SPATIAL CONNECT

Flooding in rural Victoria
Hazards and Disasters

Answers

Part 1: Where will it flood?

Getting started

1. Click on the blue 'i' button after the green active layer text. When was this data updated – how current is it?

Data updated 15 March 2017; very current - at the time of writing.

2. What do you think the word "riverine" means? Look the word up to check your understanding.

Relating to rivers, watercourses and lakes.

3. The thick red line on the map is the Corangamite Catchment Management Authority boundary and the flood data is only available within this region.

   a) While looking at the map, move the *Transparency* slider all the way to the left and then to the right several times. What water features do the blue areas (in two shades) appear to match with? You may like to zoom into the map to see this in more detail.

   Flooding data corresponds to lakes and rivers.

   b) The two shades of blue show how much flood data is available for an area. According to the legend in the main panel, what do they each represent? For which kind of data is there more coverage?

   'Detailed flood data' and 'limited flood study data', the latter being more prevalent.

Navigating the map

4. Hide the *Flood information* panel and use the map navigation controls to zoom into Colac. Make sure the *Transparency* slider is at the middle point. Explore and observe the Colac township and surrounds.

   a) What kind of data is available for the area of Lake Colac and near its shoreline?

   'Limited flood study data'

   b) What kind of data is available for the creeks flowing north, through Colac township, into Lake Colac?

   'Detailed flood data'

   c) Using map evidence, what is the name of the creek to the south-east side of Colac that floods?

   Barongarook Creek

   d) Why might the Catchment Management Authority (CMA) have invested in one kind of data for the town area, and another for the area around the lakes? Use the 'Imagery' or 'Hybrid' views to visit the lake shore areas to assist you.

   The lake shore areas and surrounds are largely agricultural land with little impact due to inundation, while the creeks affect residential and rural residential properties, which has high potential impact.

Understanding property flood data

Flood data table explained

5. Refer to the Colac key map, and navigate to the area to the west of Lake Colac near Rossmoyne and Sheehans Roads.

   a) Click on the point indicated by the number 1 on the key map. The property boundary will appear on the map and information for it will appear in the *Flood information panel*. What is the street address for the property?

   75 Boylans Lane Cororooke 3254

   b) The property at point 1 is located in the light blue flood area which means there is "limited flood study data" within its boundary. What flood data does the information panel tell you is available?

   "No detailed flood study data available for the selected area".

   c) Click on point 2 in the key map. What is the street address for the property?

   100 Rossmoyne Road Colac West 3250

   d) During a time of flood, will all of the two properties be under water? How do you know this?

   No, because only a portion of each property, closest to the lake, is shaded.

   e) Turn on the *Hybrid* map option and zoom into the area of property 2. Would a 1% flood impact any buildings?

   No, the property buildings are to the west of the flood-prone area of the property; only paddocks are affected.

   f) The property at point 2 includes the darker blue indicating that there is *detailed flood data* available, which will be obvious in the information panel on the left of the screen. Looking at this information, you can see that *Regional Flood Mapping* was carried out in 2016, naming the two creeks involved. You identified one creek in 4(c), above. What is the name of the creek flowing into Lake Colac at the western end of the town, where you are now investigating?

   Deans Creek

   g) The minimum 1 in 100 year flood depth in the table is 0.00m. What would this mean?

   This some part of this property has the potential not to flood at all in a 1% flood; it would be higher in elevation, for example.

   h) What is the maximum flood depth predicted for property 2 in centimetres? Use your ruler to determine where the water would come up to on your leg if you were standing in water this deep.

   27cm – over ankle height, somewhere on the shin.

   i) The average adult human normally walks at around 1.4 metres per second (m/s), with a fast walk being 2.4 m/s, and a jog at 3.6m/s. Use this information to describe the impact of water moving at this speed in this area?

   At 0.71m/s that is about half walking speed; quite slow moving.

   j) Click the *Tools* button on the toolbar and select the *Measure distance* tool (). Click on the area behind the property's buildings, move to the closest part of the indicated flooding, and double-click. The measured distance will appear in the tools window. Approximately how far from the property's buildings would flood waters reach in a 1% flood?

   ~700m

   k) Close the map tools panel, and return to *Map* view.

Integrating Natural Resource Management Planning Portal

6. Lake Colac is its own catchment with the two main watercourses flowing through the Colac township itself from the south, rising on the northern slopes of the Otway Ranges. Follow the steps for *Integrating Natural Resource Management Planning Portal* and zoom in on the Colac region. The two streams will be outlined as a blue line.

   a) Using your navigation skills and the distance measure tool found in this portal (the same steps as in 5(j)), determine an approximate length of the eastern-most of the two watercourses. You will not be able to follow every bend in the stream but be as accurate as you can.

   Barongarook Creek will be line measured at ~12km

   b) The actual length of this stream is about 13km. Your measured length was probably less than this. Why is this the case?

   Tool-measured length because at this scale and using the tool, not every bend and meander in the creek is being measured.

   c) Repeat the measurement exercise for the creek to the west. How long have you estimated it is?

   ~16.5km

   d) How would you be able to more accurately measure the lengths of these watercourses using the tool?

   zoom in on the streams and follow the path of each more closely.

Property flood reports

7. Enter 24 Wallace Street Colac 3250 into the address search at the top left of the screen and press the *Enter* key. When the address is returned as a hyperlink in the menu, click on it and it will be shown on the map. From the flood information panel, download the full flood report for the property.

   a) Who is likely to want such a report?

   The owner/resident of the property.

   b) How is this property zoned for development? Are there any other planning conditions (or overlays) noted for the property?

   Zoned general residential. Land subject to inundation.

   c) Looking at the map and/or the map extract in the report document, what is the most important thing to notice about which part of this property is subject to flooding?

   The portion of the property subject to flooding includes the residence itself; the backyard and shed/carport being less affected.

   d) Enter 24 Wallace Street Colac 3250 in either Google Maps or Google Earth and use Street View to "stand outside" the property, using the zoom to enlarge the view of the house. A standard house door is about 2m high. Carefully, on your screen, use a piece of paper and pen to mark the top and bottom of the door. Using the maximum flood depth data, use a third mark to represent the height of the flood using that 2m scale. Next, place the door-bottom mark at ground level against the side of the house on the left side near the driveway. Estimate how far above the door level (in centimetres) the water would reach using your flood level mark.

   This exercise should reveal that 20-30cm of water depth would reach inside the house.

   e) Read this article about the flooding of 16 September 2016: http://www.colacherald.com.au/2016/09/huge-sandbagging-effort/. It mentions several Colac roads where sandbagging protected homes. Wallace Street was not listed; why not?

   The flood on this occasion was not at the 1 in 100 year level, so this area was not affected.

f) Based on what you can see of the 24 Wallace Street house, would sandbagging the doors likely be effective in keeping out flood water?

Sandbagging would probably prevent major damage, yes.

g) On the left of the screen, read the section of the full flood report section on “decision guidelines”. The second paragraph points out that local councils – in this case the Shire of Colac Otway – must consider potential flooding with approving land development. The Corangamite CMA is responsible for such assessments in this region. With this in mind, in your own words, summarise the five points the CMA considers when assessing developments.

Keeping people safe, one property making the flooding of neighbouring properties worse, protecting the environment, ensuring property is not damaged, and making sure the community and emergency services are not put under pressure.

h) In the following section of the decision guidelines, point number 3 talks about a building’s minimum floor height. Why would floor height matter? The house at number 24 Wallace Street is nearly 100 years old – why would its floor level be below the flood level?

Buildings can be designed so that the floor height is above the level of the expected 1% flood, keeping water out of the building. Number 24 was built well before the flood modelling. It is not a new building so it does not have to follow the new rules.

When it floods

8. Watch the video found at http://youtu.be/6ii2BVrhGDo?t=22, though to the 2:48 minute mark. This was filmed during the Barwon River flood of 16 September 2016 at Breakwater, a suburb of Geelong.

a) The children’s crossing sign (visible at 1:27 and 1:54 in the video) is approximately 2.5m tall, and the road edge markers, about 1m in height. Using these as a reference, estimate how deep the flood water appears to be at this point on Gundog Lane.

~50cm deep

b) Based on the video, how would you characterise the flow velocity of the flood waters? Would it be safe to cross in a vehicle?

Fast and powerful flow; unsafe for a car to cross

c) In the Corangamite Flood Portal, use the *Tools* button and enter the latitude **-38.182195** and the longitude **144.365268** in the *Go to location* boxes and click *go*. A green marker will be located at this point on the map. Using the distance measuring tool (see 5(j)), how far is it from the green location marker to the edge of the predicted 1 in 100 year flood level, to the east along Gundog Lane?

~40m

d) Zooming out, and using the measuring tool once again, measure approximately how far it is from the edge of the flood zone from Breakwater Road in the west, to Gundog Lane in the east, keeping in line with the road. Using the flood depth you recorded near the edge of the flood area in 8(a), how likely is it that the water is deeper along other parts of these roads?

~1.17km. A very high likelihood that other parts of the flooded area are much deeper.

e) Briefly turn off the flood layer in the main panel so there are no boxes now ticked. Switch to the *Imagery* view. Use the measuring tool to measure the width of the Baron River (the Gundog Lane road bridge is a good guide). How long is it?

~58m

f) Using your measurements from 8(d) and (e), how many times wider would the Barwon River become in a 1% flood?

1700/58 = ~29 times wider

g) Switch the riverine flood layer back on. Why might the railway line not shaded in blue?

The railway line has been designed to sit above the 1 in 100 year flood level so that trains can keep running during a flood.

9. Using the latitude and longitude in 8(c), open Google Earth and add a placemark ( ) using these coordinates. Zoom into the untitled placemark on the map (it is in Geelong).

   a) Use Street View to position yourself on the placemark and face west along Gundog Lane bridge looking west. Find the children crossing sign and road edge markers in the view. Why might the bridge have no railings on the sides (look at the video again to help you answer)?

   The road has no railings so debris from floodwaters will not build up and hold water back.

   b) What do you notice runs along each side of the roadway where the first edge markers are situated? What would this be for?

   Drainage grates run along each side of the road. They speed up drainage of water in flood times. As the road is designed to be flooded, it is more a causeway than a bridge.

   c) Turn your view to look east along Gundog Lane. Using this view and the Flood Portal flood line. Why is it obvious from the shape of the land that the 1% flood would stop here?

   Because the land rises enough at this point and is above the floodplain.

   d) Go back to the vertical aerial view in the Flood Portal. Make sure you are on *Imagery* view. You can also move the transparency slide to see both layers of information. What is the main land use of the flood area along the line of Gundog Lane and Breakwater Road? What other land uses are less, but still affected?

   Most of the area is recreational reserves and sports grounds. Some industrial and commercial land is affected, including roads.

   e) Zoom out and use the transparency tool to look at the larger flood area. What do you notice about the land use in the flood area?

Flood planning – will my house flood?

10. Images A-E are taken in the township of Buninyong, on the Geelong side of Ballarat. They show various views of De Soza Park that has the Union Jack Creek flowing through it. This creek, which is a small tributary of the Yarrowee and Barwon Rivers, is prone to flooding.

   a) Using images A and B looking west, describe the shape of the land to the north (right) of Union Jack Creek, compared with the south (left side) as you look downstream from this location. Image C gives the perspective looking south across the creek. What can you observe about the residences on the south compared with the north? (You might like to label N, S, E and W on the photo/s to help).

   The northern side of the creek is higher in elevation than the south side. The houses on the lower, south side are closer to the creek.

Union Jack Creek, Buninyong (4 and 5 Gum Tree Court properties and De Soza Park)

   b) Enter the Flood Portal, and using Tools > Go to location and the coordinates -37.64871 and 143.88159 to add a place marker to the map. This is the point from which the panorama (Image B) was taken. Ensuring Query mode is set to ON, click at the marker (zoom in a little and click on the very tip of the green marker). From the pop-up, what is the maximum flood height (in metres) and velocity (in m/s)?

   Flood height 1.27m and velocity 1.4m/s

   c) Now enter the street address 4 Gumtree Ct Buninyong 3357 into the address search window. The property boundary will appear on the map. Using the images, what is the property being used for? The houses on either side are constructed and under construction.

   The lot is vacant.

d) Using the query mode, click in each corner of the property boundary; northwest, northeast, southeast and southwest on the court (see key map). What are the flood depths given for each point?

NW: ~1.00m, NE: ~1.24m, SE: ~0.86m, SW: ~1.12m, noting that clicking in slightly different places may give similar, but varying results.

e) Image D shows the fence on the rear boundary of numbers 4 and 5 Gumtree Court, on De Soza Park. The full height of the fence is 1.17m and the red line marked is 0.9m above the ground level. Given your results from 10(d), what can you say about the potential height of 1% flood water in relation to the fence in the corner where the tree is?

The 1% flood water would be over fence height in the NE corner where the tree is located.

f) Using the data from 10(d), describe the situation for the house at number 4 (Image E) in a 1% flood. What does it mean for the house pictured at number 5?

The entire number 4 Gumtree Court property would be under water, ranging from 0.86m to 1.24m in depth. The residence at number 5 Gumtree Court would be under water to a considerable depth in some places as well.

g) Imagine that you are the owner of the block at number 4 and wished to build a house. Do some research about building houses in flood prone areas and list three things that you could do to protect your home, once built.

See the example in the links. Raising the floor level so the living spaces are above the predicted flood level. Build a two storey house with less important spaces at ground level, such as a garage or store room. Use building materials that can withstand waterlogging. Improve site drainage to remove water quickly after a flood, etc.

h) Images F, G and H compare views of Union Jack Creek during the 2011 flood and the same views without flooding. For reference, the bridge can be seen in the image B panorama, and is higher than the surrounding ground level. Given this evidence, what is your conclusion about the water level compared with the residential blocks? Where might the level of this flood reach on the fence in image D?

The water clearly would have covered at least part of these blocks to a shallow depth. On image E, water in 2011 would likely cover the bottom, horizontal fence board.

i) Image G was taken at the approximate location **-37.64860** latitude and **143.88163** longitude looking downstream. Use the *go to location* feature of the Google Earth to find this location and orientate yourself. Using the *hybrid* view, determined what change seems to have occurred in the area of the Gumtree Court development with regard to vegetation. This can be confirmed by using the Google Earth *historical imagery* feature ( ).

The majority of the vegetation has been cleared from this area. The treed area to the left of the image on the far side of the stream – which has water around it – has been cleared for the residential development. This is very clear on images G and H.

j) Compare image F (a smaller flood than a 1% flood) with image C (without flooding). Look at the Flood Portal map in 'hybrid' view to see the possible extent of a 1% flood (which would be much higher than the 2011 flood). Keeping this in mind, in your opinion, should the local council have allowed this residential development to go ahead? Justify your answer.

The logical response is that the local council should not have allowed the development to proceed because houses will be affected by severe flooding at some point. Alternatively, the Council should have made sure the houses were designed and built to withstand a 1% flood.

k) Just because a 1 in 100 year flood has not happened in living memory, does it mean it will never happen? Is it possible for more than one 1 in 100 year floods to occur in the same century, or even in the same year?

A 1% flood always has a probability of occurring. It is possible for multiple floods of this size, or larger, to occur at any time, as we are only dealing with statistical probability, not reality.

Summary

Describe how spatial technologies (GIS maps) are useful in helping manage flooding in this area? How can authorities use this tool to plan for a flood hazard?

Students own summary answers

Part 2: Will sea level rise make floods worse?

Procedure

1. In the map view, zoom in to the Bellarine Peninsula, including Geelong, Portarlington, Queenscliff, Ocean Grove and Barwon Heads (Scale = ~1 : 289K). Toggle the *Coastal Flood Extent - 1% (1 in 100 yr) with 80cm Sea Level Rise* layer on and off. Describe which places would be affected by sea level rise of 80cm plus flooding caused by rainfall.

   Coastal margins and inland low-lying areas where lakes are currently located will be inundated. Students should be able to give specific examples.

2. What are some likely impacts of this scale of sea level rise?

   Some areas will be permanently inundated (under water) and be unsuitable for use by people. Some people will have to move from their homes. Access roads will become accessible. Services such as power and sewerage will need to be re-routed, etc.

3. The Flood Portal combines the 1% (1 in 100 year) flood with a sea level rise of 80cm (0.8m). The CSIRO has modelled different sea level rise scenarios; 'low', 'medium' and 'high' scenarios (which can be considered projections or predictions).

   a) Using the table on OzCoasts, from which year is the sea level rise calculated? Starting from a fixed date is known as relative change.

   Sea level rise is measured relative to the 1990 sea level.

   b) In which scenario is a 0.8m rise found?

   The CSIRO 'medium' scenario, which is called A1FI.

   c) Under this scenario, by what year is a 0.8m rise expected to occur? This scenario for sea level rise is the one that the world trends are generally following in reality, at the present time.

   A 0.8m or 80cm is expected in 2100

   d) How many years is it from the relative date to the predicted date for 0.8m of sea level rise?

   1990-2100 is 110 years

   e) Calculate how many millimetres are in 0.8m? Using the answer you found in (d), calculate how many millimetres per year, on average, the sea level must rise to reach 0.8m.

   0.8m = 800mm, so 800/110 = 7.27mm per year on average

   f) Using your answer from (e), how many millimetres should sea levels have risen already? Using the same average annual rise, what would the sea level be in 2030?

   1990 to 2017 is 27 years, 27x7.27 = 196.29mm. In 2030 the rise should be 290.80m

   g) Look at the OzCoasts table again and note the predicted 2030 sea level rise for our scenario. You will notice that your answer for (f) is much greater than the figure shown in the table. Graph A shows what the sea level rise pattern is using an annual average. Graph B shows the modelled change. How does this explain the difference in your calculations?

   The medium A1FI scenario predicts 0.15m (150mm) of rise in 2030. The disparity is explained by the graph: linear change given by the average, but accelerating change in reality – an upwards curve – so the average is considerably above the prediction for 2030.

   h) Explain what the effect will be of 'normal' flooding caused by high rain events, when added to sea level rise of 0.8m?

   Sea level rise will inundate currently settled land. Storm flooding from rain will impact areas not currently affected at the current sea level. Ever larger areas will be subject to inundation over time.

i) What will have to be done to the flood models over the next few decades?

They will have to be updated to take account of the new sea levels.

4. Watch the videos for Barwon Heads and Ocean Grove, but *only* the 'without adaptation' sections (to the 1:04 mark of each).

a) For each, note at what level residential areas appear to be affected in each location.

Barwon Heads: 0.6m with storm surge, Ocean Grove: 0.0m with storm surge

b) In the Flood Portal (in Hybrid view), zoom into this area. Use the transparency tool to identify the potential sea level rise impact regions of each video.

The regions are on opposite sides of the Barwon River, approximately 2km apart, clearly indicated with the 0.8m sea level rise on. The Ocean Grove impact region is to the northeast of the Barwon Heads impact region.

c) Pause the Ocean Grove video at the 0:45 mark, where it shows the 0.8m rise with storm surge. Now zoom in and look at the same area in the Flood Portal. It may help you to identify the Club Grove Private Cabin Park on both. It is also useful to toggle between the two layers – the riverine flood 1% and the coastal flood with riverine flood at 1% - this shows the added impact of an 80cm sea level rise over the same area. The extent of flooding in the portal is greater? Why is this the case?

The video only models sea level rise plus storm surge. The Flood Portal adds the impacts of flooding from rainfall in a 1 in 100 year (1%) flood, flowing to the coast via watercourses.

5. Now watch the remainder of the videos that includes the adaptations.

a) For each location, what is the adaptation strategy used? Explain how they work.

Barwon Heads: back valves on water outfall pipes that stop water flowing back up the pipes from the sea. Ocean Grove: seawall that prevents sea water reaching inland by forming a barrier.

b) For Barwon Heads, pause the video and click between the 0:44 and 2:16 marks to compare before and after the adaptation with a 0.8m rise. Do the same for 0:58 and 2:33, at the 1.4m rise with surge. Do the pipes appear to do much to the inundation levels? With rainfall flooding added, what would be their likely value?

The pipes have little impact on inundation. They would assist with removing flood waters from inland more quickly.

c) For Ocean Grove, pause the video and click between the 0:45 and 2:10 marks, which show the impact of a 0.8m rise with surge, before and after adaptation. Describe the difference.

The majority of the residential land is protected, with only recreational space, including the golf course, inundated.

d) Why does the adaptation in Ocean Grove have no impact at the 1.1m sea level rise and above? Compare the 0:53 and 2:16 video time marks. How might this strategy make the situation worse at that point?

The seawall is 1.0m high and once sea level rise is 1.1m and above it becomes ineffective. At that point, the seawall would hold the water on the land side, like a dam, making the inundation last longer.

6. Go to the Our Coast *Coastal impact solutions* page: http://www.ourcoast.org.au/solution_matrix.php and select Private > Buildings & Land – Residential. This provides links to information about what can be done to retreat from, adapt or accommodate, and defend against sea level rise.

a) Will all of these strategies work for both sea level rise and flooding from storm rainfall? Why/why not?

No, because many of the strategies are protecting water coming from the seaward side, not from inland.

b) Spend some time looking into the strategies, and from each of the categories, decide which of them would be appropriate for rainfall flooding as well.

Retreat: planning. Adapt: building design, drainage, emergency planning, resilient infrastructure, raise land levels, planning. Defend: emergency planning, raise land levels, planning.

c) What would happen to flood models, such as the Flood Portal, if land levels were raised? How might this strategy 'go wrong'?

The models would become obsolete and inaccurate. Such a strategy cause flooding to occur or increase in unintended locations, with negative results, if not properly planned.

Summary

Describe how spatial technologies (GIS maps) and scientific modelling are useful in helping manage flooding in these coastal areas? How can authorities use these tools to plan for a flood hazard?

Students own summary answers