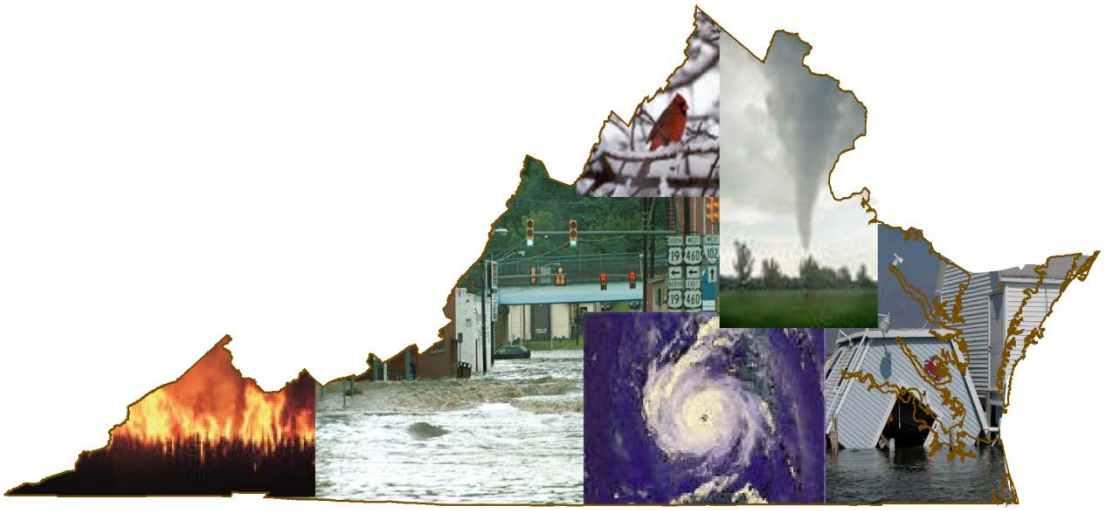
COMMONWEALTH OF VIRGINIA

Hazard Mitigation Plan



Chapter 3
Hazard Identification and Risk Assessment (HIRA)

Section 3.16 – Overall Hazard Results

SECTION 3.16

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Section 3.16: Overall Hazard Results

Summary of HIRA

Section 3.7 through 3.15 discussed the probability, impacts, and risks for each of the natural hazards that have been determined to have a significant impact on the population and infrastructure in the Commonwealth of Virginia. This final sub-section to the HIRA provides an overall assessment and summary of the individual hazard analyses.

GIS data for critical facilities and state facilities was used to determine risk for the infrastructure in Virginia. Section 3.4 fully describes the datasets that were used to create these two datasets that are referred to as critical facilities and states facilities.

Summary of Risk Assessment

Vulnerability of state and critical facilities is discussed in each of the hazard sub-sections in the HIRA. The individual hazard sections highlight the results of the analysis completed for this plan. Refer to the tables in these sections to determine what facilities are at greater risk for each hazard type; analysis is based on GIS intersections of the facility data with the geographic extent (GE) data. The data used for this analysis is available, through VDEM, for localities to use to update their plans. This information is ideal for determining structural mitigation strategies.

Critical Facility Risk

The majority of all critical facilities are located in medium and low hazard zones, less than a third are located in high risk zones. The tables in each of the hazard specific hazard analysis sections can be used as a starting point for determining what types of mitigation actions would help to lower the vulnerability of critical facilities in the Commonwealth. For example, there are 2 schools located in the special flood area Zone AE with floodway and 50 schools in a Zone AE without a floodway. Since schools are often used as shelters it would be an excellent idea to investigate those locations to determine if the risk is real or a result of the spatial data limitations.

Section 3.4 describes the critical facility types and sources that were used for the vulnerability analysis in each of the hazard specific sections. Critical facilities point locations will be made available to localities through VDEM and can be used at the local level to determine if the spatial locations are correct. If acceptable, this analysis could be used to identify and recommend mitigation projects.

State Facility Risk

Similar to the critical facility analysis, state facilities were intersected with the GE for each hazard to determine which risk zone each building fell within. A summary of this data is available in each of the hazard sections in this report. Appendix 3.16b summarizes, by agency name, the number of buildings and total known exposure for each hazard category. This information would be ideal to use in planning future mitigation actions. Over 200 state agencies have at least one structure located within any "high risk" hazard zone, as defined by GE.

Overall Ranking Results

Section 3.6 describes the local plan ranking. As discussed, the local plan ranking compares agreeably to the new ranking that was developed for this report. Hazards that were considered negligible were included as textual descriptions in the major hazard sections. This includes erosion, thunderstorm, lightning, hail, extreme heat, extreme cold, and tsunami. Analysis was not completed on human caused and hazardous materials since VDEM has separate plans that address these hazards in detail. Table 3.16-1 shows the overall ranking results of this plan.

To determine the overall hazard ranking, the total ranking values (RS value) for each of the hazards were separately averaged to determine what hazards should be considered the most significant in Virginia. Section 3.5 describes the ranking parameters that were used for this analysis.

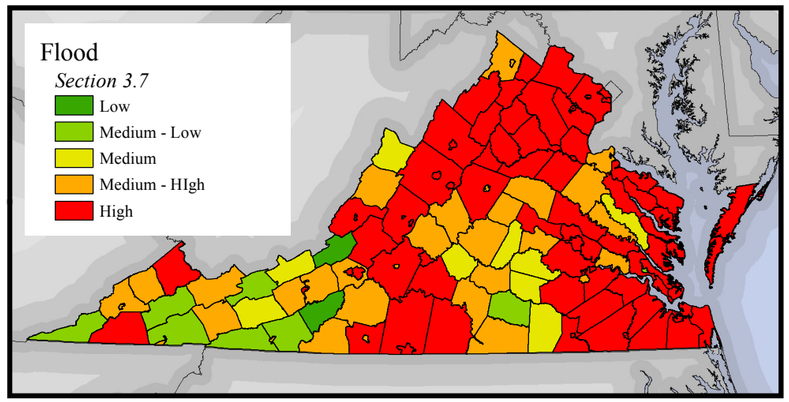
Table 3.16-1: Overall hazard ranking for the Commonwealth of Virginia

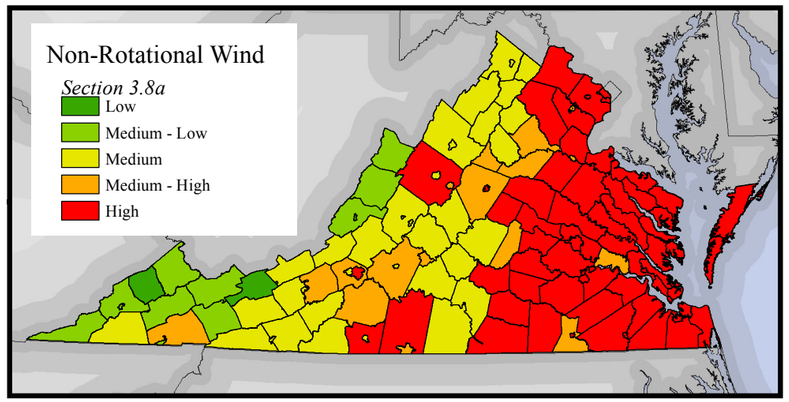
High	Medium-High	Medium	Medium-Low	Low	Negligible
Flood	Non-Rot.Wind Winter Storm Tornado	Drought Wildfire	Earthquake Landslide	Karst Flooding due to Impoundment Failure	Erosion Thunderstorm Lightning Extreme Heat Extreme Cold Tsunami

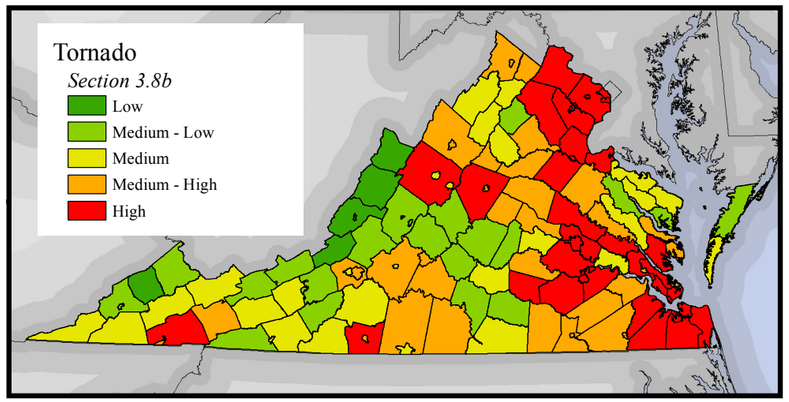
The individual hazard sections provide information and analysis tables for which jurisdictions are considered high risk areas. Figure 3.16-1 provides a summary of each of the individual hazard ranking maps. As stated multiple times in this section, this analysis is only representative of the NCDC data that was used. It is known that the time period of this data is small in comparison to the known historical events. For example, Hurricane Camille in 1969 is before the period of record kept on flooding and landslide, although both were incurred during that event.

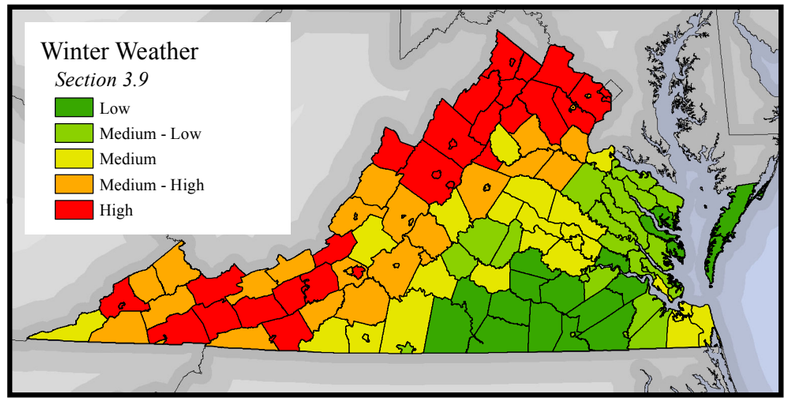
The data does not fully represent geological hazards but in the absence of better data NCDC was used to represent risk in Virginia. Currently Virginia Department of Forestry (VDOF) is the only geological agency to maintain a comprehensive database. Contacts for land subsidence and karst did not have available spatial data to use for this revision.

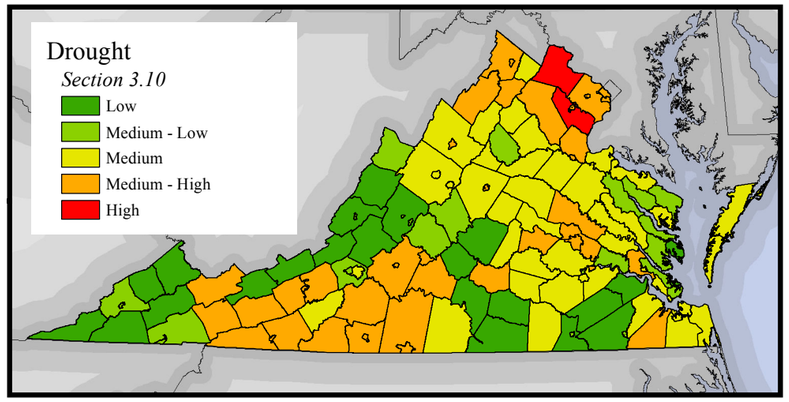
Figure 3.16-1: Hazard Ranking Risk Maps

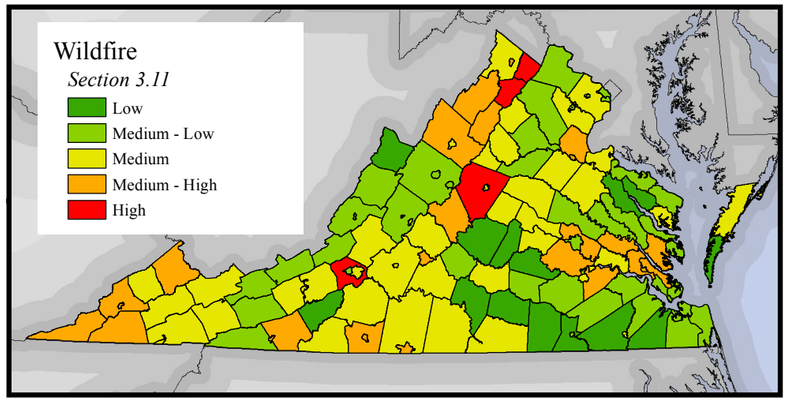


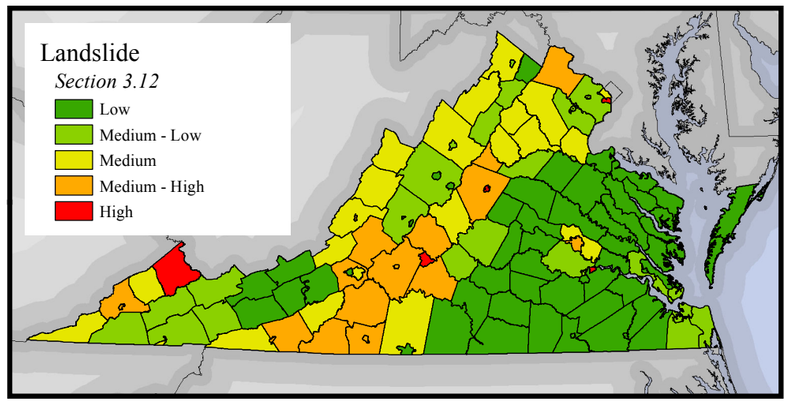


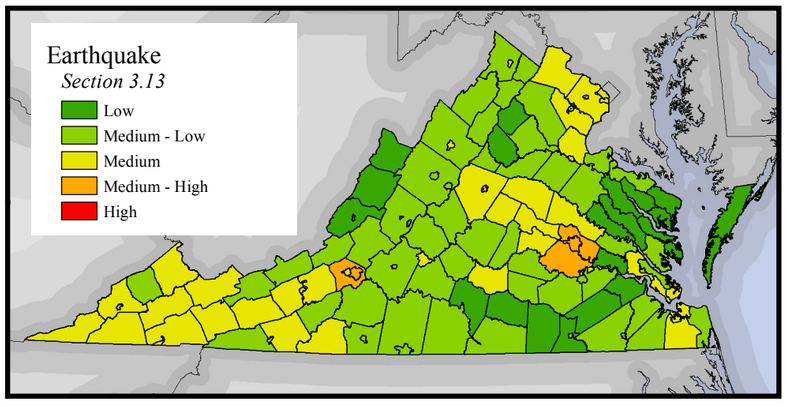


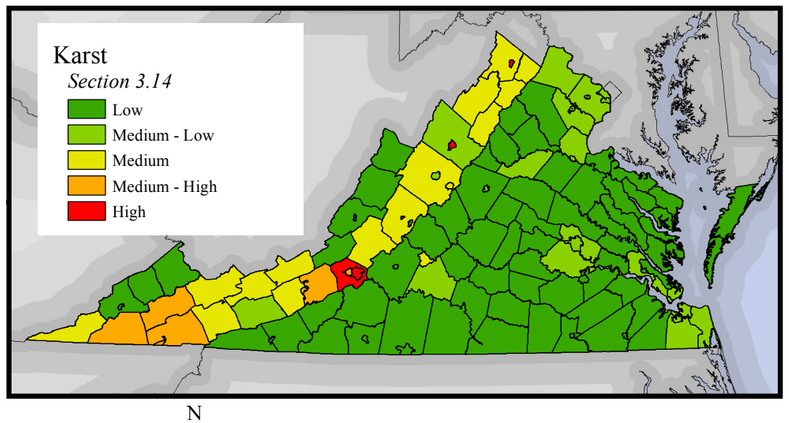












<u>PROJECTION:</u>

VA Lambert Conformal Conic
North American Datum 1983

<u>DATA SOURCES:</u>

CGIT Ranking Methodology
VGIN Jurisdictional Boundaries
ESRI State Boundaries

DISCLAIMER: Majority of available hazard data is intended to be used at national or regional scales. The purpose of the data sets are to give general indication of areas that may be susceptible to hazards. In order to identify potential risk in the Commonwealth available data has been used beyond the original intent.

<u>HAZARD RANKING:</u>

This is a summary of the individual hazard risk maps found in Section 3.7 through Section 3.14.The parameters used to create the Hazard Ranking Parameters and Risk Maps are explained in Section 3.5.

Estimating Potential Losses

The local hazard mitigation plans were reviewed to determine if the local plan loss estimates could be summarized to create statewide loss estimates. During the review it was noticed that some plans did not include complete loss estimates and others were highly variable in the methodology used. A summary of the local plan loss estimates for hurricane and flood is provided in Table 3.6-4 of section 3.6. The variability in the local loss estimates limits the ability to integrate them into statewide vulnerability and loss estimate. Ideally, future revisions to the local plans could follow a standard template for loss estimation that would allow the next revision of the state plan to seamlessly integrate the information from the local plans.

Rough estimates of annualized losses can be generated based on the NCDC Storm Events database, which documents the damage costs associated with the various hazards. Supplemental annualized loss values for flooding, hurricane winds, and earthquake have also been derived from the other sources as described in each individual hazard section. NCDC did not include any historical information about damages due to Karst / Land Subsidence, and is not included in the loss estimates. Impoundment Failure was not included as part of the hazard ranking due to lack of data. See the Flooding due to Impoundment Failure section 3.15 for more details.

Based on information from the NCDC database, the Commonwealth of Virginia can expect approximately **$155,016,463** in annualized damages due to all the hazards that impact Virginia. As discussed in Section 3.3 this data has limitations due to the amount of historical data available, and reporting of significant events. By substituting the supplemental annualized loss values for flood, non-rotational winds, and earthquake the Commonwealth of Virginia could expect **$242,437,356** in annualized damages due to all the hazards that impact Virginia.

Table 3.16-1 below illustrates the number of years of record for each hazard, total damages reported in 2011 dollars, and annualized loss values. Flooding and non-rotational wind make up approximately two-thirds of annualized damages. Based on this analysis, flood and non-rotational wind mitigation strategies should be a high priority for the Commonwealth.

It should be noted that the estimates given for annualized loss are only based on the hazard categories that were determined to be significant types in Virginia. Table 3.3-4 includes the NCDC categories that make up each of the established HIRA hazard types used in this analysis. A complete listing of the NCDC categories would yield annualized loss values significantly different from what is listed in Table 3.16-1. Hazards such as hail, lighting, and extreme temperatures were not included in this analysis for reason discussed in section 3.1 of this plan.

Annualized Loss by Jurisdiction

The NCDC information used to generate Table 3.16-1 was also used as parameters in the hazard ranking. The hazard specific sections (3.7-3.14) include information regarding the annualized loss by jurisdiction. The ranking and risk parameter maps show the annualized property and crop

damages, injuries and deaths, and events as established using NCDC data. The hazards that used an established method for calculating annualized loss (flood, non-rotational winds, and earthquake) are explained in detail in those sections.

Annualized loss from VDOF is included in this table but was not used as the final annualized loss value for the Commonwealth. The differences in these two values are described in section 3.11of this plan.

HAZUS-MH loss estimates are significantly higher than the NCDC estimates. This is to be expected as the HAZUS-MH results consider total direct economic losses including damage to structural, non-structural, building contents, inventory loss, relocation, income loss, rental loss and wage loss. NCDC loss estimates are solely based on the reported crop and property damage of past events. Although the numbers are different, each version of the annualized loss has hurricane winds as the highest loss hazard in the Commonwealth followed directly by flooding.

Table 3.16-2: Annualized loss values from NCDC and additional sources

Hazard Type	NCDC				Other Source	
	Years of Record	Annualized Property Damages	Annualized Crop Damages	Total Annualized Loss	Total Annualized Loss	Data Source
Flooding	1993 - 2011	$37,086,577	$7,017,721	$44,104,298	$78,980,327	Floodplain Analysis
Non-Rotational Wind	1955 - 2011	$58,458,748	$4,905,064	$63,363,813	$96,155,812	FEMA HAZUS
Drought	1993 - 2011	$0	$21,418,983	$21,418,983	*Not Available*	
Earthquake	*Not Available*				$12,940,544	FEMA HAZUS
Tornado Wind	1951 - 2011	$21,625,337	$116,675	$21,742,012	*Not Available*	
Winter Storm	1993 - 2011	$3,902,886	$94,851	$3,997,738	*Not Available*	
Wildfire	1995 - 2011	$249,029	$249,029	$377,009	$7,189,330	VDOF (1999 - 2008)
Landslide	1994 - 2011	$12,610	$0	$12,610	*Not Available*	
Land Subsidence (Karst)	*Not Available*				*Not Available*	
Total	**$121,335,188**	**$33,681,275**	**$155,016,463**	**$242,437,356**		

Comparison with Local Ranking

Table 3.6-2 of the Local Plan Incorporation section (3.6) shows the average ranking for the local plans and statewide analysis. Three of the hazard categories that were addressed in the local plans were not considered in the state plan; these include hazardous materials, terrorism, and biological, radiological and epidemics. The COVEOP has separate plans that address human caused, radiological, and hazardous materials. Erosion, extreme heat, extreme cold, thunderstorm, lightning, hail, and tsunami have been included as textual descriptions in the major hazard sections. Of the hazards considered, the average rankings in local and state analysis are analogous.

Minor differences in the local and statewide ranking can be seen in Table 3.6-2 of section 3.6. The statewide analysis grouped the local plan categories of wind and hurricane together as non-rotational wind since the resulting damages are the same for these hazards. Tornado received a "medium" ranking for the local plans but was elevated to a "medium-high" risk in the state plan. Impoundment failure received a ranking of "medium-low" in the local plans but was reduced to a "low" ranking for the state plan. Earthquake and landslide received a local plan average ranking of low and the statewide analysis resulted in a medium-low ranking. As discussed in section 3.1 and 3.6 detailed analysis was not completed for erosion, thunderstorm, hail, lightning, extreme heat, extreme cold, tsunami, hazmat, terrorism, and biological, radiological, and epidemic hazards.

Comparison with Demographics and Land Use

Section 3.1 of this plan describes the general land use and population trends in Virginia over the last couple of decades. Four of the nine hazards were considered high risk in Northern Virginia communities; these areas are also experiencing a large surge in population and development.

South-Central and Southwest Virginia have been experiencing relatively low development, and in some extreme cases, population decline. These areas are often impacted by all of the hazards but because of the low population they have received a lower ranking.

Local hazard mitigation plans lacked detailed information about land use and future development planning. Generalized information about land use planning has been made at the State level but really should be evaluated locally. Land use planning, completed at local level, can reduce risk to the population and infrastructure by addressing the hazards that impact the jurisdiction. It is necessary for this to be done at the jurisdictional level since this is where planning, regulation, and taxation happen. For example, jurisdictions in the Ridge and Valley could evaluate karst zoning ordinances to limit development or population growth in areas known to have sinkhole development. Currently, revised land-use data is spotty depending on the sophistication of the local government and the need, will or ability to update information. A consistent land-use and population revision for the entire state at any specific time is going to remain a challenge that technological advances should overcome in the future. To that end, information from regional

planning district commissions, many of whom provide GIS support to their member localities, will be critical to future HIRA revisions. VDEM mitigation staff will be coordinating with localities to ensure that future revisions of their local plans will be standardized and will have the ability to be uploaded and used in the next revision of the statewide hazard analysis.

Limitations of Data

It should be noted that the data sources used in this ranking/prioritization are varied in their degree of completeness, accuracy, precision, etc; our ability to accurately prioritize some of the hazards would be improved with better information about them (e.g., landslide, karst, etc.). Further discussion on the data limitations and how the data was adapted for analysis is available in section 3.5 and in the hazard specific sections (3.7 – 3.15).

Future Revisions to HIRA

An attempt was made to include the "best available" data for this revision of the hazard mitigation plan. Spatial data is constantly changing and efforts are being made to increase the accuracy of this data by many local, state and federal agencies. As this data is made available it will be used in revisions to this plan.

Using HIRA results in Mitigation Strategies

Data limitations have been fully noted throughout the HIRA section. Some of the issues can be resolved with closer coordination with federal, state, and local institutions. Data creation and management issues will take more time and effort to resolve and incorporate into revisions of this plan. The HIRA sub-committee members are dedicated to the long-term vision of this plan and are currently working towards the next revision. Below is a summary of some of the issues that have been discussed throughout this section. Mitigation action items have been created to address most of these.