

FEWSION COVID-19 Crisis Briefing for Media and Decision Makers

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Overview

This document provides an overview of key facts and maps from the NAU-led FEWSION™ project (<https://fewsion.us>) for use during the next week of the COVID-19 crisis in the United States. The media, local and state decision-makers, Congressional staff and emergency managers are intended audiences for this information, but this information should not be directly released to the public. Please contact FEWSION project director Ben Ruddell of Northern Arizona University at 928-523-3124 and Benjamin.ruddell@nau.edu with questions or interview requests.

For the media, it's important to know that this is *big data at work.* Using National Science Foundation and U.S. Department of Agriculture basic science funding and building on the hard work of many scientists and public-serving federal agencies, FEWSION™ has produced the only system available in the world to visualize and explore an entire nation's supply chains. This is something new and different, and uniquely actionable, that urgently needs to be shared with U.S. decision-makers and the public. Amid a sea of repetitive bad news on COVID-19, this is different! If you provide exposure to this information and this tool, you will bring attention to this unique and underexposed resource, and you will help U.S. communities and citizens make more informed decisions about the current crisis. These visual data are *personal* because they are specific to each U.S. community and each part of the economy. If you are worried about whether your grocery store or pharmacy or hospital is going to have the food, medicine and equipment it needs to support your family during this crisis, then you are going to be very interested in—and mostly comforted by—the information in these maps! Journalists, please help get the word out about this information.

We think the interesting story at the present moment is about what U.S. communities' supply chains look like and how these supply chains can be disrupted by a shock like COVID-19. The public, and decision-makers, can see their community's supply chains on the FEW-View™ website (<https://fewsion.us/few-view/>, a joint effort of NAU and the ASU Decision Theater, ©Arizona Board of Regents). For instance, by selecting your community in FEW-View™ "build your own scenario" function, then using the "inflow" menu item and selecting "inflow," you can see where your community's supply chains are concentrated for any critical supply like food, pharmaceuticals, (toilet) paper, mixed freight (groceries and general goods), etc. If a serious

disruption affects those source locations due to travel restrictions or worker illnesses, your community's supply chain is at risk and may need to adapt.

Secondarily, your audience is also interested in knowing how "resilient" their supply chain is (see FEW-View's "analytics" menu)—that is, if one source is disrupted (e.g. because of lockdowns such as those happening in New York City and other major cities right now), does your community already have a supply chain set up that has other options? For example, Arizona has some of the least resilient supply chains for mixed freight (read below), because Arizona's supply chain for product distribution and processing mostly runs through the Phoenix and LA metro areas, so if those areas are compromised, Arizona needs to substantially rebuild its supply chains. Most other U.S. communities are more flexible and resilient than that. FEWSION can also assess the resilience of any U.S. community to a specific supply chain problem like the current New York City lockdown by pulling up FEW-View™ "analytics" menu and selecting "leverage," which would in this example show you New York City's control over your community's supply chain.

We provide in this briefing six relevant examples of how emergency managers and decision makers, along with the public and the media, can use the FEW-View™ system and FEWSION™ data to understand national supply chain issues related to COVID-19. However, the real value lies in convincing a user to visit our website and see for themselves.

For all users it is important to understand that this provisional information is not to be used for critical emergency management decisions or major national-scale media releases without talking to an expert like Dr. Ruddell first, because we need to safeguard that the information is being interpreted correctly during this emergency situation. There are many caveats and nuances that must be considered when using data.

In all communications, it is important to emphasize the following: at present the U.S. supply chain is holding up and is proving resilient! The facts and maps provided herein help explain to the public and to decision makers why US supply chains are so resilient to a shock like COVID-19. However, there are areas of some concern, or at least specific interest, that decision-makers and the public should be aware of at this time.

Example 1, NYC Pharmaceuticals and Medical Equipment: New York City, the current epicenter of the COVID-19 crisis in the U.S., is a source of pharmaceuticals to the U.S., but it does not exceed 10% of any community’s pharmaceutical supply chain, so the nation is resilient to these disruptions (below). Indianapolis, IN, Richmond, VA, Memphis, TN, Houston, TX, Chicago IL, and Grand Rapids, MI, are among the most exposed to pharmaceutical disruptions originating in New York City.

Notable COVID-19 lockdowns in effect as of March 24th, 2020 (not from FEWSION™ data)

- Europe
- East Asia
- New York City and the mid-atlantic generally
- California
- Seattle area
- Chicago
- Houston

Source: <https://www.usatoday.com/in-depth/news/2020/03/24/coronavirus-state-measures-contain-disease-vary-widely/2897975001/>

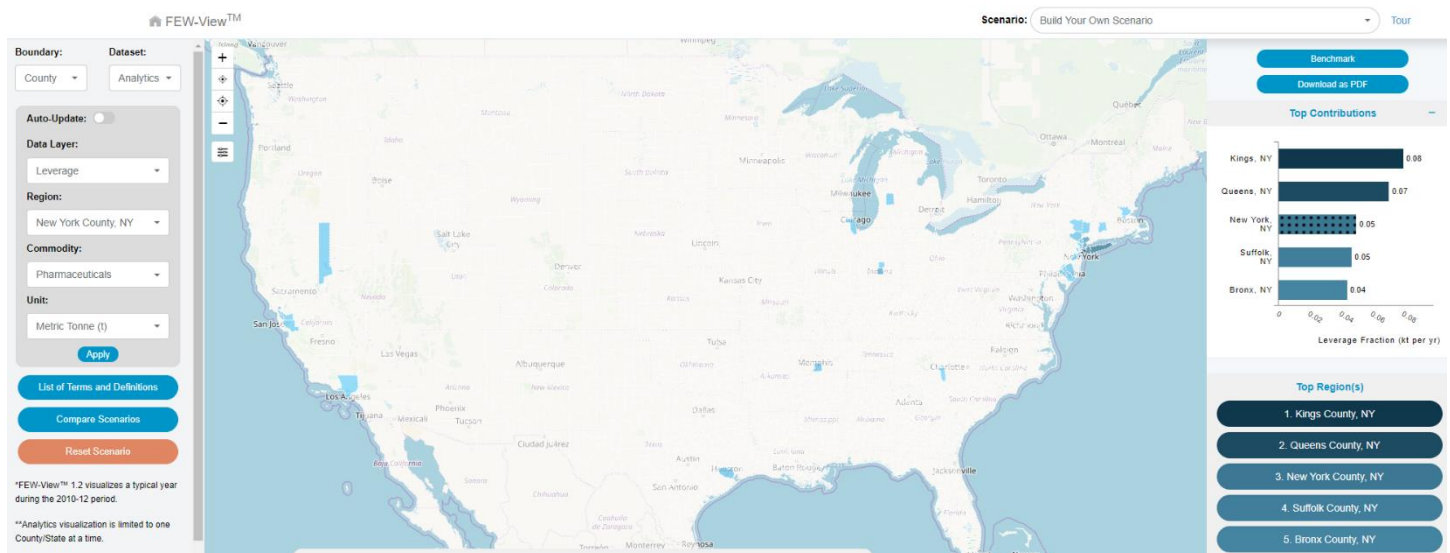


Figure 1a: New York City’s fractional contribution to each US community’s pharmaceutical supply

New York City sources its pharmaceuticals mostly from other northeastern U.S. states, but also notably from California, Illinois, Michigan, Texas, Colorado, and Mexico (dark areas in the map below indicate large sources of pharmaceuticals to the State of New York).

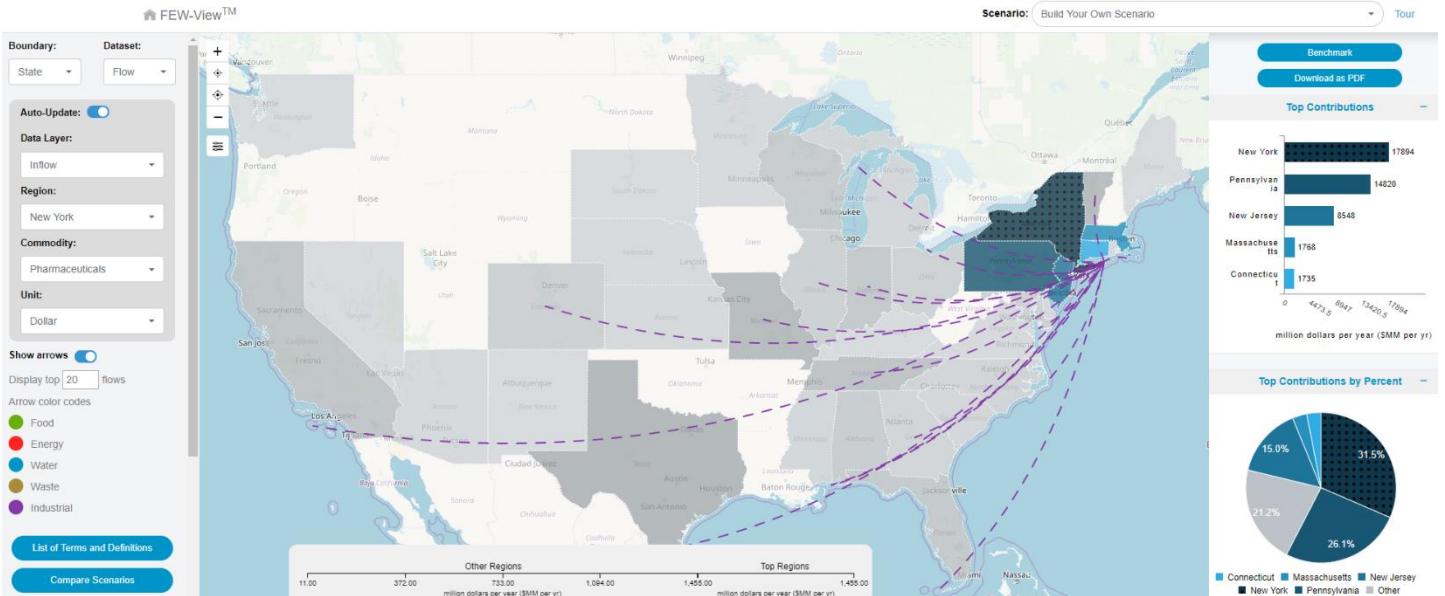


Figure 1b: Sources of pharmaceuticals to the State of New York

New York City’s supply of precision instruments and medical equipment—like badly needed ventilators—is concentrated in California cities like Los Angeles and San Francisco, in nearby communities in the NYC metro area, and in Boston, MA, along with Salt Lake City, UT, and Washington, D.C. (dark areas and arrows in the map below indicate major sources of medical equipment to New York City).

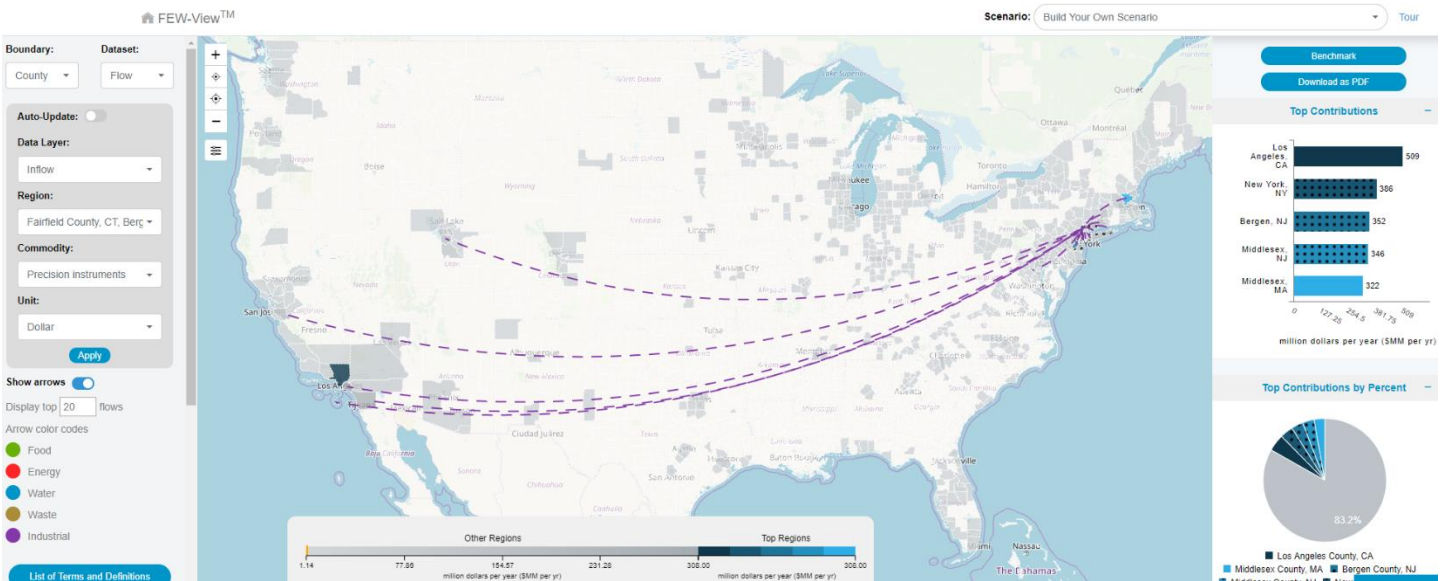


Figure 1c: Sources of precision instruments (including medical equipment) to New York City

Example 2, U.S. Pharmaceutical and Medical Equipment Sources: Although it is true that the U.S. sources some of its pharmaceuticals from China, India, and other countries, many are manufactured and processed domestically, and all are distributed through domestic warehouses. The largest domestic sources and distributors of pharmaceuticals are Los Angeles, CA, Chicago, IL, Memphis, TN, Columbus, OH, and Phoenix, AZ (dark areas in the map below are large sources and distributors of pharmaceuticals).

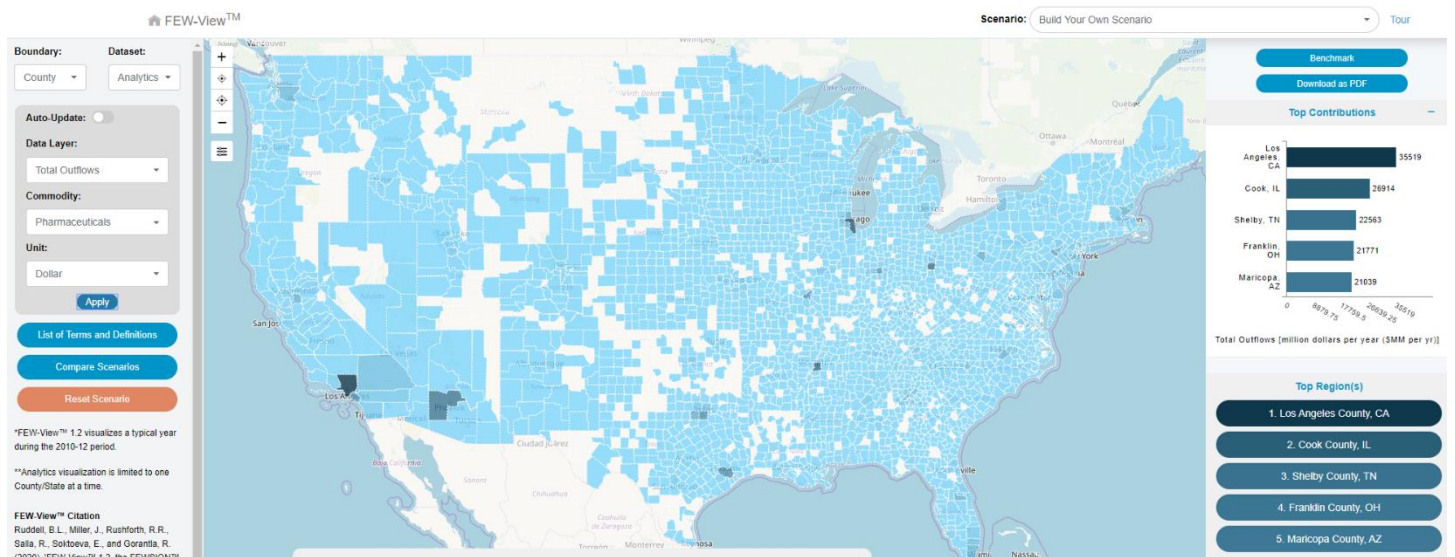


Figure 2a: US domestic sources and distributors of Pharmaceuticals

U.S. sources of precision instruments like medical equipment are concentrated in (mostly) different locations. Ventilators, among other medical equipment, are a critical resource during the COVID-19 crisis. Major sources of medical equipment in the US are concentrated in the areas of Los Angeles, CA, San Diego, CA, Houston, TX, Boston, MA, San Francisco, CA, Minneapolis MN, Dallas TX, Memphis, TN, and Seattle, WA (dark areas in the map below are major sources and distributors of medical equipment).

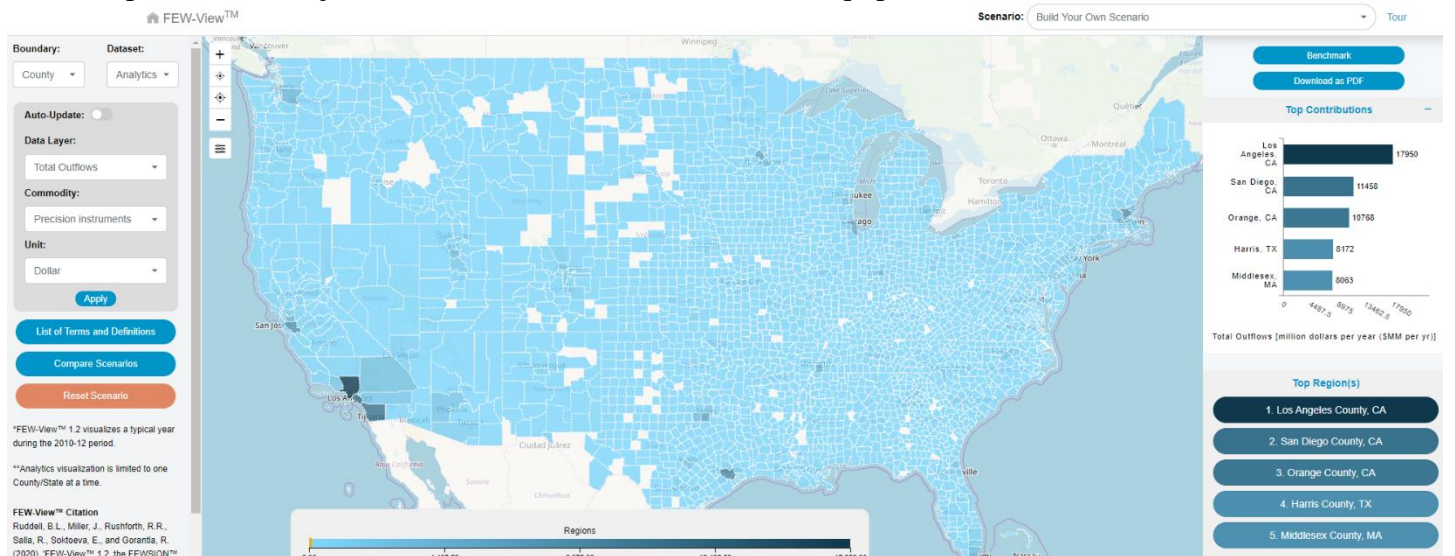


Figure 2b: US domestic sources and distributors of precision instruments including medical equipment

Example 3, U.S. Toilet Paper Sources: There has been a shortage of toilet paper in the U.S. since the beginning of the COVID-10 crisis. This is due largely to distribution bottlenecks, rather than a disruption of production. Leading U.S. sources and distributors of toilet paper include the Chicago area, which is currently in lockdown (three of the top 10 distributors), along with paper production centers in the southeastern U.S., Wisconsin, the Pacific Northwest, and the Los Angeles area. (Dark areas in the map below are large sources or distributors of toilet paper and related paper products.)

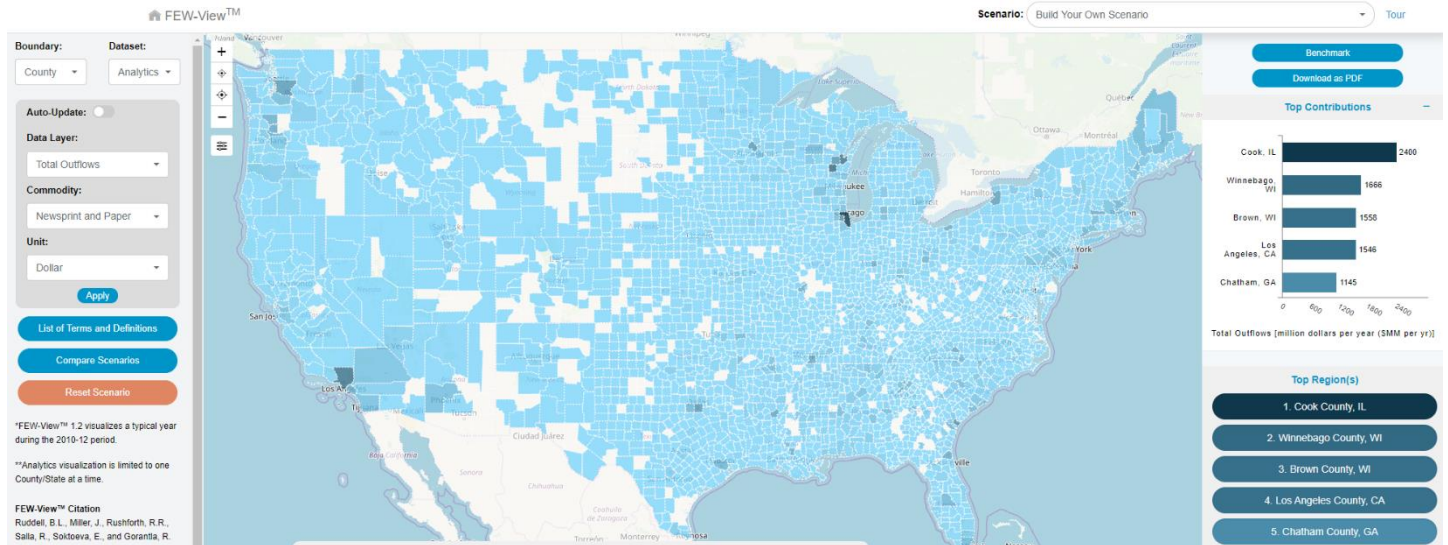


Figure 3a: US domestic sources and distributors of paper products including toilet paper

Top US distributors of Toilet Paper (not from FEWSION™ data)

Company	Headquarters	Annual Sales
1 Fastenal	Winona, MN	250+
2 Elite Restaurant Equipment	Newark, NJ	10-24.9
3 Kyana Packaging & Industrial Supply	Louisville, KY	10-24.9
4 First Choice Industrial Supply Company	Oakdale, CA	5-9.9
5 AmeriPak	Lebanon, IL	5-9.9
6 Concept Supply, Inc.	Chattanooga, TN	1-4.9
7 Orr & Orr, Inc.	Bedford Park, IL	1-4.9
8 Addison Building Materials	Arlington Heights, IL	1-4.9
9 Capital Janitorial Supply & Service, LLC	Richmond, VA	<1
10 World Packaging Co., Inc.	Wood Ridge, NJ	--

Source: <https://www.thomasnet.com/articles/top-suppliers/toilet-paper-manufacturers-companies-suppliers/>

Example 4, U.S. Food Sources and Distribution Network Resilience: The U.S. is one of the largest producers of food in the world and is a net exporter of food to the world. Although all food supply chains start at farms, a complicated supply chain connects farms to consumers through feedlots and grain storage, food processing plants, warehouses, and retailers. The main U.S. sources and distributors of “Table Ready” processed foods are the metro areas of Los Angeles, CA, Chicago, IL, Dallas, TX, Grand Rapids, MI, Seattle, WA, and Indianapolis, IN, which concentrate food processing and warehousing functions (dark areas in the map below are large sources or distributors of table ready food). Disruptions to the food processing and distribution warehouse network are a far greater challenge from a pandemic, as opposed to disruptions to farms and crops which might be the result of a drought or other weather disaster.

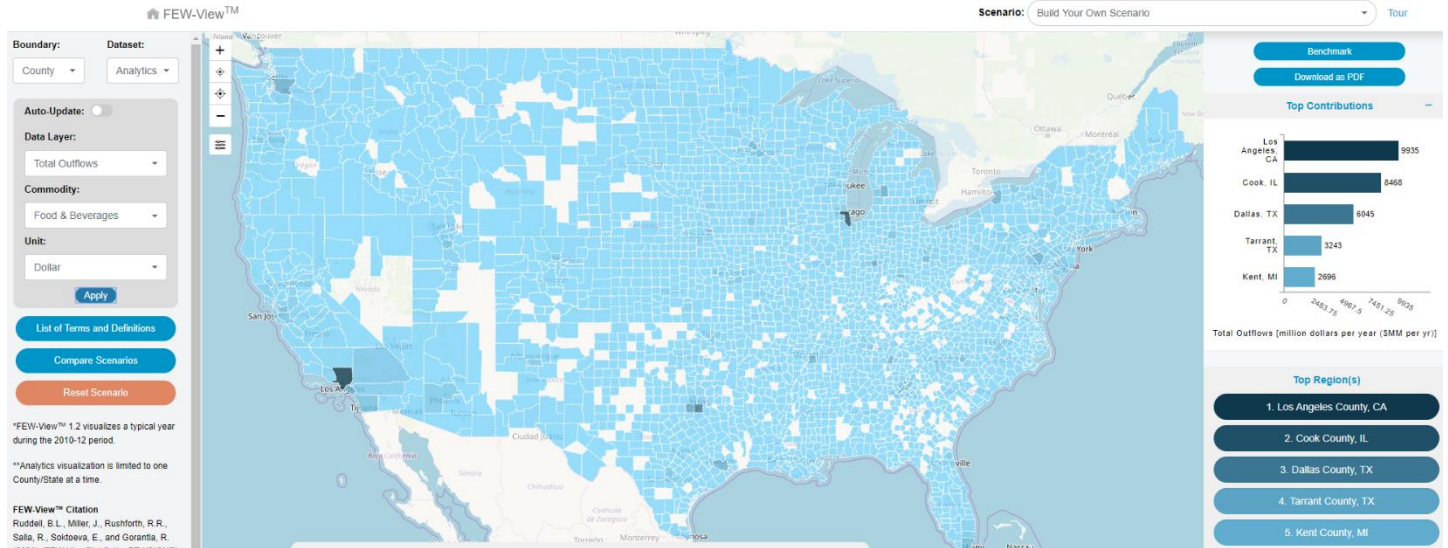


Figure 4a: US sources and distributors of table ready food

By contrast, the other end of the supply chain—farms—is concentrated in rural areas and small cities, especially in the West and Midwest. California and southern Arizona are the single largest concentrations of farms growing crops destined for American tables, but a large contribution is also made by the Midwest and Pacific Northwest, along with distribution and shipping centers like the areas around Los Angeles, CA, Chicago, IL, Fresno, CA, Seattle, WA, Portland, OR, and especially New Orleans, LA (dark areas in the map below are large agricultural product sources and distributors). It is also important to understand that a lot of America’s agricultural products come from Canada, Mexico, and the rest of the Americas, so COVID-19 disruptions in those locations will impact the U.S. farm supply chain.

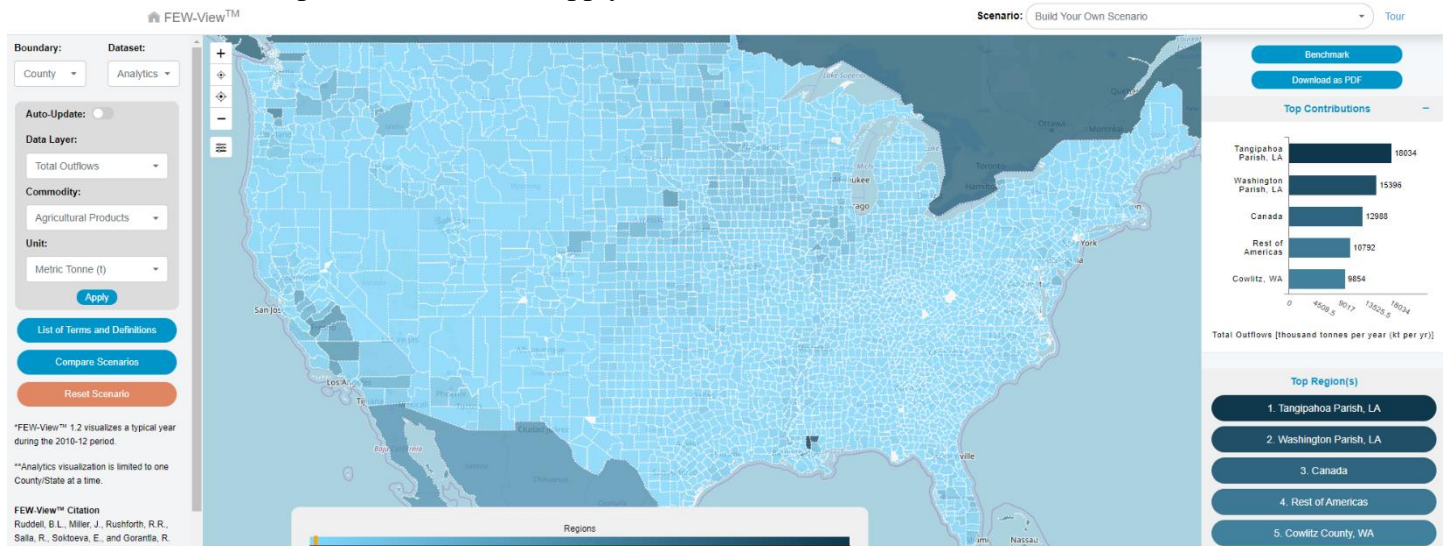


Figure 4b: U.S. sources and distributors of raw agricultural products (e.g. animal feed, grain, livestock)

However, the food distribution system is very resilient! Especially in our cities, there is a wide diversity of sources and distribution networks to work from; this diversity of sourcing makes the network resilient (dark areas in the map below have very resilient food distribution systems). Rural areas with long and narrow food supply chains are at the most risk from food distribution disruptions during this crisis—and to a lesser extent West Coast cities like Seattle, WA, Los Angeles, CA, Salt Lake City, UT, or Denver, CO, which are more self-contained and therefore less diverse are also at some mild risk.

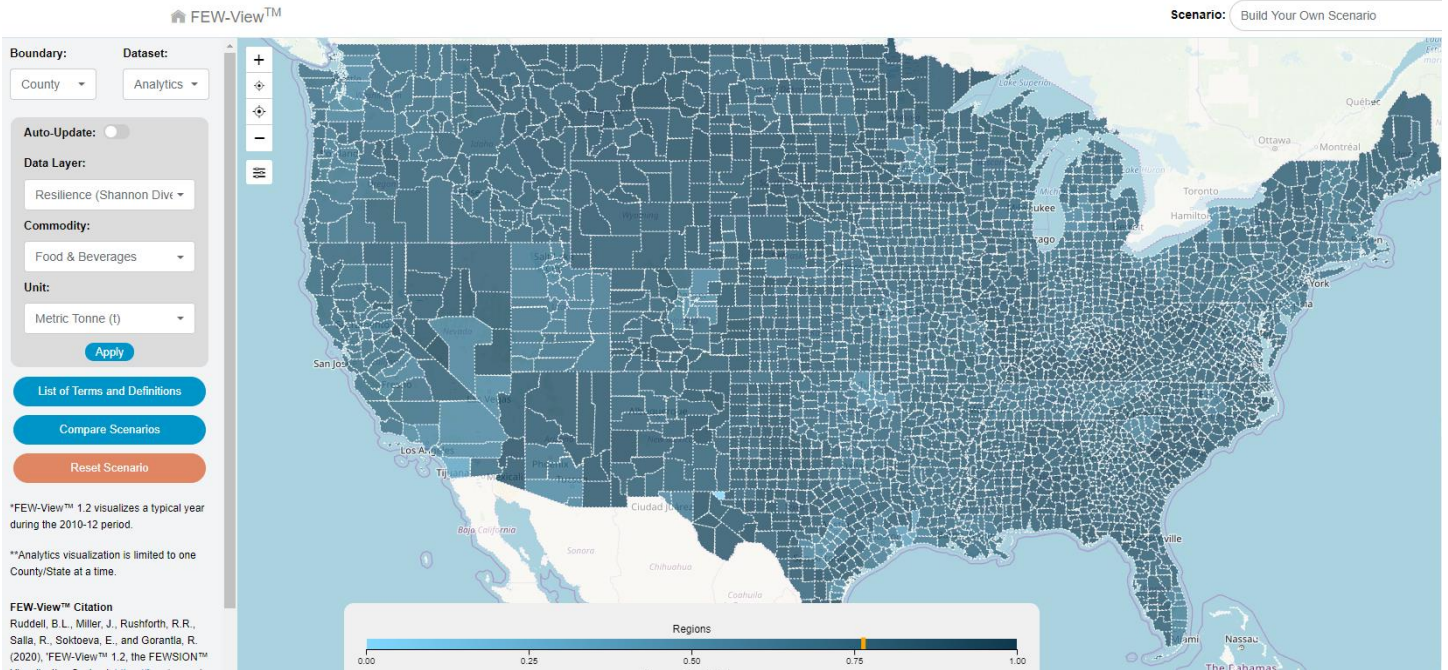


Figure 4c: Resilience, as measured by diversity, of each U.S. county’s table ready food supply chain

Example 5, Mixed Freight and its Distribution in the U.S.: Mixed freight is mostly borne by heavy truck and comprises a large fraction of the total U.S. supply chain; mixed freight volumes are highly correlated also with distribution systems for staples like groceries and food, medicines, and daily essentials. The national hubs for mixed freight distribution and sourcing are the areas of Los Angeles, CA, Houston, TX, Dallas, TX, Chicago, IL, Phoenix, AZ, Seattle, WA, and in general Ohio and Pennsylvania (dark areas in the map below are major sources of mixed freight flows in the U.S.). These distribution hubs are keys for the national logistics network.

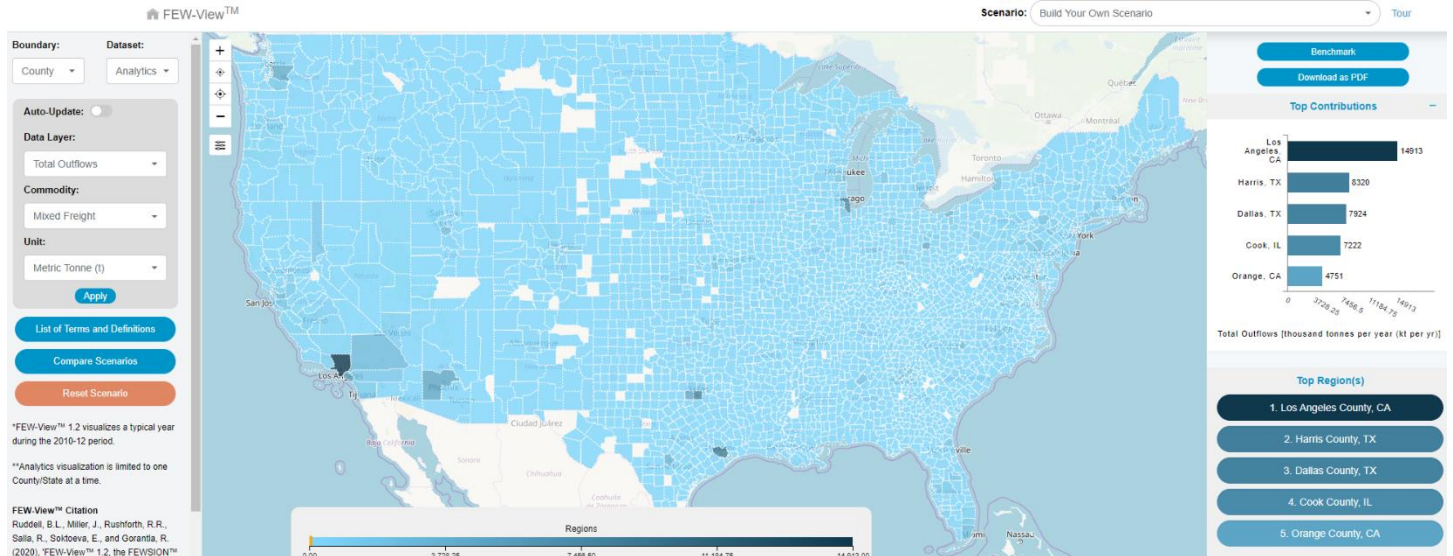


Figure 5a: U.S. domestic sources and distributors of mixed freight (e.g. truckborne general freight)

The mixed freight distribution network for most U.S. communities is generally quite diverse and therefore quite resilient to COVID-19 disruptions (dark areas in the map below have very resilient mixed freight distribution supply chains). The central Midwest (centered on Missouri), Mid-Atlantic (Virginia up to Pennsylvania), and South/Southeast are especially diverse and resilient freight supply chains. However, these mixed freight supply chains are less resilient on the West Coast, especially in the Southwest, where distribution supply chains have more bottlenecks and fewer well established options. Southern California, Las Vegas, NV, Seattle, WA, Utah, and especially Arizona are areas of concern where greater risks may exist and more need to adapt the supply chain may exist as COVID-19 progresses—particularly as the crisis becomes more severe in Los Angeles and Phoenix.

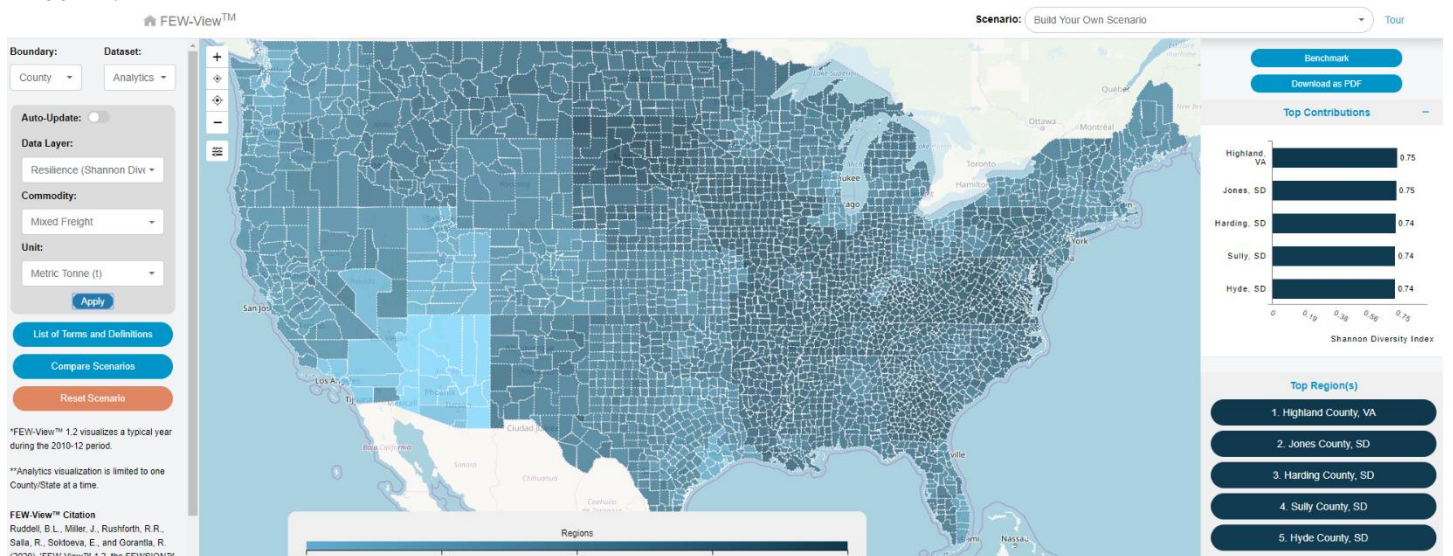


Figure 5b: Resilience, as measured by diversity, of each U.S. county's mixed freight supply chain

Example 6, Arizona’s Supply Chains: The FEWSION™ project is a public service of NAU, the ASU Decision Theater, and the Arizona Board of Regents, so the State of Arizona’s supply chains will receive special attention in this last example.

Arizona’s pharmaceutical sources and distribution centers are concentrated 71% in the Phoenix metro area, with other notable sources including Southern California, San Francisco, CA, Memphis, TN (probably via FedEx associated distribution in the case of Memphis), and Alabama. Counting California sources, well over three-quarters of Arizona’s pharmaceutical supply is concentrated in the region. See the map below, where dark areas and arrows represent large sources of pharmaceuticals for Arizona. This is both a strength and a weakness, because (a) our State leadership can work directly and efficiently with its largest corporate suppliers in the Phoenix area to prepare and control the emergency, but (b) if COVID-19 were to compromise the local pharmaceutical supply chain, this could be a disaster for the State of Arizona. As a result, and to prepare for a more resilient pharmaceutical supply chain, we recommend that the industry and the leadership in Arizona ensure that contingencies for supply from other U.S. and global regions are in place, and/or strengthen eastern U.S. supply chains that route through Memphis.

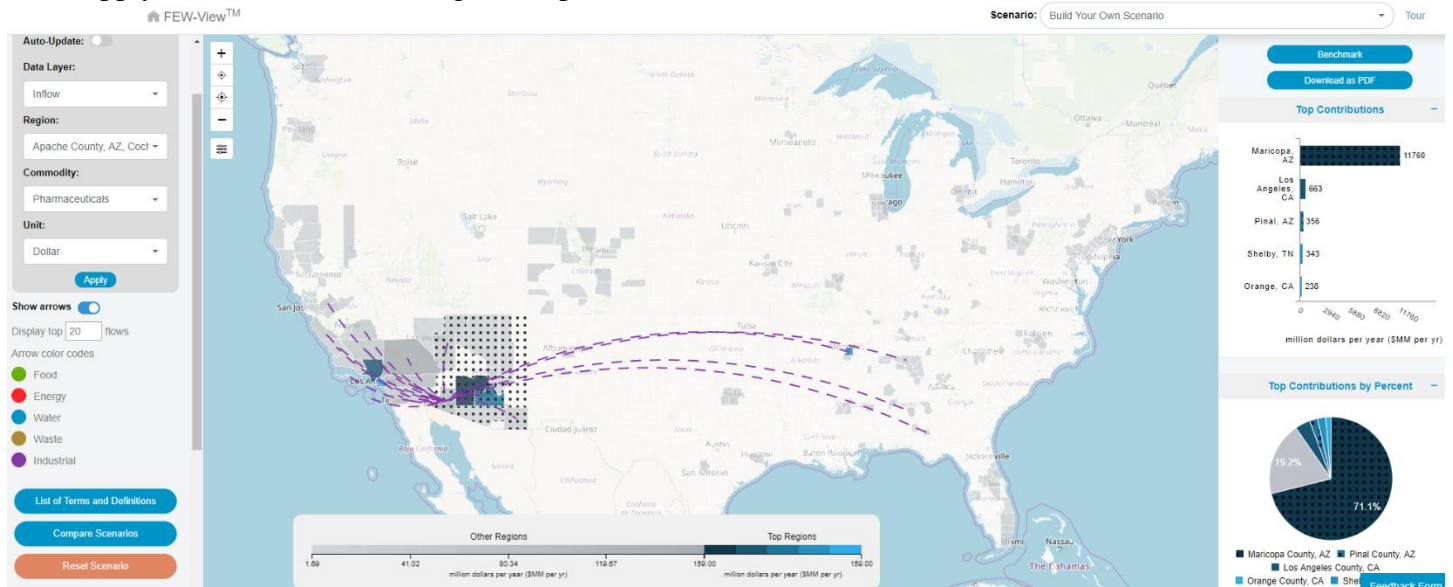


Figure 6a: Arizona’s sources of pharmaceuticals

By contrast, Arizona’s suppliers of precision instruments and medical equipment are more far-flung, including Chicago, Boston, New York City, Salt Lake City, and Denver (along with Southern California, as usual), and the Phoenix metro area is only one of several major sources (see the map below). This is a more geographically diverse and resilient supply chain. However, this medical equipment tends to be highly specialized, and is sold by only a few companies in small volumes, so geographical diversity may be a misleading indicator in this case. It is therefore recommended that steps be taken to secure essential medical equipment, in anticipation of possible medical equipment supply chain fragility.

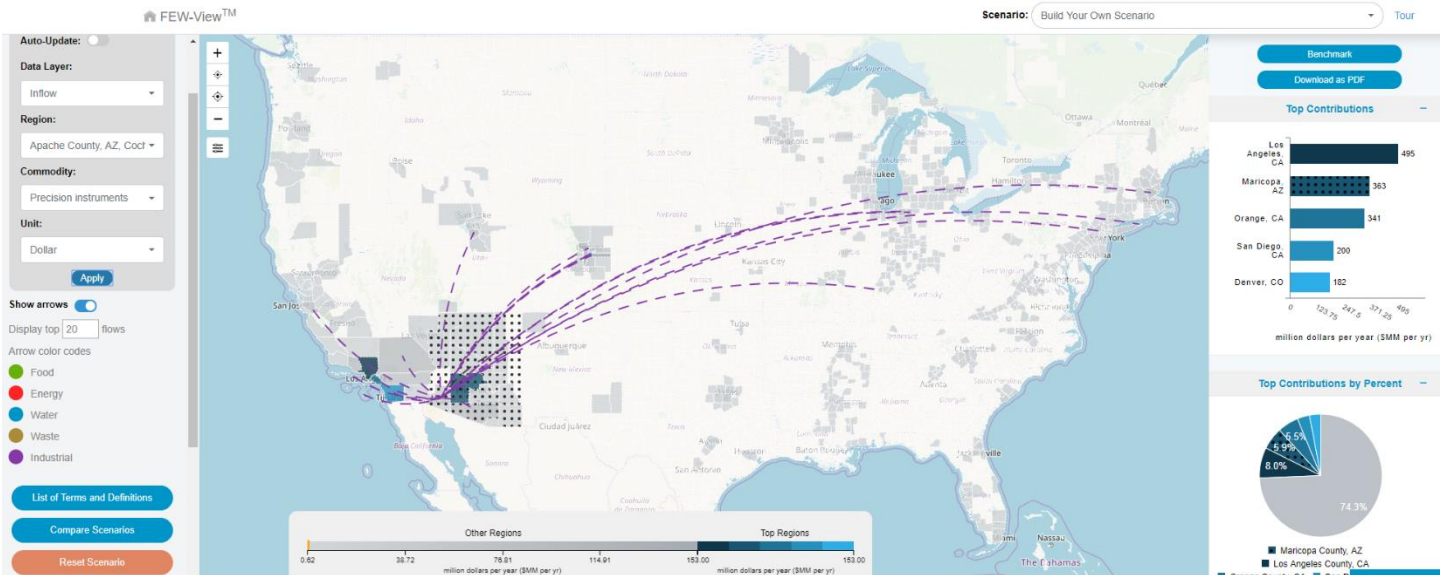


Figure 6b: Arizona's sources of precision instruments including medical supplies

Arizona's "table ready" food supply is heavily processed, warehoused, and distributed through the Phoenix metro area and from Southern California sources, but there is also a lot of food coming from the areas of Chicago, IL (mostly in summer), Portland, OR (mostly in summer), New Orleans, LA, and the Midwest (largely beef and meat products) (see the map below). Arizona and Southern California are national hubs for fresh produce and table-ready food and are essential sources and distributors both for themselves and for the national food supply chain's security. It is important that leaders in Arizona (and California) focus on protecting the food supply chain's safety and integrity during the COVID-19 crisis, including a special emphasis on agricultural and food processing worker health. If we fail to prevent a disruption of the local food supply chain here, the people of Arizona (and California) will probably suffer greater impacts than others due to our self-reliance on locally produced food products.

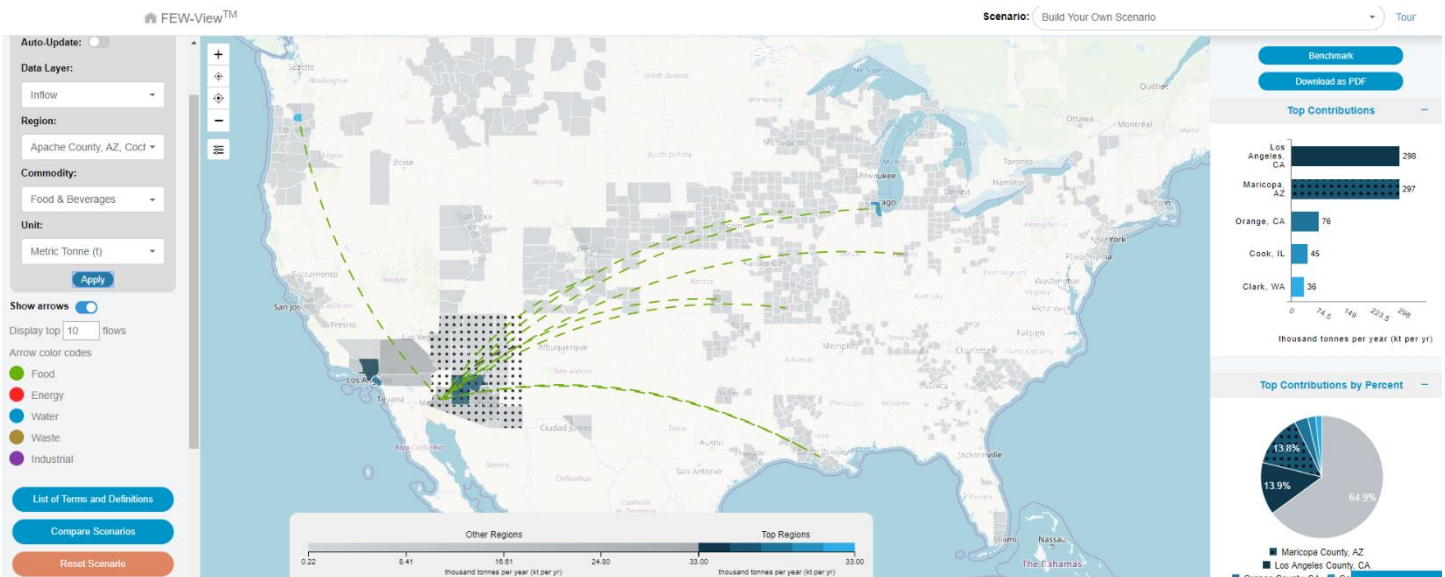


Figure 6c: Arizona's sources of table ready food

Summary of FEWSION™ COVID-19 Findings and Recommendations at the Present Time

The FEWSION™ project's data and the FEW-View™ visualization system provide broadly useful and spatially specific analysis and visuals for every U.S. community's supply chains. Every U.S. community's leaders should be aware of the structure of their community's supply chains and should understand potential weaknesses and vulnerabilities as the COVID-19 crisis expands and moves across global supply chains. Every community and industry has unique issues, but we have in these examples uncovered some common themes:

1. The U.S. supply chains are structurally resilient to COVID-19 (and all-hazards threats in general), with some narrow exceptions. The geographical diversity, polycentricity (that is, many-hubs), excellent connectivity, and size of the U.S. economic and supply chain system allows the nation's companies and logisticians to compensate for disruptions in any given city or region. Even during the COVID-19 pandemic, not all U.S. cities and regions will be affected at the same time. Although capacity may be strained in specific supply chains (e.g. groceries, medical supplies), the structure of the overall system is resilient, diverse, and adaptable.
2. Supply chain hubs including the metro areas of Los Angeles, CA, Chicago, IL, Dallas, TX, Houston, TX, Memphis, TN, Seattle, WA, New Orleans, LA, Salt Lake City, UT, the Mid-Atlantic region between New York City and Richmond, VA generally, and Phoenix, AZ, concentrate an unusual volume and breadth of supply chain sourcing and distribution, and are therefore critical to support and sustain during the national logistical response to COVID-19.
3. The current crisis in New York City requires national supply chain support from as far away as Los Angeles, but a large fraction of the supply chain capacity needed to support New York City's epidemic is located within 200 miles of the city, owing to concentrations of medical equipment and pharmaceutical capacity in New Jersey, New York, Pennsylvania, and Massachusetts.
4. Western U.S. cities (along with Alaska and Hawaii) pose unique supply chain challenges because of their geographic isolation from other and their relatively high self-sufficiency, which creates greater challenges to adapting damaged supply chains if these cities' local logistics are disrupted by COVID-19. Owing to their isolation, concentration, and critical importance for the national food and medical supply chains, protecting and sustaining supply chains in the Seattle-Portland and SoCal-Las Vegas-Phoenix-Tucson corridors should be a special focus in the next two months as the epidemic intensifies.
5. Rural communities face special concerns due to their generally narrow and fragile supply chains (e.g. one truck once a week from one warehouse). While these communities are not themselves especially vulnerable to the COVID-19 crisis, they also often have few options for supply and may find themselves with large (in relative terms) shortages if distribution is disrupted.
6. The private supply chain's greatest strength is its complexity, diversity, and adaptability. The private supply chain capacity in the U.S. is roughly 100 times larger than the capacity of any government agency to provide critical supply. Moderate to large adaptations have already been required by America's companies and will continue to be required. It is therefore essential that government intervention and rulemaking carefully restrains itself from enforcing sweeping, highly restrictive, or one-size-fits-all measures to control private supply chains, because these controls could damage the supply chain's ability to adapt to the unfolding crisis. The system's diversity and flexibility is its strength!