Workflows Assignment 4

General / Tips

Setup ArcGIS Environment	Follow the steps outlined in the document Lab Fundamentals in LMS to set up your project environment.
File Save	Save your work often as ArcGIS is prone to crashing, especially when working with large files.
GEOM20013_A3_ Description	Refer to document GEOM20013_A4_Description for the description and assessment details for this assignment.
	Remember to use the 'Search' function on the right of ArcPro interface to look for various tools mentioned in this document.

Task 1 Beginning the exercise – Preparing your data sources

Select Location	Decide on which state or region you are interested in. This may relate to the availability of the data elements of your choice below.
Select Elements	Brainstorm and gather all necessary data elements related to your disaster hazard. Some suggestions on data sources can be found towards the end of this document.
	Data you need include hazard(s) and element(s) at risk.
Prepare Raster Layers	Use the Polygon to Raster Tool to create raster layer from data that you have in a Vector format when required (eg. Land use, tree density etc.).
	Raster layers can also be created from various analysis tools (eg. various Flood Analysis tools, Slope, Aspect, Euclidean Distance, Network Analysis etc.).
Reclassify Rasters	Raster layers need to be standardised for calculations to be carried out properly.
	Reclassify raster layers to a standardised scale with the 'Reclassify Tool'. Either found through the Geoprocessing Tab on the right-hand side. Or use the *Remap raster function,* found under the Imagery top menu > raster function > Reclass > Remap. Raster functions make any new data, compared to tools.
	If data is continuous (eg. Terrain, temperatures), meaningful class breaks can be introduced. These can be automatically computed (Jenks - Natural breaks, based on data distribution) or defined by you (i.e., from 1-100 or 1-10 etc).
	If data are discrete, individual classes can be classified (eg. Land use: Farm = 20, Forest = 80).
	https://pro.arcgis.com/en/pro-app/tool-reference/3d-analyst/an-overview-of-the-raster-reclass-toolset.htm

Task 2 Processing data

Creating Hazard Map

Hazard maps can be produced by adding rasters together, possibly with weighted factors. The following tools can be used:

Weighted Overlay – weighting factors for all hazard rasters need to add up to 1. Recall Lecture on multicriteria analysis.

https://pro.arcgis.com/en/pro-app/tool-reference/spatial-analyst/weighted-overlay.htm

Raster Calculator – weighting factors can be a fraction, eg. Tree density x 0.8, total no more than 1. This exposes a similar tool as Weighted overlay, but exposes the full power of map algebra for combining layers.

https://pro.arcgis.com/en/pro-app/tool-reference/spatial-analyst/raster-calculator.htm

If you don't want to make more data and want a faster result, use *Calculator* under Raster Functions.

You can use map algebra functions such as a *Conditional* statement. This is required to multiply or add rasters togtther with Null values.

Con(IsNull("tree_density"), 0, "tree_density")

Apply Hazard Values

The values within the hazard map are then applied to various elements of your choice (eg. Population, infrastructure, industry, environment etc.) to obtain the risk value.

Use 'Extract Values to Points' tool to apply the hazard value to a point layer.

Use 'Extract by Mask' tool to apply the hazard value to polygon layers.

The above steps introduces a new Hazard value field into the attribute table. Use the Field Calculator to carry out the operation:

*Risk = Hazard Value * Vulnerability Value.*

Based on the data source or your research you can apply one Vulnerability Value for all the elements in the attribute table, or different Vulnerability Values by classes (eg. Different age ranges, amount of patients in hospital, population density etc.).

Polylines to Points

If an data source is in polylines, use the 'Feature Vertices to Points' tool to convert them into points followed by 'Extract Values to Points' tool as mentioned above to apply any values.

http://pro.arcgis.com/en/pro-app/tool-reference/data-management/feature-vertices-to-points.htm

Raster Calculator

After rasters are produced from various tools mentioned above(eg. 'Polygon to Raster' tool), the 'Raster Calculator' tool can also be used to apply Vulnerability Value.

	You can also explore masking when using raster calculator.
Smoothing Raster data	As a more advanced step, you may consider smoothing your data to remove small insignificant variations, possibly results of measurement errors (i.e., in terrain). This can be done using focal statistics (for instance, a local mean value). https://pro.arcgis.com/en/pro-app/help/data/imagery/focal-statistics-function.htm
Convert Values for Raster Data	Sometimes you may be required to convert a value (NoData or Null value included) to another value within a raster. You can use the *Set Null* map algebra function or the remap raster function. https://pro.arcgis.com/en/pro-app/tool-reference/spatial-analyst/raster-calculator.htm https://pro.arcgis.com/en/pro-app/help/data/imagery/remap-function.htm
Tip	It is best to show elements at risk in their native format provided, eg. Hospitals as points, Land areas as polygons etc.

Task 3 Creating useful maps

Hazard Maps	Hazard maps like the one described in Task 2 are useful in highlighting the hazards and process of obtaining the Risk Assessment. You will need to produce at least one or two in the report.
Risk Maps	To create the resulting risk maps, each elements at risk layer must first be a raster. Use tools like Polygon to Raster and Point to Raster to achieve this. The elements at risk layers contain information on their vulnerability weight. The rasters can then be combined using Raster Calculator for the final risk map, with the weight values for each main element at risk.
Results	The end results would ideally be a series of maps ranging from the Hazard mapping illustrating Hazard values, followed by Risk maps with Vulnerability and Hazard value applied to an element at risk, and finally the final Risk map with all the elements at risk, vulnerabilities and hazard values combined according to the formula. *Presentation of maps*: Recall the elements of a good map from A1. What symbols do you display? Be extra careful about colour choices. Consider the colour ranges of the maps you produce: what are the low values, what are the high values? How would you communicate these best in colours? You do not need to create your own schemes, but consider carefully which of the schemes applies best.

http://pro.arcgis.com/en/pro-app/help/mapping/layer-properties/color-schemes.htm

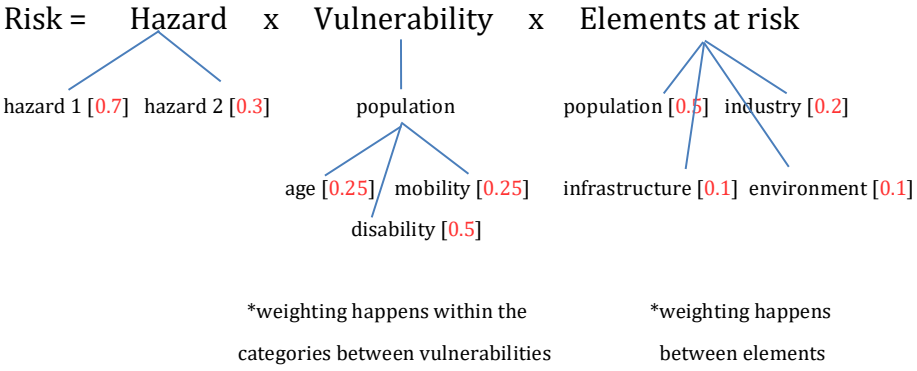
https://alexurquhart.com/post/cartography-tips-arcmap/

https://www.futurelearn.com/courses/maps-geospatial-revolution/0/steps/30211

Risk Calculation

Sample risk calculation

Risk Analysis Formula



Data Sources

Here are some suggested data sets and sources and what you can do with them. Remember you can use your own data you have found as well, which is in fact encouraged! Showing to do extra and interesting things may bring extra bonus marks.

This data in exception to the Queensland data will be a zipped file called (Extra) Disaster Data.

Census Data

To calculate population density and population age as vulnerabilities, as well as any other factors you can find.

Population Density: you can use *censuscounts_mb_2011_aust.csv* along with the mesh block for your state. Eg. Western Australia is *mb_wa_2006_census*. Mesh blocks are smaller than SA1 and SA2 areas, thus data will be more granular (better resolution).
Population Age: Find population age in CSV data in *2011_BCP_SA1_for_AUST_short-header* and join to *2011_SA1_shape* like assignment 1, SA1 areas are smaller than SA2 so data will be more granular.

datapacks.censusdata.abs.gov.au/datapacks/

DEM

Digital elevation model can be used to calculate slope and aspect.

	all-things-spatial.blogspot.com.au/2011/11/new-elevation-and-land-cover-data.html
AURIN	Online portal with a wealth of datasets covering various aspects of urban environments in Australia, eg. Australian Bureau of Statistics, Geoscience Australia, various Victorian departments, VicRoads etc. www.aurin.org.au
Australia OSM	Open street map – publicly sourced data for roads, public amenites, electricity lines, land use etc. Many different elements are present here. www.openstreetmap.org However, you are advised to use government sourced data layer for roads and public transport whenever possible (shown below).
Victoria Data:	Disaster Data files attached in LMS, and www.data.vic.gov.au
Address Points	Points of every address in Australia, use extract value to point tool to get risk value for each address.
Building Points	Same as above but for each building.
Building Polygon	Same building points but has polygon outline shape of building.
Burn History	The past burns history, more recent burns are less risk.
Burn Plan	Where the department plan to burn off, probably higher risk areas.
Schools	Add the CSV file then right click in the table in ArcMap and click display XY data – it will show the locations of the schools as X(lat) and Y(long) data in the table.
Fire Infrastructure	Points of fire infrastructure, extract value to points to get risk, may have vulnerability based on type eg. Water Tank = 30 and Wooden Building = 80. Multiply this value by the Hazard value extracted to obtain Risk value.
Fire Instalments	Same as above but for other instalments.
Land Use	Categorise different land use types with different risk values, eg. For flood farm = 80 and forest = 40 hazard values.
Public Transport	Extract the hazard values to these bits of infrastructure to see how at risk they are.
Sport and Recreation	Sports and recreation facilities.
Hospitals	Locations of hospitals.
Vic_Roads	The road network, use Euclidian distance tool to get distance from roads in a raster.

Water Points	Water infrastructure. Can use Euclidian distance tool (Spatial Analyst > Distance) to obtain distance as the further away the more risk there is.
Bushfire Prone Area	Areas already stated as bushfire prone.
Brigade Locations	Once again similar to Water Points, you can use the Euclidian distance tool to obtain distance from fire stations.
Queensland Data:	Links are provided for the following Queenland data sources. Click "Go to Resource" and request the data as a shapefile and in the coordinate system you have chosen in your ArcMap environment. General link: www.data.qld.gov.au
Roads	Can use Euclidian distance tool to get distance to roads, or use network analysis to do analysis routing to landmarks (below) along the network eg. towns or fire brigades. https://data.qld.gov.au/dataset/baseline-roads-and-tracks-queensland/resource/84c77700-b827-4e3e-8b53-10bfa5b402a7
Landmark Areas	Landmarks including schools, hospitals etc. https://data.qld.gov.au/dataset/landmark-areas-queensland/resource/7a449b4c-7168-422b-829f-eda8fc803124
Rail Network	Railway network. https://data.qld.gov.au/dataset/transport-features-queensland-series/resource/87227ac9-2148-4ed0-996f-3f7a080f70a2
Different Transport and Infrastructure	Use for elements at risk and hazards etc. https://data.qld.gov.au/dataset/transport-features-queensland-series
Watercourses	Good for flood analysis. https://data.qld.gov.au/dataset/watercourse-identification-map-queensland-series
Rainfall	Flood analysis – areas with more rainfall has higher flood risk. https://data.qld.gov.au/dataset/average-yearly-rainfall-isohyets--1920-to-1969--queensland
Hydrographic Features	Flood analysis. https://data.qld.gov.au/dataset/hydrographic-features-queensland-series
Drainage	Boundaries and names of Queenland's five drainage divisions. https://data.qld.gov.au/dataset/drainage-divisions-queensland
Dams and Weirs	Flood analysis – size may affect floods, infrastructure vulnerable to flooding.

	https://data.qld.gov.au/dataset/dams-and-weirs-queensland
Drainage Basins	Boundaries and names of Queenland's drainage basins (catchment). https://data.qld.gov.au/dataset/drainage-basins-queensland
Flood Extent Series	This can be very useful in showing floodwater inundation. https://data.qld.gov.au/dataset/flood-extent-series
Erosion Prone Areas	Ideal for flood and landslide analysis. https://data.qld.gov.au/dataset/erosion-prone-area-series
Floodplian Assessment	Estimation of potential flood hazard areas. https://data.qld.gov.au/dataset/queensland-floodplain-assessment-overlay/resource/68aca06b-12f6-458d-b0c6-c7f806877eb8
Electrical Distribution Network	Electrical distribution network. https://data.qld.gov.au/dataset/overhead-and-underground-electrical-distribution-network/resource/65d6e7b0-1ea9-4a0f-a32f-50fe55b6fa43
Land Use	Certain types of land use may be more prone to flooding or landslides. https://data.qld.gov.au/dataset/regional-land-use-categories-regional-plans-series
Land Cover and Trees Study	Areas with more trees may be less prone to flooding and landslides. https://data.qld.gov.au/dataset/statewide-landcover-and-trees-study-queensland-series
Bushfire Prone Area	Bushfire prone area from vegetation hazard class. https://data.qld.gov.au/dataset/bushfire-prone-area-vegetation-hazard-class-queensland-series
New South Wales Data:	www.data.nsw.gov.au

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