Supplemental report

Project name: Descriptive study of visitation trends at FEMA Disaster Recovery Centers

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This report provides the full results for this project as well as supplementary analyses not reported in the Project Abstract.

The Analysis Plan was posted on the OES website on October 7, 2024. We received data from FEMA which contained visit counts and service/activity counts defined at the Disaster Recovery Center (DRC) date level for all DRCs that opened between January 19, 2022 and April 29, 2024, and closed by June 29, 2024.[1,2] In addition to this data, we utilized several publicly available datasets to enrich the analysis.[3] These include three datasets provided from OpenFEMA, FEMA's public data portal: Disaster Declaration Summaries, Registration Intakes Individual Household Program, and FEMA regions. We also used USDA's 2023 Rural Urban Continuum Codes to quantify urbanity of DRCs.

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[1] The Analysis Plan stated that we would analyze data for DRCs that opened between January 1, 2022 - December 31, 2023. However, on receiving data from FEMA, we noted that there was data for DRCs that opened after December 31, 2023 (6 additional DRCs); we decided to include these in the analyses.

[2] The analysis includes DRCs associated with disasters declared between January 5, 2022 - December 13, 2023.

[3] These publicly available datasets were accessed in October 2024.

Overview

Below, we describe high-level findings from this descriptive study, organized by the three overarching research questions:

RQ1: What does the life cycle of a DRC look like during a disaster response?

- **It takes on average 1 month to open DRCs after a disaster declaration.** Time to open varies by disaster type: DRCs associated with tornado disasters had the quickest time to open (mean = 11 days), whereas those associated with fire disasters had the longest time to open (mean = 64 days).
- **DRCs are typically operational for 30 days on average.** This varies by the following contextual factors:
    - Disaster type: DRCs associated with fire disasters are open the longest duration on average (41 days), whereas those associated with severe storm disasters are open for the shortest duration on average (22 days).
    - Disaster severity: DRCs operational time varies by disaster incident duration. For example, disasters lasting 1 day have a DRC average operational time of 26 days, whereas those lasting 11-20 days have an average operational time of 34 days.
    - Geographical factors: DRC operational time also varies by FEMA region, and by urbanization. For example, rural DRCS are open for 27 days on average, urban DRCS are open for 31 days on average.
- **The number of DRCs opened in the aftermath of a particular disaster varies by contextual factors.** For example:
    - Disaster type: An average of 24 DRCs per disaster were set up in the aftermath of hurricanes, while an average of 10 DRCs per disaster were set up in the aftermath of both floods and severe storms.
    - Disaster severity: There appears to be a positive relationship between disaster incident length and the number of DRCs per disaster, in that longer disasters are associated with more DRCs being stood up. However, it appears that this relationship breaks for disaster incidents that last more than 100 days.
    - Geographical location: FEMA region #2 shows the highest number of DRCs per disaster, followed by region #4 and region #1.

RQ2: What does DRC visitation look like during a disaster response?

- DRCs experienced the maximum number of (1) first-time visits an average of 7 days after opening, (2) return visits on average 20.88 days after opening, and (3) total visits (including first-time and return) approximately 9.91 days after opening.

- Across all DRCs and operational days, the average proportion of return visits is 29.4%. The highest proportion of return visits takes place 26.5 days after opening on average.
- DRC overall visit counts vary by disaster type. For example, DRCs associated with tornados have the highest total visit count the earliest out of all disaster types at 2.3 days after opening on average; those associated with winter storms have the highest visit count at the latest, 14 days on average.
- DRC return visit counts also vary substantially by disaster type. For instance, DRCs associated with severe storms have their maximum proportion of return visits 19.3 days after opening on average; DRCs associated with fire disasters experience their maximum proportion of return visits 37 days after opening.

RQ3: What do the different services/activities that DRC visits seek help for look like during a disaster response?

- In-person interactions provided by DRCs is an important way for survivors to check the status of in-process activities.
- The most common services/activities at DRCs overall were 1. “Status Checks”, 2. “Hazard Mitigation”, 3. “Documentation” and 4. “Registration”. “Status Checks” were by far the most common activity among DRC-days and across DRCs.
- For each of the service/activity types, we also calculate the percentage of days that given service/activity is the most frequent and the average day when it is most frequent. This provides a baseline understanding of when survivors might visit DRCs for different reasons.

Departures from analysis plan

After the transfer of the data, we made several departures from the posted Analysis Plan, described further below.

Merging procedure:

In order to merge visit and service/activity count data with Disaster Declaration Summaries data we needed to merge based on county names, as opposed to a unique identifier such as county Federal Information Processing Standards (FIPS) codes. The Disaster Declarations Summaries data is defined at the disaster-county-FIPS-code/place code levels. Counties were identified by their name as well as their three-digit FIPS code. In instances where there was no county FIPS code (such as in townships or Tribal areas), the county FIPS code is assigned to be “000”. To differentiate across such disaster declarations, this data includes a variable called “placecode”, which is a unique identifier of these areas which do not have a corresponding county FIPS code. This is in contrast to the level of observation for the visit and service/activity count data provided by FEMA. In the provided FEMA data, the daily DRC observations are geographically identified by their county/parish/borough names and ZIP code. Preprocessing steps included standardization,

renaming areas to reflect their designated counties (such as renaming "St. Louis City" to "St. Louis" or renaming "Hoopa Valley Indian Reservation" to "Humboldt"), corrected instances of incorrect spelling (renaming "Monterrey" to "Monterey") and creating duplicative Disaster Declaration Summaries observations for those observations within the visit and service/activity count dataset that did not have a corresponding observation.[4]

Categorization of services/activities:

After inspecting the service/activity names from the visit and service/activity counts data provided from FEMA, it was determined that the data was not a categorical variable but rather a text-entry field, although many observations were clustered around a handful of activities. In order to categorize activities, we created a crosswalk between the service/activity name and the newly created variable for binning called "ServiceActivity". We utilized the FEMA acronyms document to make educated guesses of the meaning of certain service/activities, in addition to ensuring the crosswalk was sensible and acceptable to project collaborators.

Data exclusions:

Finally, there were some observations which were removed from the analytical dataset due to missingness of certain variables. There were 28 observations (out of 12,196) where the variable "Visit Date" was missing within the FEMA provided visit count data and 34 observations (out of 177,849) with a missing "Visit Date" variable within the FEMA provided service/activity data. We exclude these observations from the analysis. There are also 11 mobile DRCs (out of 108 mobile DRCs) where the earliest recorded visit date occurs prior to the recorded DRC open date. To accurately capture a DRCs true open date, we compute a DRC's open date as the earliest recorded visit date.

Overview of constructed dataset

In the constructed dataset, there are a total of 408 DRCs associated with 33 declared disasters (12 severe storms, 10 floods, 7 hurricanes, 2 fires, 1 tornado, and 1 winter storm).[5] For comparison, between 2020 and 2021 there were a total of 438 unique disaster declarations with 119 of those disasters having the Individuals and Household Program or Tribal request initiated. This was computed using the year from the "Declaration Date" variable, as well as the "IH Program Declared", "IA Program Declared", and "Tribal Request" variables provided by OpenFEMA's Disaster Declaration Summaries dataset. This is in contrast to the 212 unique disaster

[4] For example, The OpenFEMA Disaster Declaration Summaries data did not have an observation corresponding to a disaster number 4652 for Santa Fe County, although there were observations associated with a disaster number 4652 for Santa Fe County in the FEMA visit and service/activity count data. To account for this, we duplicated the closest geographical observation for that particular disaster (Mora County) in order to properly merge the OpenFEMA Disaster Declaration Summaries data and the FEMA visit and service/activities count data together.

[5] Given the number of disasters represented in the data are limited for certain disaster types (i.e., fire, tornado, and winter storm), the trends we present in this report for these disaster types may be less representative of overall trends, and should be interpreted with caution.

declarations with 27 of those having the Individuals and Household Program or Tribal request between 2022 and 2023.[6,7]

To uniquely identify DRCs within the dataset, we created a variable called "DRCUniqueID" which groups DRCs by the "DisasterUniqueID", "DRC", and "DRCName" variables within the visit and service/activity count data provided by FEMA. A subset of DRCs had more than one name and location and sometimes had different opening and closing dates. This is because some DRC locations were non-standard DRCs, for example, they were mobile DRCs (MDRCs), community recovery centers (CRCs), or document dropoff centers (DDCs).

For the purpose of this analysis, we treat DRCs that have a separate name/location as separate DRCs. In total, we have 408 DRCs composed of 294 standard DRCs, 108 MDRCs, 4 CRCs, and 2 DDCs. After removing observations which are missing a recorded visit date, we have 12,167 DRC-date observations in the analytical dataset. Supplemental analyses on DRC type can be found in Appendix B.

In around two years of data, DRCs had approximately **549,000 visits**[8] (356,000 million first-time visits and 194,000 return visits). Breaking down these visits based on disaster type, **56,085** visits were associated with a fire disaster, **61,862** visits were associated with a flood disaster, **374,520** visits were associated with a hurricane disaster, **55,032** visits were associated with a severe storm disaster, **1,271** visits were associated with a tornado disaster, and **1,122** visits were associated with a winter storm disaster.

Results

As an overview, our three main research questions (RQs) involve the DRC lifecycle (RQ1), visitation behavior (RQ2), and service/activities (RQ3). For each RQ (and sub-RQ), we provide the computed corresponding statistic and an explanation of how we computed the statistic below. Where relevant, we also include supplemental analysis under each RQ (i.e., analysis not pre-specified in the Analysis Plan).

[6] This was not pre-specified in the pre-analysis plan.

[7] There are two disaster incidents which were associated with a Tribal request. One was a severe storm in Maricopa County, Arizona in 2022 and another was a winter storm in Humboldt County, California in 2023.

[8] Our data comprises daily counts of visits, rather than individual-level data on visitors. Therefore, we refer to all counts throughout the analysis as "visits" rather than "visitors".

RQ1: What does the life cycle of a DRC look like during a disaster response?

RQ1(a): How long on average does it take to stand up DRCs after a disaster declaration has taken place?

After a disaster is declared, it takes an average of **30 days** (median = 20 days) to open DRCs.[9] Across the 33 unique disasters in our data, it took on average 10 days (median = 9 days) for the first DRC to open (after disaster declaration date).

There are differences in stand-up time by disaster incident type. DRCs associated with tornado disasters had the shortest stand-up time (average = 11 days, median = 8 days), followed by those associated with flood disasters (average = 24 days, median of 22 days), severe storm disasters (average = 26 days, median = 18 days), and hurricane disasters (average = 34 days, median = 22 days). DRCs associated with winter storms and fires had the longest stand-up time; an average of 53 days (median = 53 days) and 64 days (median = 22 days), respectively.

Supplemental analysis

Stand-up time across DRC types: We also examine how DRC stand-up time varies across DRC types. Standard DRCs stand-up with quickest with an average of 23 days between disaster declaration date and DRC opening date. This is followed by MDRCs and DDCs. CRCs have the longest delay of an average of 200 days between disaster declaration and DRC opening date.

[9] This is calculated as the average of the difference between disaster declaration date and the first date a DRC was operational, across all DRCs.

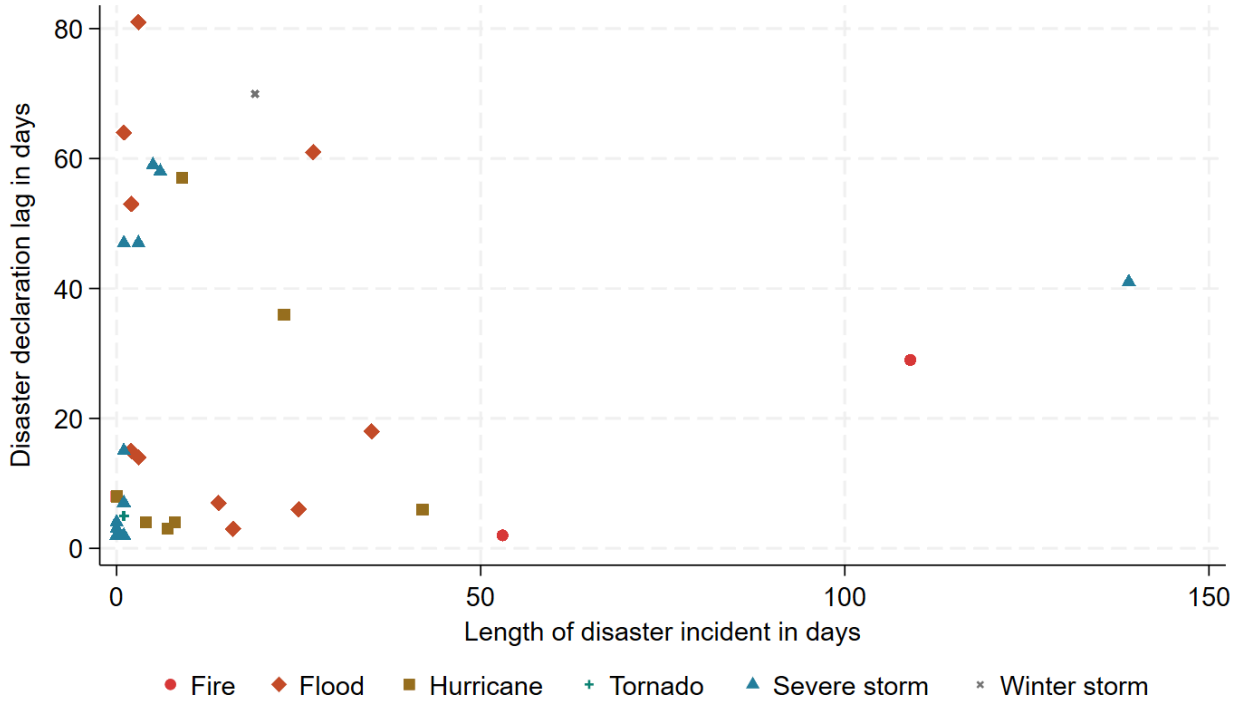
Table 1. Mean and median number of days between disaster declaration and DRC opening date by DRC Type

DRC type	Number of DRCs	Mean	Median
Standard Disaster Recovery Center (DRC)	294	23	16
Mobile Disaster Recovery Center (MDRC)	108	43	36
Community Recovery Center (CRC)	4	200	200
Document Drop-off Center (DDC)	2	61	61

Time between disaster incident start date and declaration date ("declaration lag"): It takes an average of **25 days** (median = 14 days) to declare a disaster, computed as the average of the difference between the incident start date and the disaster declaration date ("declaration lags") for all disaster declarations (33 disasters in total). Declaration lags differ across disaster incident types; tornado disasters have an average declaration lag of 5 days (median = 5 days), fire disasters have an average declaration lag of 15 days (median = 15 days), hurricanes have an average declaration lag of 16 days (median = 6 days), severe storms have an average declaration lag of 24 days (median = 11 days), flood have an average declaration lag of 32 days (median = 16 days), and winter storms have an average declaration lag of 70 days (median = 70 days).

Declaration lag by disaster incident type: To visualize the disaster declaration lag (days between disaster incident start date and the disaster declaration date) by disaster incident type, we provide a scatter plot of the disaster declaration lag against disaster length in Figure 1. We see that there isn't a clear relationship between disaster length, disaster declaration lags, or disaster incident type.

Figure 1. Scatterplot of disaster declaration lag and length of disaster in days



Note: Each marker in the graph represents a different disaster (33 disasters in total). The declaration lag is computed as the difference between the disaster incident start date and disaster declaration date for each disaster incident.

RQ1(b): How long on average are DRCs typically operational?

DRCs are open for an average of **30 days** (median = 23 days), with an interquartile range of 8.5 days and 43 days.[10] Note that not all DRCs are open for continuous consecutive days (i.e., a DRC may be open for June 3rd, 4th, and 6th, but not the 5th). We infer that a DRC was closed for the day if there were zero observations for a particular DRC date. We therefore exclude the possibility that the DRC was open but did not create a record for that day.

Supplemental analysis

DRCs' planned closing dates: There were 11 instances where DRCs were open longer than their planned closing date.[11] Of these 11 DRCs, 8 were open for 10 or fewer additional days, one was open for an additional 11 days, one was open for an additional 20 days, and one was open for an additional 36 days.

DRC operational time by DRC type: We also examined how long a DRC is open on average by DRC type (results in Table 2 below). Standard DRCs are open the longest with an average of 38 days while MDRCs are open the shortest duration of 9 days.

[10] The average is computed by creating a count of DRC-days at the DRC-level and averaging across DRCs.

[11] Of the 408 DRCs, 171 (or 41.9%) did not have a planned closing date.

Table 2. Mean and median DRC operational time by DRC Type

DRC type	Number of DRCs	Mean	Median
Standard Disaster Recovery Center (DRC)	294	38	30
Mobile Disaster Recovery Center (MDRC)	108	9	6
Community Recovery Center (CRC)	4	22	25
Document Drop-off Center (DDC)	2	14	14

RQ1(c): Does DRC operational time vary based on different contextual factors (e.g., disaster type, disaster severity, geographical location, population)?

Disaster type

In Figure 2, we provide a box and whisker plot of the number of days a DRC was open ("DRC operational time") by disaster type. We also report out the mean and median days open by disaster type below in Table 3.[12] DRCs associated with fire disasters are open the longest, followed by tornadoes, hurricanes, floods, and severe storms.

[12] Disaster type was computed by utilizing the 'incidentType' variable in the Disaster Declaration Summaries dataset.

Figure 2. Box and whisker plot of DRC operational time by disaster type

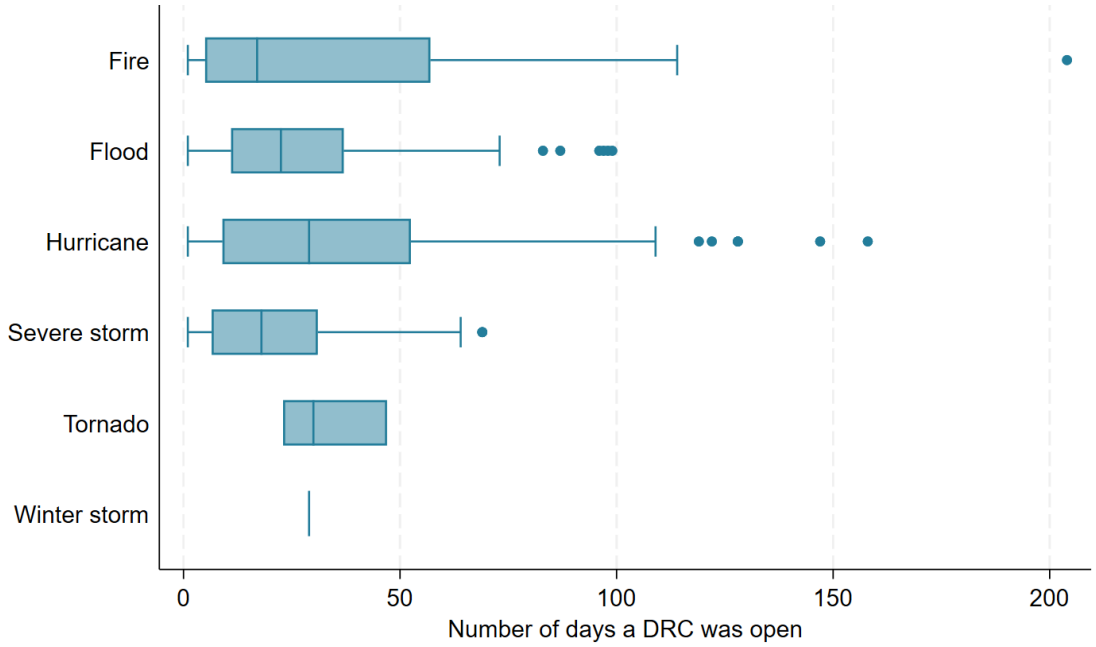


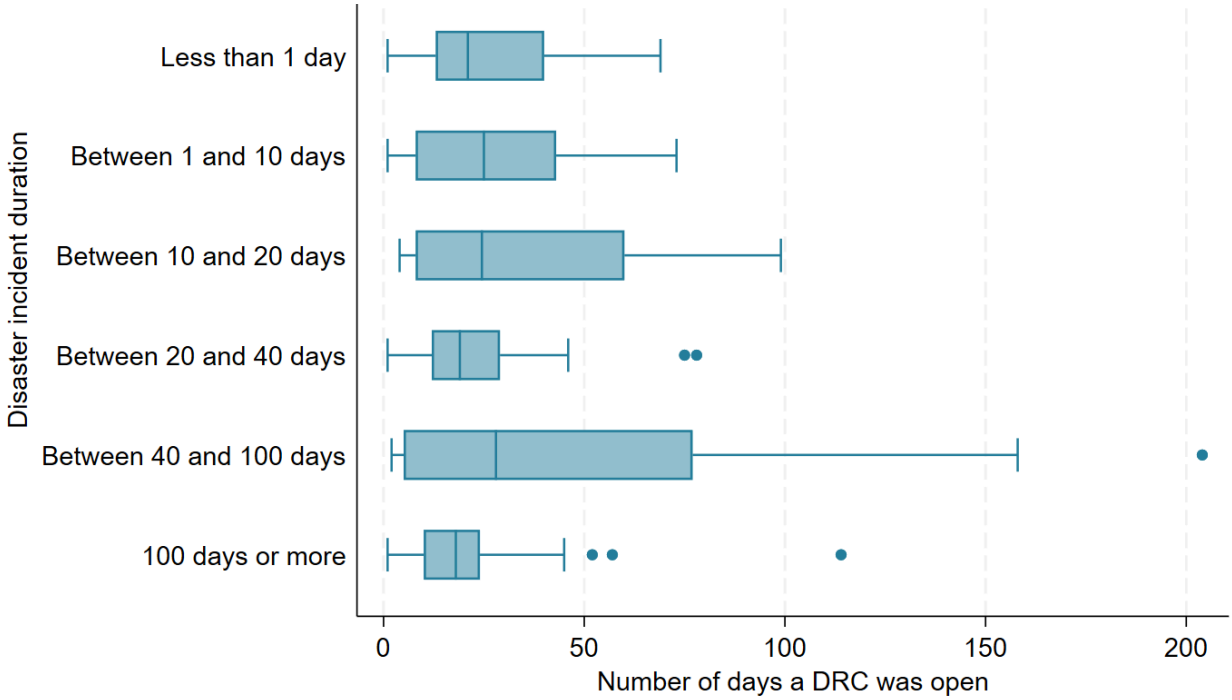
Table 3. Mean and median DRC operational time by disaster type

Disaster incident type	Number of DRCs	Mean (in days)	Median (in days)
Fire	16	41	17
Hurricane	168	35	29
Tornado	3	33	30
Winter storm	1	29	29
Flood	104	27	22
Severe storm	116	22	18

Disaster severity:

Next, we look at how DRC operational time is related to disaster severity. Disaster severity can be proxied by disaster incident length,[13] as documented in the Analysis Plan. We also explore how DRC operational time relates to other potential proxy measures for disaster severity, such as total registrations (see Table 11).[14] Figure 3 provides a box and whisker plot of the number of days a DRC was open by disaster length. We also report mean and median operational time by disaster incident length in Table 4.

Figure 3. Box and whisker plot of number of days a DRC was open by disaster incident length



[13] We compute disaster incident length as the difference between incident start date and incident end date measured in days and bin observations into disaster length categories.

[14] This analysis was not pre-specified in the Analysis Plan.

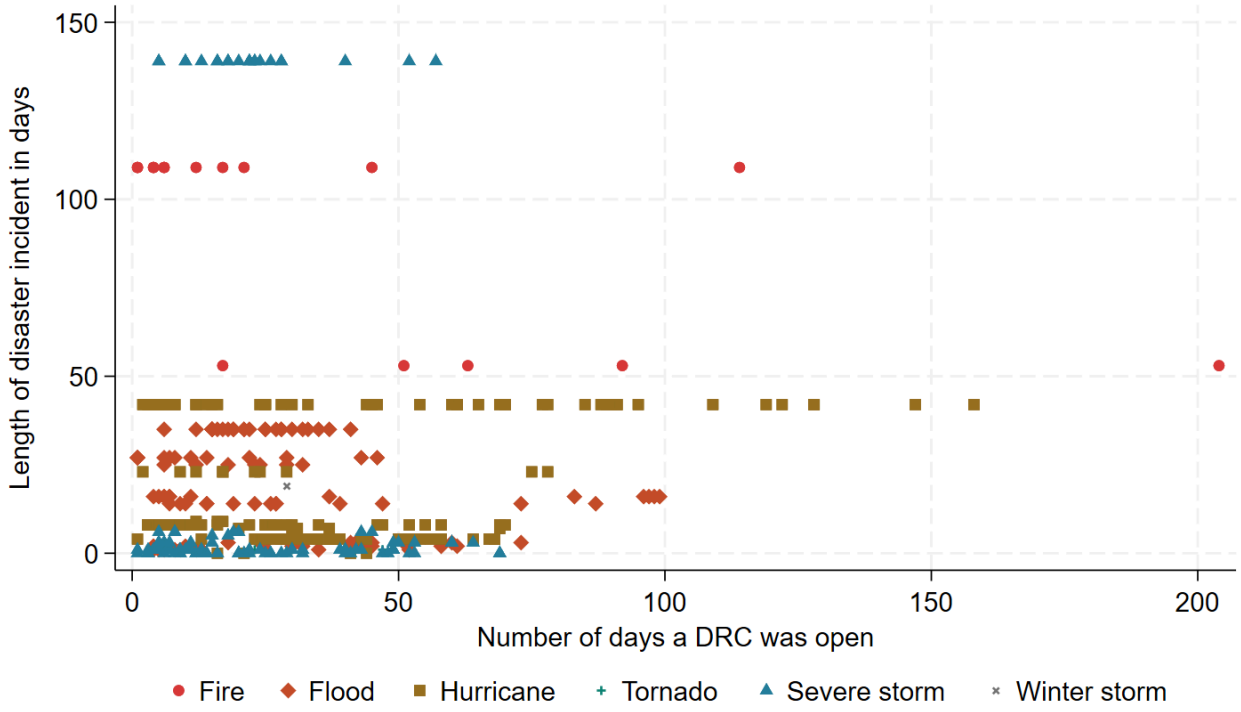
Table 4. Mean and median DRC operational time by disaster incident length

Disaster incident length	Mean	Median
Less than 1 day	26	21
Between 1 and 10 days	27	25
Between 11 and 20 days	34	24.5
Between 21 and 40 days	22	19
Between 41 and 99 days	46	28
100 days or more	22	18

Figure 4 plots of the disaster incident length against DRC operational time[15], which shows that within a particular disaster (i.e., across a particular horizontal line), there is substantial variation in the number of days a DRC is operational.

[15] This visualization was not pre-specified in the Analysis Plan.

Figure 4. Scatter plot of disaster incident length and DRC operational time, by disaster incident type



Note: We plot 33 different disaster incidents and only have 1 tornado and 1 winter storm occurrence in our data. Therefore, the disaster incident length is the same for the tornado and winter storm, but may vary for other disaster incidents plotted here (i.e., there are 12 severe storms, 10 floods, 7 hurricanes, and 2 fires).

Geographical location:

We also look at DRC operational time based on geographical factors, including FEMA region and urban versus rural classification of the DRC. Table 5 provides the mean and median DRC operational time by FEMA region. We visualize the average days DRCs were open across FEMA regions in Figure 5.

Table 5. Mean and median number of DRC operational time, by FEMA region[16]

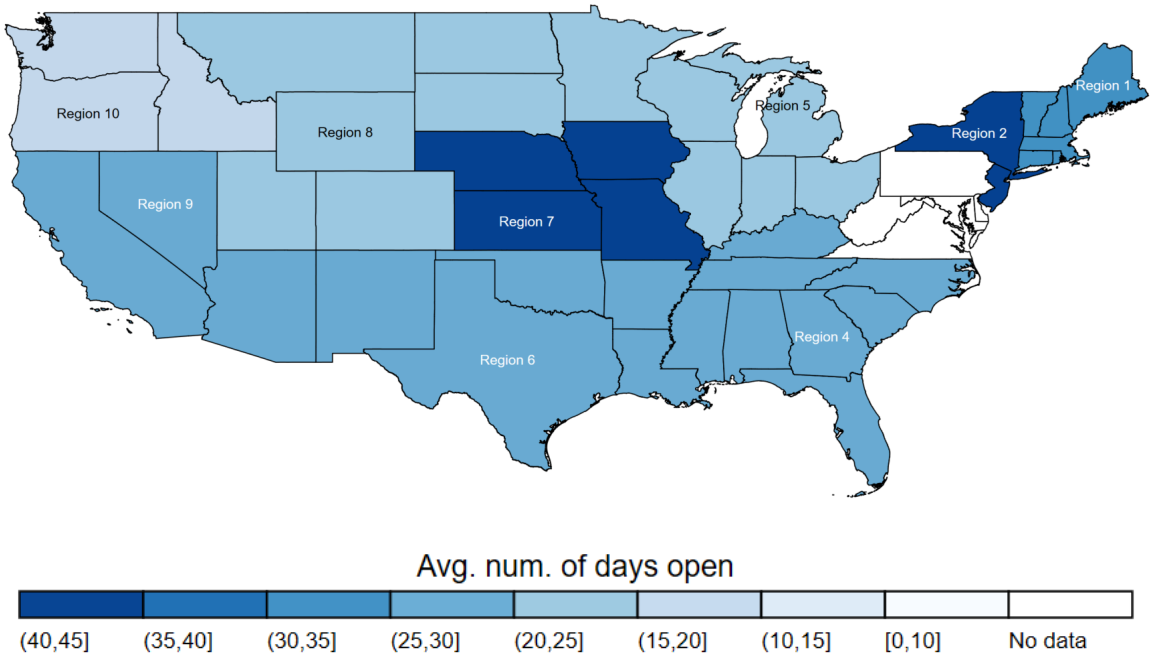
FEMA region	States/territory	Mean	Median
1	Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont	30	25
2	New Jersey, New York, Puerto Rico, Virgin Islands	41	38
4	Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee	30	17
5	Illinois, Indiana, Michigan, Minnesota, Ohio, Wisconsin	22	10
6	Arkansas, Louisiana, New Mexico, Oklahoma, Texas	28	20
7	Iowa, Kansas, Missouri, Nebraska	42	42
8	Colorado, Montana, North Dakota, South Dakota, Utah, Wyoming	21	23
9	Arizona, California, Hawaii, Nevada, Guam, American Samoa, Commonwealth of Northern Mariana Islands, Republic of Marshall Islands, Federated States of Micronesia	29	22

[16] FEMA regions sourced from: https://www.fema.gov/about/regions.

10	Alaska, Idaho, Oregon, Washington	16	10

Note: Since there were no observations within FEMA region #3, it is excluded from the tabulation.

Figure 5. Average number of DRC operational time, by FEMA region



Note: Region 3 is excluded from the map since there are no DRCs in our dataset for that region. The geographical regions of Hawaii, Alaska, American Samoa, Guam, Puerto Rico, U.S. Virgin Islands, and Northern Mariana Islands are excluded from the map for visual clarity.

Next, we consider how DRC operational time differs for DRCs in urban vs. rural places.[17] Table 6 contains the mean and median DRC operational time by urbanity. DRCs located within an urban county were open for 31 days on average while DRCs located within a rural county were open for 27 days on average.

[17] Each DRC is merged to its corresponding USDA rural urban continuum code by FIPS code. We define a county to be urban if its description was "metro" or had a continuum code 3 or lower and defined a county to be rural if its description was "non-metro" and had a continuum code of 4 or higher.

Table 6. Mean and median DRC operational days by urbanization

Urbanization	Mean	Median
Rural	27	20
Urban	31	25

Supplemental analysis

DRC operational time by DRC type and urbanization: In Table 7, we report the average number of days open by DRC type and urbanization.

Table 7. Average DRC operational time (in days) by DRC type and urbanization

DRC type	Rural	Urban
Disaster Recovery Center (DRC)	34.8	39.4
Mobile Disaster Recovery Center (MDRC)	6.78	9.82
Community Recovery Center (CRC)	25	20.3
Document Drop-off Center (DDC)	13.5	N/A

DRC operational time by DRC type and disaster incident type: We provide the average DRC operational time by DRC type and disaster incident type in Table 8.[18] For fire, hurricanes, and severe storms, we see that MDRCs are open for a much shorter period of time in comparison to standard DRCs.

[18] Note that many of the cells are empty for CRCs and DDCs since there were no DRCs of these types that experienced that particular disaster incident type.

Table 8. Average disaster operational time (in days) by DRC type and disaster incident type

DRC type	Fire	Flood	Hurricane	Severe storm	Tornado	Winter storm
Standard Disaster Recovery Center (DRC)	63	32.50	45.85	27.7	35	29
Mobile Disaster Recovery Center (MDRC)	4.66	11.52	6.92	9.08	30	–
Community Recovery Center (CRC)	–	–	21.5	–	–	–
Document Drop-off Center (DDC)	–	–	–	13.5	–	–

Disaster incident length by disaster type: We also examined how disaster incident length varies by disaster types. Fires have on average the longest duration with 81 days, followed by winter storms (19 days), hurricanes (13.28 days), severe storms (13.08 days), and floods (12.8 days). Tornadoes have the shortest disaster duration of 1 day.

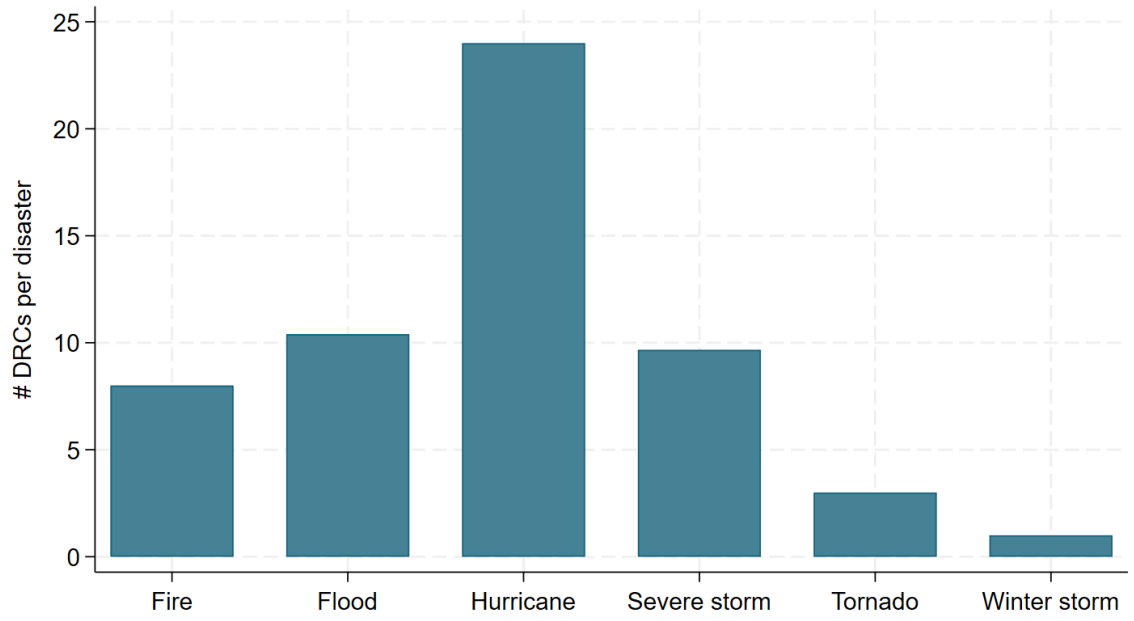
RQ1(d) How many DRCs are stood up for different disaster types? Does the number of DRCs stood up for a given disaster relate to different contextual factors (e.g., disaster severity, geographical location)?

We count the number of DRCs associated with each disaster type. Table 9 contains these counts in column 2. Because the frequency of disaster types varies within the data, we also report the average number of DRCs per disaster in column 4 (rounded to the nearest integer). Hurricanes have the most DRCs as well as the most DRCs per disaster incident, followed by floods, severe storms, and fires. Figure 6 contains a bar graph visualizing the data reported in Table 9 column 4. Results of a one-way Analysis of Variance test (ANOVA) found that the average number of DRCs per disaster is not significantly different across disaster incident types ($p = 0.185$).

Table 9. Number of DRCs by disaster incident type

Disaster incident type	Number of DRCs	Number of disasters	Number of DRCs per disaster
Hurricane	168	7	24
Severe storm	116	12	10
Flood	104	10	10
Fire	16	2	8
Tornado	3	1	3
Winter storm	1	1	1

Figure 6. Number of DRCs per disaster by disaster incident type



Number of DRCs by disaster severity

Next, we consider how the number of DRCs relates to disaster severity, see Table 10. As before, we proxy disaster severity by disaster length.[19] Column 2 reports the number of DRCs associated with various disaster lengths measured in days. Note that disaster length is defined at the disaster-level and thus we see that there are multiple disasters occurring within a particular disaster length bin. Column 3 contains the count of disasters within each disaster duration bin. We then compute the number of DRCs per number of disasters within the duration bin in column 4.

Table 10. Number of DRCs by disaster incident duration

Disaster incident duration	Number of DRCs	Number of disasters within duration bin	Number of DRCs per disaster within duration bin
Less than 1 day	37	5	7.4
Between 1 and 10 days	186	17	10.9
Between 11 and 20 days	28	3	9.3
Between 21 and 40 days	55	4	13.7
Between 41and 99 days	69	2	34.5
100 days or more	33	2	16.5

Another way to provide a proxy measure for disaster severity is analyzing the total number of registrations associated with a disaster. While we cannot assume that this indicates disaster severity directly, it provides information on the population number affected by the disaster. To compute the total number of registrations associated with a disaster, we summed the total number of registrations ('Total Valid Registrations" variable in the Registration Intake Individuals Household Programs dataset) by disaster and county and binned the observations into categories based on the number of registrations in the thousands.[20] Note that there were two DRC-level observations which did not have a corresponding "Total Valid Registrations" observations and thus

[19] This analysis is not pre-specified in the Analysis Plan.

[20] Registrations are for the FEMA Individual and Household Program (IHP).

were excluded in this count.[21] Table 11 contains the count of DRCs by the total number of valid registrations in thousands.

Table 11. Number of DRCs by disaster by total valid registrations

Total valid registrations (thousands)	Number of DRCs	Number of rural DRCs	Number of urban DRCs
0 to 100	16	5	11
101 to 500	77	42	35
501 to 999	37	20	17
1 to 10 thousand	158	65	93
11 to 20 thousand	30	4	26
21 to 500 thousand	88	5	83

Number of DRCs by geographical location - FEMA region

Table 12 contains the number of DRCs by FEMA region. We see that FEMA region #4 has the highest number of DRCs (194), while FEMA region #8 and #7 both have the least (7 DRCs). To control for the number of disasters within each region, we also report the number of DRCs per disaster by FEMA region in column 5 of Table 12. After adjusting for the number of disasters each FEMA region experiences, we see that FEMA region #2 has the most DRCs per disaster, followed by region #1 and region #10. Our interpretation is that although FEMA region #4 experiences more disasters, the disasters experienced in FEMA region #2 demand more DRCs. For visual representation, Figure 7 maps the number of DRCs per FEMA region while Figure 8 maps the number of DRCs per disaster by FEMA region. A one-way ANOVA test on the number of DRCs at the disaster-level concludes that there are no significant differences in the mean number of DRCs per disaster across FEMA regions ($p = 0.92$).

[21] These two observations include Disaster Unique ID 4680 Hardee County and Disaster Unique ID 4697 Washington County.

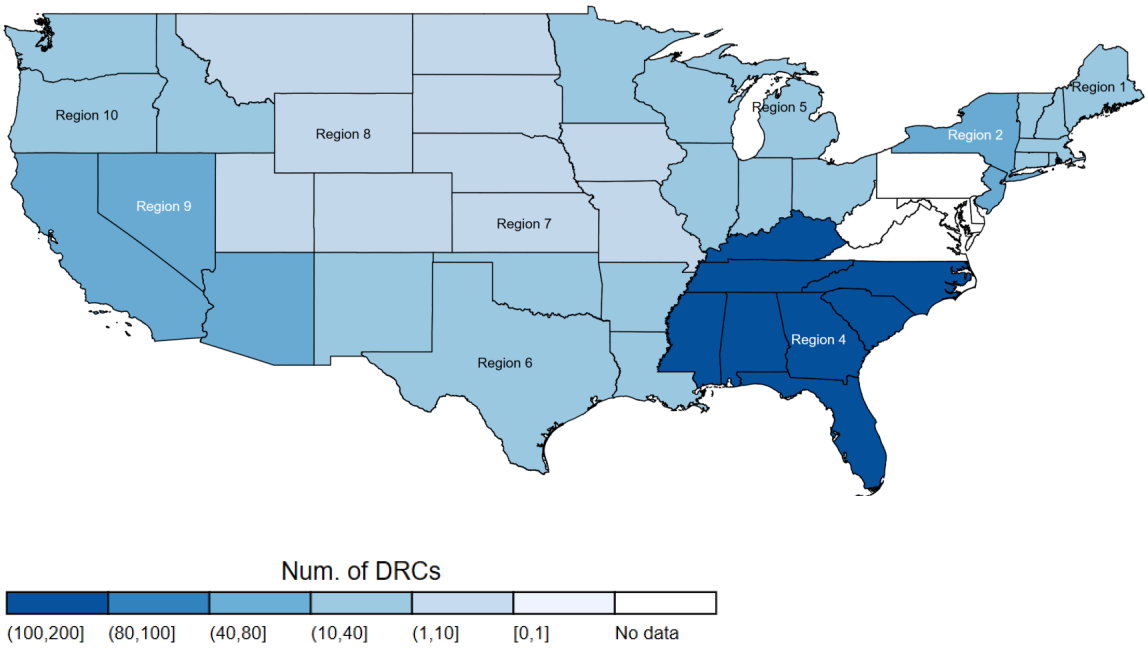
Table 12. Number of DRCs by FEMA region

FEMA region	State/territory	Number of DRCs	Number of disasters	Number of DRCs per disaster
1	Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont	14	1	14
2	New Jersey, New York, Puerto Rico, Virgin Islands	49	2	24.5
4	Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee	194	13	14.9
5	Illinois, Indiana, Michigan, Minnesota, Ohio, Wisconsin	38	4	9.5
6	Arkansas, Louisiana, New Mexico, Oklahoma, Texas	27	4	6.7
7	Iowa, Kansas, Missouri, Nebraska	7	1	7
8	Colorado, Montana, North Dakota, South Dakota, Utah, Wyoming	7	1	7
9	Arizona, California, Hawaii, Nevada, Guam, American Samoa, Commonwealth of Northern Mariana Islands, Republic of Marshall Islands, Federated States of Micronesia	60	6	10

10	Alaska, Idaho, Oregon, Washington	12	1	12

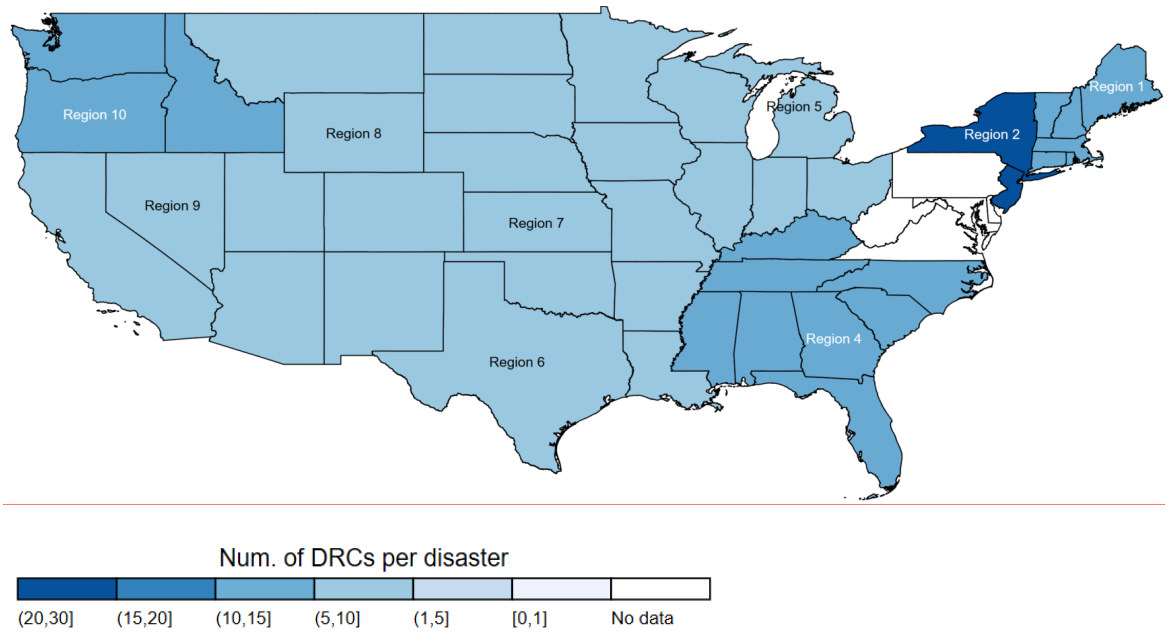
Note: Since there were no observations within FEMA region #3, it is excluded from the tabulation.

Figure 7. Number of DRCs by FEMA region



Note: Region 3 is excluded from the map since there are no DRCs in our dataset for that region. The geographical regions of Hawaii, Alaska, American Samoa, Guam, Puerto Rico, U.S. Virgin Islands, and Northern Mariana Islands are excluded from the map for visual clarity.

Figure 8. Number of DRCs per disaster by FEMA region



Note: Region 3 is excluded from the map since there are no DRCs in our dataset for that region. The geographical regions of Hawaii, Alaska, American Samoa, Guam, Puerto Rico, U.S. Virgin Islands, and Northern Mariana Islands are excluded from the map for visual clarity.

Number of DRCs by geographical location - urban vs. rural location

Table 13 contains the number of DRCs by urbanization, as well as the number of counties within each category and the number of DRCs per county by urbanization. We see that after adjusting for the number of disasters within a region, the number of DRCs is very similar across urban and rural places. The results of a one-way ANOVA has determined that there is no significant difference between the number of DRCs between urban and rural regions ($p = 0.659$). Note that for the one-way ANOVA, the unit of analysis is at the county-disaster level since urbanization is defined at the county level.

Table 13. Number of DRCs by urbanization

Urbanization	Number of DRCs	Number of counties	Number of DRCs per county
Rural	143	87	1.6
Urban	265	152	1.7

Supplemental analysis

Number of DRCs by county population: We also explore how the number of DRCs correlates to a county population level. Using the data merged in from USDA, we obtain a population estimate of the associated county from the 2020 U.S. Census. At the disaster-county level (a total of 239 disaster-county observations within our dataset), we see there is a positive Pearson correlation coefficient between the county population estimated by the 2020 census and the number of DRCs ($\rho = 0.48$, $p < .001$) and total days open ($\rho = 0.27$, $p < .001$).

Number of DRCs per disaster incident type by DRC type: Below we tabulate in Table 14 the number of DRCs stood up by disaster incident type and by DRC type. Community Recovery Centers (CRCs) were only deployed in hurricane disasters while Document Drop-off Centers (DDCs) were only deployed for severe storm disasters.

Table 14. Number of DRCs per disaster incident type by DRC type

DRC type	Fire	Flood	Hurricane	Severe storm	Tornado	Winter storm
Community Recovery Center (CRC)	–	–	4	–	–	–
Document Drop-off Center (DDC)	–	–	–	2	–	–
Disaster Recovery Center (DRC)	10	79	122	80	2	1
Mobile Disaster Recovery Center (MDRC)	6	25	42	34	1	–

Number of DRCs by DRC type and urbanization: In Table 15, we count the number of DRCs stood up by both urbanization and DRC type. DDCs are exclusively located in rural counties. MDRCs are more likely to be deployed in urban counties and this pattern is also present for standard DRCs.

Table 15. Number of DRCs by DRC type and urbanization

DRC type	Rural	Urban
Community Recovery Center (CRC)	1	3
Document Drop-off Center (DDC)	2	0
Disaster Recovery Center (DRC)	102	192
Mobile Disaster Recovery Center (MDRC)	38	70

RQ2: What does DRC visitation look like during a disaster response?

RQ2(a): When during a disaster response are people most likely to visit DRCs?

To answer this question, we create a variable called "DRC-day" which is a cumulative count of days open for a particular DRC. For example, the 5th day a particular DRC was open would have DRC-day equal to 5. For each DRC, we find which DRC-day had the most visits (a sum of first-time visits and return visits). We then compute the average DRC-day among this set of DRC maximum visit days.

We find that DRCs experienced the highest number of visits on average **9.91 days** after opening (median = 5.75 days). DRCs experienced the highest number of first-time visits an average of **7 days** after opening (median = 4 days) and experienced the highest number of return visits on average **20.88 days** after opening (median = 15 days).

Supplemental analysis

Visit counts by urbanity: Rural DRCs had a cumulative count of 120,587 visits and an average daily visit count of 31 (with an interquartile range of 7 to 35 visits) while urban DRCs had a cumulative count of 429,314 visits and an average daily visit count of 52 (with an interquartile range of 10 to 66 visits).

Visit counts by DRC type: CRCs have the maximum number of daily visits **13.25** days after opening, while DDCs have their day of maximum visits **5** days after opening. Standard DRCs have their maximum number of visits **11.77** days after opening while MDRCs have the maximum number of visits **4.82** days after opening.

RQ2(b): When during a disaster response are repeat visits to DRCs most prevalent?

We use the same methodology as RQ2(a) above but only consider return visits. Across all DRCs and all operational days, the average proportion of return visits is **29.4%.** DRCs see the highest proportion of return visits **26.5 days** after opening on average (median = 18 days).

Supplemental analysis

Return visits by DRC type: When examining these numbers by DRC type, we find that the average proportion of return visits is higher for CRCs (**70.2%**) and DDCs (**68.9%**) in comparison to standard DRCs (**32.4%**) and MDRCs (**18.8%**).

All non-standard DRCs experience the maximum proportion of return visits sooner than standard DRCs. Standard DRCs have their maximum proportion of return visits **33.6** days after opening, while CRCs, DDCs, and MDRCs experience their maximum proportion of returnvisits **9.6**, **11.3**, and **7.94** days after opening, respectively.

RQ2(c): When during a disaster response are people most likely to visit DRCs by different disaster types?

Table 16 provides the average DRC-day when DRCs experience their highest visit count (column 2) as well as the highest proportion of return visits (column 3). DRCs associated with tornado disasters face the day with the highest visit count the earliest, 2.3 days after opening, while winter storms face the maximum visit count the latest at 14 days. The day that demonstrates the maximum return proportion of visits varies substantially across disaster incident types. For example, DRCs associated with severe storms have their maximum proportion of return visits 19.3 days after opening on average while DRCs associated with fire disasters experience their maximum proportion of return visits 37 days after opening.

An one-way ANOVA shows that disaster types do not explain differences in the day with the most visits (p = 0.6236) but do explain differences in the day with the maximum proportion of return visits (p = 0.000).

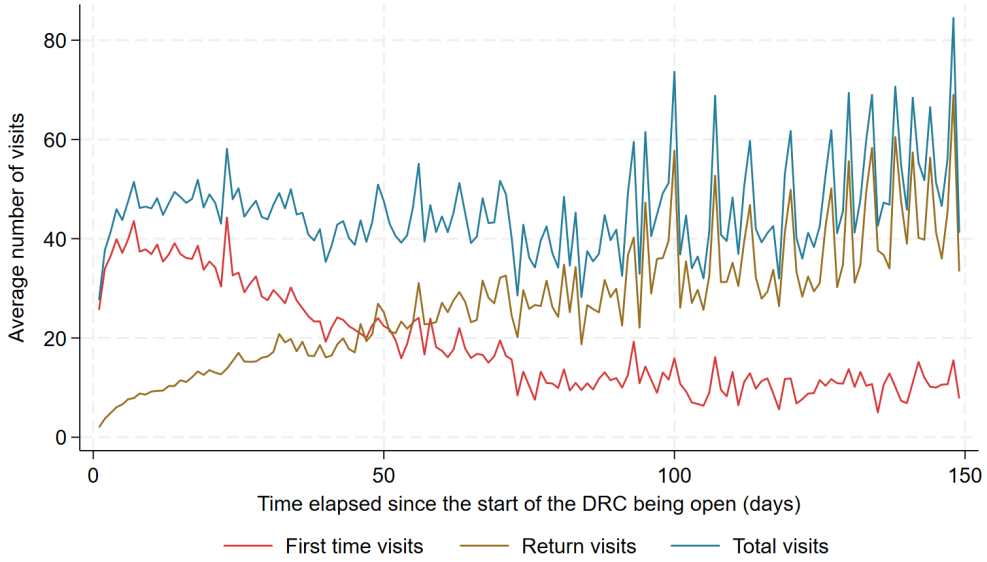
Table 16. Average day DRCs experienced maximum count of visits and maximum proportion of return visits by disaster type

Disaster incident type	Day of maximum visit counts	Day of maximum proportion of return visits
Winter storm	14	33
Flood	10.7	22.6
Hurricane	10.1	32.7

Severe storm	9.2	19.3
Fire	9.2	37
Tornado	2.3	32.7

For visual purposes, we also include line graphs of the average number of first-time visits, return visits, and total visits across all DRCs (Figure 9) as well as separately by disaster incident types (Figures 10-15).

Figure 9. Average daily visits across DRC lifecycles



Note: The graph above reports visit counts for the first 150 days

Figure 10. Average daily visits across DRC lifecycles - severe storm disasters

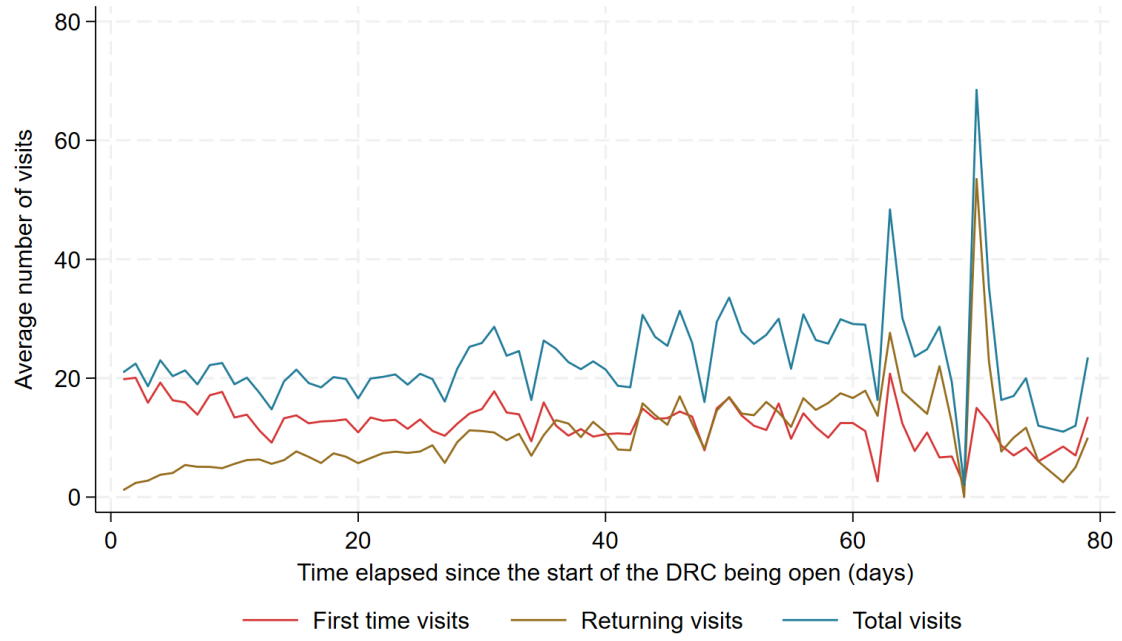


Figure 11. Average daily visits across DRC lifecycles - winter storm disasters

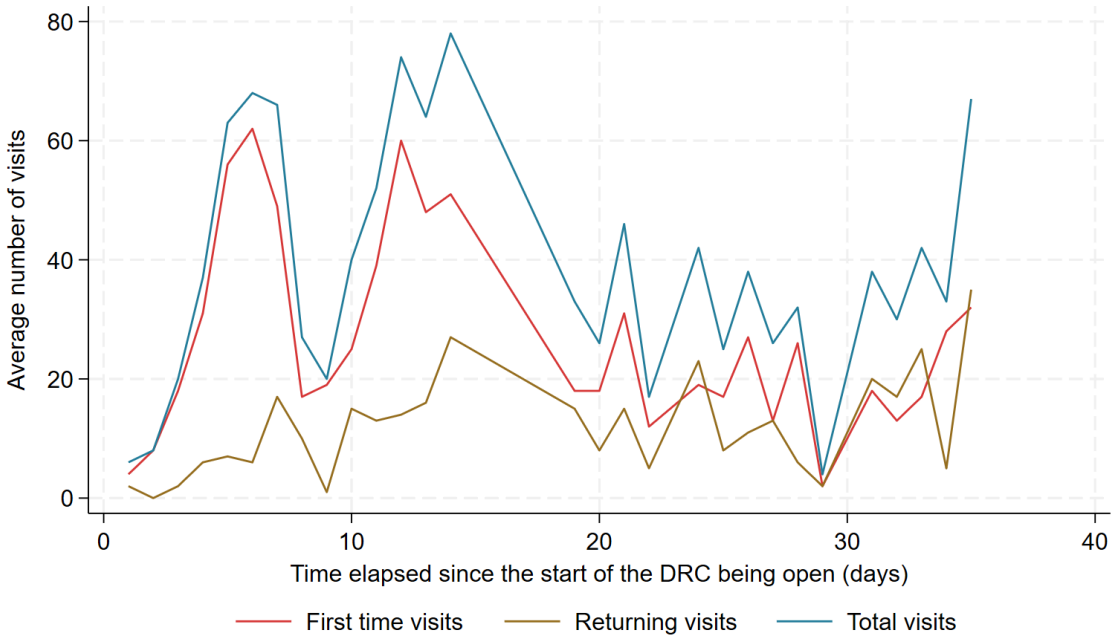


Figure 12. Average daily visits across DRC lifecycles - tornado disasters

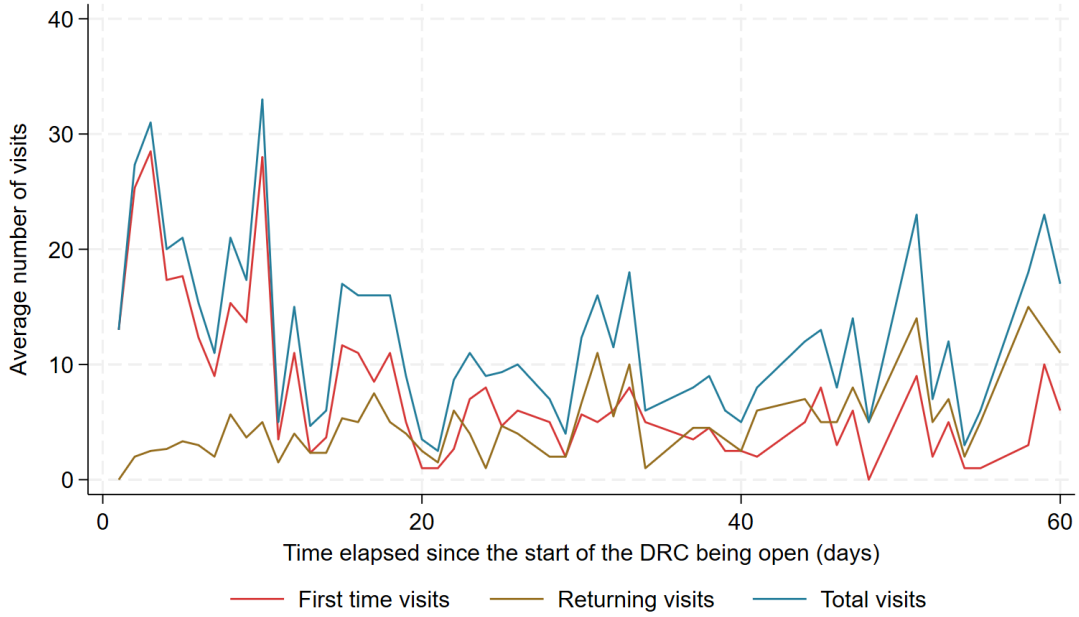
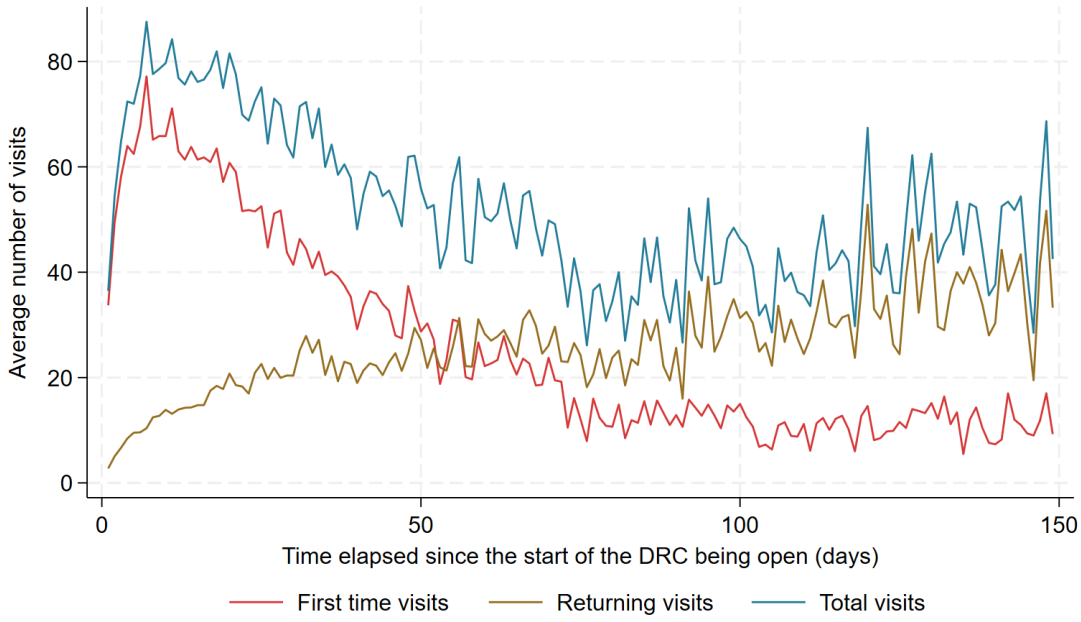
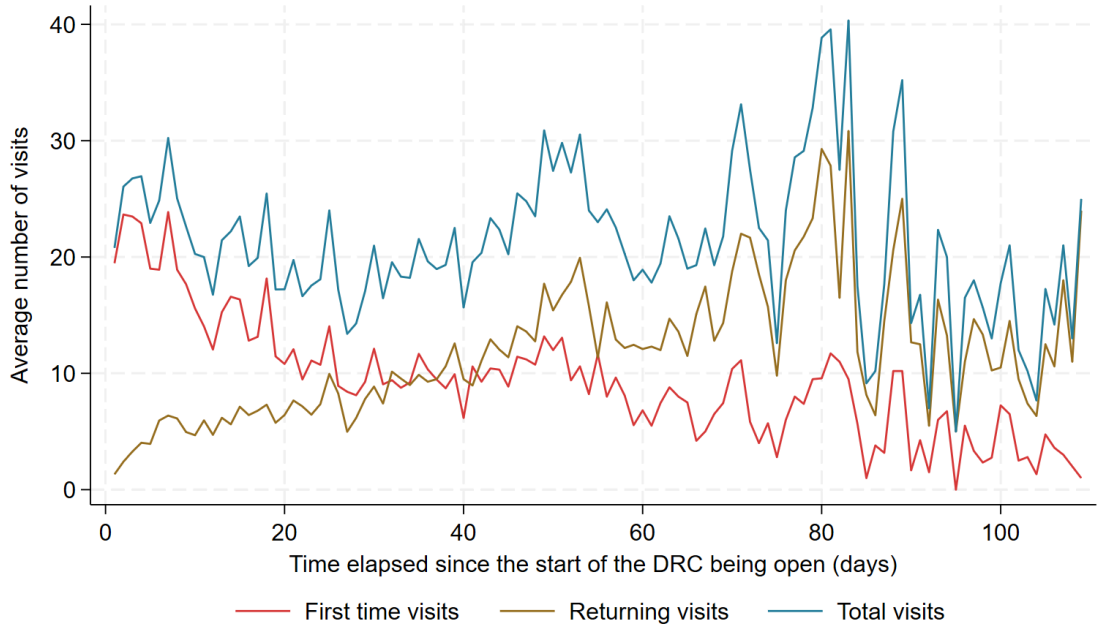


Figure 13. Average daily visits across DRC lifecycles - hurricane disasters



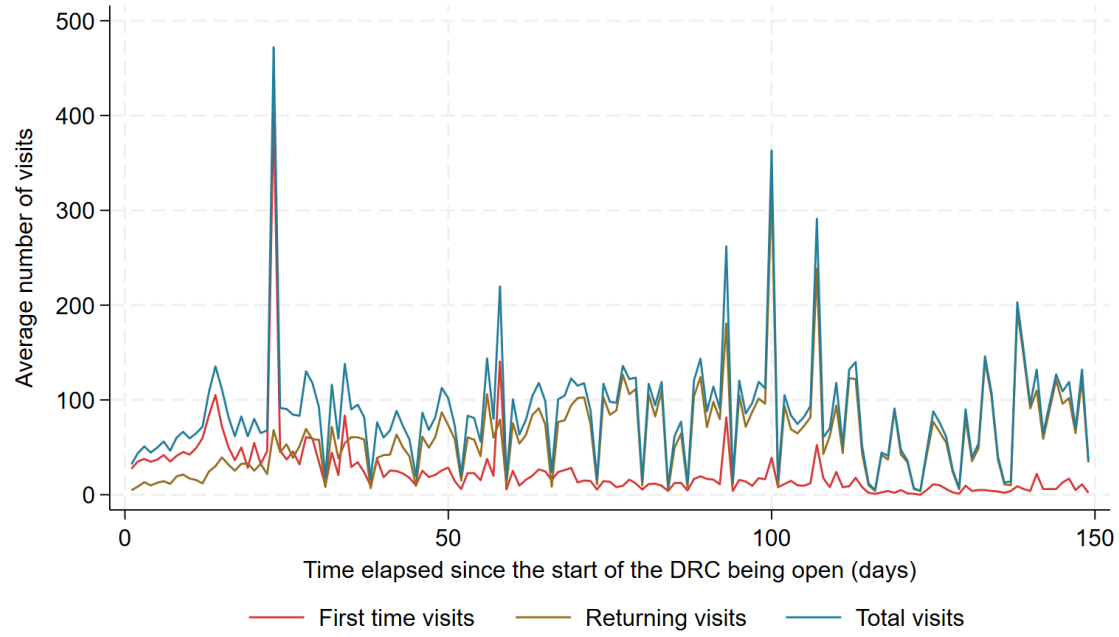
Note: The graph above reports visit counts for the first 150 days.

Figure 14. Average daily visits across DRC lifecycles - flood disasters



Note: The graph above reports visit counts for the first 150 days.

Figure 15. Average daily visits across DRC lifecycles - fire disasters



Note: The graph above reports visit counts for the first 150 days.

RQ3: What do the different services/activities that DRC visitors seek help for look like during a disaster response?

Note that for this portion of the analysis, we exclude the "Exit Interview" service/activity as it is never the sole purpose of a visit.

RQ3(a): What are the most common activities that DRC visitors seek help for?

To calculate activity frequency, we sum the number of service/activity counts for each service/activity category across DRCs and visit dates (see Table 17). The five most common activities at DRCs are "Status Checks" (29.6%), "Hazard Mitigation" (10.1%), "Documentation" (7.3%), "Registration" (7.1%), and "Federal Program" (6.2%).

Table 17. Total frequency by service/activity

Service/activity	Total count	Percentage
Status Check	392,115	29.6%
Hazard Mitigation	133,985	10.1%
Documentation	96,939	7.3%
Registration	94,724	7.1%
Federal Program	82,341	6.2%
Personal Property	71,052	5.4%
State/Local Services	67,280	5.1%
Housing Assistance	62,531	4.7%
Home Repair	56,384	4.3%
NGO	51,384	3.9%
Information Only	42,595	3.2%
Inspection	35,821	2.7%
Uncategorizable	33,942	2.6%
Counseling	32,259	2.4%
Appeal	30,872	2.3%
Closing	10,265	0.8%
Transportation	9,135	0.7%
Update/Change	7,080	0.5%
Food Assistance (EBT/SNAP)	5,774	0.4%
Medical/Dental/Funeral	2,673	0.2%
Tax and Legal Services	2,576	0.2%
Dependent/Pet Care	691	0.1%
Clean up	681	0.1%
Request	672	0.1%

SBA	494	0%
Application Help	340	0%
Insurance	240	0%
Fraud/ID Theft	150	0%

Supplemental analysis

Most common service/activity by DRC type: For each DRC, we identify the service/activity which had the most visits in a day across a DRC's entire lifecycle. We count the number of DRCs which had the particular service/activity as its identified primary activity by DRC type. Table 18 provides these counts of DRCs by service/activity and DRC type. For a majority of standard DRCs, MDRCs, and CRCs and DDCs, "Status Checks" are the primary activity.

Table 18. Number of DRCs with service/activity as its primary activity by DRC type

Service/activity	Standard Disaster Recovery Center (DRC)	Mobile Disaster Recovery Center (MDRC)	Community Recovery Center (CRC)	Document Drop off Center (DDC)
Status Check	242	83	4	2
Registration	20	9		
State/Local Services	10	6		
Information Only	7	9		
Hazard Mitigation	6	7		
Personal Property	3			
Federal Program	3			
NGO	2	2		
Housing Assistance	2			
Documentation	2	4		
Home Repair	1	2		
Food Assistance (EBT/SNAP)	1			

Note: Some cells are blank within the table since some DRC types never had a particular service/activity as its primary activity.

RQ3(b): How does the most common activity change over the course of disaster responses?

We find the most frequent service/activity for each DRC and visit date. For each DRC, we then compute the percentage of days a particular service/activity was the most popular for a DRC.[22] We then find the average percentage of days a service/activity was the most popular across DRCs.[23] Table 19 column 2 contains the percentage of days a service/activity was the most popular. For example, we find that "Status Checks" was the most popular service/activity in 68.7% of all DRCs, followed by "Registrations" (most popular 12.5% of the time). From there, percentages for the most frequent service/activity drop precipitously. Note that some services/activities were never the most popular activity on a given day, such as "Fraud/ID Theft". Using this constructed dataset, we compute the average DRC-day by service/activity. Table 19 column 3 shows how many days after opening on average a particular service/activity was the most frequent. For example, "Appeals" are the most popular service/activity approximately 33.7 days after opening a DRC on average.

Table 19. Percentage of days service/activity was the most frequent activity and average day where most frequent

Service/activity	Percentage of days most frequent activity	Average day when most frequent
Status Check	68.7%	19.4
Registration	12.5%	10.1
Hazard Mitigation	8.1%	15.0
Information Only	7.8%	15.9
Documentation	7.2%	26.4
State/Local Services	5.8%	18.1
Federal Program	3.1%	22.9
Home Repair	2.8%	28.6
Housing Assistance	2.3%	24.4

[22] Calculated as the number of days a particular service/activity was the most frequent, divided by the total number of days the DRC was open.

[23] Calculated as the sum of the percentage of days across DRCs divided by the total number of DRCs. Note that in this approach, we are treating each DRC with equal weight in our final calculation.

Personal Property	1.9%	23.8
NGO	1.6%	15.5
Uncategorizable	1.51%	26.7
Appeal	1.2%	33.7
Inspection	0.9%	22.9
Counseling	0.6%	21.3
Transportation	0.2%	16.5
Closing	0.2%	59.7
Food Assistance (EBT/SNAP)	0.1%	14.2
Tax and Legal Services	0.1%	30.3
Application Help	0.02%	9
Medical/Dental/Funeral	0.02%	42.5
Request	0.02%	1
Dependent/Pet Care	0.02%	9
Insurance	0.01%	46
Update/Change	0%	.
Fraud/ID Theft	0%	
Clean-up	0%	
SBA	0%	

Note: Average day when most frequent is computed among all DRCs which reported a particular service/activity as its most frequent. As such, services/activities which were never reported as the most frequent service/activity did not have a corresponding DRC-day and thus are excluded from this calculation.

Next, we look at the primary service/activity associated with each DRC. For each DRC-day, we calculate the daily service/activity percentage for a particular service/activity (i.e., total visits for a particular service/activity divided by the total number of service/activities for that DRC-day). We then define a DRC's primary activity by finding the service /activity that had the maximum daily service/activity percentage across its lifecycle. We then count the number of DRCs which had the particular service/activity as its identified primary activity. Table 20 provides these counts of DRCs

by service/activity. By a large margin, “Status Checks” are the most popular service/activity across a majority of DRCs.

Table 20. Number of DRCs with service/activity as its primary activity

Service/activity	Number of DRCs with service/activity
Status Check	331
Registration	29
Information Only	16
State/Local Services	16
Hazard Mitigation	13
Documentation	6
NGO	4
Home Repair	3
Personal Property	3
Federal Program	3
Housing Assistance	2
Food Assistance (EBT/SNAP)	1

RQ3(c): What types of activities are most common for different disaster types (e.g., flooding, hurricane/tropical storms), and when?

Similar to the approach in RQ3(b), we find the most frequent service/activity on each DRC-day and calculate the average DRC-day when this occurred for every DRC. We then compute the average DRC-day at the disaster incident level aggregating across individual DRCs. Table 21 provides the average day when a particular service/activity was the most frequent by disaster incident type.

Table 21. Average day when services/activities occur most frequently at a DRC by disaster incident type (excluding exit interviews)

Service/activity	Fire	Flood	Hurricane	Severe storm	Tornado	Winter storm
Appeal	42.33	33.54	50.71	20.57	22	
Application Help		9				
Closing		33.92	71.65			
Counseling		31.91	20.17	8.92		
Dependent/Pet Care		9				
Documentation	30.6	23.85	33.76	19.84	27.9	
Federal Program	29.05	19.71	31.82	16.5		
Food Assistance (EBT/SNAP)		20.83	9.13	25		
Hazard Mitigation	12.33	15.55	18.09	11.29	10.33	16.11
Home Repair	46.43	29.58	38.99	18.43		
Housing Assistance	46.23	26.2	25.21	18.91	18.5	
Information Only	21.66	14.89	18.61	13.73	20.13	
Inspection	36.15	18.9	26.81	18.93	13	
Insurance		46				
Medical/Dental /Funeral			50	35		
NGO	16.47	16.16	17.75	12.07		
Personal Property		23.21	29.35	18.2	39	
Registration	12.1	10.8	9.28	10.08	8.17	15.71

Request				1		
State/Local Services	58.74	13.24	22.9	15.59		11.71
Status Check	25.3	17.36	23.82	14.19	22.21	30.67
Tax and Legal Services		46.14		14.5		
Transportation	1	17.38	22	17.25		
Uncategorizable	85.89	23.26	37.84	11.18		

Note: Average day with most frequent service/activity is computed among all DRCs which reported a particular service/activity as its most frequent. Services/activities that were never reported as the most frequent service/activity on any DRC-day for a particular disaster incident type are excluded from this calculation.

We also explore an alternative approach by looking at the DRC-day when a particular service/activity reaches its maximum percentage of all services/activities sought by visits each day.[24] We first compute the daily service/activity percentage for each service/activity at the DRC-day level. Next, we find the DRC-day(s) when the maximum service/activity percentage occurred for each service/activity at each DRC.[25]

Table 22 reports the average peak DRC-day when each service/activity occurred most frequently across disaster types. Where there were disaster incidents matched with DRCs that had zero observations for a particular service/activity, this will show an empty cell in the table below. The popularity of service/activities varies across the DRC lifecycle for different disaster types. For example, the "Clean Up" service/activity reached its maximum percentage early in the DRC life cycle (10 DRC-days) for DRCs associated with fire disasters, but reached its maximum percentage later (52 DRC-days) for DRCs associated with hurricane disasters.

[24] Note that this statistic assumes that daily service/activity percentages are "single peaked" throughout a DRC's lifecycle.

[25] When a DRC-service/activity reaches its maximum service/activity percentage on multiple days, we average these DRC-days first at the DRC-level. For example, if the maximum service/activity percentage for "Documentation" is 8% for a particular DRC, and this occurs on DRC-days 10 and 20, we calculate the average peak DRC-day for "Documentation" for that DRC to be (10+20)/2 = 15. We then average the peak DRC-days for each service/activity across disaster incident types.

Table 22. Average day with maximum service/activity percentage by disaster incident type (excluding exit interviews)

Service/activity	Fire	Flood	Hurricane	Severe storm	Tornado	Winter storm
Appeal	23	22	31	21	43	35
Application Help	86	23	40	35		
Clean up	10		52	28		
Closing	49	26	38	26	36	27
Counseling	45	16	20	14	45	
Dependent/Pet Care	21	24	20	25	26	5
Documentation	26	19	30	18	26	20
Federal Program	28	19	23	16	36	26
Food Assistance (EBT/SNAP)	18	16	10	18		
Fraud/ID Theft		50	18	13		
Hazard Mitigation	18	15	17	12	13	2
Home Repair	23	21	25	16	10	31
Housing Assistance	42	17	20	17	34	24
Information Only	8	16	23	14	19	29
Inspection	41	16	24	17	20	19
Insurance		21	31	17		
Medical/Dental/ Funeral	44	20	29	22	30	24
NGO	7	15	18	12	10	
Personal Property	19	17	22	15	26	31

Registration	8	11	12	9	11	9
Request		9	18	16		
SBA		63	26			
State/Local Services	41	15	19	13	26	10
Status Check	36	19	28	18	30	32
Tax and Legal Services	61	20	26	21	47	
Transportation	36	21	29	17	30	10
Uncategorizable	28	17	26	14	9	7
Update/Change	31	23	28	16		

Note: Average day with maximum service/activity percentage is computed among all DRCs which reported a particular service/activity as its maximum. Service/activities which were never reported for a particular disaster incident type did not have a corresponding DRC-day and are excluded from this calculation.

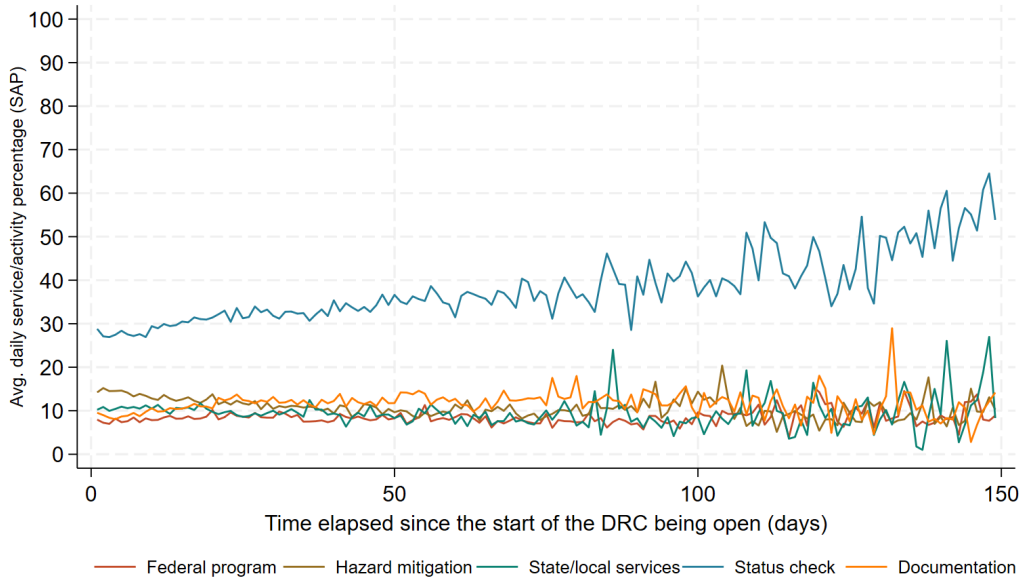
Supplemental analysis

Top five daily average service/activity percentages, by disaster incident type: We also include a visualization of the top five daily average service/activity percentages for all DRCs as well as broken down into disaster incident types (see Figures 16-22).[26,]

Finally, we look at how the daily total of service/activities compares to the daily total of visits. In almost all DRC-days, the total number of service/activities (minus exit interviews) is less than the recorded number of visits (11,852 out of 12,164, or 97% of DRC-days). On average, each visitor to DRC is recorded to participate in 3.3 service/activities across all DRC-days.

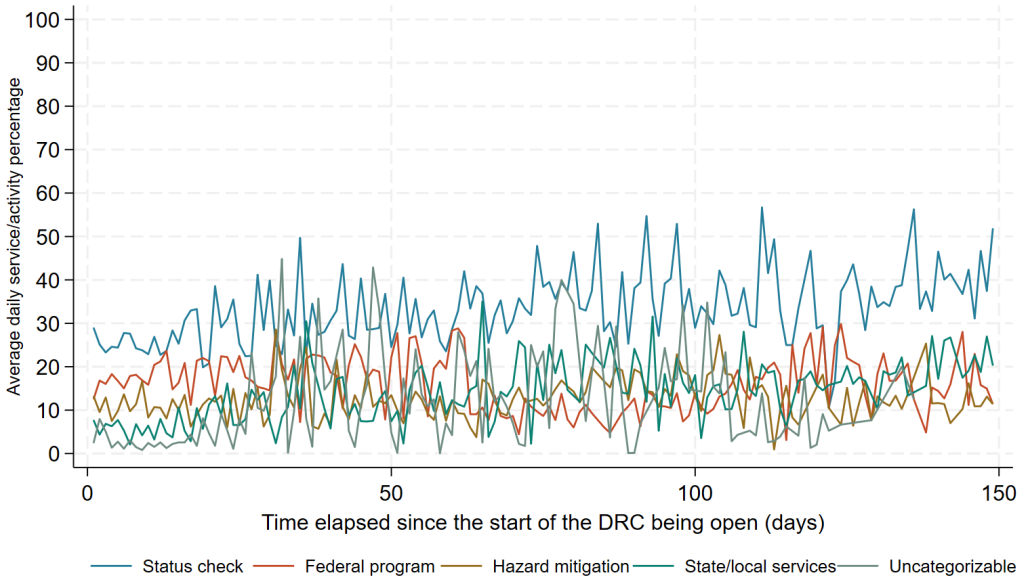
[26] As with the proceeding analyses of visit services/activities, "Exit Interview" is frequently the most common service/activity across all disaster types. Our understanding of exit interviews is that they occur after a visitor completed all other activities within a DRC and are interviewed by a DRC staff member. As such, we excluded the "Exit Interview" service/activity from the analysis.

Figure 16. Top five average daily service/activities across all DRCs



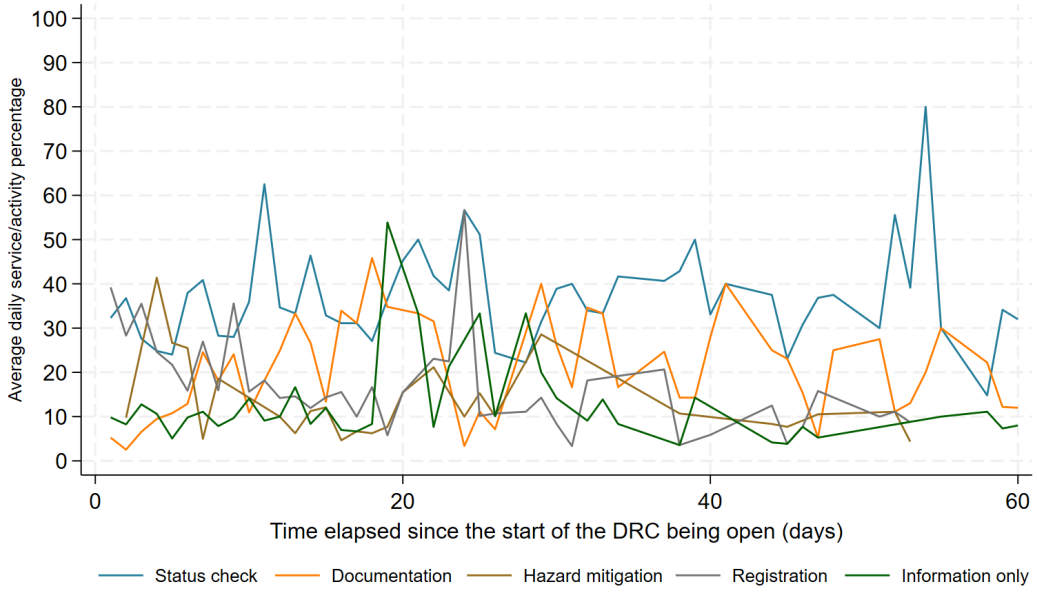
Note: Selection of the top five service/activities excluding exit interviews (defined as highest average SAP) across all DRCs. SAP is defined as daily service/activity percentage. Only the first 150 days of a DRC are presented.

Figure 17. Top five average daily service/activities for fire disasters



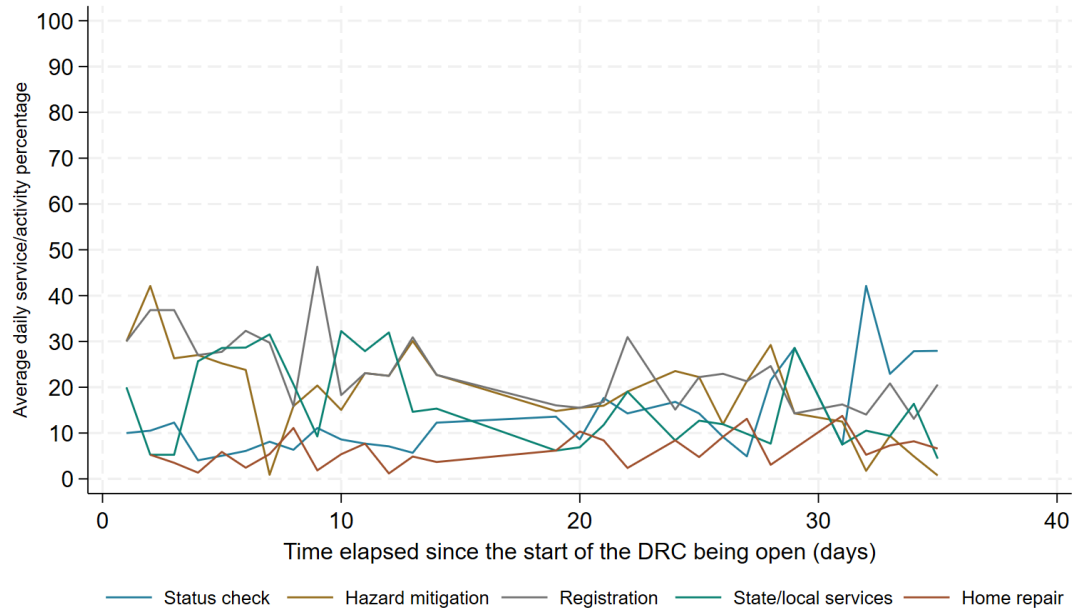
Note: Selection of the top five service/activities excluding exit interviews (defined as highest average SAP) across all DRCs. SAP is defined as daily service/activity percentage. Only the first 150 days of a DRC are presented.

Figure 18. Top five average daily service/activities for tornado disasters



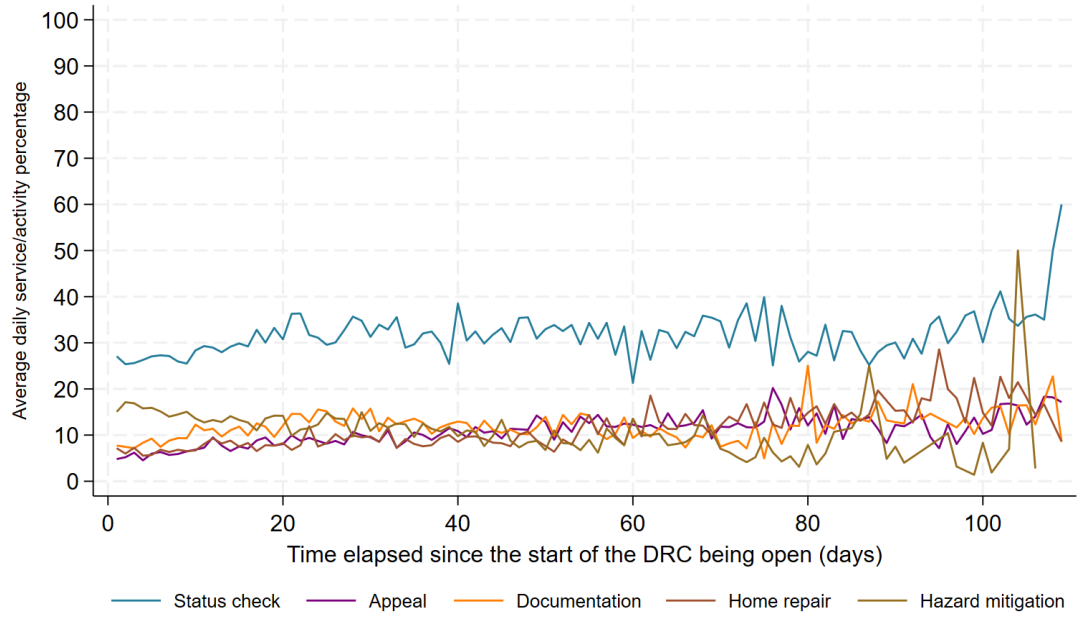
Note: Selection of the top five service/activities excluding exit interviews (defined as highest average SAP) across all DRCs. SAP is defined as daily service/activity percentage.

Figure 19. Top five average daily service/activities for winter storm disasters



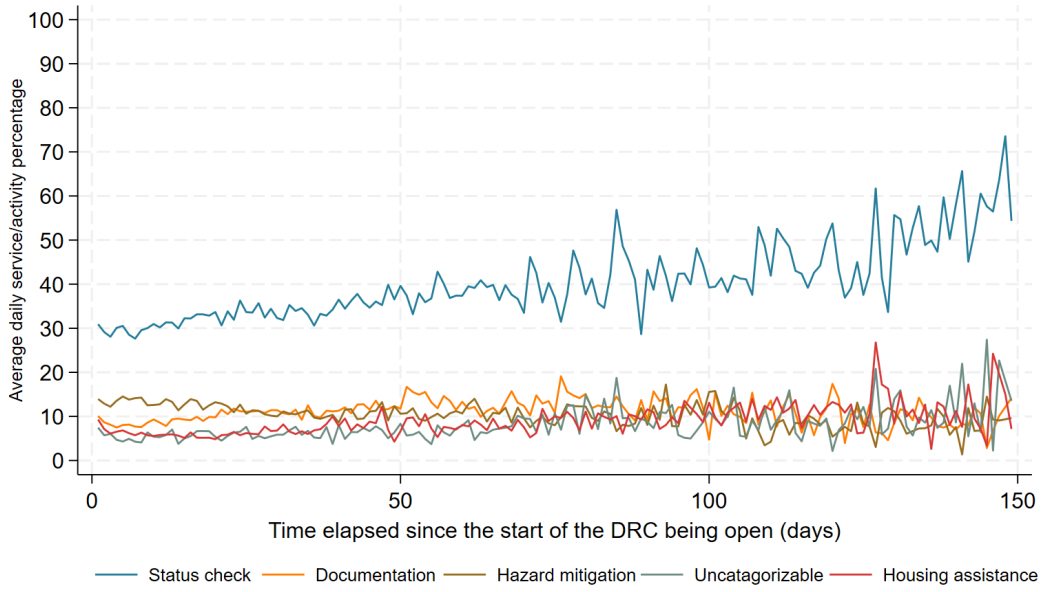
Note: Selection of the top five service/activities excluding exit interviews (defined as highest average SAP) across all DRCs. SAP is defined as daily service/activity percentage.

Figure 20. Top five average daily service/activities for flood disasters



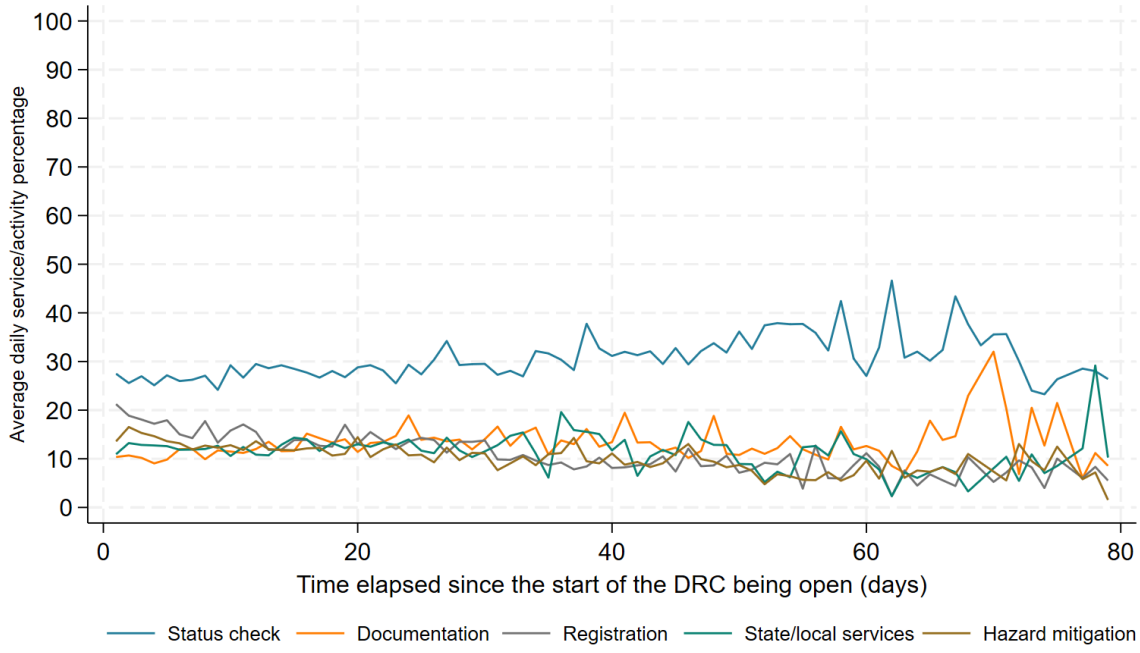
Note: Selection of the top five service/activities excluding exit interviews (defined as highest average SAP) across all DRCs. SAP is defined as daily service/activity percentage. Only the first 150 days of a DRC are presented.

Figure 21. Top five average daily service/activities for hurricane disasters



Note: Selection of the top five service/activities excluding exit interviews (defined as highest average SAP) across all DRCs. SAP is defined as daily service/activity percentage. Only the first 150 days of a DRC are presented.

Figure 22. Top five average daily service/activities for severe storm disasters



Note: Selection of the top five service/activities excluding exit interviews (defined as highest average SAP) across all DRCs. SAP is defined as daily service/activity percentage. Only the first 150 days of a DRC are presented.

Other analyses

Analyses on FEMA Defined Disaster Recovery Centers (DRCs)

There are 408 unique DRC locations within our constructed dataset. There are 294 standard DRCs, 108 MDRCs, 4 CRCs, and 2 DDCs. Utilizing the unique DRC identifier provided by the FEMA datasets (the "DRC" variable), we can see how many DRC locations are affiliated with one another. For consistency in terminology, we refer to this higher-level of DRC identification as the FEMA-DRC.

There are 43 FEMA-DRCs within the constructed dataset. For each FEMA-DRC, there are on average 9 DRC locations with 7 of those being standard DRCs, 2 of those being MDRCs, and less than 1 of those being a community recovery center or document drop-off center. Of the FEMA-DRCs, 67% were only affiliated with standard DRCs and 32% were affiliated with at least one non-standard DRC.

FEMA-DRCs are spread across, on average, 8 counties with 84% of those counties being categorized as urban. For FEMA-DRCs which are only affiliated with standard DRCs, FEMA-DRCs span on average 2.5 counties (86% urban) while FEMA-DRCs affiliated with at least one non-standard DRC spanned an average of 19 counties (79% urban).

FEMA-DRCs on average are open 36 days while FEMA-DRCs affiliated with only standard DRCs are open for an average of 40 days while FEMA-DRCs affiliated with at least one non-standard DRC are open for 28 days on average.

FEMA-DRCs which are affiliated only with standard DRCs experience an average of a total of 35,939 visits whereas FEMA-DRCs which are affiliated with at least one non-standard DRC experience an average of a total of 24,801 visits.