Act (CWA) National Pollutant Discharge Elimination System (NPDES) data. These additional data resulted in the addition of over 500 additional facilities that represent businesses in industry sectors that are not covered under the TRI program (e.g. transportation services, scrap metal yards, etc.).

The water permit data captures other facilities of concern in non-covered sectors, such as transportation terminals and other similar places where materials might be stored, but not "processed". However, there may still be gaps in the data for industries not covered under any of the programs above, such as retail establishments with large inventories of paints and cleaners, or large commercial buildings that might be using regulated materials for their building operations (HVAC), etc. However, stakeholders perceived that the data were helpful in identifying clusters or neighborhoods of facilities where one could target the development of collaborative efforts between the businesses, introduce trainings for local businesses, or highlight other methods that would allow for spillovers between sectors, regardless of their program coverage under pollution prevention laws.

Also note that there are over 10,000 facilities that are required to report under the New Jersey "Right to Know" guidance. This analysis reduces the number of facilities to a more manageable number of facilities for specifically understanding a scope of mid-tier manufacturing facilities that are not typically covered through pollution prevention efforts available to small retail establishments, or large high risk facilities. While there is some overlap, the purpose of this specific analysis was to identify alternative methods to target and identify businesses that might not be included under pollution prevention programs.

Table 1: Programs and Facilities Included in the Analysis

	Program Name	**Description**	**Number of Facilities in NJ**
Covered Facilities	Toxics Reduction Inventory (TRI) Source: EPA	• Must meet minimum reporting threshold for a limited number of chemicals in specified covered industries (defined by NAICS code) • Releases are estimates, not actual monitored readings	376
	Resource Recovery Act (RCRA) Source: EPA	• Monitoring data for those that handle or transport hazardous materials. • Only "generators" included for this analysis, as opposed to all handlers.	327 174 Matched to TRI
	NJ Toxic Catastrophe Prevention Act (TCPA) Source: NJDEP	• All facilities monitored under state statute for the Toxic Catastrophe Prevention Act. • Locations of Extraordinarily Hazardous Substances (EHS)	48 39 Matched to TRI
	NJ Discharge Prevention Containment and Countermeasure (DPCC) Source: NJDEP	• All facilities monitored under state statute for New Jersey Spill Compensation and Control Act. • Generally, facilities that store 20,000 gallons or more of New Jersey-regulated hazardous substances, excluding petroleum products, or 200,000 gallons of regulated hazardous substances including petroleum products.	252 115 Matched to TRI

	NJ Community Right to Know (RPPR) Source: NJDEP	• All facilities required to report presence of hazardous materials through the state Community Right to Know program through a Release and Pollution Prevention Report (RPPR)	Approx. 10,000 335 Matched to TRI
Additional Facilities	NJ Waster Water Permits (WWP) Source: NJDEP	• All facilities permitted for waste water releases into state water bodies	622 58 Matched to TRI
	National Pollutant Discharge Elimination System (NPDES) Source: EPA	• Federal monitoring reports for facilities permitted to release waste into water bodies	622 All matched to NJ WWP Data

Flood Hazard Data

The data Rutgers used pertaining to flood hazards reflect past, present, and projected future environmental conditions. The data used for this analysis were from publicly accessible federal sources (i.e. FEMA and NOAA) with the exception of the use of the coastal flood exposure data developed by the Center for Remote Sensing and Spatial Analysis at Rutgers University.

	Data Used	Data Source	Description
Past	• Hurricane Irene storm surge • Superstorm Sandy storm surge	• FEMA – MOTF • FEMA	• Provided from FEMA to Rutgers CRSSA. • The Sandy Surge data were created from field-verified High Water Marks (HWMs) and Storm Surge Sensor data from the USGS through 14-February 2013. HWMs and Surge Sensor data are used to interpolate a water surface elevation, then subtracted from the best available DEM, to create a depth grid and surge boundary by state. (description text source: FEMA MOTF website)
Present	• FEMA Preliminary Flood Insurance Rate Maps (PFIRMs) • FEMA Q3 100 year flood plain • Coastal Flood Exposure - Current	• FEMA • FEMA • Rutgers CRSSA	• Digital FEMA flood data. The data represent the digital riverine and coastal flood zones available as of 2014 and are the recently released Preliminary Flood Insurance Rate Maps. • The Q3 flood layer was FEMA's first foray into providing a GIS data product for the **National Flood Insurance Program (NFIP)** *Flood Insurance Rate Maps (FIRMs).* They were produced between 1996 and 2000. They were produced using heads-up digitizing from paper maps and distorted to approximate real world geography. This data was included to capture areas of the state where the new PFIRMS did not cover. • Data shows a ranking (Moderate, High, and Extreme) of coastal flooding exposure for present day (representative of 2000). SLR projections are not included as part of this analysis.
Future	• Coastal Flood Exposure – 2050, 2100 • SLOSH Category 1-3 • Sea Level Rise 1-6 feet	• Rutgers CRSSA • NOAA • NOAA	• Data shows a ranking (Moderate, High, and Extreme) of coastal flooding exposure for the years 2050 & 2100. SLR projections are included as part of this analysis. • Data were derived from storm surge inundation maps. These maps represent maximum of maximum (MOM) outputs from Sea, Lake, and Overland Surges from Hurricanes (SLOSH) modeling of hurricane scenarios for hurricane evacuation studies. The storm surge data do not account for sea level rise. Source: Federal Emergency Management Agency, U.S. Army Corps of Engineers, NOAA. • Sea level rise inundation scenarios ranging from 0 to 6 feet above mean higher high water (MHHW). Derived from data created for the NOAA Sea Level Rise and Coastal Flooding Impacts Viewer and NJ Floodmapper.

Analysis Outcomes: Past

Rutgers overlaid the information of the 1,302 New Jersey facilities that were present in the analysis with past, present, and future flood hazard conditions described in the last section. From a statewide perspective, the results of the analysis with the past flood hazards pointed to the following observation:

267 of the 1,302 facilities were located in areas inundated by previous storm events (i.e. Past). Rutgers examined the two major storms that impacted New Jersey in recent years, Hurricane Irene (August 28, 2011) and Superstorm Sandy (October 29, 2012). Both storms caused major damage and destruction and impacts were felt across the State for both storms.

The facilities were analyzed independent of one another so that the data produced from the analysis can be queried for specific storm events and can be combined with other data to build scenarios as an aid for resilience planning efforts. Zeros and ones are used within the data attributes to help signify the presence (i.e. 1) or absence (i.e. 0) of a facility within a flood hazard.

Analysis Outcomes: Present

Of the 1,302 New Jersey facilities that remained from the analysis with past, present, and future flood hazard conditions the following observations were found from the present flood hazard data:

1,099 of the 1,302 facilities are located in a flood hazard of concern in present day. Again, these flood hazards included the FEMA 100 year floodplain as well as the Preliminary Flood Insurance Rate Map zones. The additional flood hazard layer for this category included the Coastal Flood Exposure hazard layer representing the year 2000 or also called "current" or "present day". For more information about each of the flood hazards used in this category, please refer back to the Flood Hazard Data Story Map frame.

Analysis Outcomes: Future

Of the 1,302 New Jersey facilities that remained from the analysis with past, present, and future flood hazard conditions the following observations were found from examining the future flood hazard data:

502 of the 1,302 facilities are potentially located in an area of a future flood hazard. The flood hazards examined for future conditions included the NOAA SLOSH models (also known as the category 1-3 hurricane storm surge models), NOAA's sea level rise data from 1ft to 6ft, and the Coastal Flood Exposure hazard layers representing the years 2050 and 2100. For more information about each of the flood hazards used in this category, please refer back to the Flood Hazard Data Story Map frame.

General Outcome

From a statewide perspective, the analysis identified 124 of the 1,302 identified facilities at least partially reside within the bounds of:

1. the Sandy Surge extent
2. the current 100-year floodplain; and
3. the 2100 Coastal Flood Exposure assessment

Industry	Facilities
Basic Chemical Manufacturing	15
Electric Power Generation, Transmission and Distribution	13
Cement and Concrete Product Manufacturing	6
Petroleum and Coal Products Manufacturing	6
Miscellaneous Durable Goods Merchant Wholesalers	6
Soap, Cleaning Compound, and Toilet Preparation Manufacturing	4
Other Chemical Product and Preparation Manufacturing	4
Motor Vehicle and Motor Vehicle Parts and Supplies Merchant Wholesalers	4
Chemical and Allied Products Merchant Wholesalers	4
Water, Sewage and Other Systems	4
OTHER	58
Total	**124**

It is worth noting that several of these industries handle or produce bulk materials that are somewhat reliant on proximity to the waterfront as a means of transporting raw materials and/or finished products.

Appendix C

Summary of Engagement Efforts

Background

The Rutgers team engaged a variety of practitioners to better understand opportunities to apply the data generated under this project to ongoing efforts related to extreme weather events, climate change preparedness and resilience. The purpose of these engagement efforts were to better understand:

- The extent to which the generated data would offer distinct value to ongoing efforts related to emergency management, planning for extreme weather events and climate change and resilience planning;
- The extent to which data regarding industrial and commercial operations was already being considered in ongoing emergency management, planning for extreme weather events and climate change and resilience planning efforts;
- The nature of technical assistance that is needed for effective use of the generated data, or some version of it, to be integrated into emergency management, planning for extreme weather events and climate change and resilience planning.

Engagement efforts included meetings with:

- City of Newark Emergency Management Coordinator;
- New Jersey Office of Emergency Management and New Jersey Department of Environmental Protection;
- Nonprofit organizations involved in resilience planning in the City of Newark: Ironbound Community Corporation, New Jersey Environmental Justice Alliance and Clean Water Action;
- Multiple government offices representing Jersey City agencies, including: Office of the Mayor, Department of Public Safety, Department of Health and Human Services, Housing, Economic Development and Commerce.

For each engagement meeting, the Rutgers team prepared an overview of the purpose of the pollution prevention project, background on the types of data used regarding industrial and commercial facilities as well as current and projected flooding conditions, and a tailored set of data outcomes what the team expected would be of greatest interest to the participants. The Rutgers team provided an initial presentation on the project and the data and, subsequently, engaged in an open discussion with the participants regarding potential uses of the data, challenges in applying the data and concerns regarding its use. An informal set of facilitative questions were on hand if needed for prompting dialogue, including:

- Are there readily available datasets, such as these, that you routinely use as part of your efforts? If so, how are those data used? Do you see improvements or additional value to the data produced as part of the Rutgers pollution prevention project?
- How self-explanatory are these data for ready use in your ongoing efforts?
- What concerns would you have about directly applying these data as part of your ongoing efforts?
- What challenges do you foresee in applying these data directly as part of your ongoing efforts?

- What types of technical assistance do you anticipate would be needed by your organization in applying these data as part of ongoing efforts? What types of technical assistance do you anticipate may be needed by the general public to understand relevance of these data?

Insights

In general, the Rutgers team heard a lot of interest for the nature of the data developed as a result of the pollution prevention project. In particular, we heard that there was benefit to having developed an analytical methodology leading to identification of current and projected flood prone industrial and commercial facilities so as to "narrow down" what facilities may be most important to address as part of resilience, emergency management and extreme weather event planning. Additionally, we heard that there was also benefit to having these analyses conducted by a reliable "third party" such as an academic institution so as to support its integration into planning efforts. More specific insights that we heard include the following:

- While there are extensive climate adaptation tools and resources available to state and local planners and practitioners, the availability of tools pertaining to impacts of climate change and extreme weather events on industrial and commercial facilities as part of holistic planning seems to be limited or non-existent. The availability of the data generated by the Rutgers pollution prevention project provides a "starting point" for efforts among community-based organizations and local officials to integrate consideration of potential exposures resulting from flood hazards facing industrial and commercial facilities into overall planning efforts.
- We heard from all of the participants in our engagement meetings that, while they saw valuable use of the Rutgers pollution prevention data as part of planning efforts, they indicated a clear need for technical assistance to support their efforts to ensure that the data was used accurately and with appropriate context. More specifically, they saw value in use of these type of data as part of planning efforts but would need assistance in integrating such data into existing programs and initiatives.
- From the local officials that we talked with, we heard that the data was helpful in that it provided a targeting of specific facilities to provide them with a manageable universe to incorporate into local planning efforts. We also heard that local agencies are not likely to have the resources needed to undertake such an analytical effort.
- Local officials also indicated the value of using a targeted dataset such as the one generated from the Rutgers pollution prevention provide to support interagency collaboration and proactive planning such as integration of resilience efforts into local master planning, inspections, and emergency management efforts. The accessibility of the Rutgers dataset, especially, would facilitate interagency shared efforts to apply it in local planning and decision-making.
- The state and local officials we talked to pointed to the state and local Hazard Mitigation Planning process as an important mechanism for integrating the data generated under the Rutgers pollution prevention project. The Hazard Mitigation Planning (HMP) process is designed to enable jurisdictions the ability to: increase awareness of threats and hazards;

build public and private partnerships focused on reducing risk; identify long-term strategies for reducing risk; aligning the HMP objectives HMP with other government and nongovernment organizations; identify areas to implement approaches addressing the greatest risks/vulnerabilities; and communicating funding priorities. With regard to hazardous substances, the 2014 New Jersey State HMP focuses on superfund sites and the transport of hazardous materials, rather than on operating facilities. Geographic references and data on superfund sites are included but the plan lacks specific references to all facilities that use or generate hazardous materials. However, the plan recognizes the value of information generated as part of the New Jersey Worker and Community Right to Know (CRTK) regulations and the Emergency Planning and Community Right to Know Act (EPCRA) Toxics Release Inventory. New Jersey's statewide HMP is to be updated in 20177 providing an opportunity for the integration of pollution prevention objectives and data into the HMP process to foster source reduction of the use and generation of hazardous materials. New Jersey's statewide HMP is to be updated in 20177 providing an opportunity for the integration of pollution prevention objectives and data into the HMP process to foster source reduction of the use and generation of hazardous materials. Integrating these data into the state HMP, in turns, creates opportunities for more targeted efforts to address potential exposures through local hazard mitigation planning.

- For the community-based organizations that we talked to, we heard a strong desire to have enhanced access to data on industrial and commercial facilities and frustration over their sense of difficulty in accessing such data. They viewed the Rutgers pollution prevention project data as valuable to local community resilience efforts as well as community-based environmental organizing in general. They indicated a strong need for technical assistance in understanding the implications of the data, and how to best apply it as part of community efforts.