# Data Training Webinar Transcript: Area and Road Ruggedness Scales

Good afternoon, everyone. My name is Ashley Murdie, your host for today's webinar. On behalf of USDA's Economic Research Service, welcome and thank you for joining us in another segment of our Data Training Webinar Series.

Today's webinar spotlights a new data product of ours, the Area and Road Ruggedness Scales, which include the first-ever detailed measures of rugged terrain with full nationwide coverage for the United States. This data product and a related report are linked in the resources tab at the bottom left-hand corner of your screen.

As part of the Data Training Webinar Series, this webinar builds upon our continued efforts to teach those interested in ERS data how to access and utilize our many data products.

Now, before I introduce our speakers, I'd like to note that this webinar is being recorded and will be posted on the ERS website next week. If at any time during the webinar you have questions, please enter them into the chat feature at the bottom, left-hand corner of the screen, and our speakers will help answer those at the end of today's presentation.

Now, it's a pleasure to introduce today's speakers: Regional Economist Elizabeth Dobis and Senior Geographer John Cromartie. Liz and John both serve in our Resource and Rural Economics Division where Liz specializes in spatial economic analysis, particularly pertaining to health, demography, and communities, while John's research focuses on rural population change, rural migration, and rural-urban classifications. Thank you both for joining us today. Elizabeth, the floor is yours…

Thanks Ashley. My name is Elizabeth Dobis, and I am a regional economist in the Rural Economy Branch here at ERS. I am a member of the team that developed the Area and Road Ruggedness Scales. The team also includes John Cromartie, Ryan Williams and Kyle Reed. I'm so excited to introduce our new data product to you today. So, without further ado, let's get started introducing the Area and Road Ruggedness Scales.

What is the Area and Road Ruggedness Scales data product? Simply put, it is a resource for researchers, federal agencies, policy makers and practitioners working to better understand and address issues of rural development, demographic change and individual and community well-being. However, this is only the tip of the iceberg when it comes to the data product.

In this webinar John and I will be going into more detail about the Area and Road Ruggedness Scales. I will be discussing what rugged terrain is and why we care about it, what the Area and Road Ruggedness Scales are, and how they were developed, and select findings from the new ERS report, *Characterizing Rugged Terrain in the United States.* These findings provide some interesting facts about ruggedness rurality and population in the United States. At this point, I will turn things over to fellow team member John Cromartie as he will be discussing how to access the Area and Road Ruggedness Scales data product and what information is included in it.

Let's start by addressing what rugged terrain is: mountains, canyons and other landscape features with variable elevation comprise rugged terrain. These pictures provide examples of the breath of rugged terrain. Rugged terrain can have sharp changes in elevation or gentle slopes. Even rolling hills have some degree of ruggedness. As you can see, there is no one size fits-all definition of what rugged terrain is. Now that we've established what we mean when we talk about rugged terrain, I'd like to address why people care about rugged terrain.

Understanding rugged terrain is important because it affects communities in complex and often contradictory ways. Rugged terrain can be both a benefit and a hindrance to communities and residents in terms of benefits. Rugged terrain is considered visually appealing by many. It may also provide recreational opportunities such as hiking, mountain climbing, hunting, fishing, and camping. Being located in or near rugged terrain may be an asset to communities by promoting economic growth through tourism and migration. However rugged terrain is also a hindrance because it limits the land available for development and makes it more time consuming or treacherous to travel to access goods and services such as groceries or healthcare. While a bit of research has been done on the benefits of rugged terrain, the role of rugged terrain as a hindrance is understudied. Um even though it may be…even though it may affect well-being of people and communities, especially in rural areas. So how can rugged terrain be measured so that both its benefits and hindrances can be studied?

Our solution was to create two different measures. Each one emphasizing different aspects of rugged terrain. These two nationwide classifications of census tracts are called the Area Ruggedness Scale, which we abbreviate as ARS and the Road Ruggedness Scale, which we call the RRS. The Area Ruggedness Scale measures change in elevation for all terrain within a census tract. Therefore, it measures the overall landscape. This type of measure has historically been used to account for the benefits of rugged terrain. In contrast, the Road Ruggedness Scale is much more restrictive. It measures changes in elevation beneath roads within a census tract focusing on the ruggedness of where people travel. This is important because the hindrances of rugged terrain are often associated with transportation. To our knowledge the Area and Road Ruggedness Scales are the first detailed ruggedness measures with full nationwide coverage for the United States and the first to provide a roads only version to help study the impact of rugged terrain on travel by car. Both measures are available for all land faced vintage 2010 census tracts for the 50 states and Washington, D.C. Now I'd like to show you maps of the ARS and RRS, so that you can get a sense of what they look like.

The map on the left is the Area Ruggedness Scale. It is a six-category scale ranging from ‘level’ represented by light orange to ‘extremely rugged,’ which is represented by dark orange. On the right is the Road Ruggedness Scale. It is a five-category scale ranging from ‘level’ represented by light yellow to ‘highly rugged,’ which is represented by dark brown. Both maps exhibit geographic patterns similar to those of a topographic relief map. The Appalachian Mountains, Rocky Mountains, Pacific Mountain System and Sierra, Nevada are clearly visible as rugged areas. The Great Plains, Corn Belt and coasts of the Atlantic Ocean and Gulf of Mexico are quite flat in comparison. However, there are more rugged areas within these regions including the Ozarks and Wichita Mountains in Arkansas, Southern Missouri and Eastern Oklahoma, the Black Hills in Western South Dakota, and the Driftless Area in Western Wisconsin along the borders of Minnesota, Iowa and Illinois. Despite the overall visual similarity between the Area

Ruggedness Scale and Road Ruggedness Scale, there are some distinct visual differences as well. In the Area Ruggedness Scale, Alaska is much more rugged when compared to census tracts in the rest of the United States, whereas roads in Alaska run through less rugged terrain in comparison to the rest of the country resulting in fewer census tracts being categorized as more rugged within the Road Ruggedness Scale. Similarly, the Badlands of North and South Dakota and the Sand Hills of Nebraska can be identified as more rugged than surrounding census tracts in the ARS, but not in the RRS. However, with the Road Ruggedness Scale, more census tracts in the Appalachians are considered rugged when compared to with others in the United States than in the Area Ruggedness Scale particularly along the Tennessee / North Carolina border and along the Kentucky / Virginia border into Southern West Virginia. This is true for Hawaii Island as well. You've probably noticed that I've been quite careful to mention the relative ruggedness of census tracts within the ARS and RRS rather than directly comparing between the two measures. Later in this webinar, I'm going to be discussing the three-step process for creating the Area and Road Ruggedness Scales to explain why this is the case. However, first I want to share some interesting facts about ruggedness, rurality and population in the United States that we found while developing the Area and Road Ruggedness Scales.

The information I will be discussing here is available in the new ERS report, *Characterizing Rugged Terrain in The United States*, which was released last month. The report includes an overall an overview of ERS' history of measuring topography through measures such as the Natural Amenity Scale, a more technical description of the data and methods used to create the Area and Road Ruggedness Scales than we will cover in this webinar and an analysis of population, population density and income across road ruggedness categories, rurality and regions in the United States. We focused on the Road Ruggedness Scale for this report because we were interested in exploring the understudied aspect of ruggedness as a hindrance particularly in conjunction with rurality though the findings, we present here are only given for the RRS. And with that, we'll move on to talk about the relationship between population and ruggedness.

We found that population and population density generally decrease as ruggedness increases. On the right we have listed population by Road Ruggedness Scale category. In 2010 nearly two-thirds of us residents lived in level census tracts. An additional 23% lived in nearly level census tracts. This means that a little less than 12% of the population lived in census tracts that are considered slightly rugged, moderately rugged or highly rugged by the RRS, and only 1.4% of U.S. residents lived in highly rugged census tracts. On the left is a chart showing the average population and population density of census tracts by Road Ruggedness Scale category in 2010. These categories are listed from left to right by increasing ruggedness. The orange bars are the average population, while the pink bars are the average population density. Population density is highest on average for nearly level census tracts with 5,514 people per square mile. It then decreases as ruggedness increases to only 3,390 people per square mile. The average population of census tracts exhibits the same trend. This makes sense. The more rugged the roads are, the more difficult it is to transverse them. So, this result is unsurprising and a good representation of most people's lived experiences. But this doesn't tell us anything about how rural these locations are. So, let's look at that next.

When you think of rugged locations, you likely also think of rural locations. However, ruggedness and rurality are distinct. The chart on the right shows population shares across rurality groups by Road Ruggedness scale category in 2010. Again, the categories are list listed from left to right by increasing ruggedness. The US total is included on the far right. In the chart we've taken the population within each category and calculated the share living in each rurality group. For example, in the level category step 73.5% of the population lived in urbanized area census tracts shown in orange, 10.4% lived in urban commuting census tracts shown in pink, and 16.1% lived in rural census tracts, which are purple. Together these shares that add up to 100% of the population living in level census tracts. The chart indicates that there's a positive correlation between ruggedness and rurality meaning that as ruggedness increases, the share of the population living in rural census tracts also increases. In level census tracts only 16% of the population lived in rural locations while in highly rugged census tracts nearly 30% of residents were rural. In fact, the rural share of residents in slightly rugged, moderately rugged, and highly rugged census tracts was higher than the national share of residents in rural census tracts. Despite this trend of increasing rurality, you'll notice that at all levels of ruggedness more people live in the urbanized area census tracts than in urban commuting or rural census tracts. Therefore, even the people living in the most rugged census tracts are primarily urban residents. So far, we've given results for the entire country. However, the physical geography of the United States is incredibly varied. So next, we'll look at how ruggedness varies across the country.

The chart on the right shows the share of the population of each state living in the top three Road Ruggedness Scale categories in 2010. The pink part of the bars represents the population share living in slightly rugged census tracts, the purple represents the share in moderately rugged census tracts, and the orange represents the share in highly rugged census tracts. These bars are cumulative so the percentage at the end of the bar is the share of the population living in any one of the top three categories. For readability we have only included States whose population in slightly to highly rugged census tracts was above the national average of 11.6%. This includes 19 States and Washington D.C. The chart does an excellent job illustrating the population shares in rugged areas vary across States. At the top was West Virginia with 80.7% of its population living in slightly to highly rugged census tracts. The remaining 19.3% of its population lived in level or nearly level census tracts. Perhaps unsurprisingly West Virginia also had the highest share of its residents living in the top category: highly rugged census tracts. Vermont was the state with the second largest population living in slightly to highly rugged census tracts at 51.6%, but you'll notice that there isn't an orange section to the bar. In fact, Vermont doesn't have any census tracts considered highly rugged by the RRS. The same is true for Connecticut and Washington D.C. However geographic variability extends beyond population shares, so I'd like to share some findings related to geographic variability that are not from this chart. The first finding is that when accounting for rurality as well as ruggedness, we saw that the rurality of the population in highly rugged census tracts also varied across States and regions. And second, when focusing on land area by Road Ruggedness Scale categories rather than population, we found that Washington state had the largest share of highly rugged land at 29.9%. Now that you've seen some examples of how the Area and Road Ruggedness Scales can be used, I'd like to move on to how they were created. Because these are novel data, sharing the three-step process of creating the Area and Road Ruggedness Scales is important to understanding the strengths and limitations of the data.

The first step in creating the Area and Road Ruggedness Scales was calculating the terrain ruggedness index or TRI. TRIs are calculated using digital elevation model data. This type of data breaks the surface of the earth into small regularly spaced grid cells, each of which contains an elevation that represents the underlying terrain. The change in elevation between a grid cell and each of its adjacent neighbors is then summarized to get the TRI value for that cell. We calculated separate TRIs for the ARS and RRS. The area TRI was used for the Area Ruggedness Scale. It was calculated using all eight of a grid cell's adjacent neighbors as illustrated in the graphic on the left. The road TRI was used for the road ruggedness scale. It was calculated using only the adjacent grid cells with roads as illustrated in the graphic on the right.

The second step in creating the Area and Road Ruggedness Scales was aggregating the grid cell TRI values to census tracts. Why census tracts? There are several reasons. First, they are the smallest geographic unit for which socioeconomic data is generally produced. Second, they provide a more accurate description of the topography within an area than would a larger geographic unit. And third they are the smallest geographic unit for which ERS has a measure of rurality. To aggregate the Area TRI and Road TRI values to census tracts, we took the mean or average of the grid cells within each census tract. The graphic on the left depicts the area TRI grid cell values within a census tract in Fayette County West Virginia, which is southeast of Charleston. You can see a variety of values within the census tract depicting more rugged land to the west and less rugged land to the east. Using the mean as our aggregate value accounts for both the high and low value values in the census tract as well as the frequency of all the area TRI values within the census tract.

The third and final step in creating the Area and Road Ruggedness Scales was using the mean TRI values to group census tracts into categories. When classifying data, it is important to choose a method that helps identify trends and patterns more easily. A good method should reflect the underlying data rather than distort it. Both the mean area TRI and the mean Road TRI census tract values have what is called a heavy tailed distribution as illustrated here. There is a concentration of census tracts across a very small range of low TRI values on the left side of the graph and far fewer census tracts across a large range of high TRI values shown on the right. The head tail brakes method is the best for classifying values distributed this way because it places more emphasis on differentiating among high values. This is perfect for our needs because it allows us to distinguish among different levels of ruggedness. However, the number of categories and the range of values in each category produced by this method is dependent on the underlying data distribution. This is emphasized by comparing the maximum mean TRI values used to construct the Area Ruggedness Scale and the Road Ruggedness Scale. The maximum mean TRI value for the road… sorry the maximum mean Road TRI value is only 135 value uh 135 meters while the maximum mean area TRI value is 243. This means that the Area Ruggedness Scale and the Road Ruggedness Scale are very different scales and cannot be directly compared even though the categories have similar descriptions.  So, for example, a census tract with a mean area and road TRI of 70 meters would be considered a highly rugged

RRS census tract but a slightly rugged ARS census tract. This is why I was very careful to mention the relative ruggedness of census tracts earlier.

So, given how different the Area and Road Ruggedness Scales are, how should they be used? The ARS and RRS have different applications. The Area Ruggedness Scale may be better suited to capturing the scenic attractiveness of rugged terrain cherished by long-term residents, tourists, and newcomers because it represents the overall landscape, while the Road Ruggedness Scale does a better job capturing travel limitations associated with rugged terrain because it focuses on roads. Another thing to keep in mind while using the Area and Road Ruggedness Scales is that there is no clear dividing line between rugged and non-rugged terrain. In other words what someone living in the Great Plains thinks is rugged may not be very rugged to someone living in the Appalachian. And while residents of the Rocky Mountains may not think that the Appalachian look very rugged, they may think that the roads are a lot more rugged in places. So, when such a division is needed, the choice of which categories to include as rugged should be made based on the goals of the project. For example, let's say we want to study the impact of ruggedness on migration. In this case, are only the most rugged census tracts those considered extremely rugged by the ARS important? Or is a broader range of ruggedness, one containing moderately to extremely rugged census tracts, a better measure of what is appealing to potential residents? And that concludes my portion of the presentation. At this time, I'd like to turn things over to John Cromartie.

Thank you, Liz, and thank you all for joining us for this webinar. I'm going to provide a walkthrough of the Area and Road Ruggedness Scales data product starting with the overview page. You can see the link to uh this website above, but more conveniently it is also in the resources tab at the bottom left. The overview page contains the most important feature of this data product.

If you scroll down to the bottom, you will see the data set itself. And I'll start by going through what you find in this data set.

So, it's an Excel file and when you download it you will find that it has three tabs. I will go through them backwards uh starting with the definitions and sources tab, but since Liz is already covered most of this I won't uh dwell here. I will rather uh move to the code book, which is uh the other the middle tab of this data set.

The code book contains a description of all the variables that are contained in the file starting with the key identifier variable, which is the census tract identifier. This is a census tract level file, and this would be the variable that you would use uh once you download it to combine with other information at the tract level. Conveniently the tracts are embedded within counties, which means that it is very easy to also add county level information to this census tract file. And if you look right below the tract FIPS you can see that we also include the county FIPS to make those types of mergers easy to do.

I want to point out a couple of other geographic identifiers that we have in included in this file that we used in the report to analyze aspects of rugged terrain. Starting with a variable of regions of the country dividing counties into physiographic regions, you will notice if you read through the descriptions of the 12 physiographic regions that you can imagine a great deal of variation in the level of ruggedness among these physiographic regions. For instance, comparing something like the southern Coastal Plains with the Intermountain West.

The second geographic identifier I want to highlight is our rurality code that we've included on here. It is an aggregation of the ERS RUCA codes, which are census tracts-based measure…which is a census tract-based measure of rurality. Here we've categorized it into three categories: urbanized, core urbanized area, uh urban commuting areas and rural RUCA codes.

Finally, you get to the scales themselves starting with the Area Ruggedness Scales…Area Ruggedness Scale. Now this is a, these are categorical variables, right? Uh but they are based on a continuous variable. The ARS is based on the mean of the terrain ruggedness index for each census tract. And as you can see, we provide that continuous measure as well…as well as other descriptive statistics. It may be the case that you have a research application in which a continuous variable like the mean ARS is more appropriate than our categorical variable. You may also want to create your own categories. And that…and this would allow you to do that.

Finally, you have in the code book you have if you scroll down to the bottom, you see we also have the same set of variables for the Road Ruggedness Scale. So that's the code book. This uh the tab on the far left is the data themselves. Uh in Excel format again, uh the columns represent observation, census tract observations, one observation for each census tract in the United States.

The columns represent the variables that I just described uh in the code book. You can see that we've provided uh easily downloadable names for these variables making it easy to download and merge with other data. And there is no other uh additional lines of information you need to worry about when downloading the file. It's very quick and easy. So that's the data set itself.

I will continue by looking quickly at the other two pages in this data product starting with the documentation page. So, we…we just looked at the overview. Now going to the documentation.

As you can see here it covers a number of topics including uh a section on strength and limitations, on data sources, on the scope and coverage of the data, etc. I will provide a quick example from the method section.

And so uh that part of the method section which Liz covered, this three-step process for creating our Road Ruggedness Scale starting with at the grid cell level, computing a grid cell terrain ruggedness index, step two: aggregating those grid cells to census tracts and calculating mean values for each census tract, and finally determinate the ordinal scale for the uh…for the ruggedness scales for both the Area and Road Ruggedness Scales. So those are the three steps described in the documentation section along with other documentation.

Finally, we have a page uh that has descriptions and maps. Liz already showed you the maps, so just as a last example, I want to show you one of the tables you will find in that description section. Here is a table for the Road Ruggedness Scales giving some descriptive values for…for each of the five levels in the Road Ruggedness Scale. If you compare the second and third columns of this table, you can get an idea of…of how our uh how this scale reflects the heavy tailed distribution of our data. If you look at the levels category, you will notice that the category values themselves cover a very narrow range for level one, only 13 meters, and yet it contains the majority of census tracts. If you compare that with level five, highly rugged, you will see that that has flipped. The range of category values is quite large. It covers 80 meters compared to 13 meters for the level, but it contains just a fraction of the census tracts. This is a very common distribution of phenomenon where you have a heavy tail and which typically, you're most interested in those high values even though they're fewer of them. And that's why the…this breakdown, these categorizations focus on those high values. So that concludes my walkthrough and the main part of our presentation.

Thanks John. At this time, we'll go ahead and open the floor for questions. Just as a quick reminder, you can submit questions to the chat feature located at the bottom left-hand corner of your screen. Alright, um to start with, um why did you create the data for 2010 census tracts, and will there be a version of this data product for 2020 census tracts?

That's a great question. Thanks Ashley. So, we created the data for vintage 2010 census tracts because it was the most recent version that also had a rurality measure. As members of the Rural Economy Branch here at ERS, John and I wanted to be sure to analyze the relationship between rurality and ruggedness in the ERS report we um that we released along with the data. And because the RUCA codes which we used to measure rurality have not yet been released for the vintage 2020 census tracts, we wanted to get this data to you, and we wanted to get the data to you as soon as possible, uh we decided to release the Vintage 2020 data first, uh which brings me to the second part of the question. So, yes, we are working on a version of the data product for vintage 2020 census tracts. So, look forward to that being released sometime in the future.

Alright, thanks uh this next question asks how are rurality groups defined?

Uh yeah, I can take that one…oh go ahead John. The uh this particular uh definition of rural is based on the ERS uh RUCA codes, the rural urban commuting area codes, and they are a census tract level definition that mimics the very, in a very similar way, the criteria that are used to define metropolitan and non-metropolitan area. So, this is a basically a measure of…of large Urban regions and their and their Hinterlands uh versus areas outside of those metropolitan regions. And they are done again at the census tract level, so it presents a somewhat different picture than you get with OMB's metropolitan areas which are county based.

Thanks John. Alright, for this next question um they ask since many census tracts are bounded by roads, how did you account for those roads?

Um I'm just trying to think, um I have received questions about this before. I think basically what you're asking is when we're calculating that road TRI if we've got the roads that are going through the um the grid cells that are not intersecting the other roads. They're all included in that um in that calculation. So, in short, we're including all of those roads in in the grid cells. So, the…we're calculating things at the grid cell level and then aggregating up to the census tract. So, if the road is along the boundary of the census tract, um it would obviously be included in the calculation at the grid cell level, and then when we aggregate up that's when it gets um attributed to the census tract itself.

Thanks Liz, another question asks um or notes that they're curious what road files um we used for this effort?

So, we used the um the Ezri Street Map Premium um North American file. I think it was Quarter 3, 2021 maybe. Um you'll have to check the report uh for the exact details, but we did use the Ezri uh Street Map Premium product um because it had uh the most complete set of roads that we had access to, both the um the highways and then the arterial… the highways, the arterials, the collector local and semi-private roads. We wanted to use them all so that we kind got the best picture of what the ruggedness was like underneath those roads.

Great, thank you. Another question asks um with the release of the Area and Road Ruggedness Scales will you be incorporating them into your measures of rurality?

John, why don't you go ahead and take this one.

Sure, uh one of the primary reasons that we uh started this project was the idea that ruggedness uh will may have an impact on the measures we use uh to calculate to delineate rural areas from urban areas. It may be that the criteria that we use for instance uh when we…we have a measure of reality based on uh travel time to the nearest urban area. These are the frontier and remote area codes and they're based directly on…. uh they measure remoteness and it's based on travel time. And it certainly can be um…you can think that ruggedness is going to have an effect on travel time and therefore may be needed to take into account when considering these rural definitions. However, we don't…we don't envision including these measures of ruggedness directly into our definitions of morality, but rather to inform the criteria that we do use to measure rurality.

Alright thanks John. Uh our next question asks, have you considered using a smaller geography than census tracts?

So, um because we wanted to make something that was usable uh for a lot of um for a broad range of socioeconomic data, uh we decided to go with the census tract level. Um the…the smaller the geography that we have, um the more difficult it is to make sure that every single uh location has a grid cell centroid in it, which we use to aggregate up. Um, so there's a lot more mismatching if you go to a smaller geography. Um so yes, we did uh in short, we did think through other types of smaller geographies, but we found that the census tract was the best fit for what we wanted to um release to the public in terms of um usability of the data for research and policy.

Thanks Liz.

I will...I will add in particular that it was important to be able to match this up with our uh Rural Urban Commuting Area Codes to sort of look at that relationship between rurality and ruggedness.

Okay for our next question, uh why is population higher in nearly level tracts compared with uh level tracts?

Yes, I, let me go back here…I will go, I think it was yes…. it’s this graph that shows yeah, a somewhat surprising finding. Uh I don't want to make too much of it because the differences are not that great, but still it was interesting to see that the average population for census tract and the and the population density were both higher in nearly level tracts compared with level tracts. The expectation would have been that the level tracts would be higher because think about it, the largest urban, large urban areas tend to be located in flat terrain. That's why you see them competing a lot with agricultural land, and so it was a bit surprising to see that in fact the nearly level category was…had a somewhat higher population density. And I believe that has to do with the fact that in addition to places with…along the coast with large cities, there is a vast area of the nation's heartland that is more remote and more uh focused on agriculture and less…and did not have the same level of urban development as you find elsewhere. And therefore, uh this very flat level terrain, uh the average population is brought down a little bit by the fact that so much of the Great Plains is found in that first category.

Thanks John. Alright, let's see here. Another question asks, have you considered looking at paved versus unpaved roads in addition to the elevation change?

Uh so when we were developing this measure, we considered a lot of different things. Um so right now, uh we're just trying to get an idea of what's going on with the land in general. What kind of elevation changes are we seeing? So that's why we've got the Area Ruggedness Scale to give us the overall picture of the overall landscape. And then we really wanted to know because roads don't go you know straight over the top of you know the Grand Tetons or something like that, we really wanted to know what was the lived experiences of people traversing these more rugged locations, um which is going to look different than when you're using the overall um you know the overall land, the measure of the overall landscape. Um in terms of the…. whether the roads are paved or graveled, that's a really important question to ask when looking at uh travel times and ease of getting to urban areas or rural areas or traversing uh a span and that's definitely something that you can take into account when doing research um and projects looking at things like that. Um but this is just to give a base idea of what's going on uh in terms of change in elevation within the census tract around those roads.

Thanks Liz. Alright next question, um why does the state graph um in reference to slide 11 show Appalachian States as more rugged than Rocky Mountain States um with higher percentages in West Virginia, Vermont and Pennsylvania compared with those of Washington, Oregon and Montana?

John, do you want to take this one?

Sure, the…the reason that Appalachian states are…appear at the top of this particular graph is because we are showing the population shares in rugged areas as opposed to the share of land area in…in rugged areas. Uh clearly when we think about the Appalachians compared with the Rocky Mountains, we think of the Rocky Mountains as more rugged and indeed if you look at some of the data from those physiographic regions for the land area, you'll see that by far, the….the region with the largest share of rugged terrain is in fact the Pacific Coast with the Intermountain West not far behind. However, there's a difference if you look at it in terms of population shares, which is what this graph is showing. So yes, the West is more rugged, but if you think about where the population lives in the west versus where they live in Appalachia, it's easy to see that that the population in Appalachia is more distributed throughout the mountain region compared with the west where population tends to be more concentrated in the flat areas of that of those regions.

Thanks John. Another question is asking how could the Area and Road Ruggedness Scale be applied in natural Hazard research?

I'll jump in uh Liz…probably has some ideas too. Uh I've had discussions with many people in that in that line of research…Uh for example, a couple of people I've talked to are interested in the impact of wildfires on rural areas on rural population and they are uh, they see this data as potentially very valuable and looking at that uh that line of research. The uh…I see many applications in the….in the broad area of hazard research and climate change.

I agree with John. The possibilities um are pretty much endless it…it really needs to be tailored to you know, to give a…a concrete answer, you know you have to sit down with the researcher and really talk about the project because there are a lot of ways that this particular product could be used for natural hazards research.

Good to know. Thank you both. Alright, uh next question when calculating the road TRI, were neighboring grid cells with roads that do not intersect used?

Uh so I sort of alluded to this earlier uh, but in short, any grid cell with a road was included when calculating that road TRI so to explain in a….in a bit more detail, what we did was we took this extensive road network, and we intersected it with the digital elevation model to create a new subset. So, we were left only with the grid cells that had a road running through them and then we took those grid cells and used that as an input to calculate the road TRI and so the resulting TRI calculations used all of the grid cells that create a container Road whether they intersected or they're just passing parallel to each other.

Thanks Liz. Okay, let's see here…Um another question asks, how might you capture the phenomenon that there are just fewer roads where terrain is rugged and that might impact access especially in rural areas?

That's a…that's a very good question. The…. that’s a challenge to doing research on the impact of ruggedness on accessibility because clearly it can…. the measure that we are presenting here is only taking into account where roads have been built. So, in order to… you would have to add additional data, do it…do an additional analysis to account for the overall lower density of roads in rugged areas. And that's the challenge we have not yet met and that's…that may be a topic for future research.

Thank you both let's see here um another question asks, uh did you use satellite data for elevation?

So, I can tackle this one. Uh the base data set that we use for the elevation data is the GM TED20, um the global multi-resolution terrain…. wow, okay the acronym is escaping me at this point. Like the words underneath the acronym are escaping…. are escaping me at this point, um but this data is um created using information from multiple different sources that was um amalgamated into a single data set. But one of the primary data sources that they used is from the shuttle terrain, uh resource mission, the SRTM data uh, which used the…this where the space shuttle flew around the earth and measured uh terrain. Um so that's…. but that was the primary input. But then there were also input from multiple other data sources used to create this GM20 data set and currently the GM TED20 data is the, the gold standard for uh global um for data, uh for usage for things like this. So, if you want to find out more about that, um you can find out more about that from the USGS.

Alright good to know thank you both um that's all we have for today so thank you Elizabeth and John for sharing your expertise and insights with us. Uh thank you also to our listeners for your interest in ERS research. Uh we hope that this data training has been helpful for you. Before we close, be sure to mark your calendar. Our next webinar will be Wednesday October 25th at 1 p.m. Eastern Time. Join us as we present our latest report on household food Security in the U.S. UI more details are soon to come on the ERS website and our social media channels.

Speaking of social media, don't forget to like, share, and follow ERS on X (formerly known as Twitter) and LinkedIn. There you'll find snapshots of our latest data, charts of note and research. That's it for now. Again, thank you all for joining us today. This concludes our webinar.