Community vulnerability to elevated sea level and coastal tsunami events in Otago

Map book

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1. Introduction

This document contains maps and diagrams to accompany the report, 'Community vulnerability to elevated sea level and coastal tsunami events in Otago', completed by the Otago Regional Council (ORC) in 2012. Ideally, the maps and diagrams in this booklet should be viewed alongside the information contained in the main report. The reader will also find a more complete introduction in that report.

Not all modelled scenarios are depicted for every community in this booklet. Generally, communities located south of Otago Peninsula are more exposed to a near-field tsunami originating from an earthquake on the Puysegur Trench to the south of New Zealand. Therefore, inundation maps for these communities are shown for the modelled 1:600-year Puysegur Trench tsunami scenario. As communities located north of Otago Peninsula generally have a higher level of exposure to a far-field tsunami originating from an earthquake off the coast of South America, inundation maps for these communities are shown for the modelled 1:500-year South American tsunami scenario. Where it appears that a particular community may be vulnerable to both of these tsunami sources, inundation maps for both the 1:600-year Puysegur Trench and 1:500-year South American tsunami have been included.

The inundation maps have been constructed using LiDAR[1] topographic data collected by the ORC in 2004. ORC holds LiDAR data for a strip of land along the coast. In some instances, the modelled level of inundation extends beyond the LiDAR coverage. Where this occurred, inundation extensions were created based on topographic data and expert interpretation. These extensions show areas that may be inundated to a depth greater than 0.5m.

This booklet also contains time series maps, which depict a modelled series of images of the tsunami's impact on the coast. The purpose of these maps is to give an indication of how long it will take a tsunami to arrive at each community after the earthquake that triggers it. The maps show that, in some instances, the water retreats from the beach before the tsunami wave hits the coast. They also indicate that a tsunami usually involves a series of waves that can continue to affect the coast for many hours.

The maps and diagrams are grouped by each coastal community and ordered from south to north. Additional information in the form of cross sections is also included for particular communities, where it aids understanding. The maps show the extent and depth of inundation over land areas only (i.e. not over areas that are normally covered in water, such as watercourses and the ocean).

[1] LiDAR. **Li**ght **D**etection **A**nd **R**anging: A mass of spot height information captured over a wide area, using an aircraft mounted laser. It has a vertical accuracy of ± 0.14m.

2. Papatowai

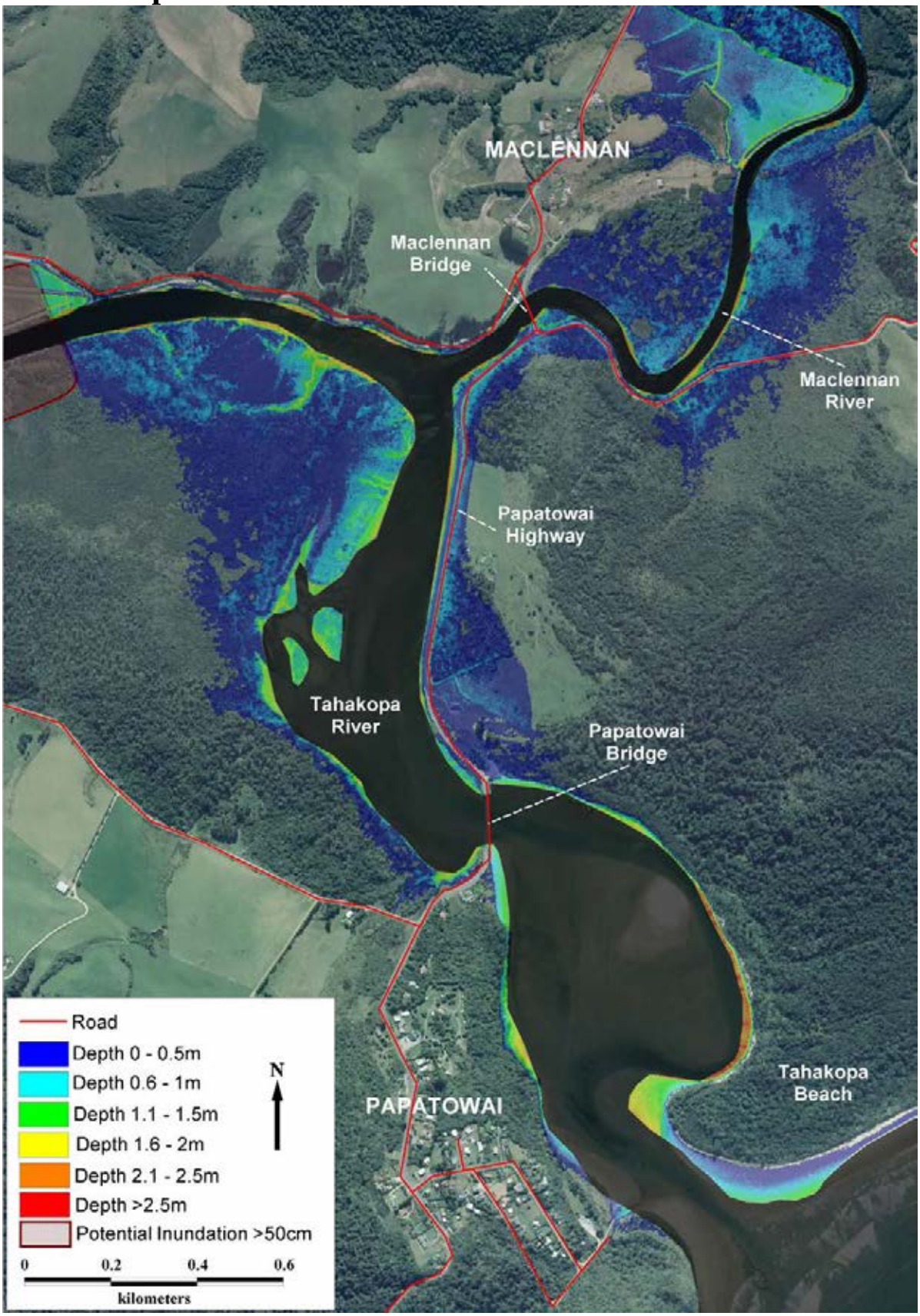

Figure A1. Maximum water depth for inundated land at Papatowai during the modelled 1:500-year elevated sea level event at mean high water spring (MHWS)

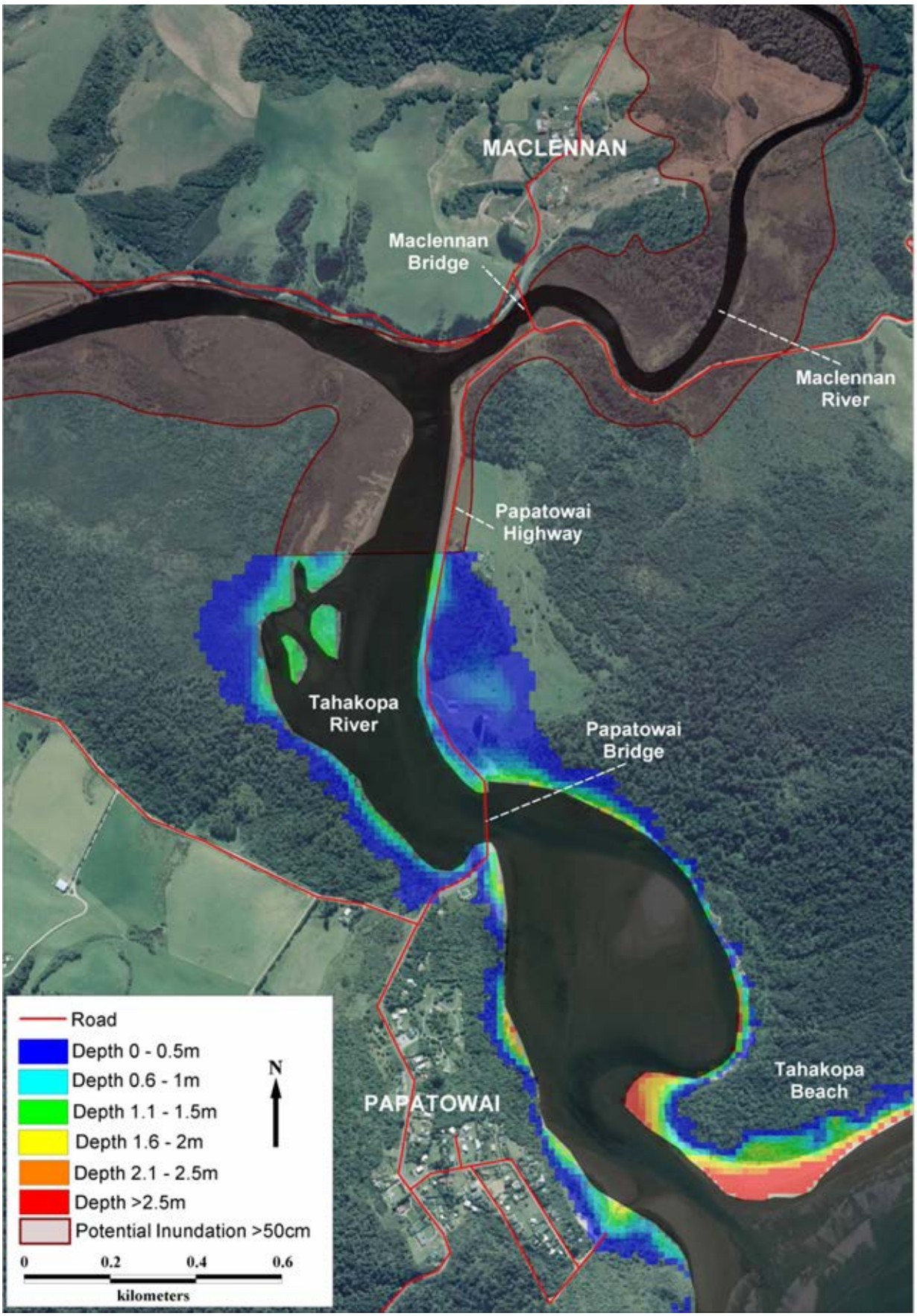

Figure A2. **Maximum water depth for inundated land at Papatowai during the modelled 1:600-year Puysegur tsunami at MHWS**

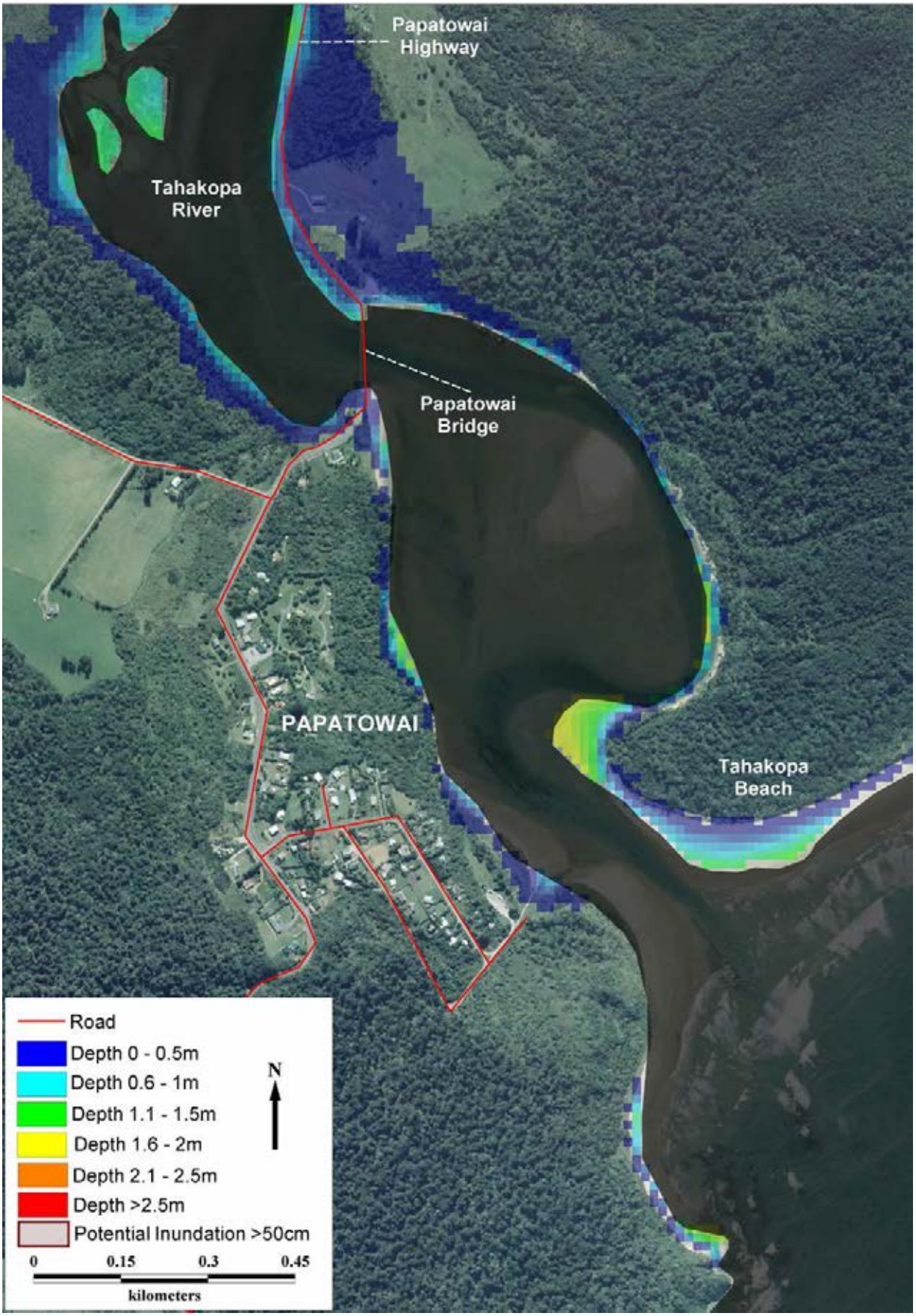

Figure A3. **Maximum water depth for inundated land at Papatowai during the modelled 1:500-year South American tsunami at MHWS**

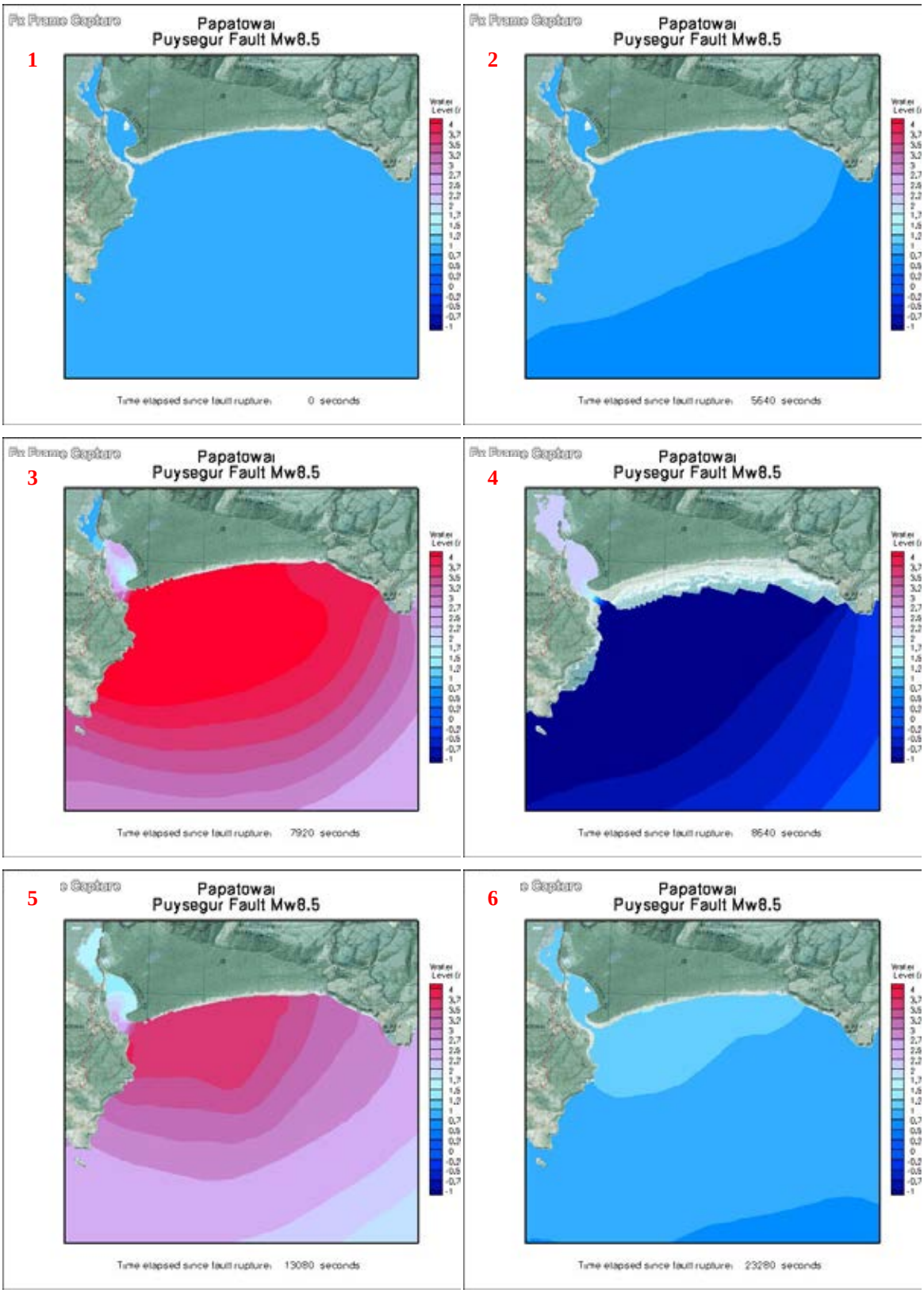

Figure A4. Time series showing changes in water level during the modelled Puysegur Fault tsunami at Papatowai

1 At fault rupture: The undisturbed level of the sea is at MHWS (0.9m).
2 1 hour 34 mins after the earthquake: The first retreat of waves occurs.
3 2 hours 12 mins: The first waves peaks at the estuary.
4 2 hours 22 mins after the first large wave: The level of the ocean retreats significantly.
5 3 hours 38 mins: Another large wave is modelled to impact the estuary.
6 6 hours 28 mins: Waves and strong currents are still impacting the estuary.

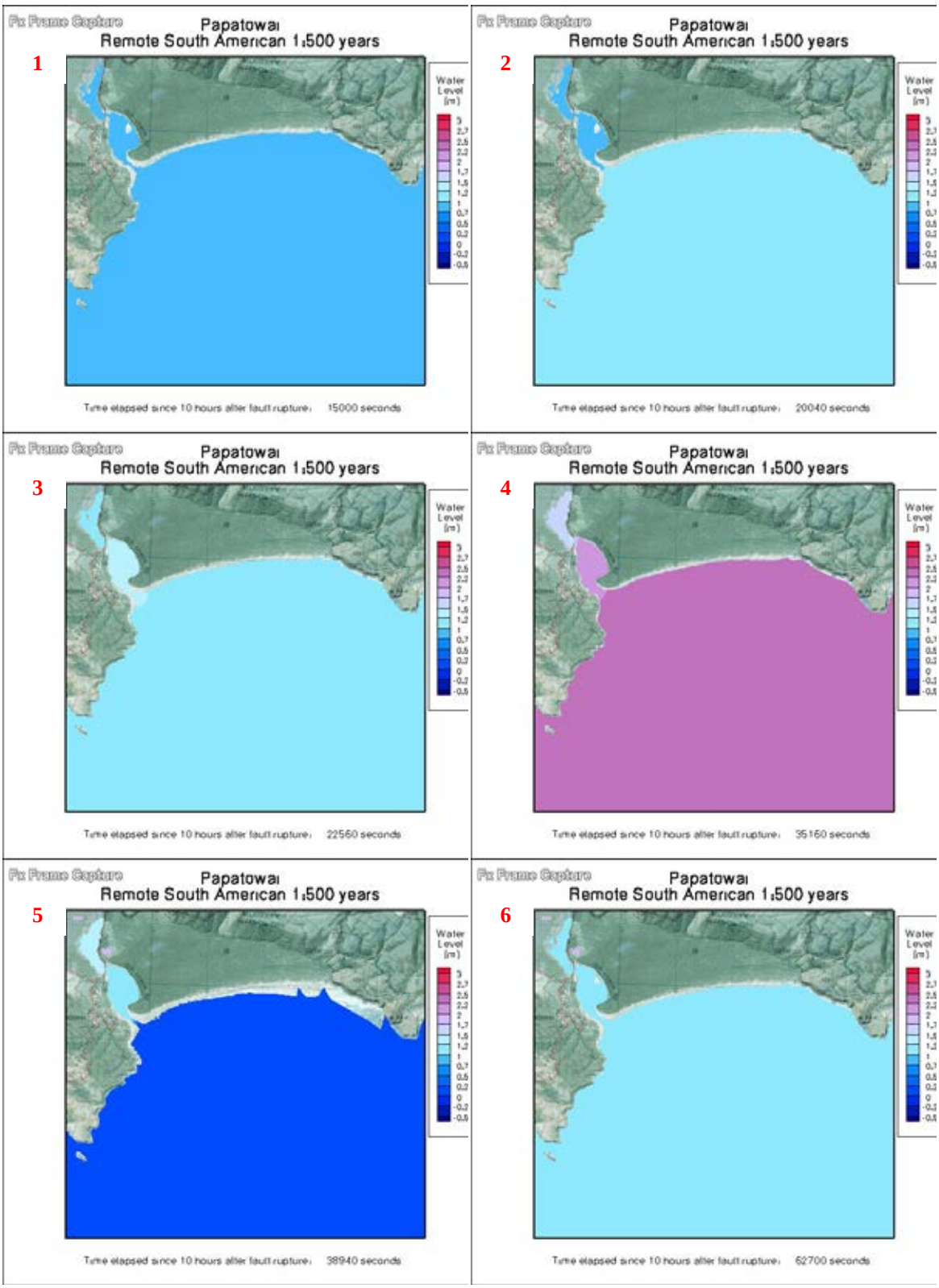

Figure A5. Time series showing changes in water level during the modelled 1:500-year South American tsunami at Papatowai

1 At fault rupture: The undisturbed level of the sea is at MHWS (0.9m).
2 15 hours 34 mins after the earthquake: The first rise in sea level impacts the coast.
3 16 hours 16 mins: The first wave peaks along the coast.
4 19 hours 45 mins: The largest wave impacts the coast.
5 20 hours 49 mins: The ocean retreats.
6 27 hours 25 mins: Waves and strong currents are still impacting the area.

3. The Catlins

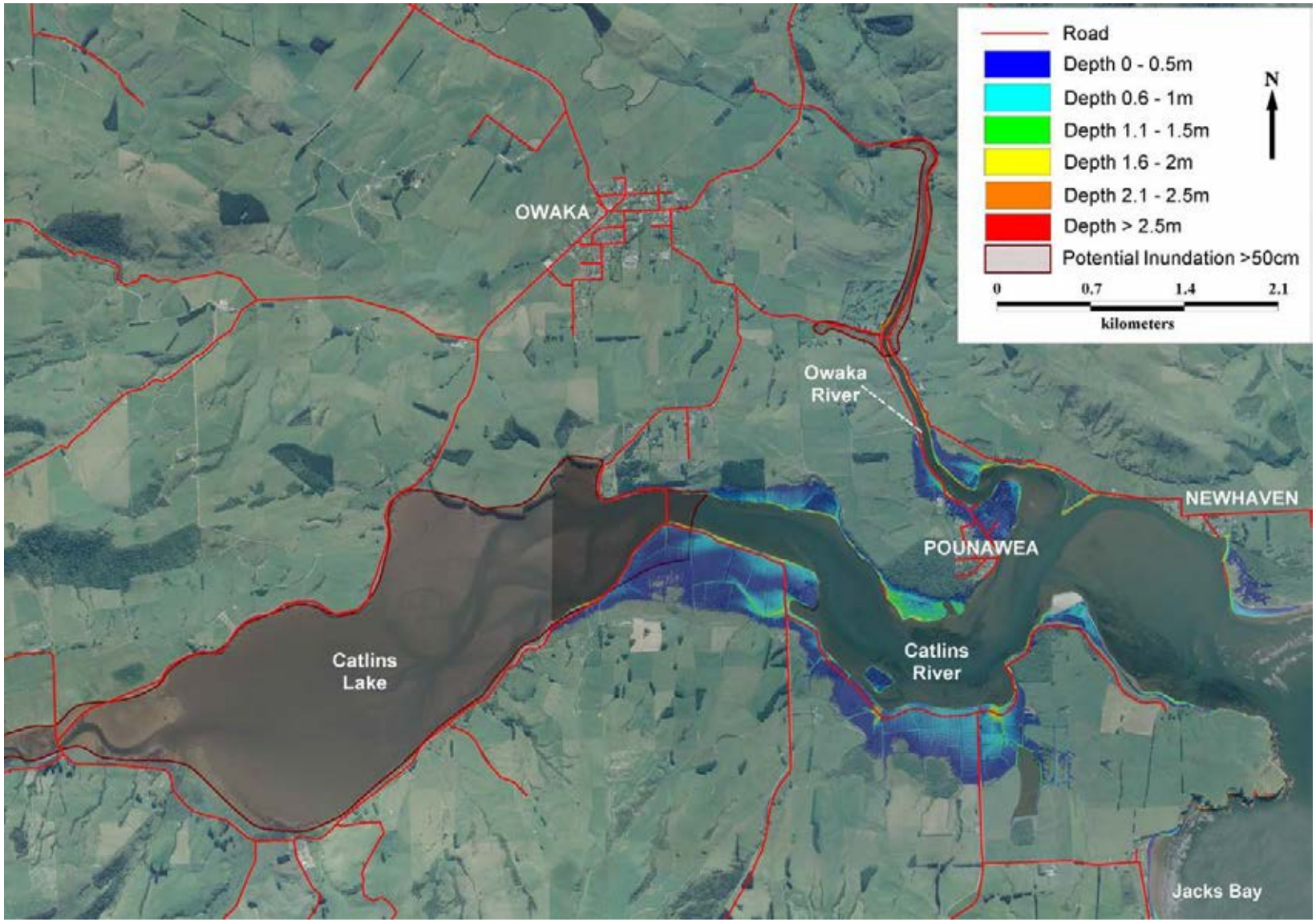

Figure A6. Maximum water depth for inundated land at the Catlins during a 1:500-year elevated sea level event at MHWS

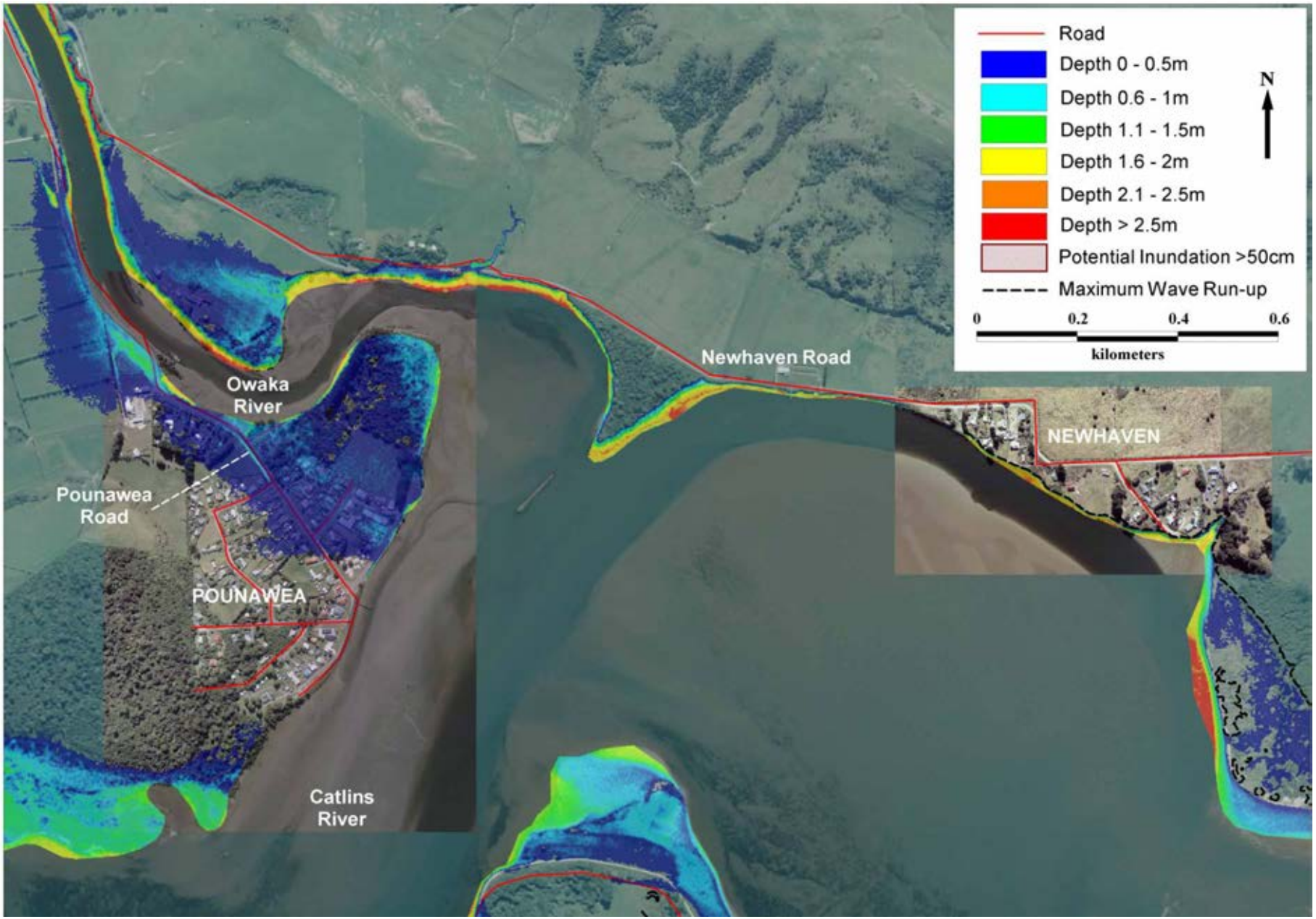

Figure A7. Maximum water depth for inundated land at Pounawea and New Haven during a 1:500-year elevated sea level event at MHWS

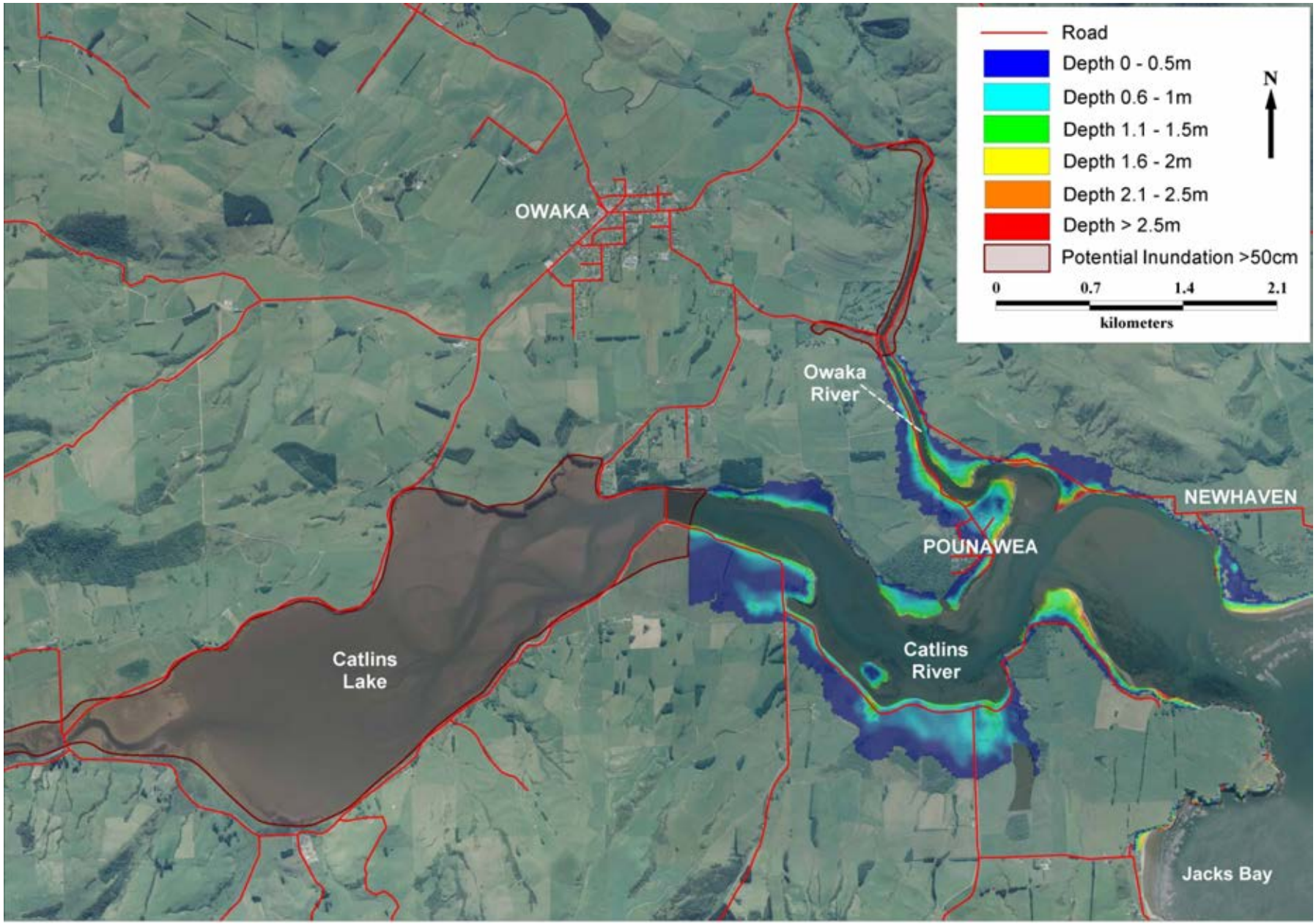

Figure A8. Maximum water depth for inundated land at the Catlins during a Puysegur tsunami at MHWS

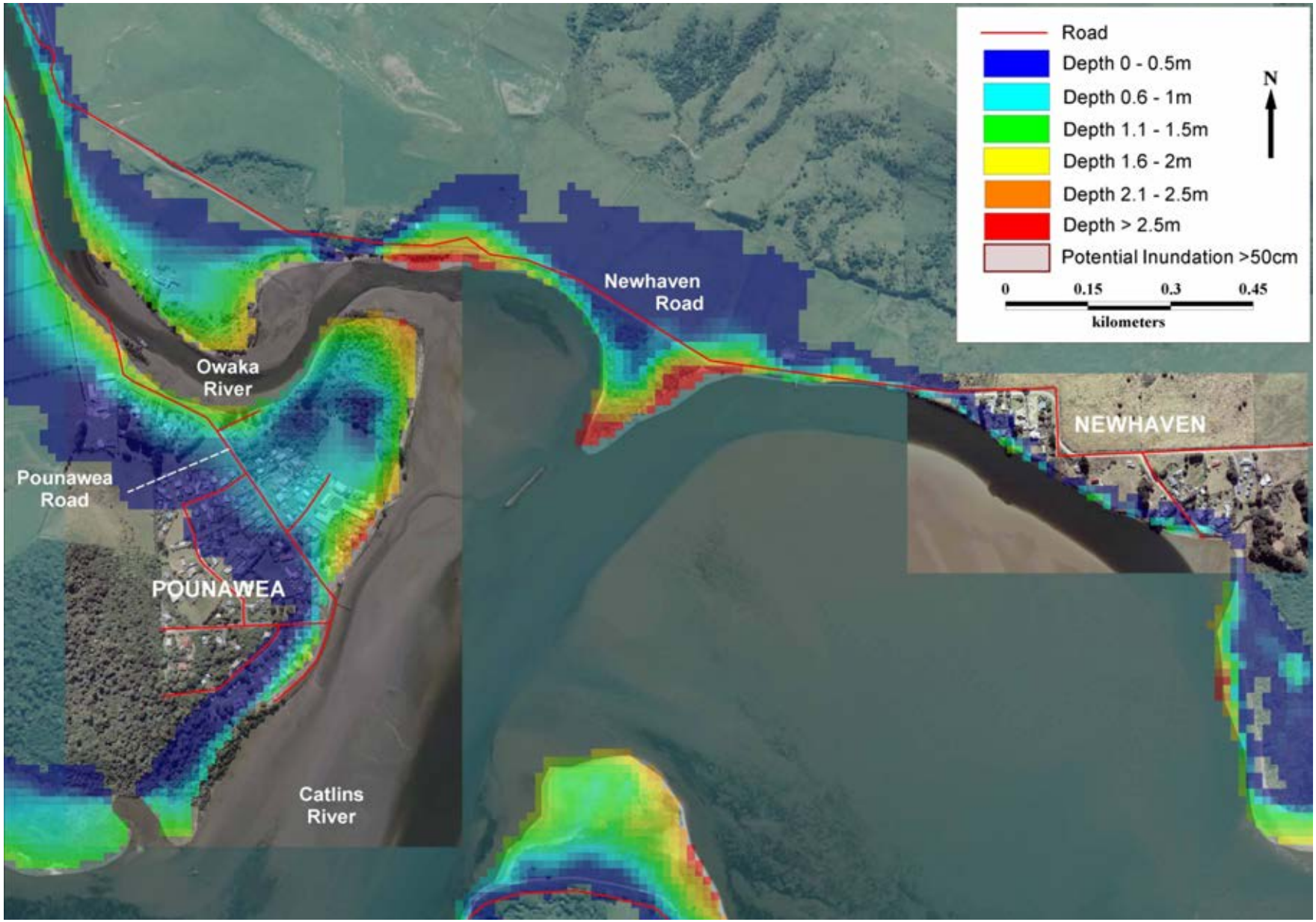

Figure A9. Maximum water depth for inundated land at Pounawea and New Haven during a Puysegur tsunami at MHWS

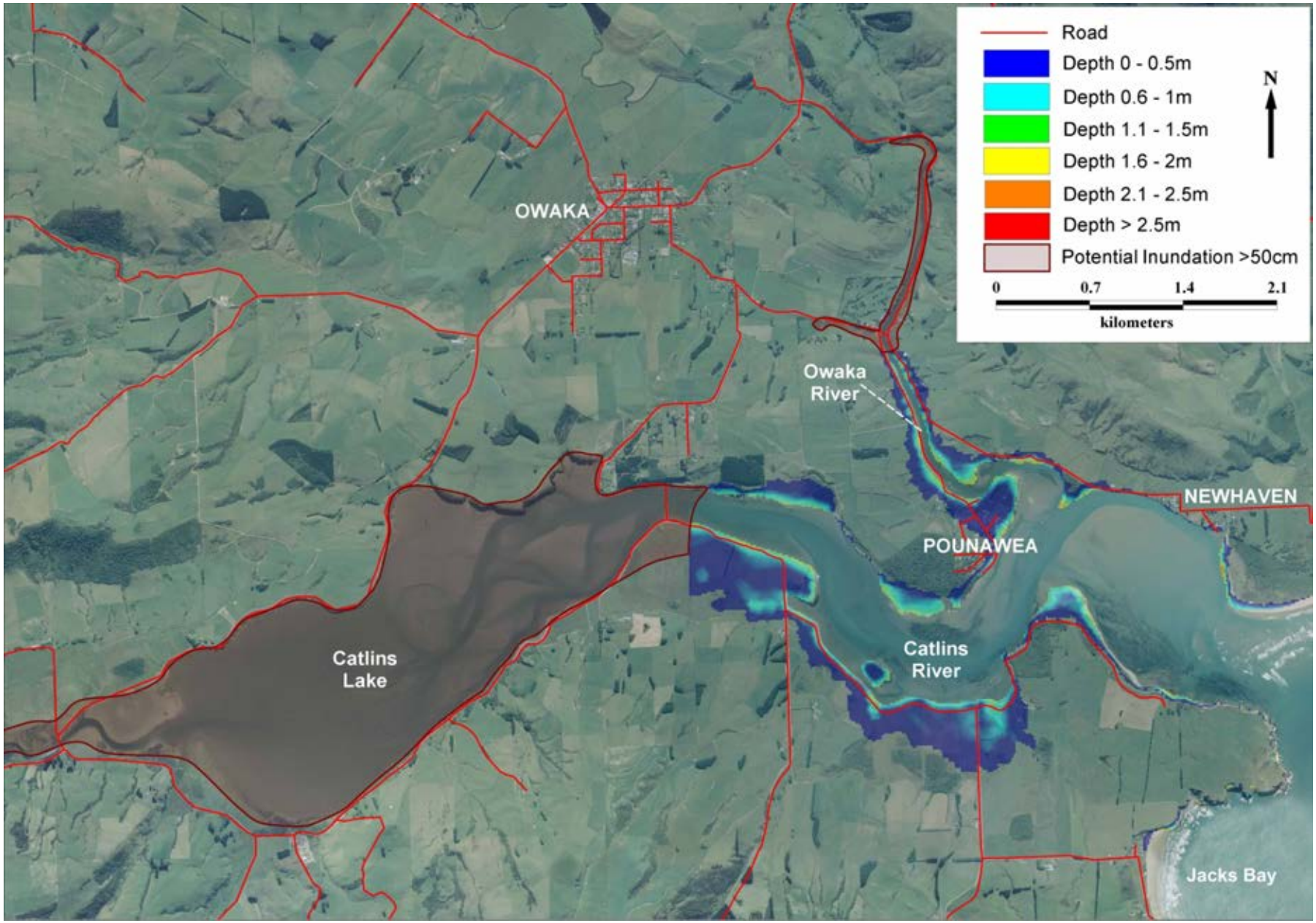

Figure A10. Maximum water depth for inundated land in the Catlins during the modelled 1:500-year South American tsunami at MHWS

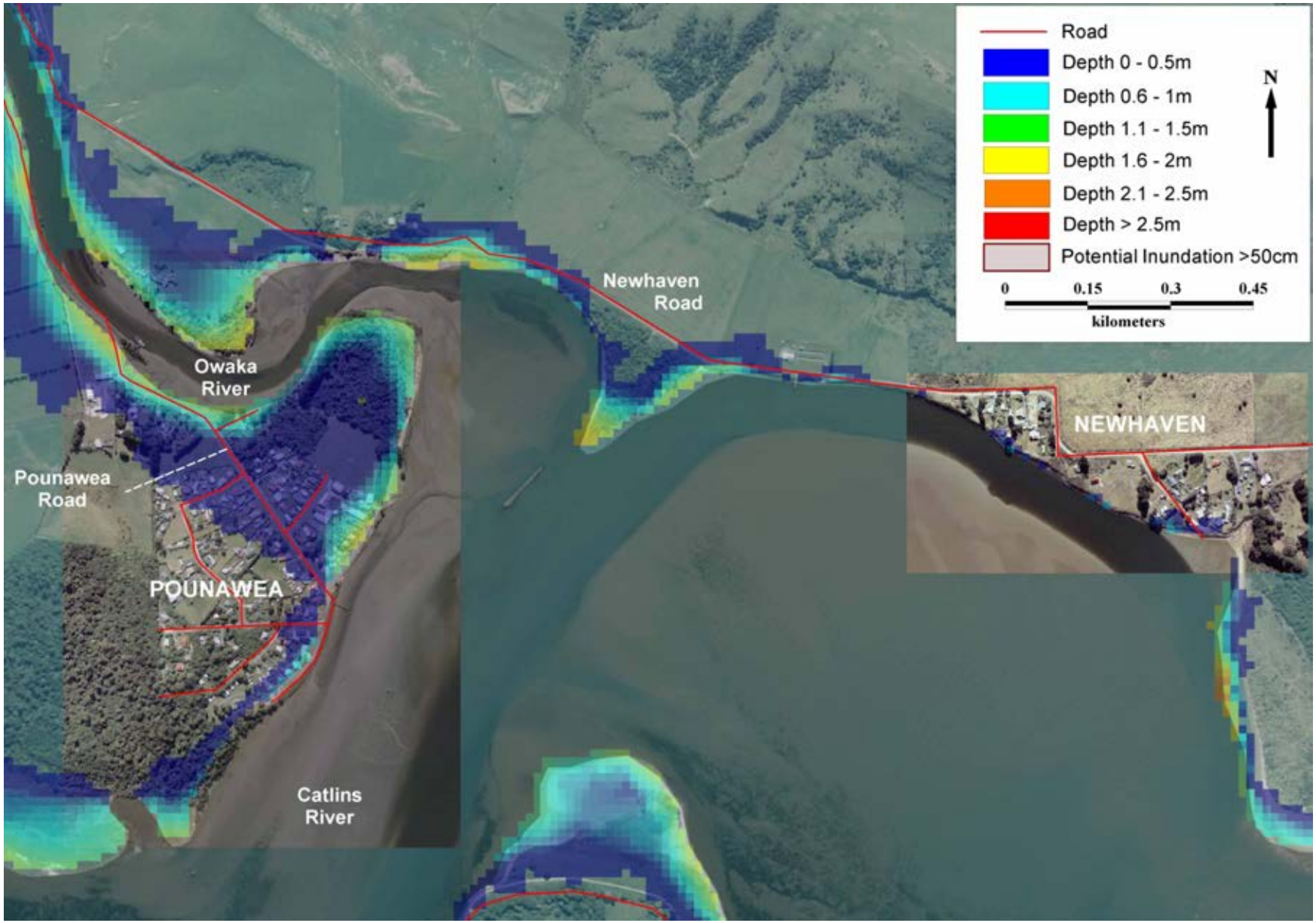

Figure A11. Maximum water depth for inundated land at Pounawea and New Haven during the modelled 1:500-year South American tsunami at MHWS

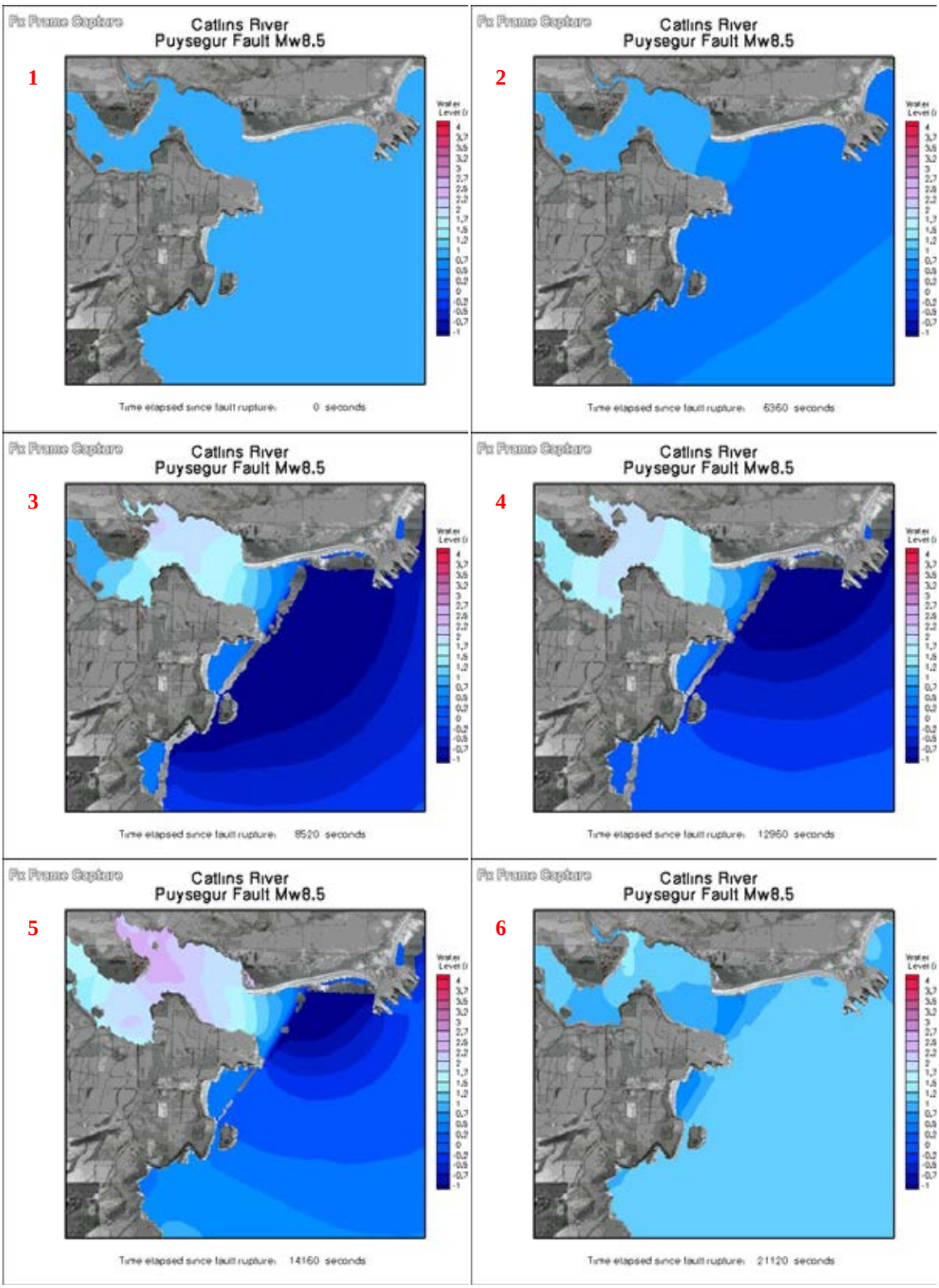

Figure A12. Time series showing changes in water level during the modelled Puysegur Fault tsunami at the Catlins

1 At fault rupture: The undisturbed level of the sea is at MHWS (0.9m).
2 1 hour 46 mins after the earthquake: The first retreat of sea level occurs.
3 2 hours 22 mins: The first wave peaks in Pounawea; retreat of the ocean is observed for the next wave.
4 3 hours 36 mins: The ocean starts to retreat significantly for the largest wave.
5 3 hours 56 mins: The largest wave impacts Pounawea.
6 5 hours 52 mins: Waves are still impacting Pounawea.

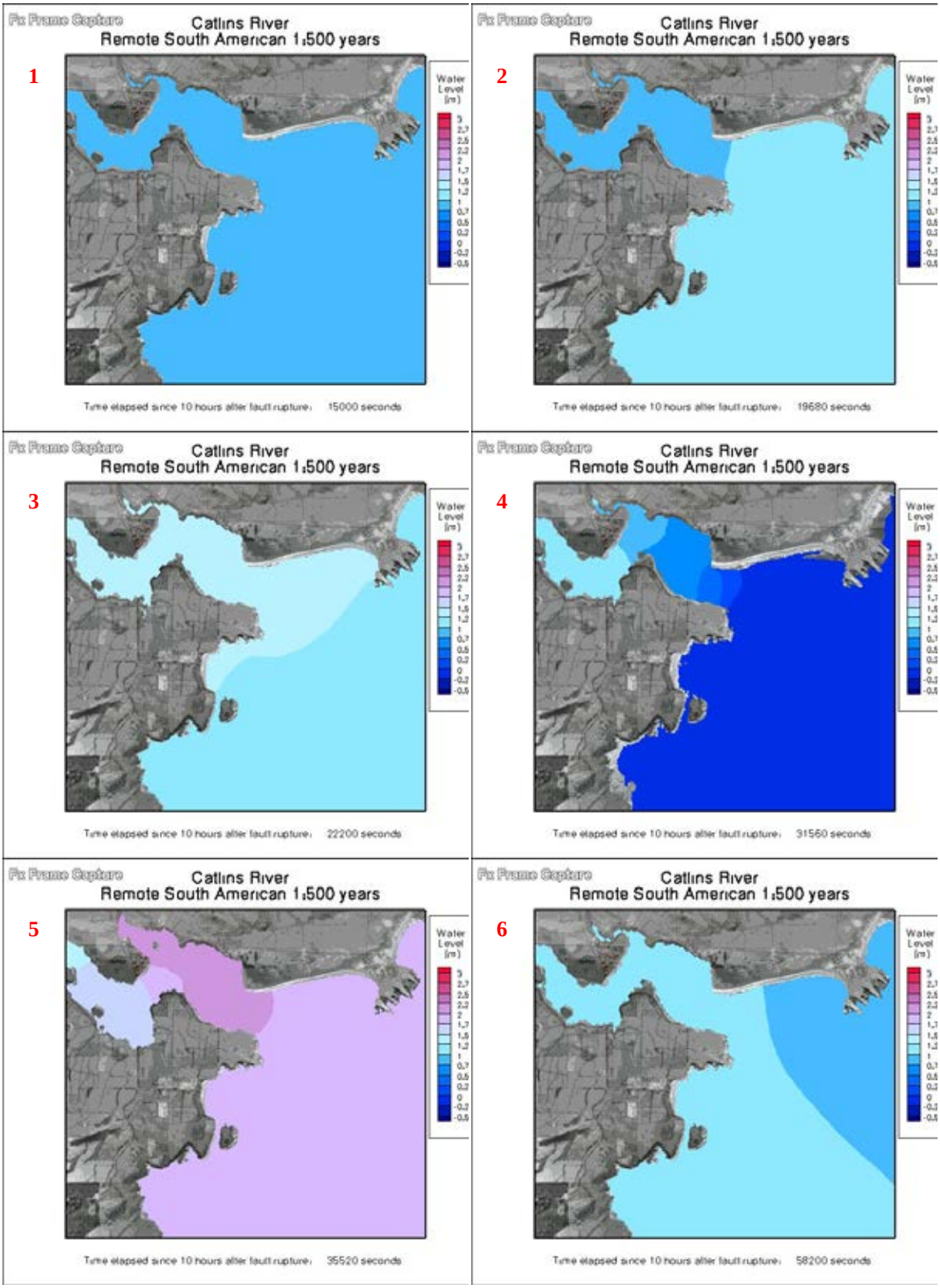

Figure A13. Time series showing changes in water level during the modelled South American tsunami at the Catlins

1 At fault rupture: The undisturbed level of the sea is at MHWS (0.9m).
2 15 hours 26 mins after earthquake: The first rise in sea level impacts the coast.
3 16 hours 10 mins: The first wave peaks along the coast.
4 18 hours 46 mins: The ocean retreats.
5 19 hours 52 mins: The largest modelled wave impacts the coast.
6 26 hours 10 mins: Waves and strong currents still impact the coast.

4. Kaka Point and Lower Clutha

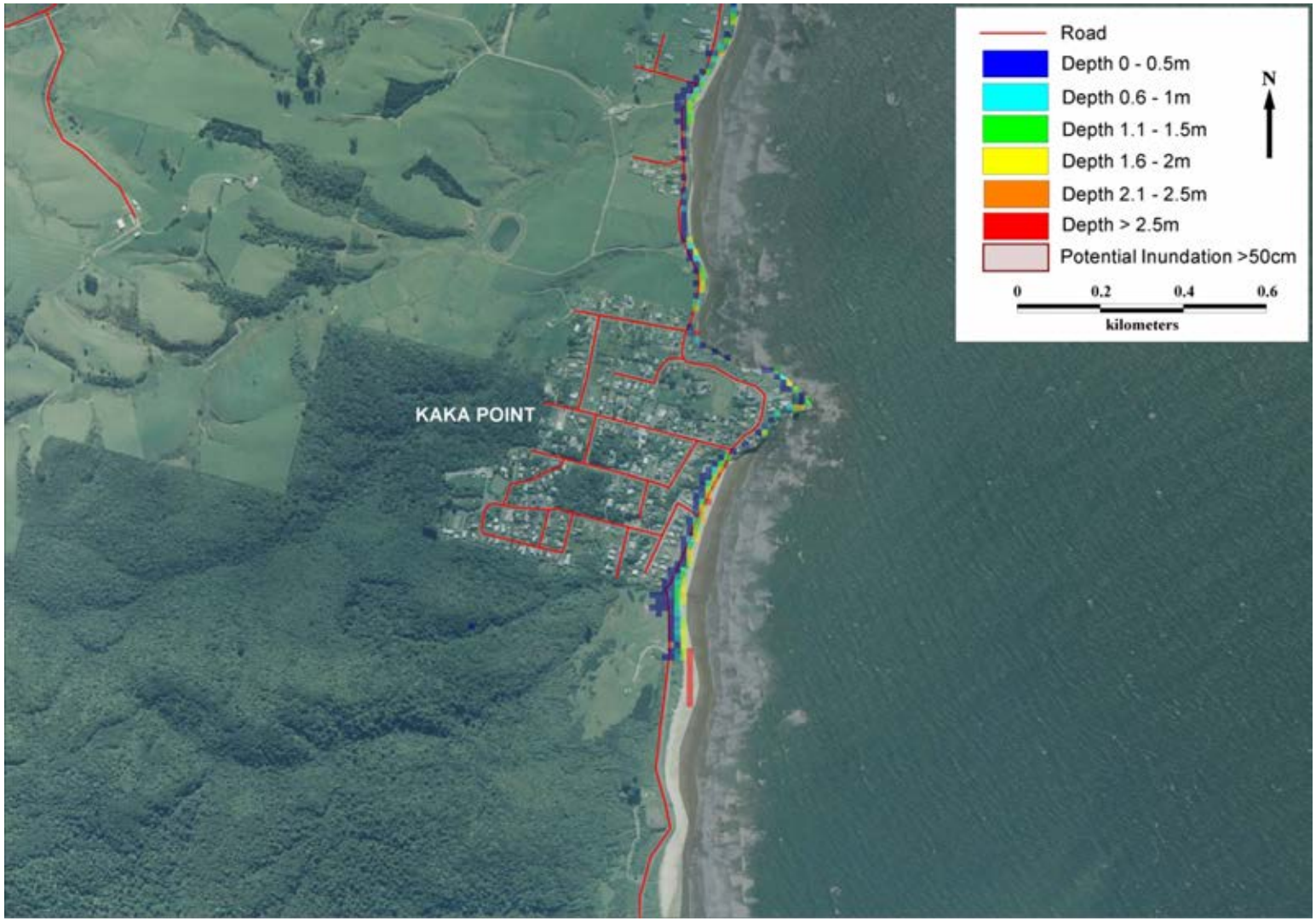

Figure A14. Maximum water depth for inundated land at Kaka Point during a Puysegur tsunami at MHWS

Figure A15. Location of cross section A-B through Kaka Point

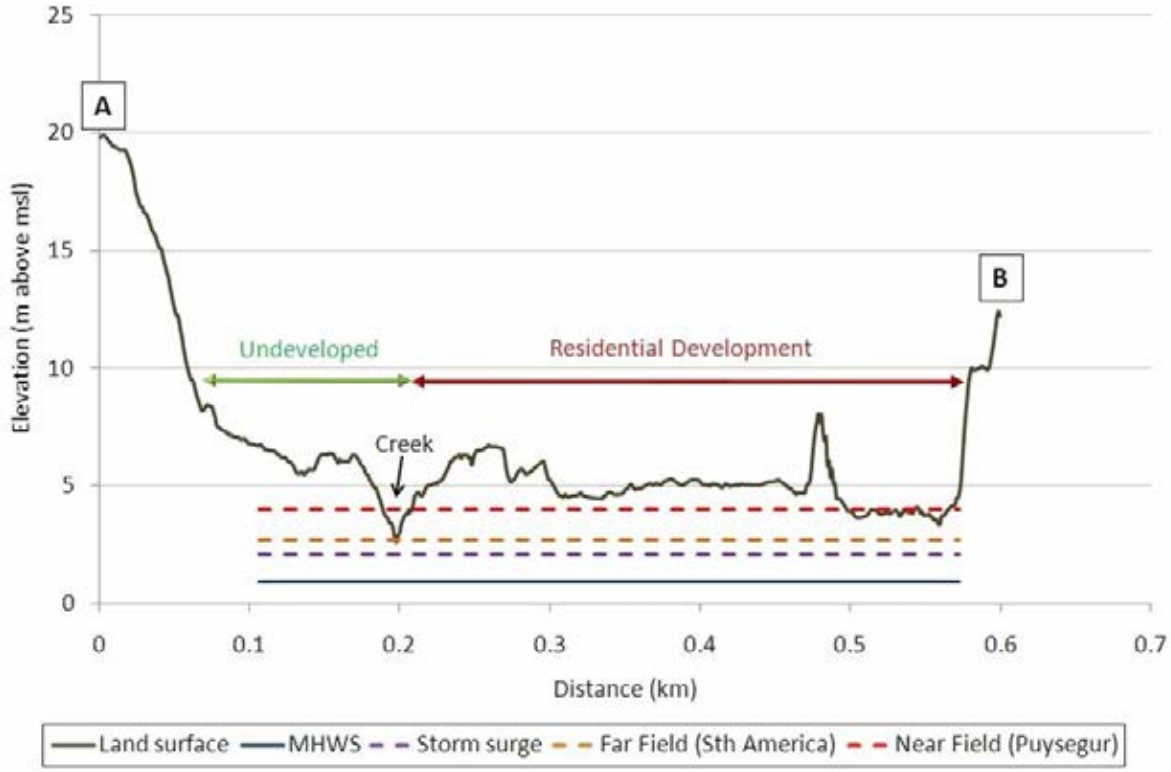

Figure A16. Cross section A-B through Kaka Point, showing the greatest extent of run-up at the coast from 1:500-year South American and 1:600-year Puysegur tsunami, and a 1:500-year storm surge event. The extent of residential development is also shown (indicative only)

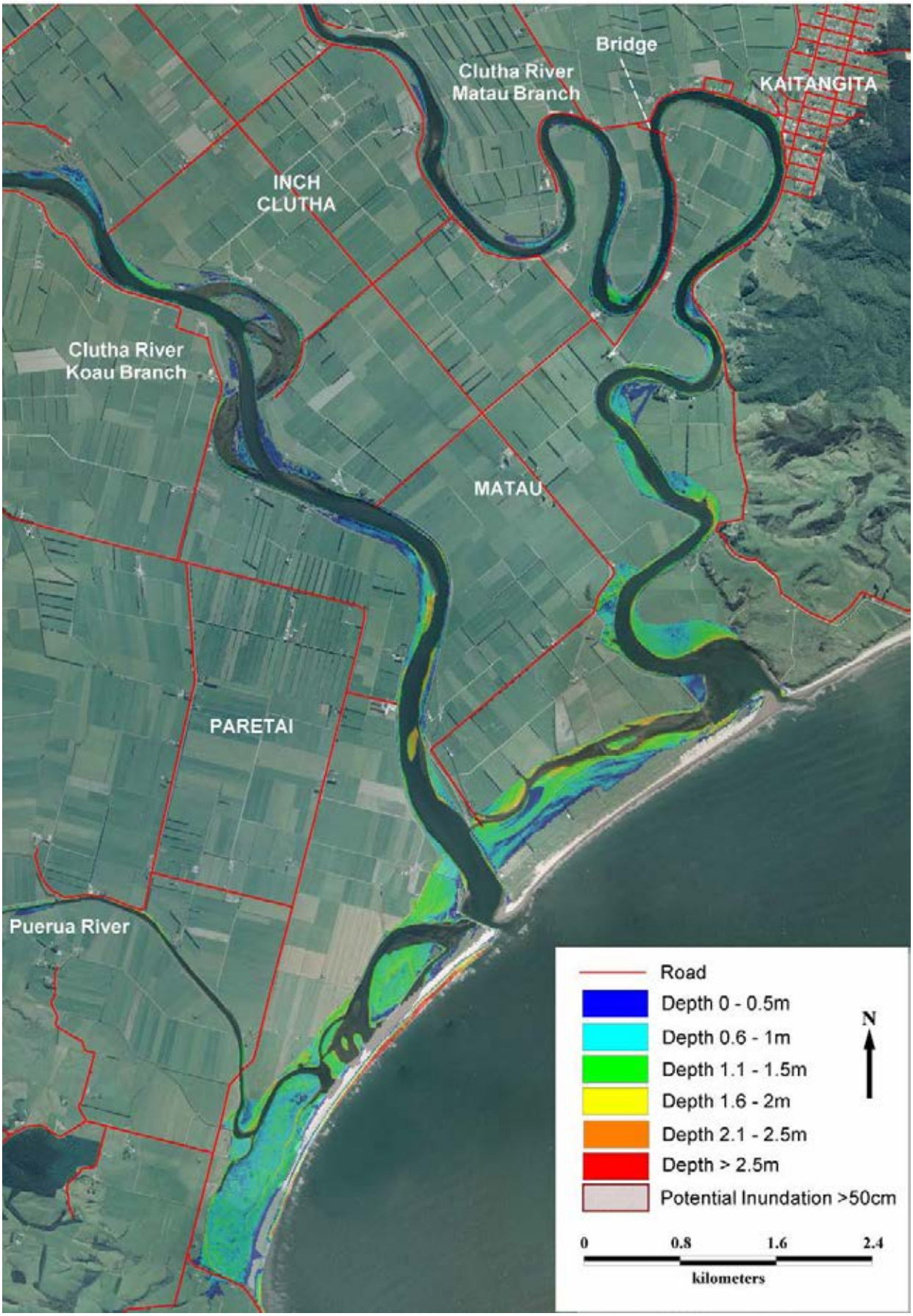

Figure A17. Maximum water depth for inundated land on the lower Clutha during a 1:500-year elevated sea level event at MHWS

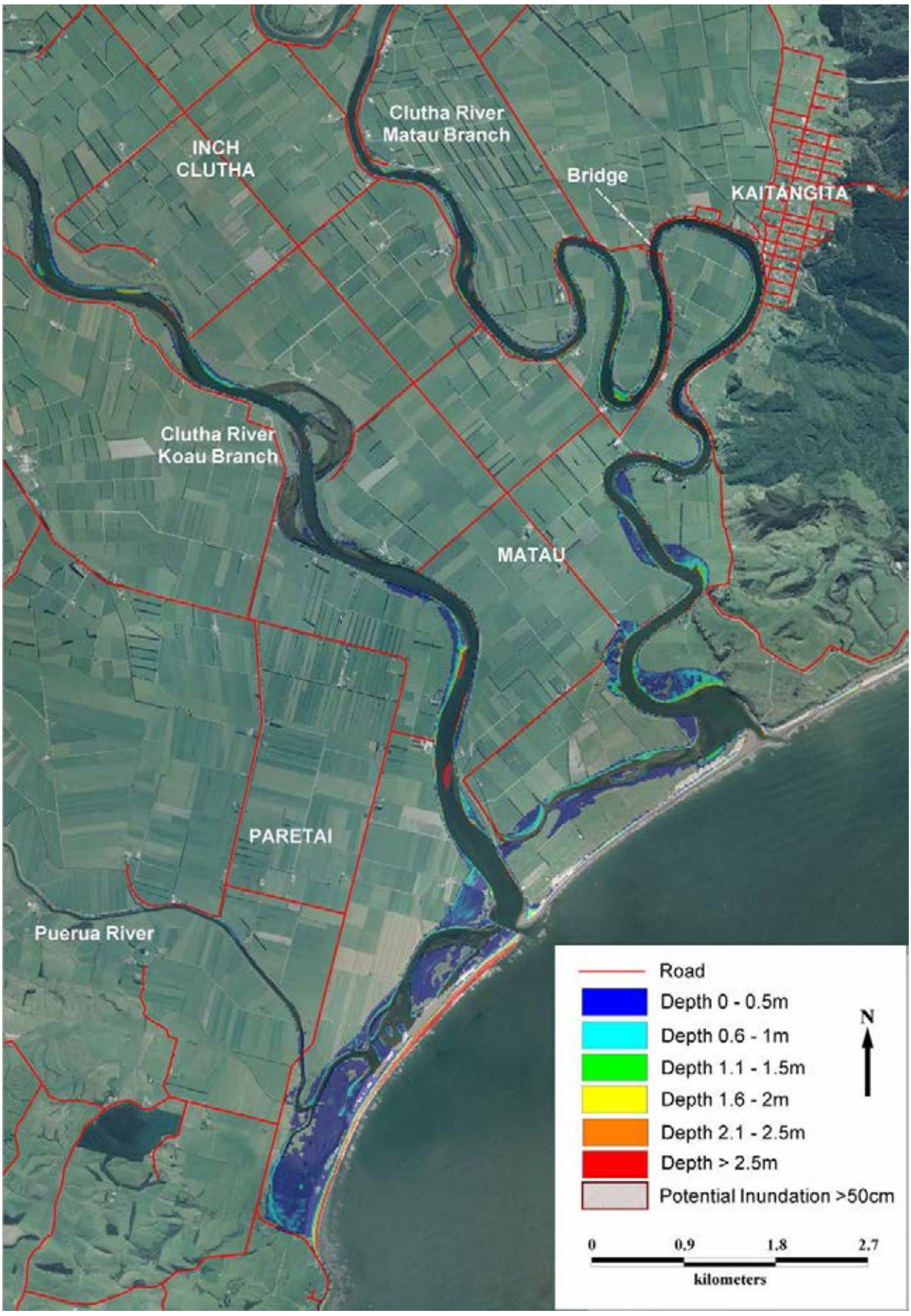

Figure A18. Maximum water depth for inundated land on the lower Clutha during a Puysegur tsunami at MHWS

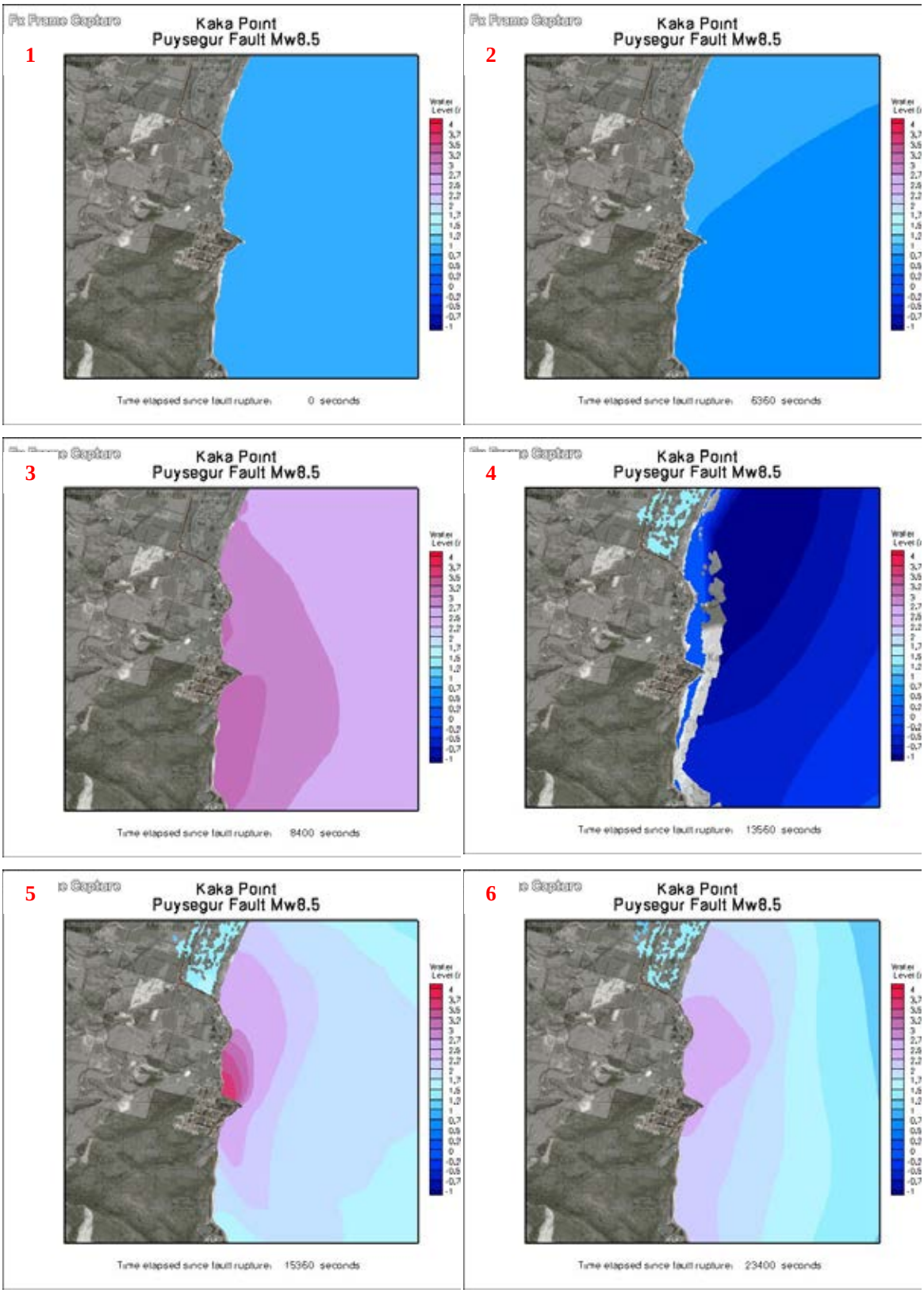

Figure A19. Time series showing changes in water level during the modelled Puysegur Fault tsunami at Kaka Point

1 At fault rupture: The undisturbed level of the sea is at MHWS (0.9m).
2 1 hour 46 mins after the earthquake: The first retreat of waves occurs.
3 2 hours 20 mins: The first waves peaks at Kaka Point.
4 3 hours 46 mins: After the first large wave occurs, the level of the ocean retreats significantly.
5 4 hours 16 mins: Another large wave is modelled to impact Kaka Point.
6 6 hours 30 mins: Waves and strong currents are still impacting the shoreline.

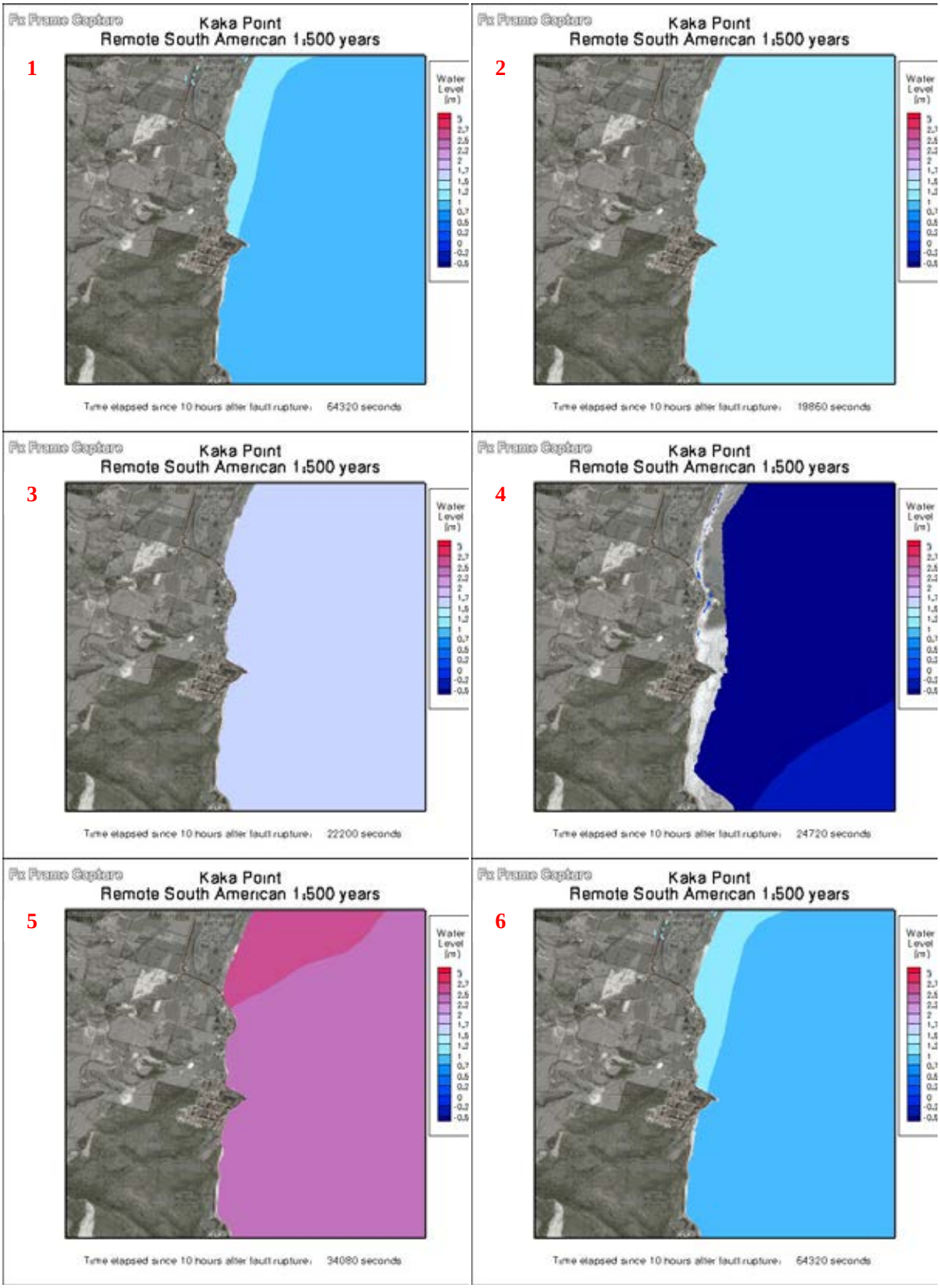

Figure A20. Time series showing changes in water level during the modelled 1:500-year South American tsunami at Kaka Point

1 At fault rupture: The undisturbed level of the sea is at MHWS (0.9m).
2 15 hours 31 mins after earthquake: The first rise in sea level impacts the coast.
3 16 hours 10 mins: The first wave peaks along the coast.
4 16 hours 52 mins: The ocean retreats.
5 19 hours 34 mins: The largest modelled wave impacts the coast.
6 27 hours 52 mins: Waves and strong currents still impact the coast.

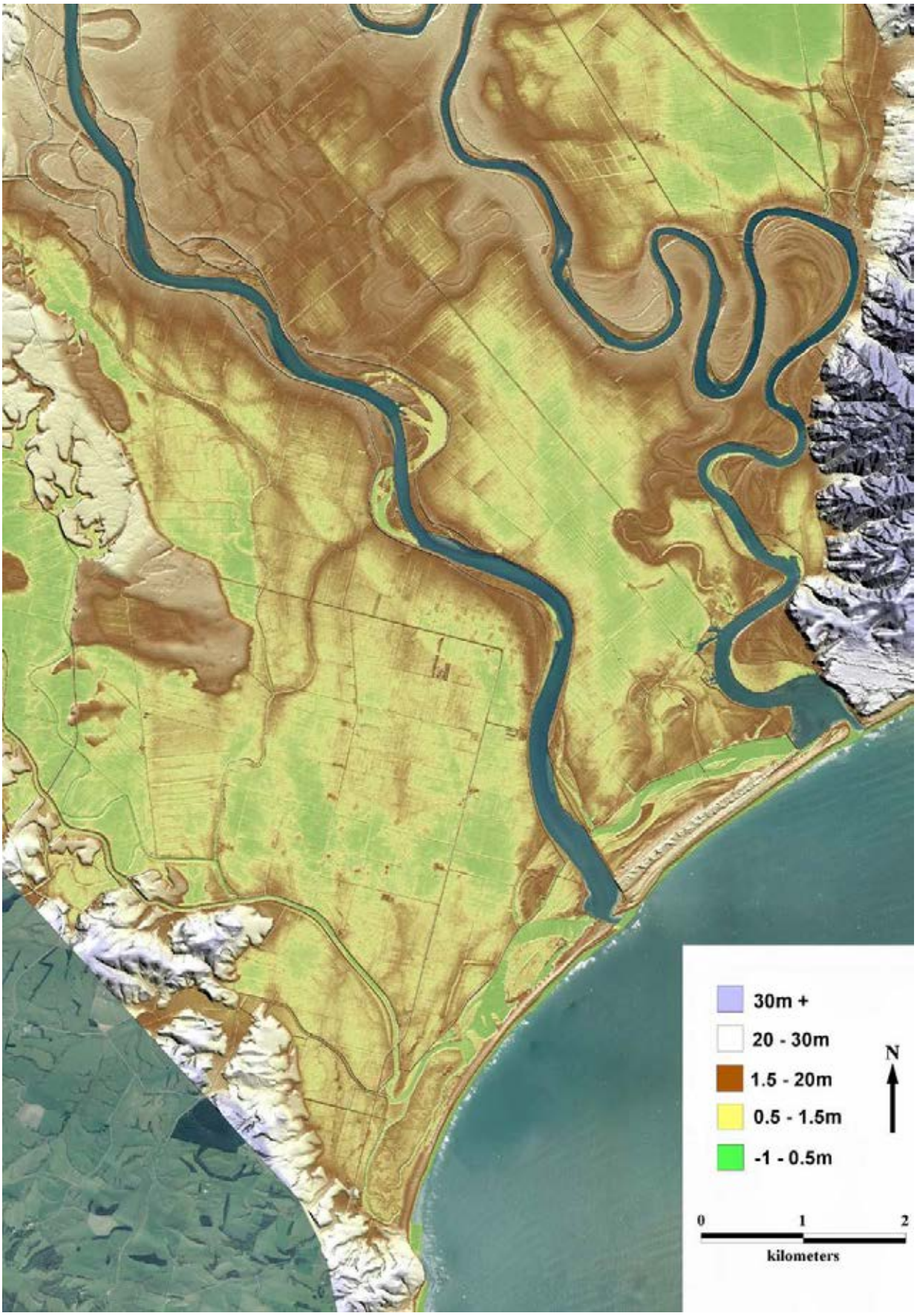

Figure A21. **Elevation map of the Clutha delta area. Height in metres above mean sea level (MSL)**

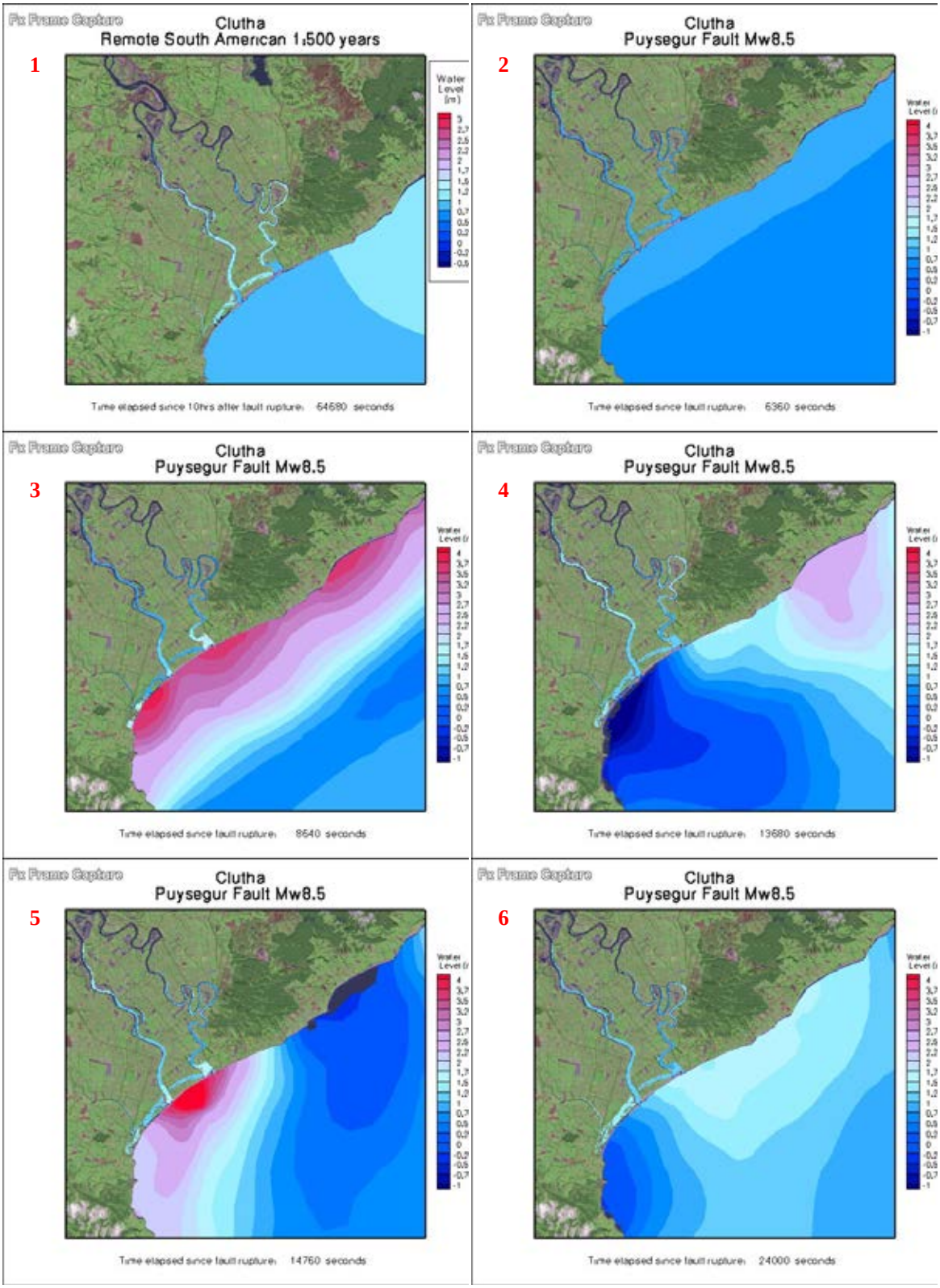

Figure A22. Time series showing changes in water level during the modelled Puysegur Fault tsunami on the lower Clutha delta

1 At fault rupture: The undisturbed level of the sea is at MHWS (0.9m).
2 1 hour 46 mins after the earthquake: The first retreat of waves occurs.
3 2 hours 24 mins: The first wave peak at the delta occurs.
4 3 hours 48 mins: After the first large wave occurs, the level of the ocean retreats significantly.
5 4 hours 6 mins: Another large wave is modelled to impact the lower Clutha delta.
6 6 hours 40 mins: Waves and strong currents are still impacting the shoreline.

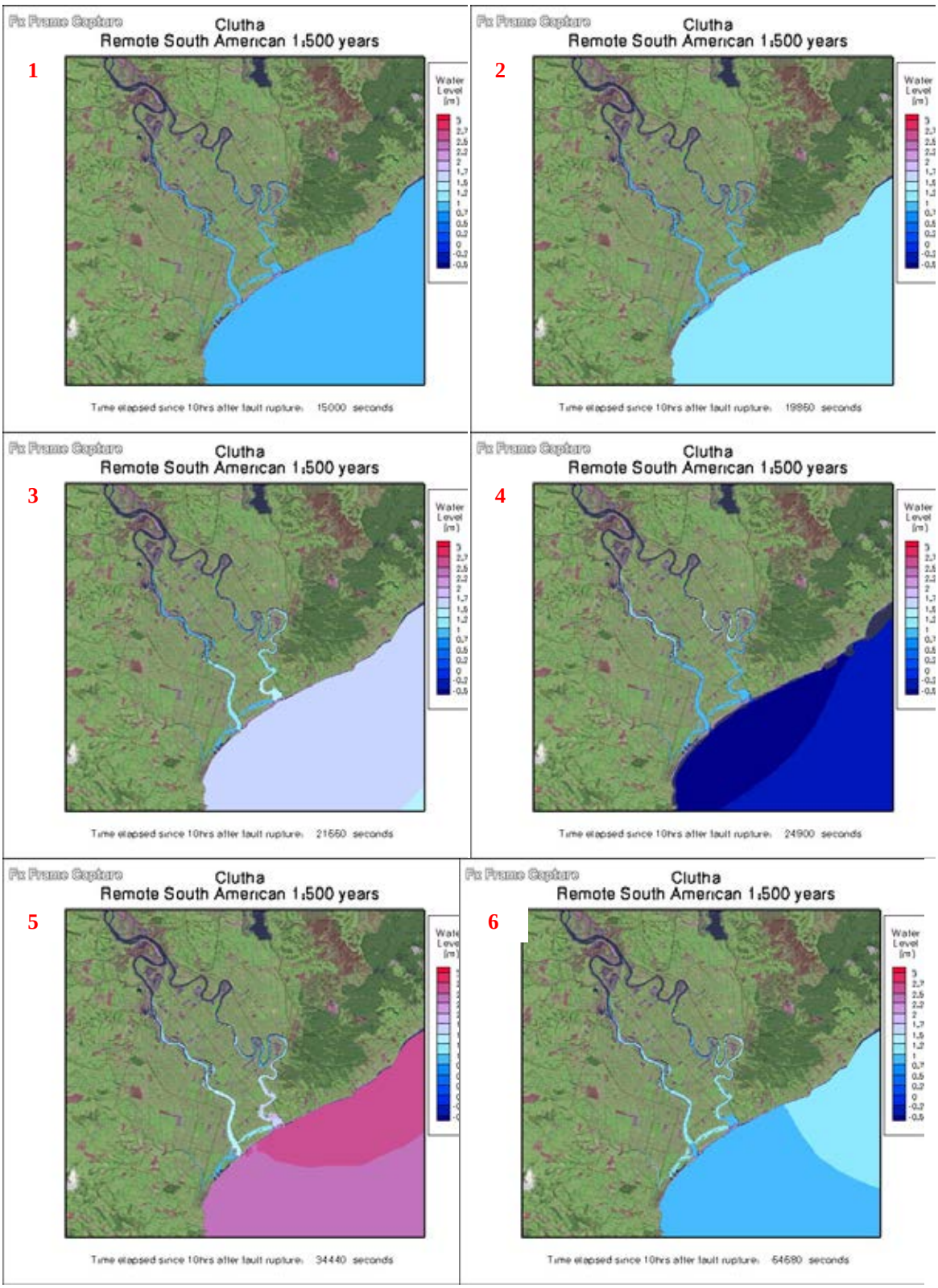

Figure A23. Time series showing changes in water level during the modelled South American 1:500 year tsunami on the lower Clutha delta

1 At fault rupture: The undisturbed level of the sea is at MHWS (0.9m).
2 15 hours 31 mins after earthquake: The first rise in sea level impacts coast.
3 16 hours 2 mins: The first wave peaks along the coast.
4 16 hours 55 mins: The ocean retreats.
5 19 hours 34 mins: The largest modelled wave impacts the coast.
6 27 hours 58 mins: Waves and strong currents still impact the coast.

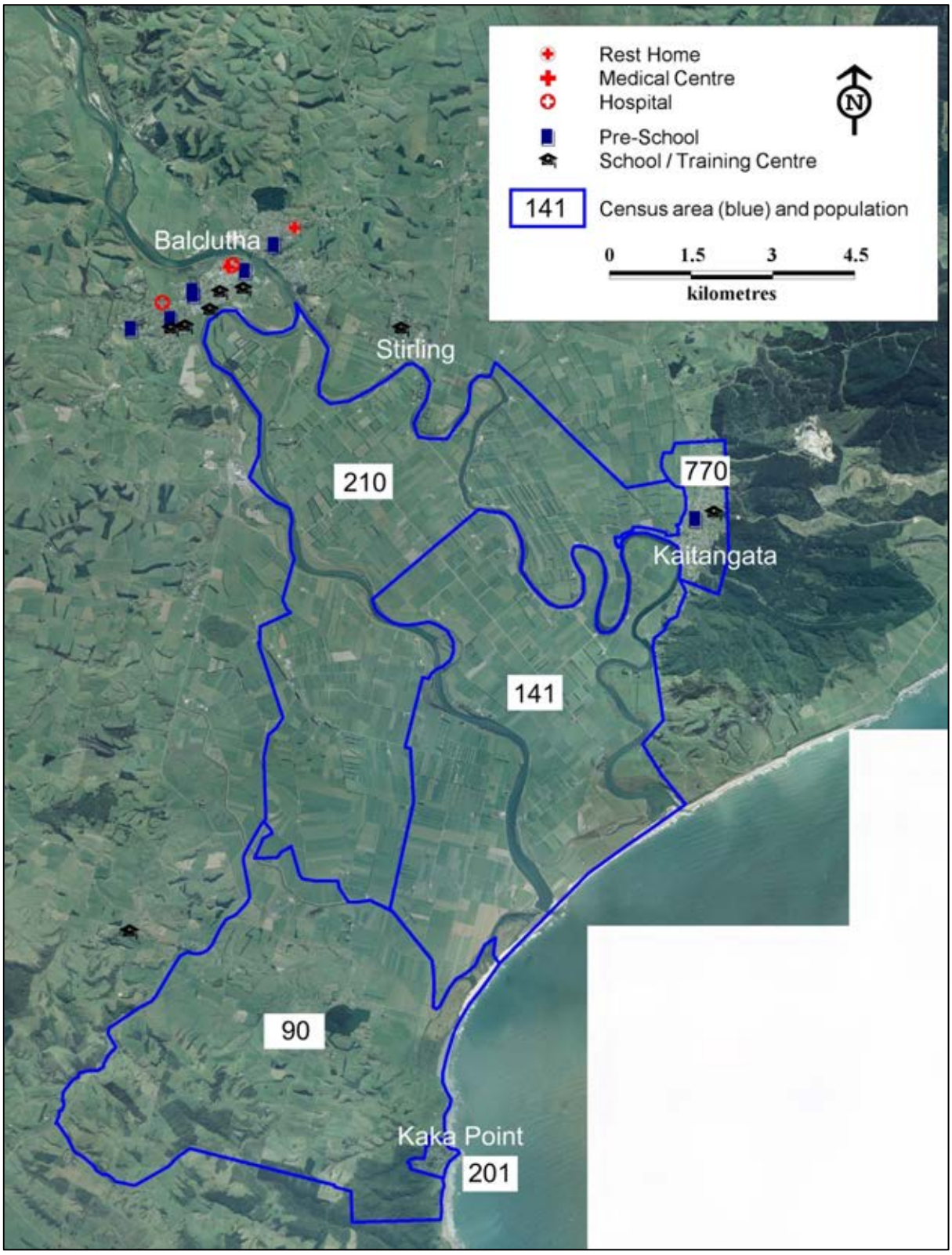

Figure A24. **Lower Clutha census area boundaries and usually resident population (2006 Census). The locations of education and health facilities are also shown**

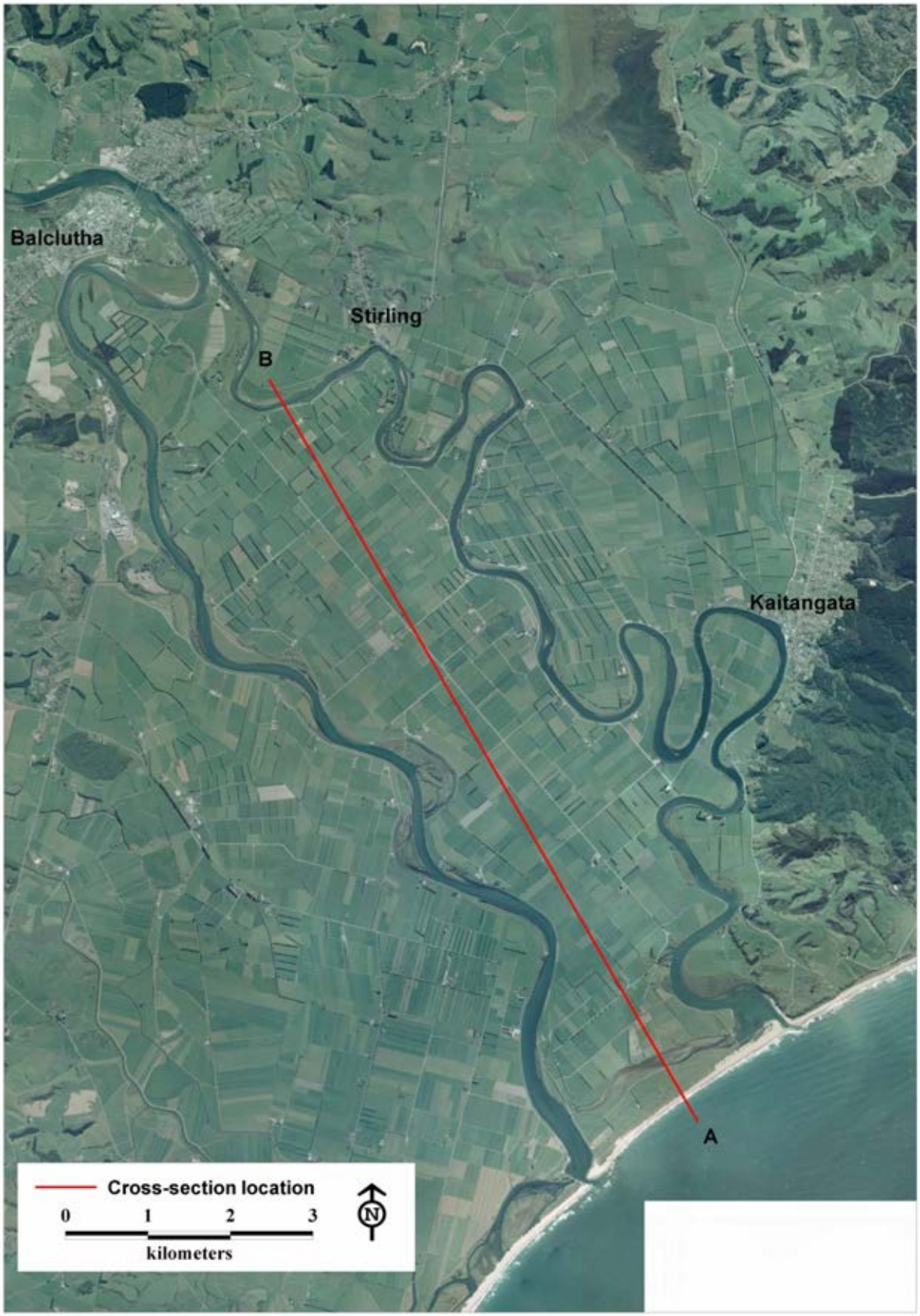

Figure A25. Location of cross section A-B through the lower Clutha

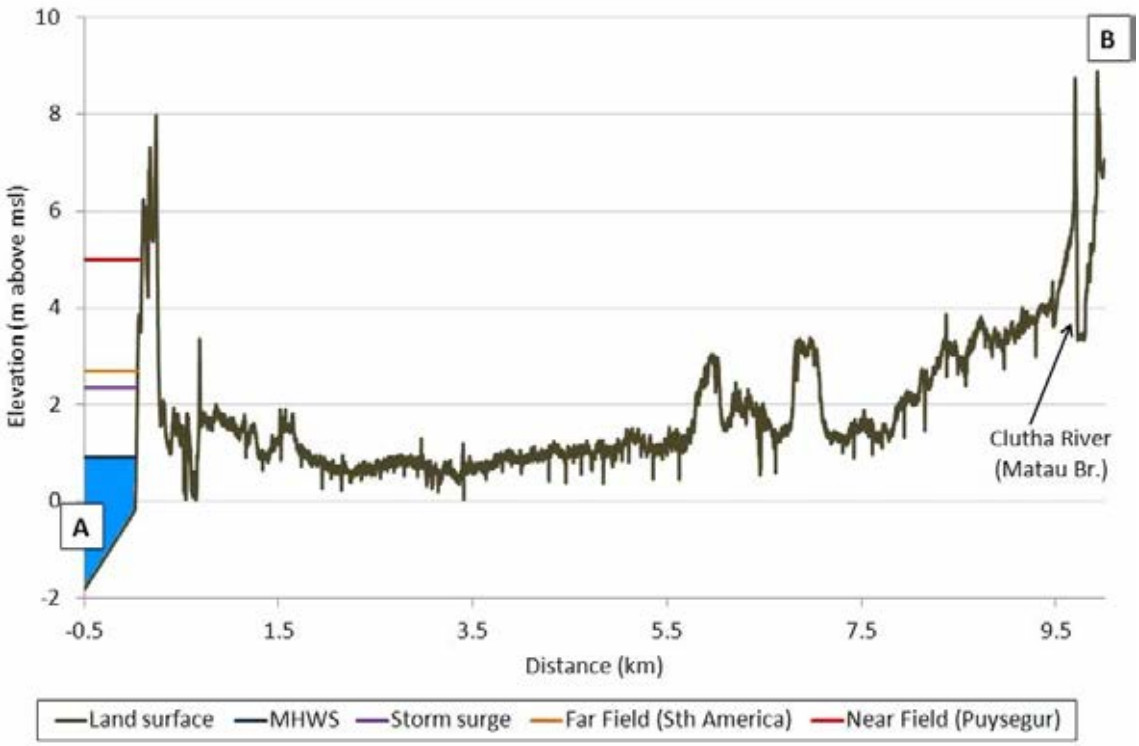

Figure A26. **Cross section A-B through the lower Clutha, showing the greatest extent of run-up at the coast from 1:500-year South American and 1:600-year Puysegur tsunami, and a 1:500-year storm surge event**

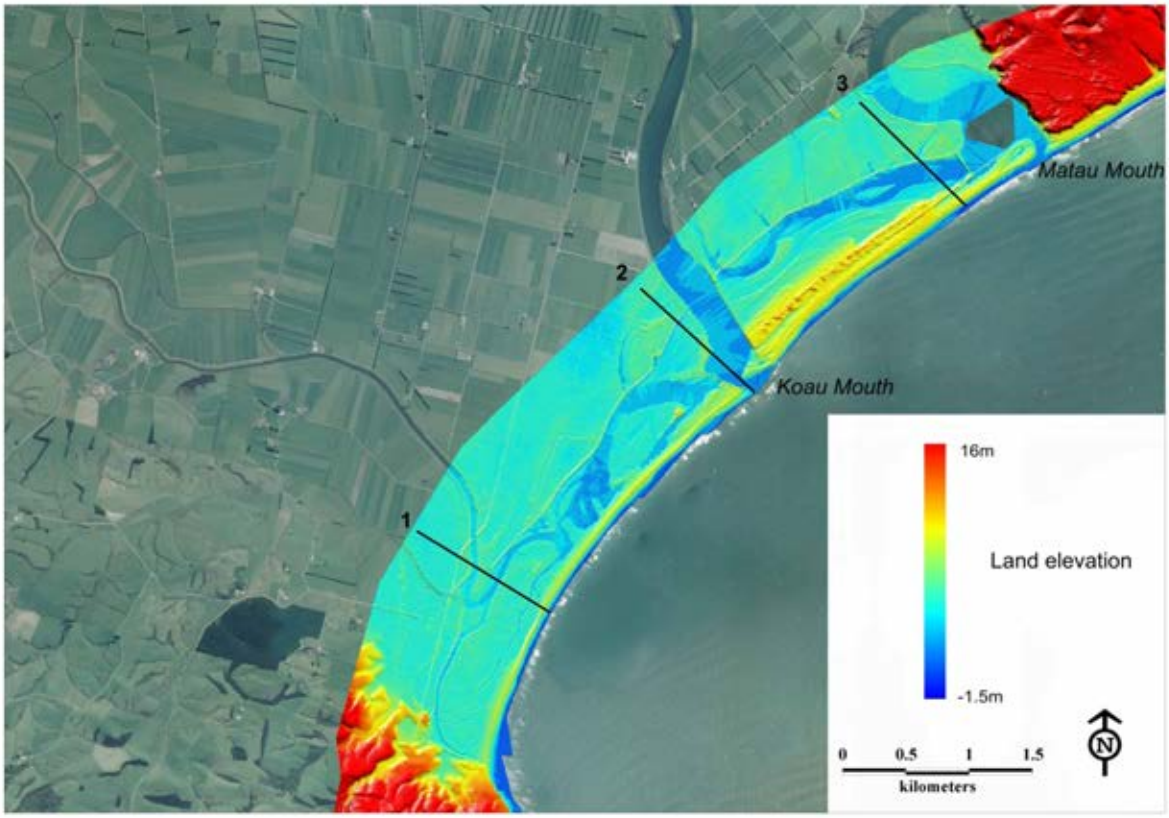

Figure A27. **Composite LiDAR and aerial photo map of the lower Clutha plain. The location of cross sections 1, 2 and 3 (shown in Figure A28 to Figure A30) are shown as black lines**

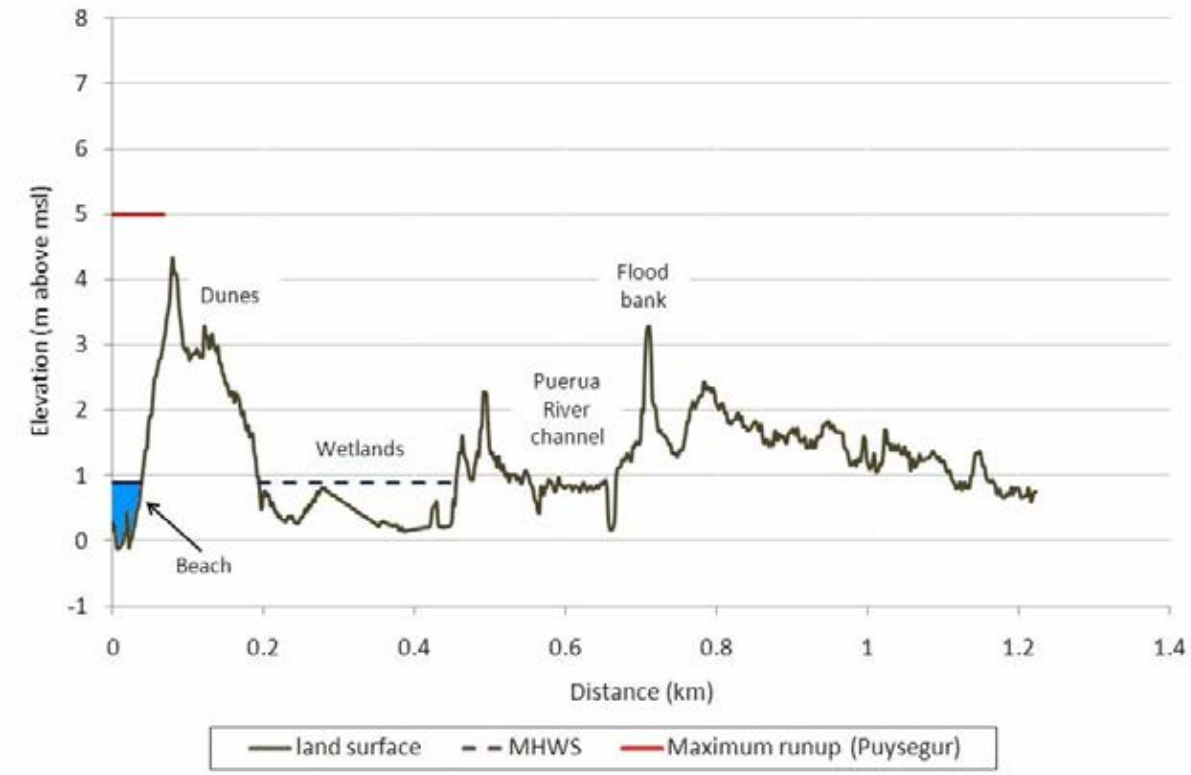

Figure A28. **Cross section 1 through the dunes and flood bank to the lower Clutha flood plain. The maximum run-up level along the lower Clutha coast line (as modelled by NIWA) of a near-field Puysegur tsunami is also shown**

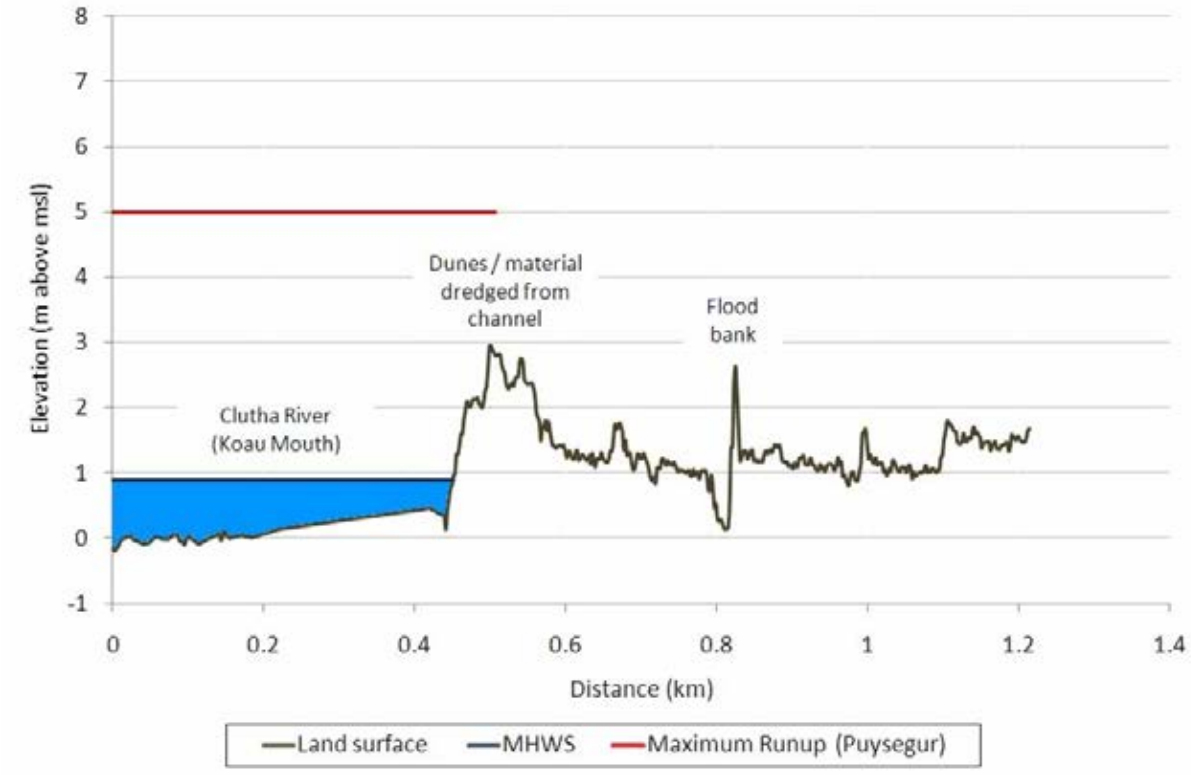

Figure A29. **Cross section 2 through the dunes and flood bank to the lower Clutha flood plain. The maximum run-up level along the lower Clutha coast line (as modelled by NIWA) of a near-field Puysegur tsunami is also shown**

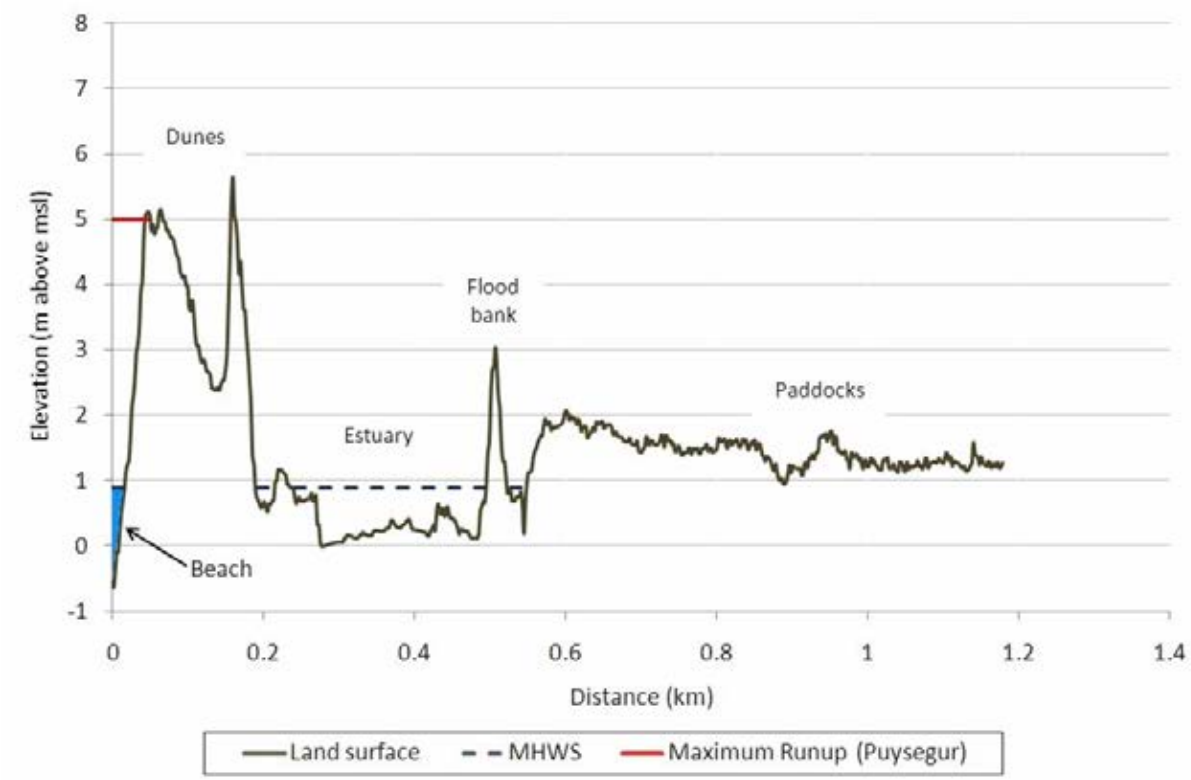

Figure A30. **Cross section 3 through the dunes and flood bank to the lower Clutha flood plain. The maximum run-up level along the lower Clutha coast line (as modelled by NIWA) of a near-field Puysegur tsunami is also shown**

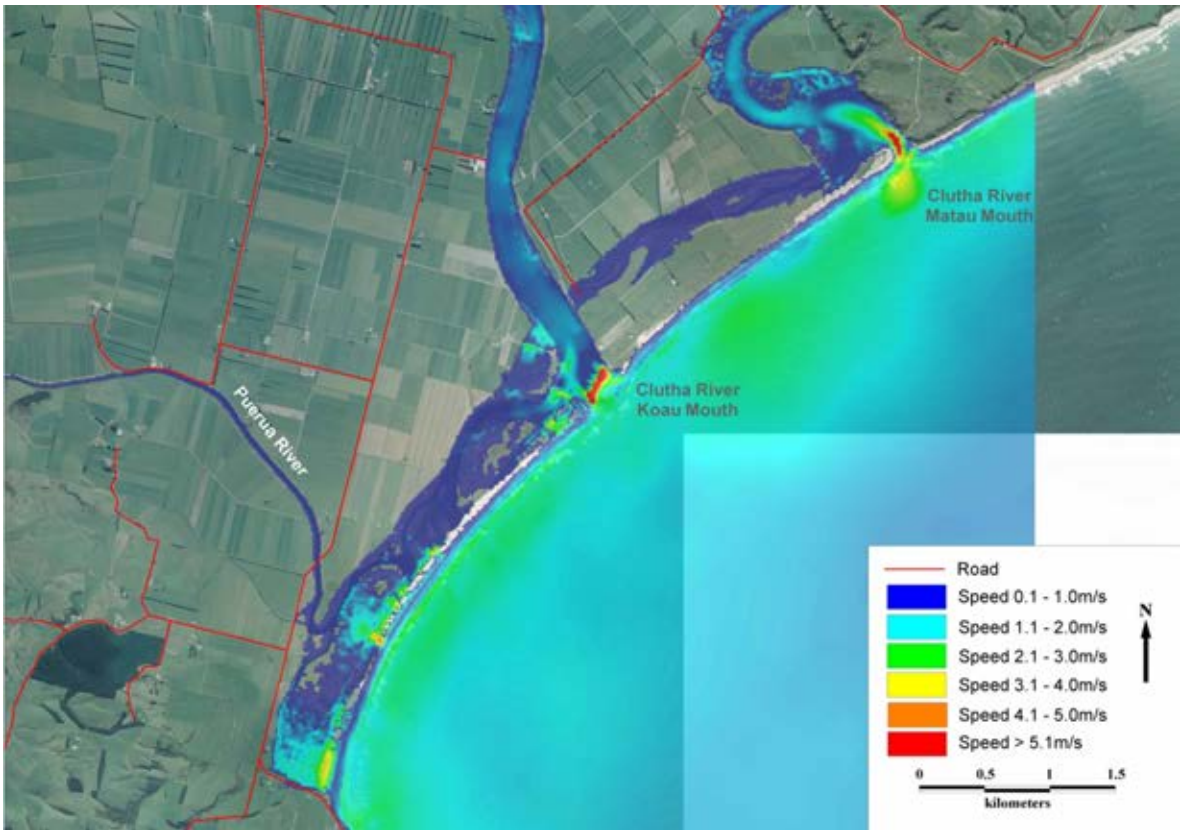

Figure A31. **Maximum water speed associated with a Puysegur tsunami at MHWS for the lower Clutha**

5. Toko Mouth

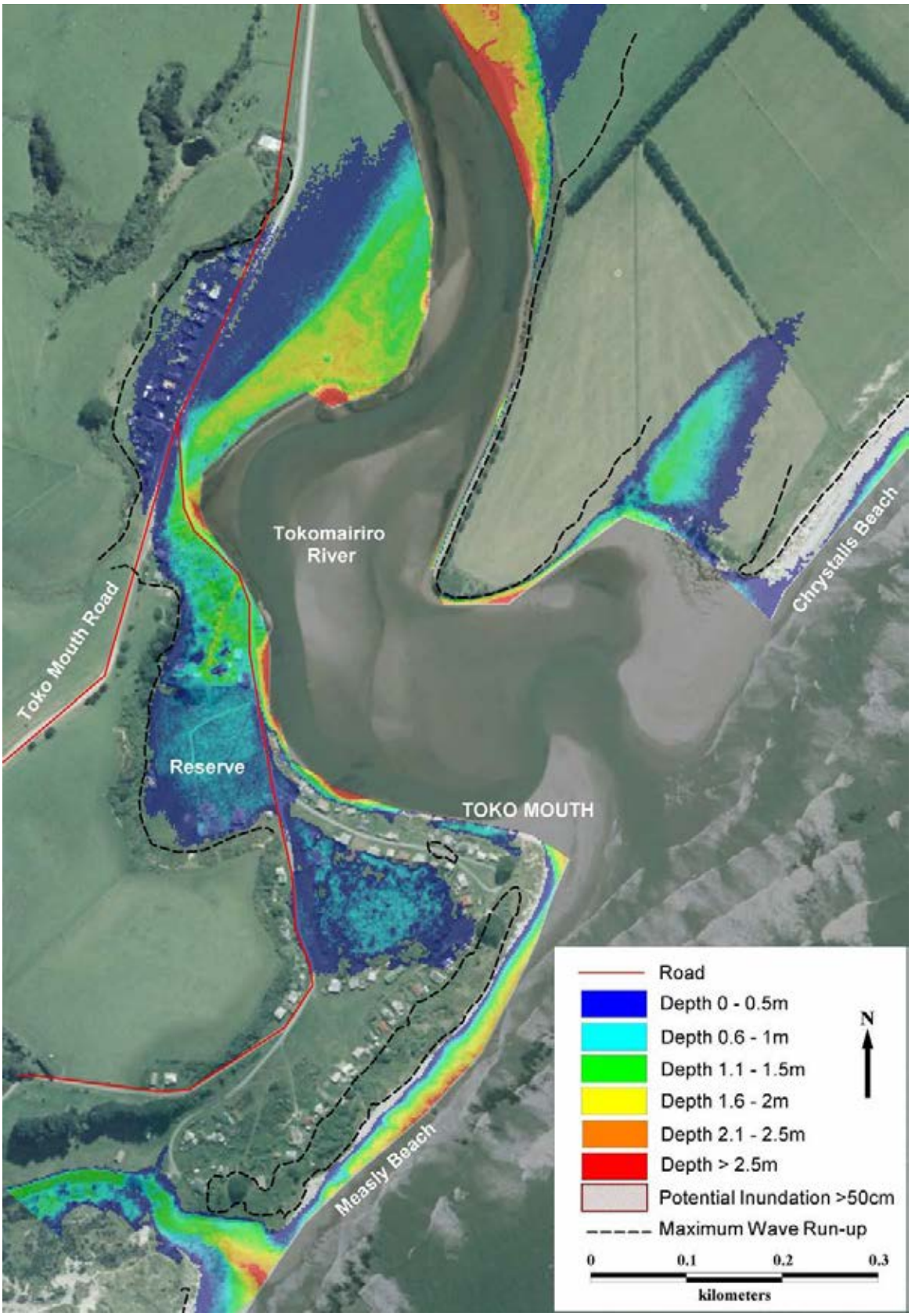

Figure A32. Maximum water depth for inundated land at Toko Mouth during a 1:500-year elevated sea level event at MHWS

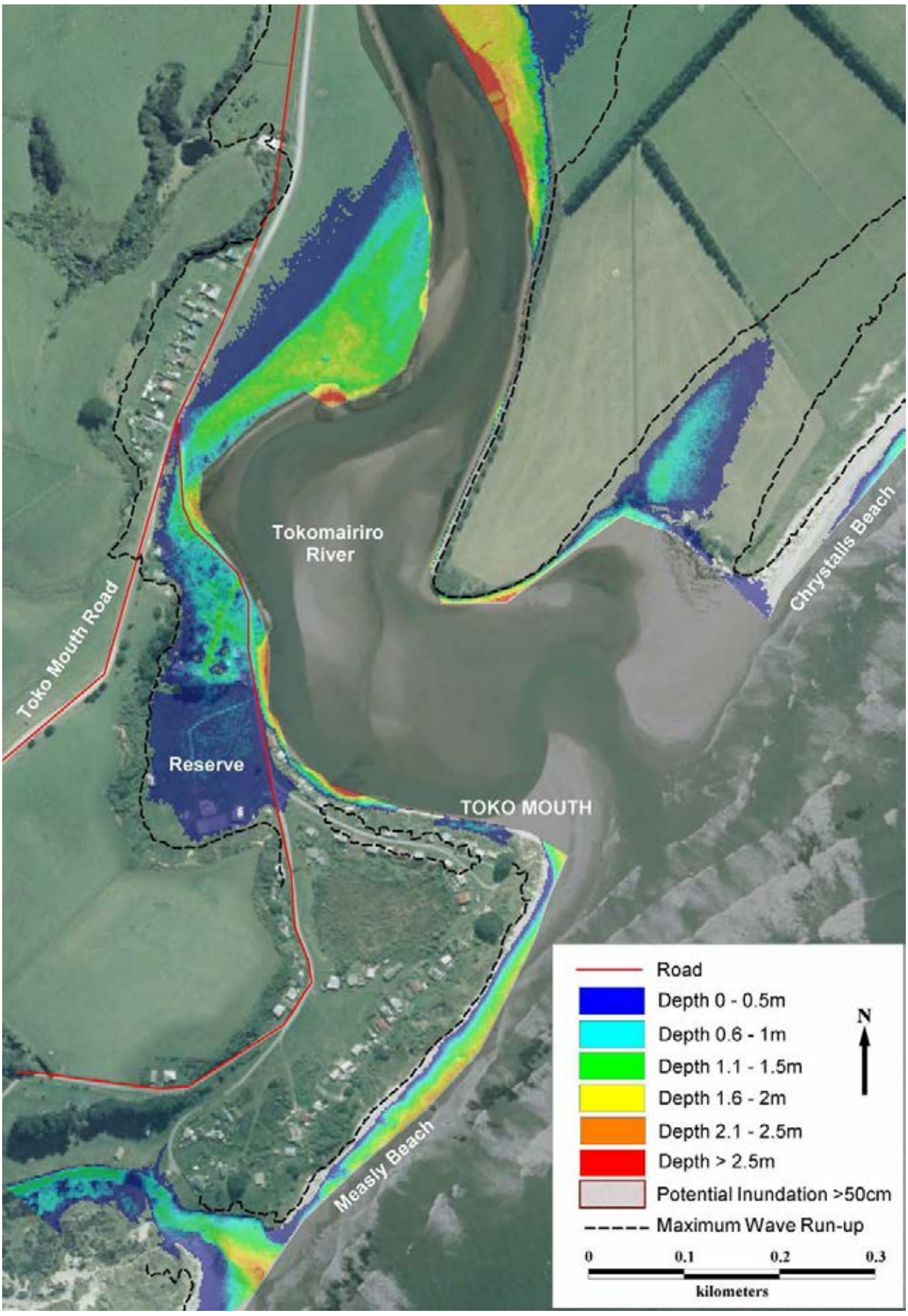

Figure A33. Maximum water depth for inundated land at Toko Mouth during a 1:20-year elevated sea level event at MHWS

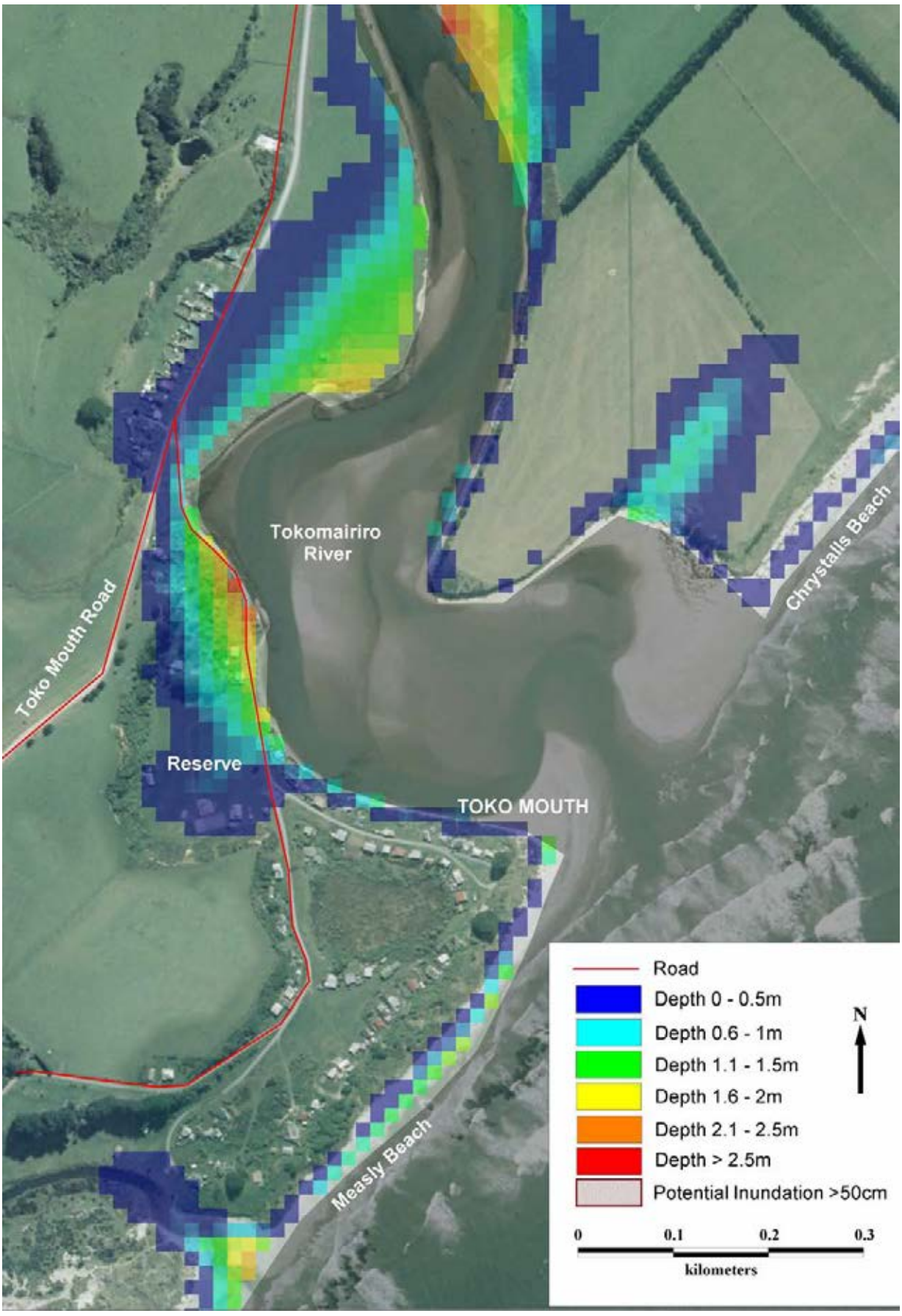

Figure A34. Maximum water depth for inundated land at Toko Mouth during a Puysegur tsunami at MHWS

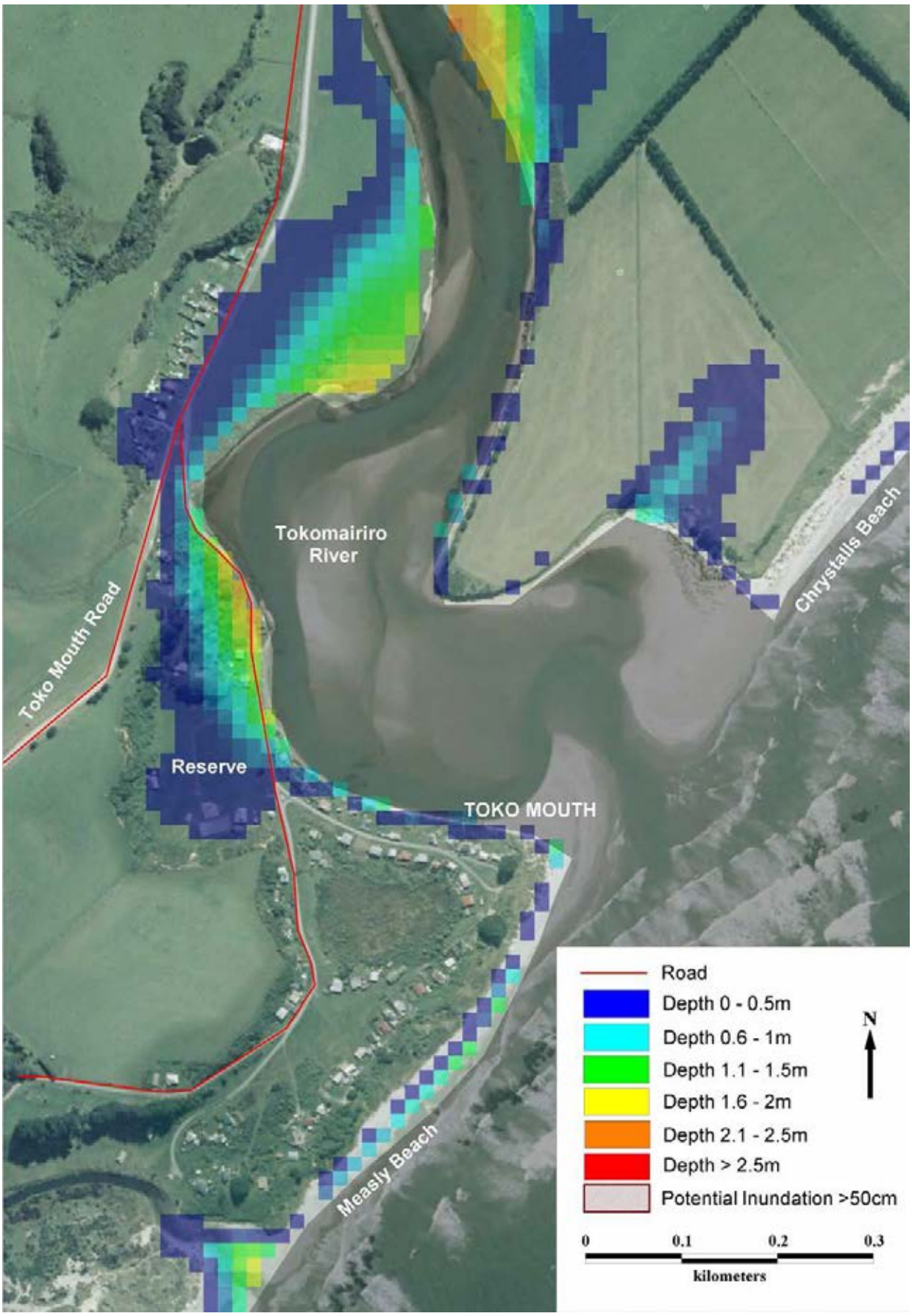

Figure A35. Maximum water depth for inundated land at Toko Mouth during the modelled 1:500-year South American tsunami at MHWS

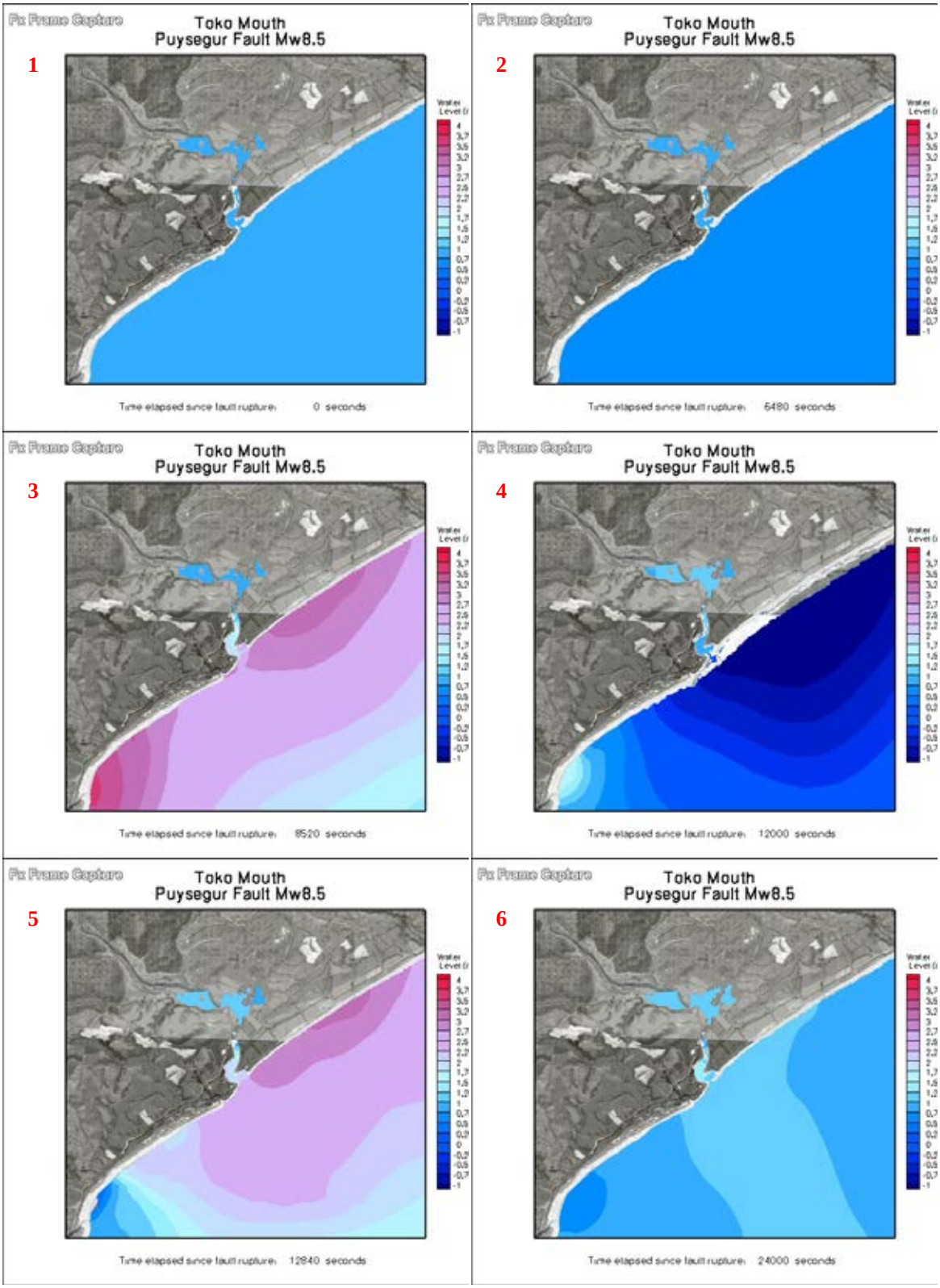

Figure A36. Time series showing changes in water level during the modelled Puysegur Fault tsunami at Toko Mouth

1 At fault rupture: The undisturbed level of the sea is at MHWS (0.9m).
2 1 hour 48 mins after the earthquake: The first retreat of waves occurs.
3 2 hours 22 mins: The first wave peaks at the river mouth occur.
4 3 hours 20 mins: After the first large wave occurs, the level of the ocean retreats significantly.
5 3 hours 34 mins: Another large wave is modelled to impact the river mouth.
6 6 hours 40 mins: Waves and strong currents are still impacting the estuary.

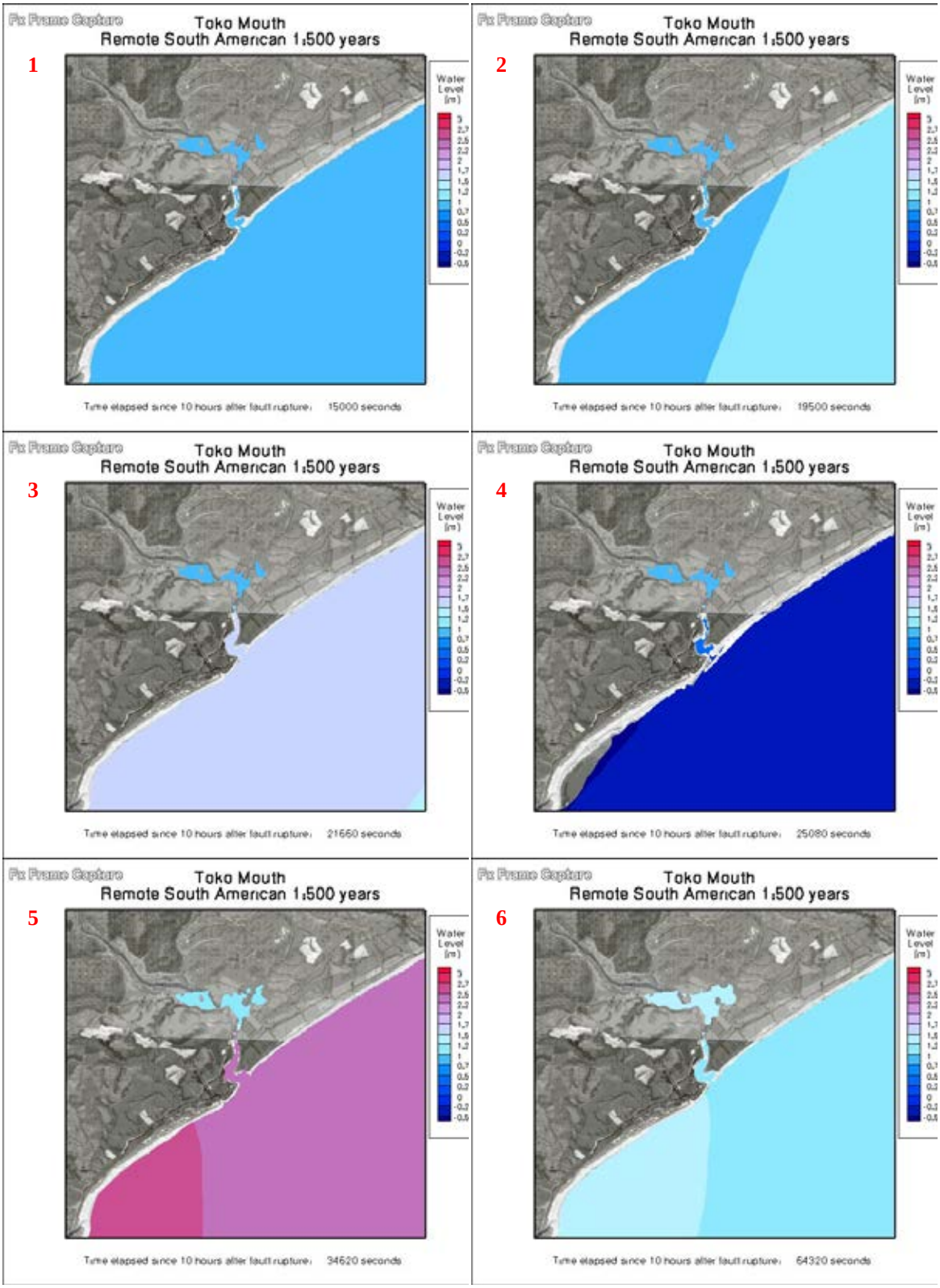

Figure A37. Time series showing changes in water level during the modelled South American 1:500-year tsunami at Toko Mouth

1 At fault rupture: The undisturbed level of the sea is at MHWS (0.9m)
2 15 hours 25 mins after earthquake: The first rise in sea level impacts the coast.
3 16 hours 2 mins: The first wave peaks along the coast.
4 16 hours 58 mins: The ocean retreats.
5 19 hours 37 mins: The largest modelled wave impacts the coast.
6 27 hours 52 mins: Waves and strong currents still impact the coast.

Figure A38. Location of cross section A-B through Toko Mouth

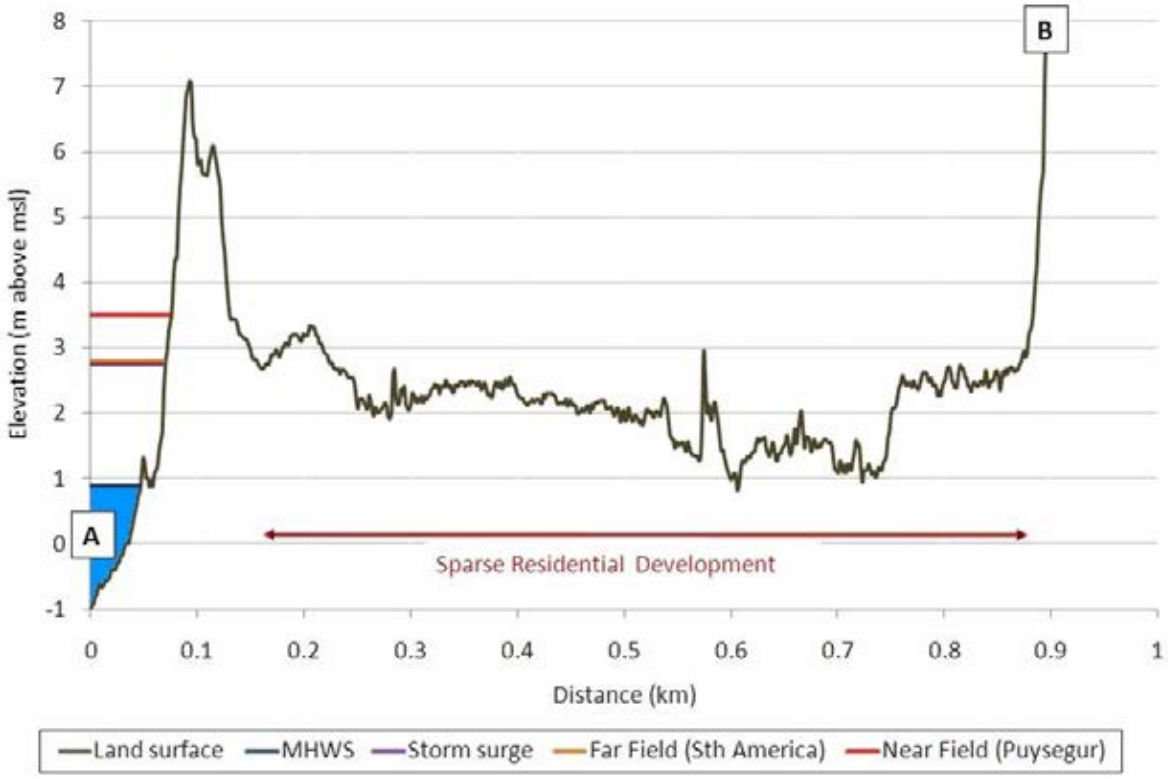

Figure A39. Cross section A-B through Toko Mouth, showing the greatest extent of run-up at the coast from 1:500-year South American and 1:600-year Puysegur tsunami, and a 1:500-year storm surge event

6. Taieri Mouth

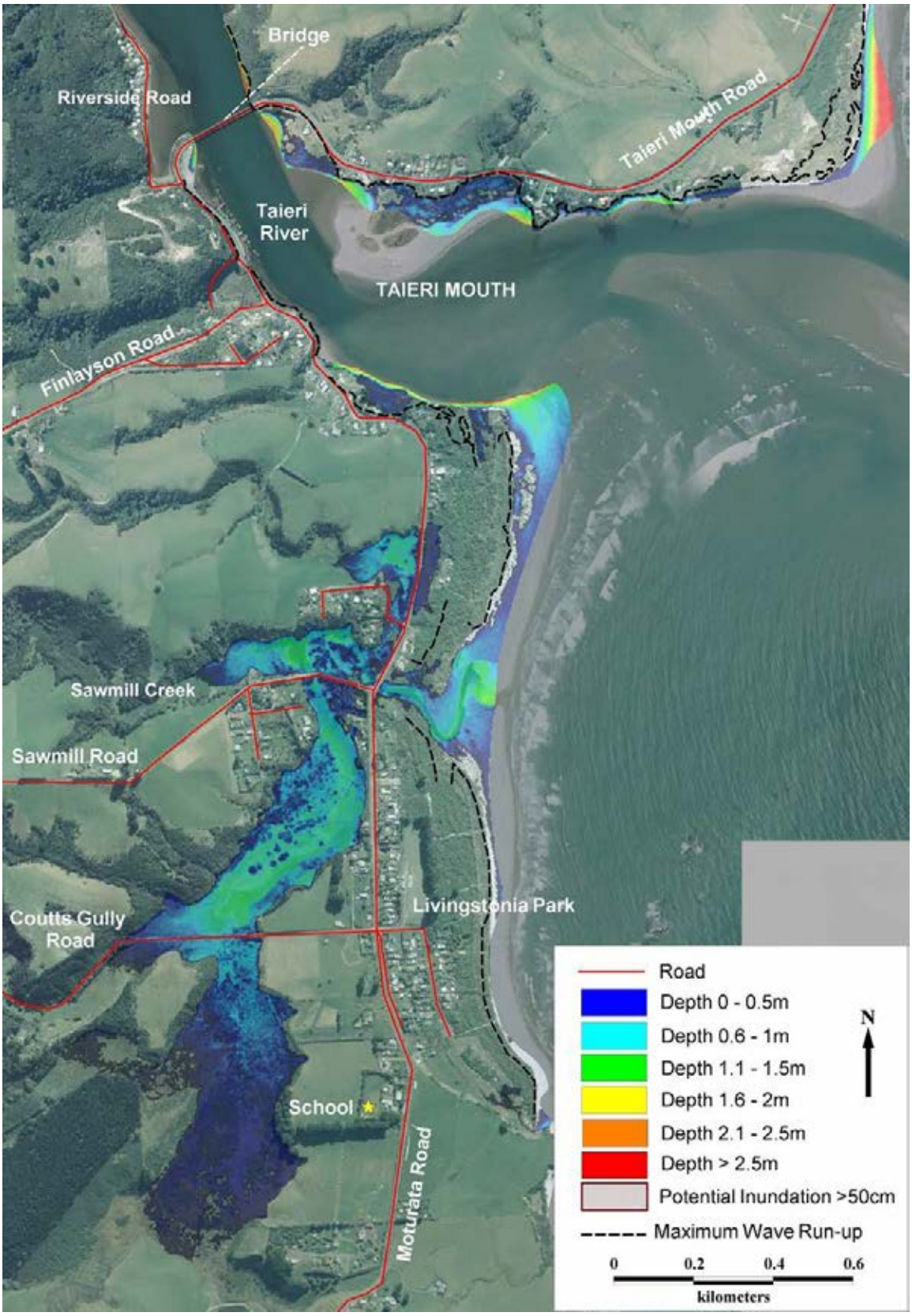

Figure A40. **Maximum water depth for inundated land at Taieri Mouth during a 1:500-year extreme sea level event at MHWS. Note that modelling does not extend beyond the Taieri River Bridge, and that inundation depths associated with this event are therefore not shown for property on Riverside Road**

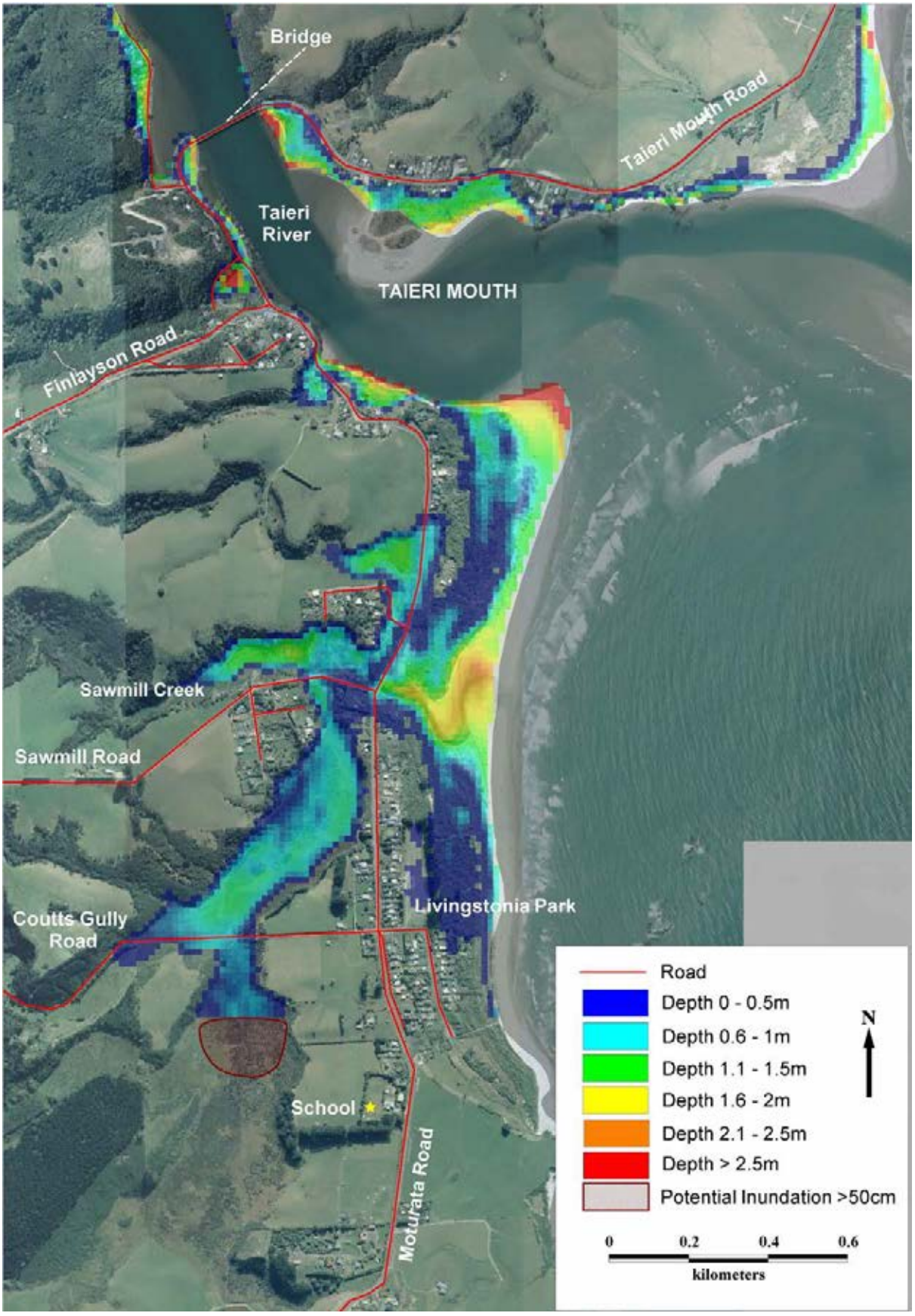

Figure A41. Maximum water depth for inundated land at Taieri Mouth during a Puysegur tsunami at MHWS

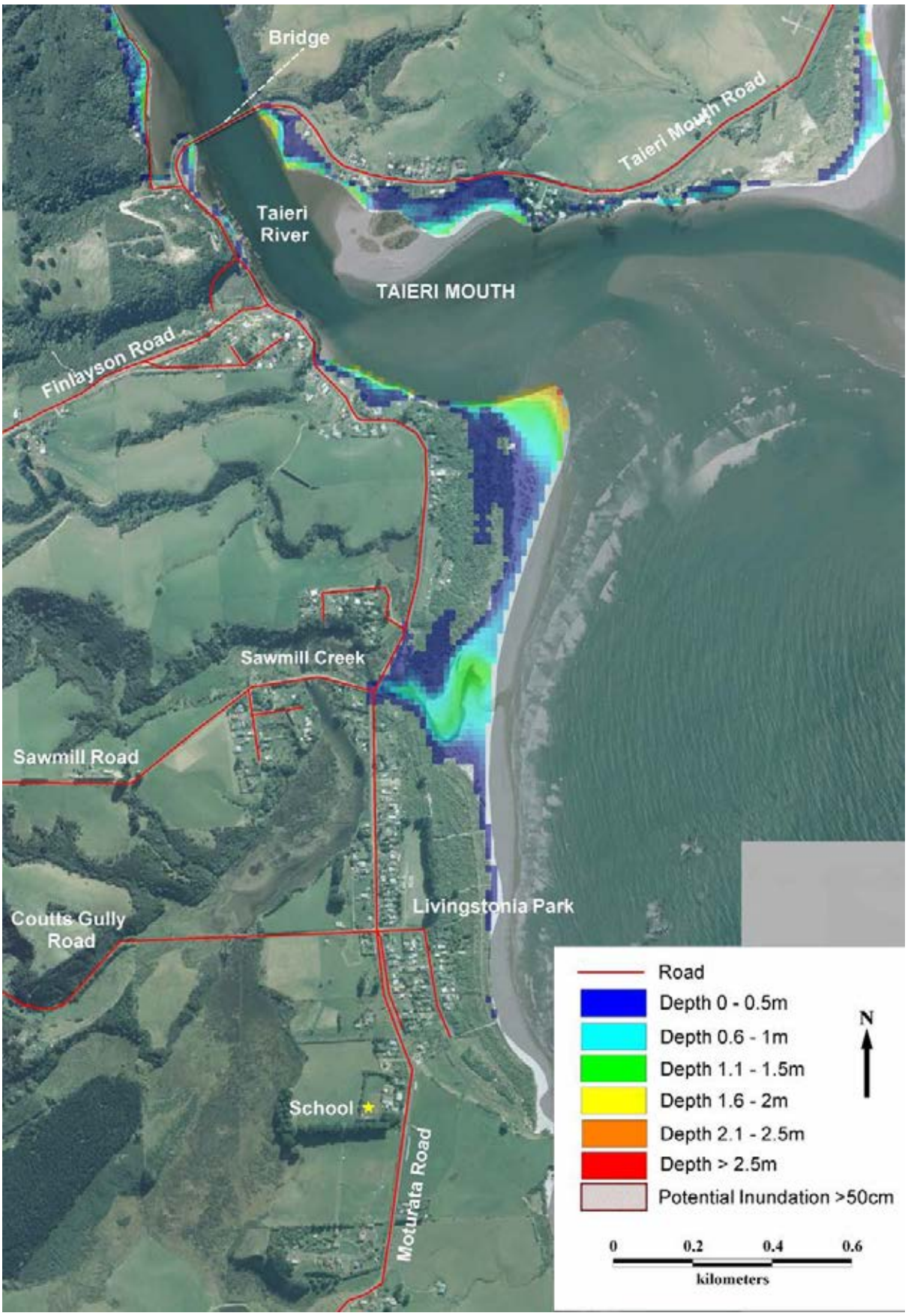

Figure A42. Maximum water depth for inundated land at Taieri Mouth during the modelled 1:500-year South American tsunami at MHWS

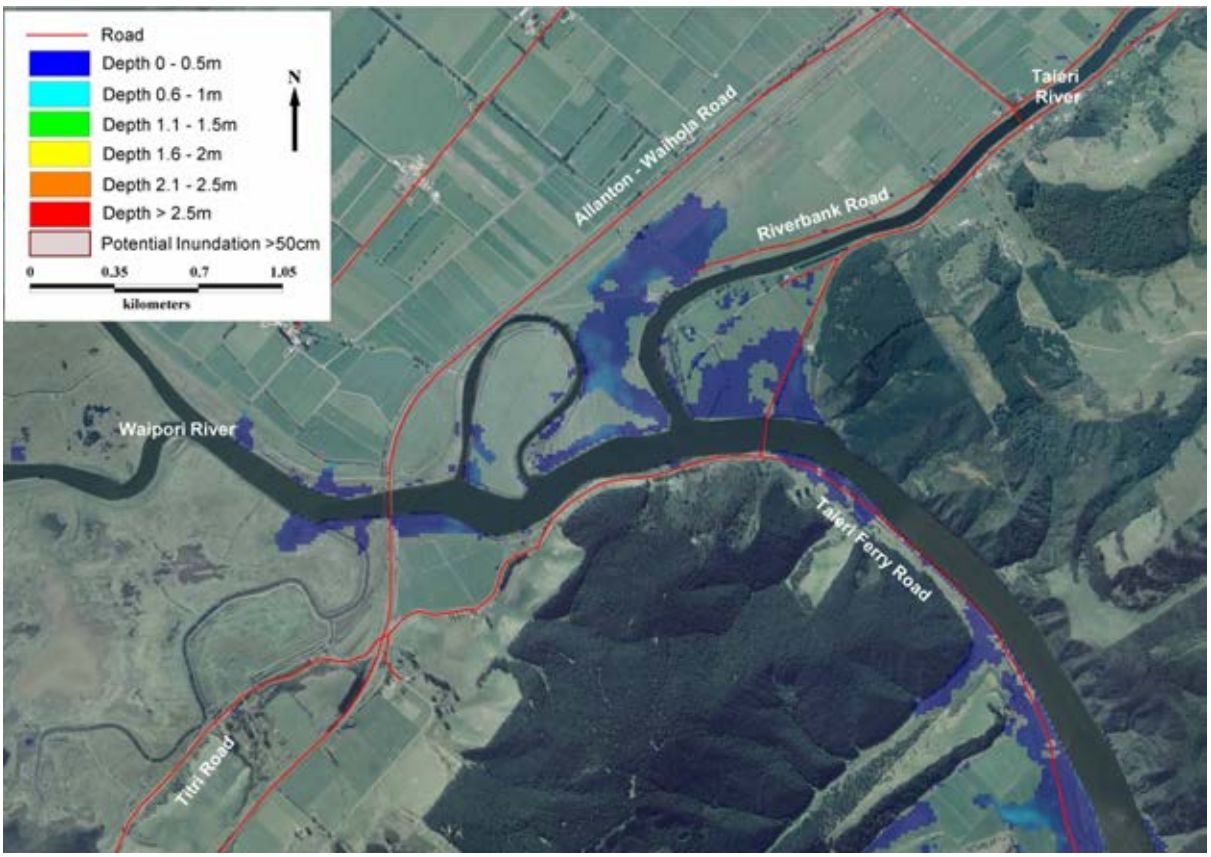

Figure A43. Maximum water depth for inundated land at Henley Ferry during a Puysegur tsunami at MHWS

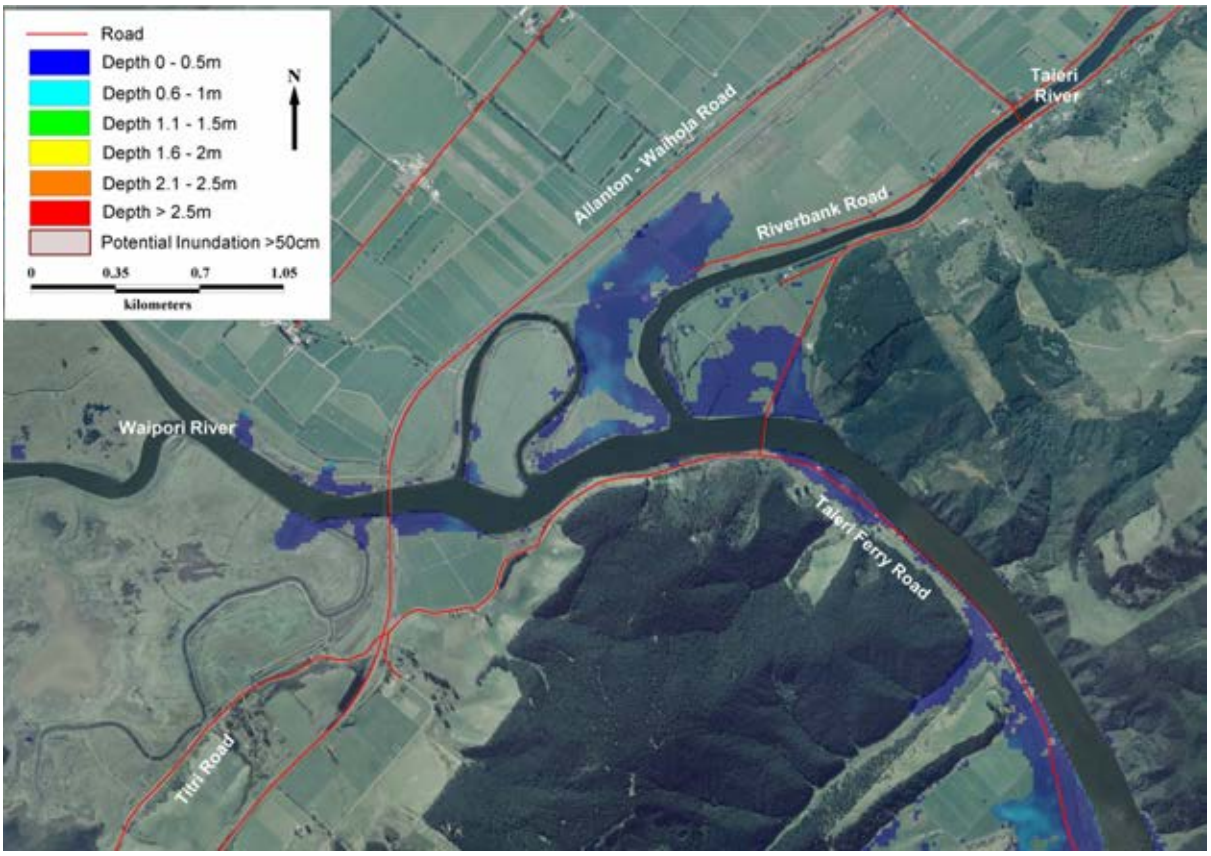

Figure A44. Maximum water depth for inundated land at Henley Ferry during the modelled 1:500-year South American tsunami at MHWS

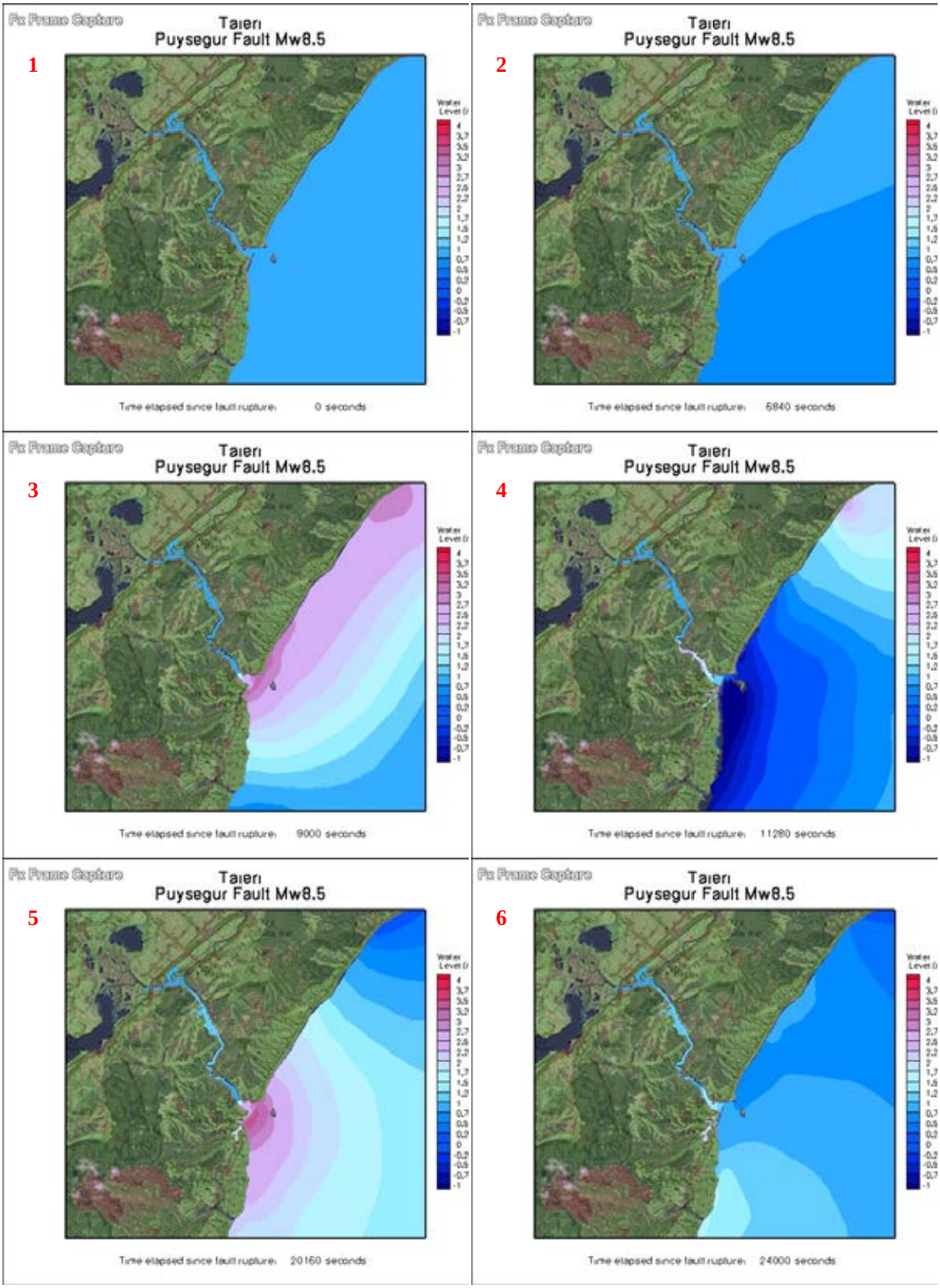

Figure A45. Time series showing changes in water level during the modelled Puysegur Fault tsunami at Taieri Mouth

1 At fault rupture: The undisturbed level of the sea is at MHWS (0.9m).
2 1 hour 34 mins after the earthquake: The first retreat of waves occurs.
3 2 hours 30 mins: The first wave peaks at the river mouth occur.
4 3 hours 8 mins: The model shows significant retreat of the ocean near Taieri Mouth.
5 5 hours 36 mins: Another large wave is modelled to impact the river mouth.
6 6 hours 40 mins: Waves and strong currents are still impacting the estuary.

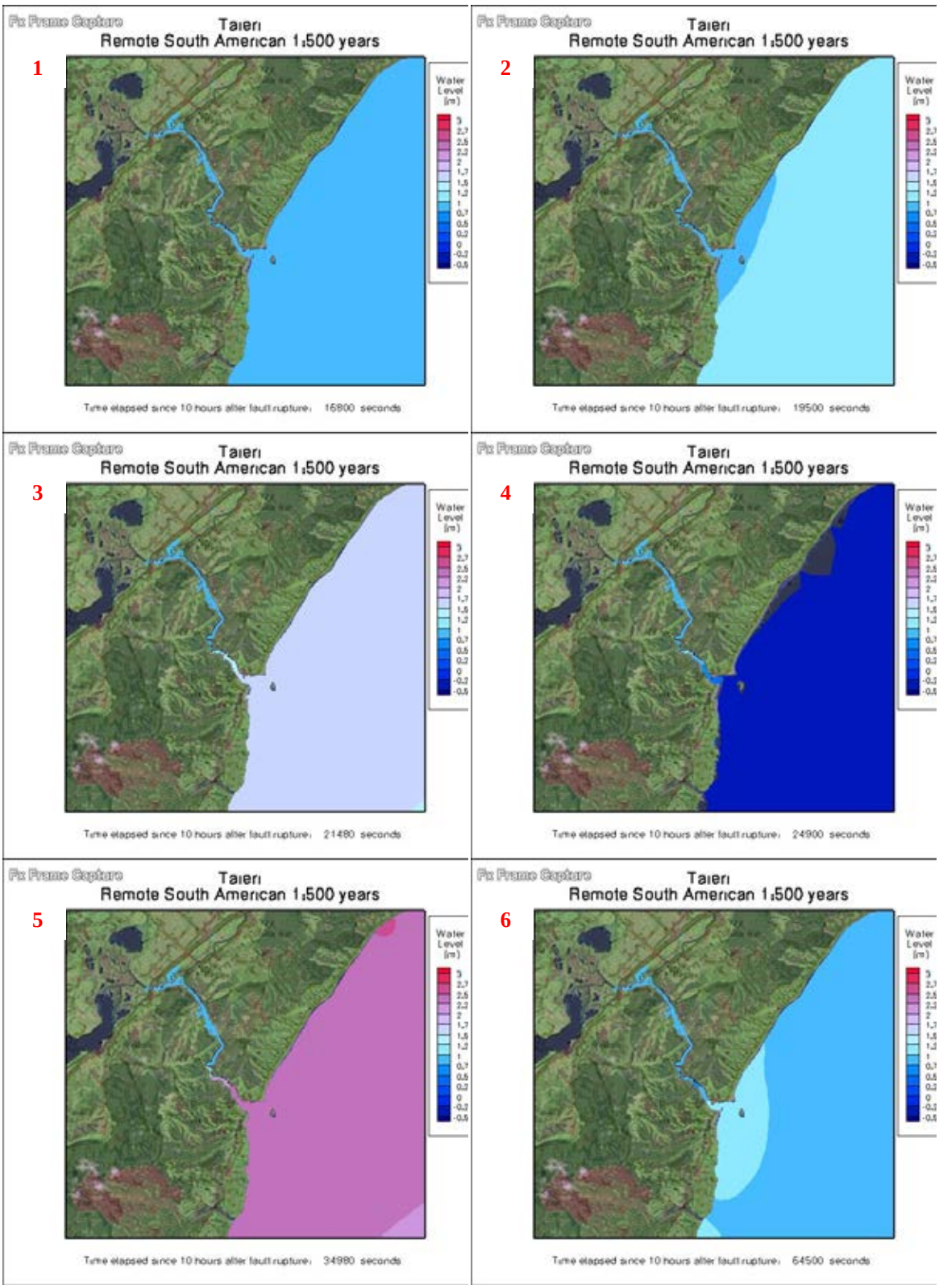

Figure A46. Time series showing changes in water level during the modelled South American 1:500-year tsunami at Taieri Mouth

1 At fault rupture: The undisturbed level of the sea is at MHWS (0.9m)
2 15 hours 25 mins after earthquake: The first rise in sea level impacts the coast.
3 15 hours 58 mins: the first wave peaks along the coast.
4 16 hours 55 mins: The ocean retreats.
5 19 hours 43 mins: The largest modelled wave impacts the coast.
6 27 hours 55 mins: Waves and strong currents still impact the coast.

Figure A47. Location of cross section A-B through Taieri Mouth

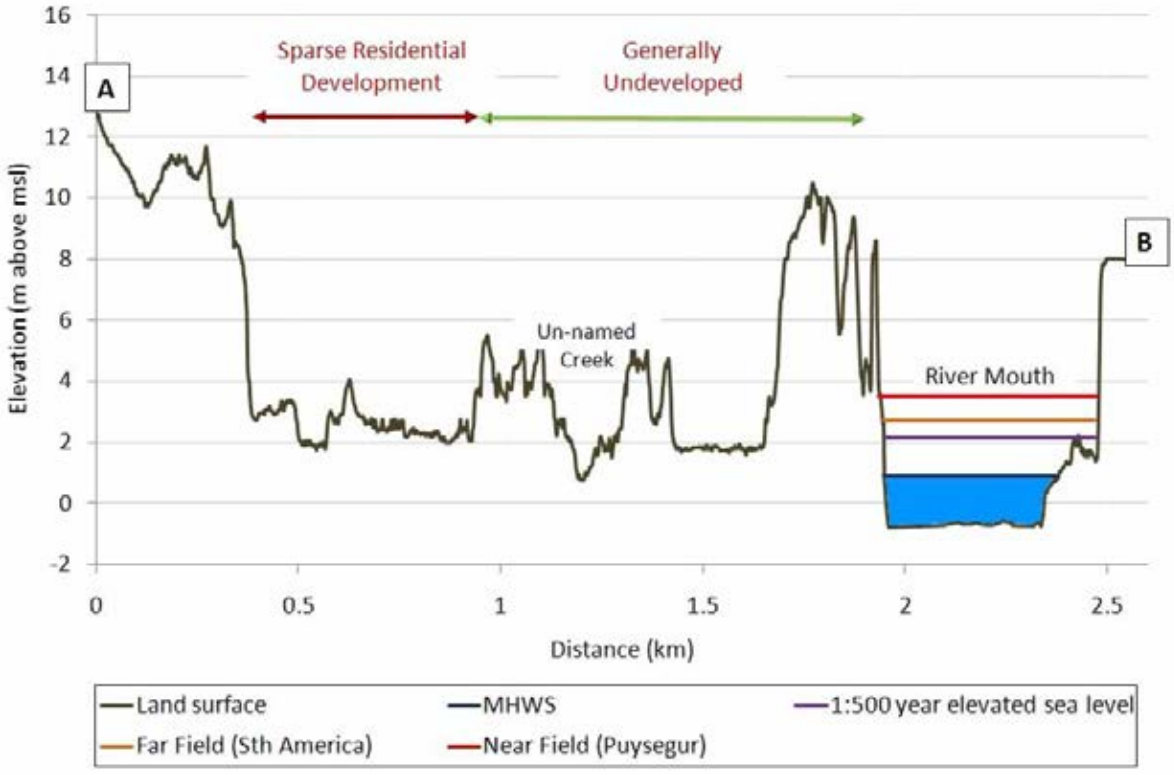

Figure A48. Cross section A-B through Taieri Mouth, showing the greatest extent of run-up at the coast from 1:500-year South American and 1:600-year Puysegur tsunami, and a 1:500-year storm surge event

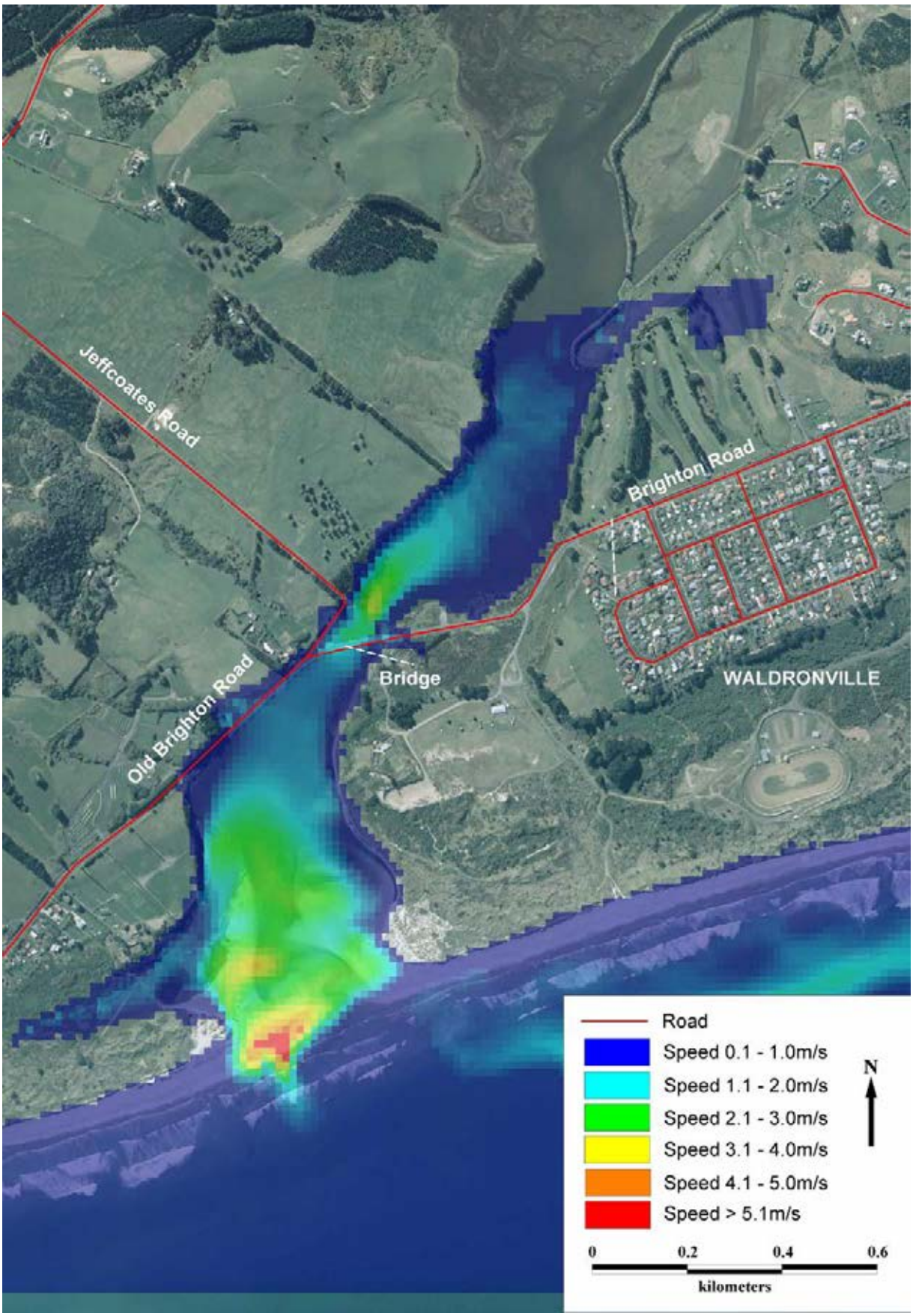

Figure A49. **Maximum water speed associated with a Puysegur tsunami at MHWS at the mouth of the Kaikorai Stream and at the mouth of the Brighton Road Bridge**

7. Brighton

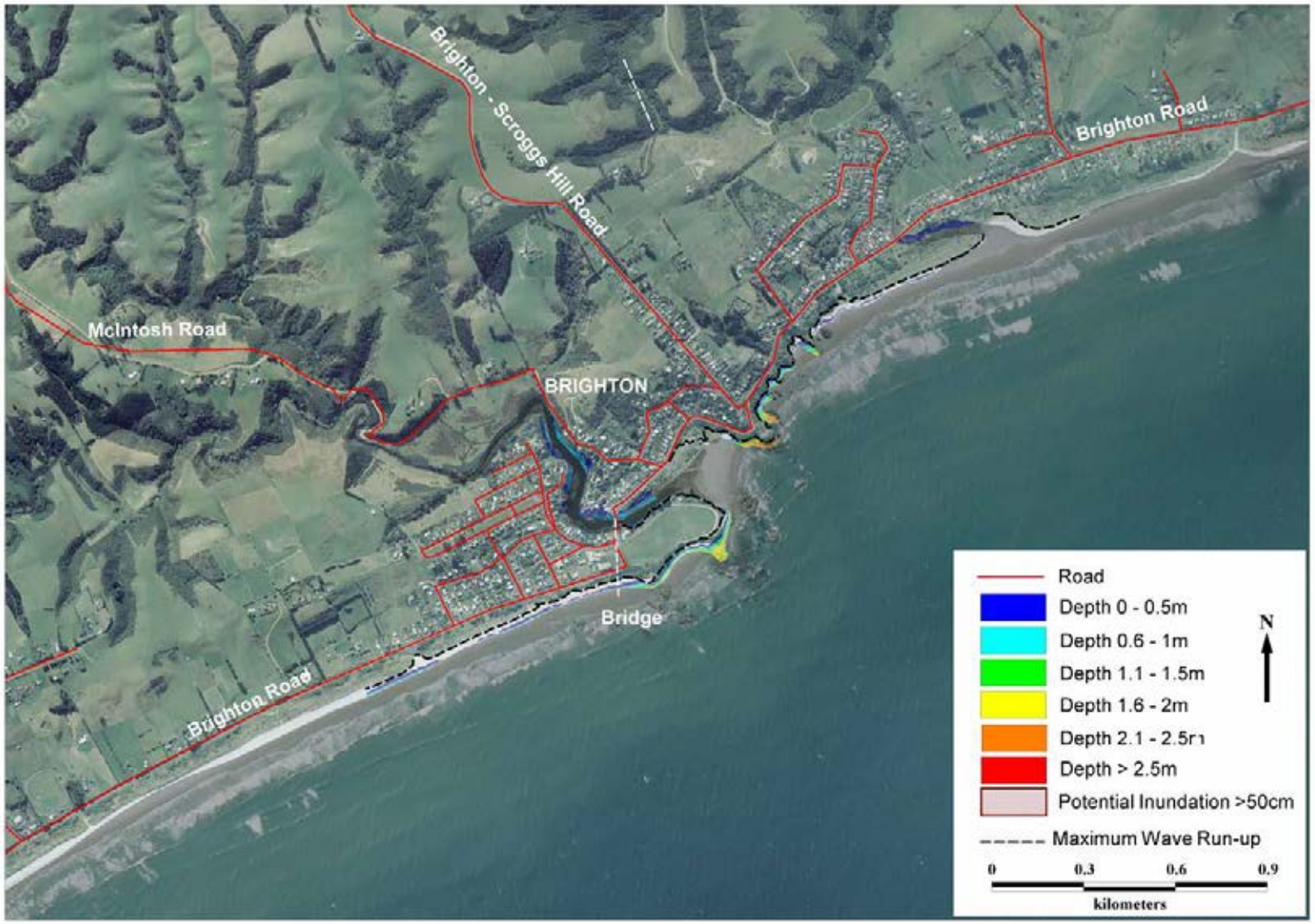

Figure A50. Maximum water depth for inundated land at Brighton during the 1:500-year elevated sea level event at MHWS

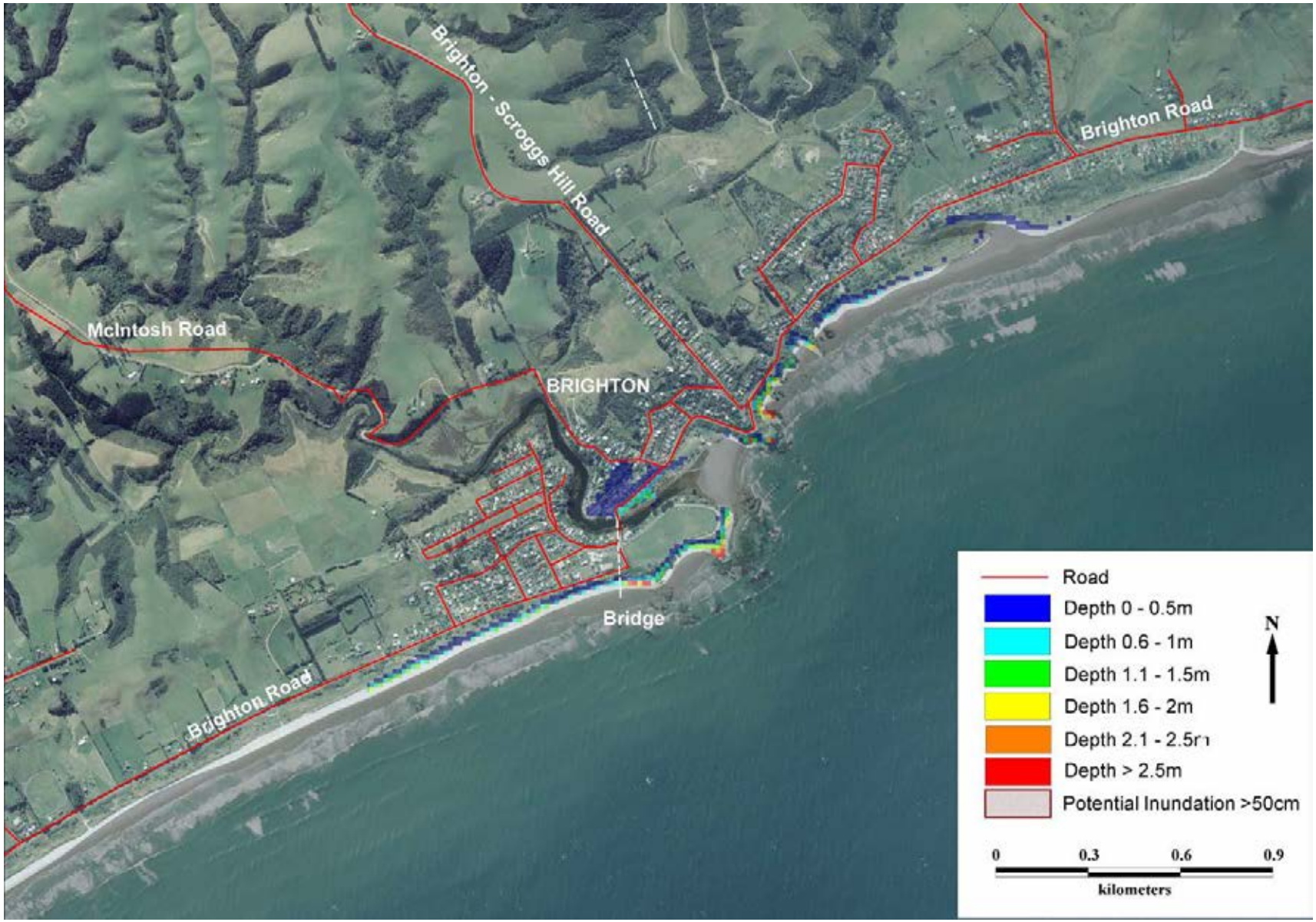

Figure A51. Maximum water depth for inundated land at Brighton during the Puysegur tsunami at MHWS

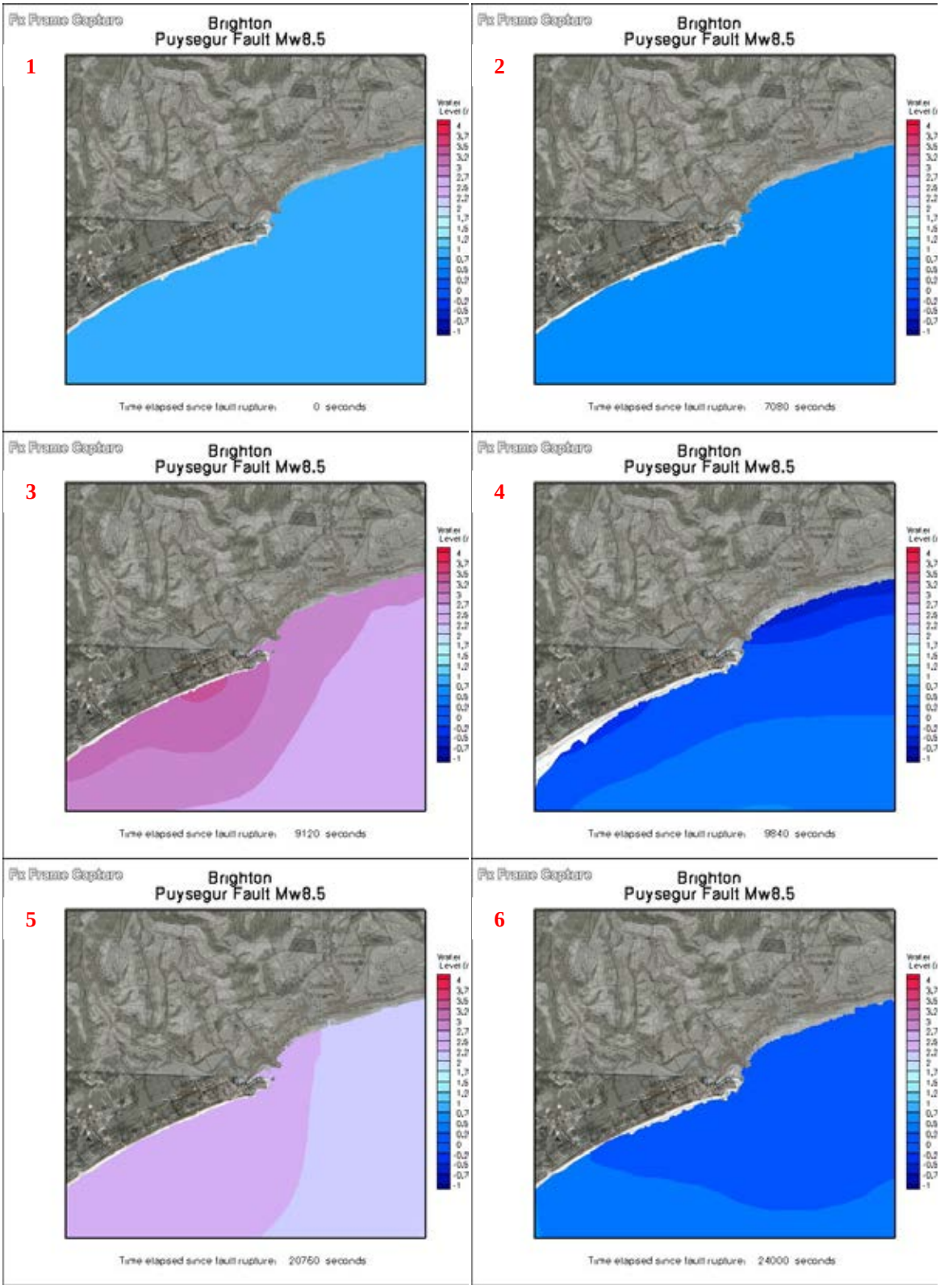

Figure A52. Time series showing changes in water level during the modelled Puysegur Fault tsunami at Brighton

1 At fault rupture: The undisturbed level of the sea is at MHWS (0.9m).
2 1 hour 48 mins after the earthquake: The first retreat of waves occurs.
3 2 hours 32 mins: The first wave peaks at the river mouth occur.
4 2 hours 44 mins: The model shows retreat of the ocean.
5 5 hours 46 mins: Another wave is modelled to impact Brighton.
6 6 hours 40 mins: Waves and strong currents are still impacting Brighton.

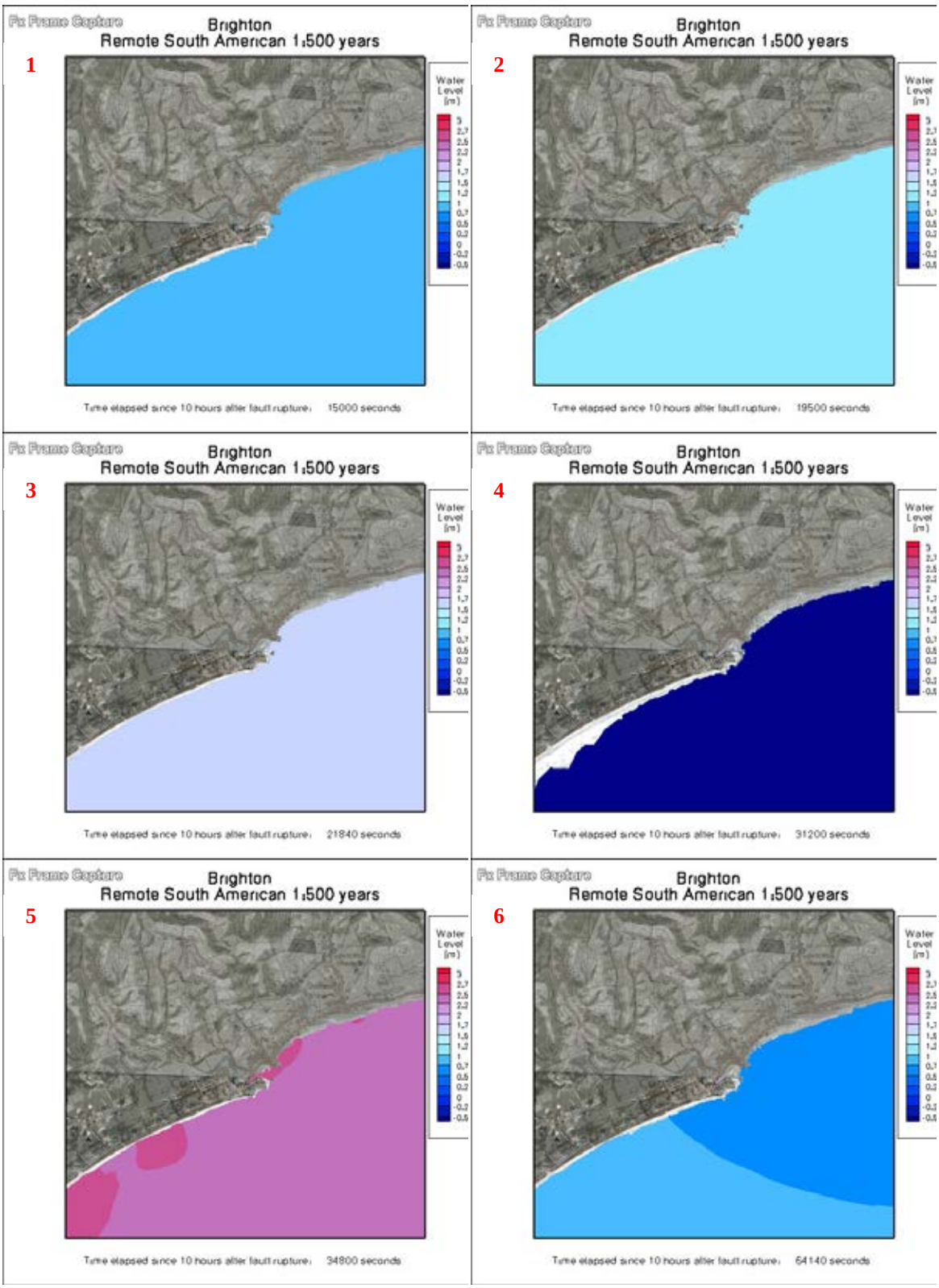

Figure A53. Time series showing changes in water level during the modelled South American 1:500-year tsunami at Brighton

1 At fault rupture: The undisturbed level of the sea is at MHWS (0.9m).
2 15 hours 25 mins after earthquake: The first rise in sea level impacts the coast.
3 16 hours 4 mins: The first wave peaks along the coast.
4 18 hours 40 mins: The ocean retreats.
5 19 hours 40 mins: The largest modelled wave impacts the coast.
6 27 hours 49 mins: Waves and strong currents still impact the coast.

Figure A54. Location of cross section A-B through Brighton

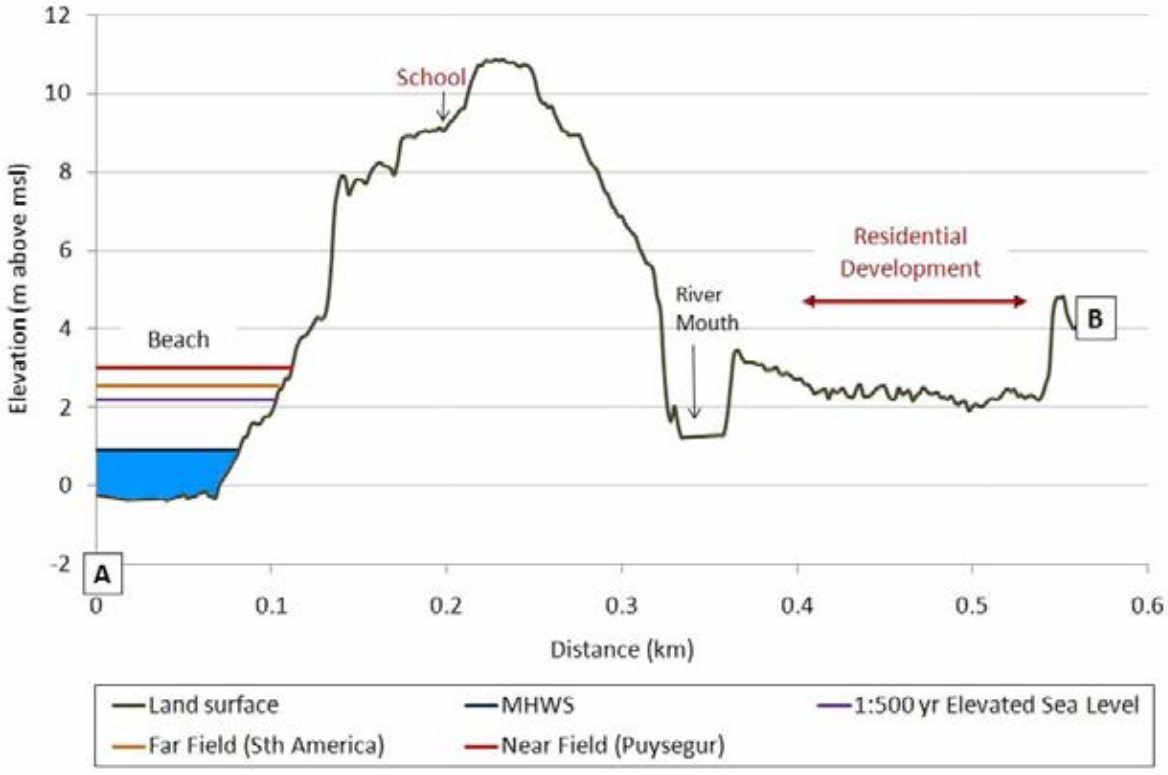

Figure A55. Cross section A-B through Brighton, showing the greatest extent of run-up at the coast from 1:500-year South American and 1:600-year Puysegur tsunami, and a 1:500-year storm surge event

8. St Kilda / St Clair

Figure A56. Elevation map of the South Dunedin area. Height in metres above mean sea level (MSL)

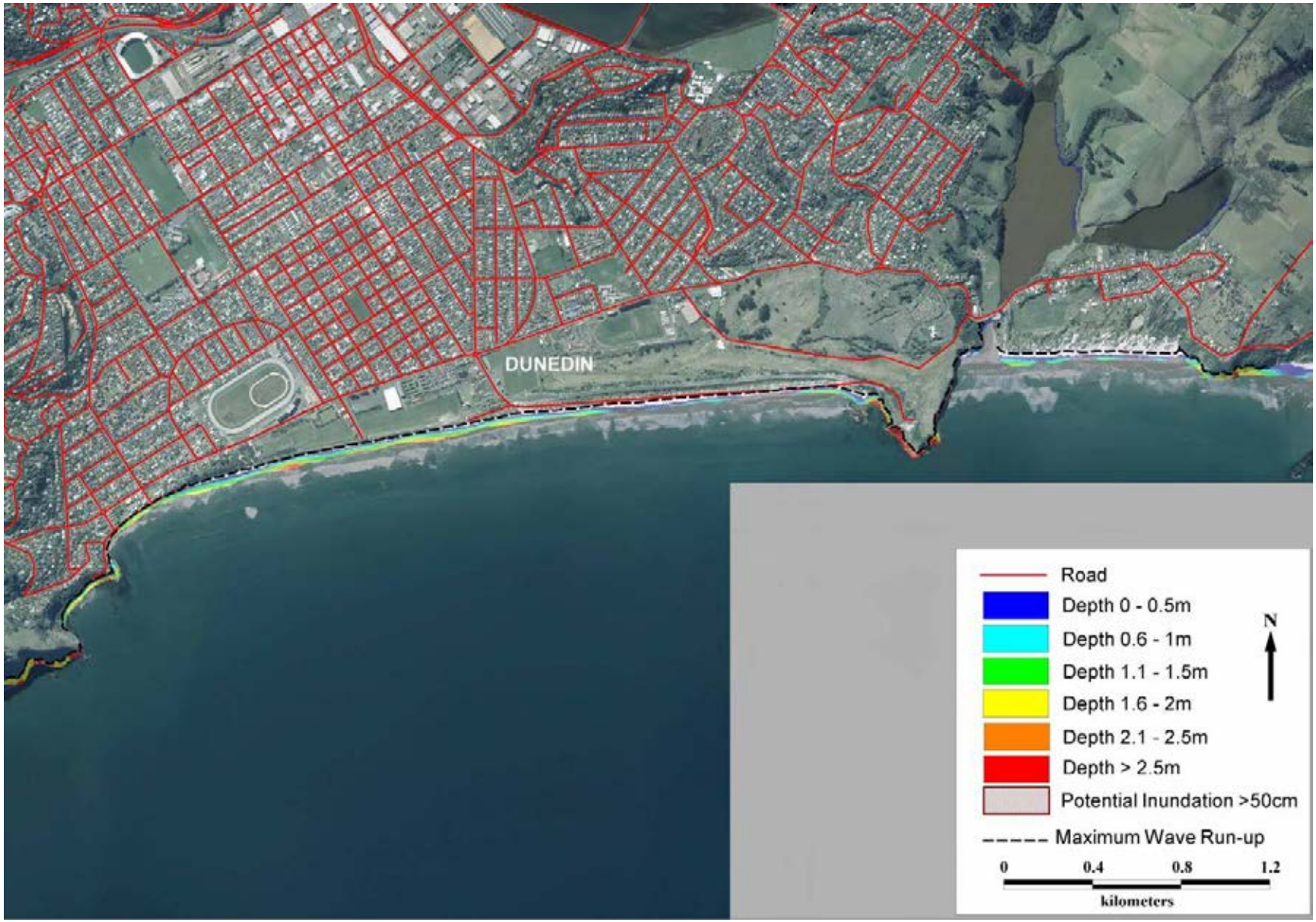

Figure A57. Maximum water depth for inundated land at St Kilda, St Clair and Tomahawk beaches during a 1:500-year elevated sea level event at MHWS

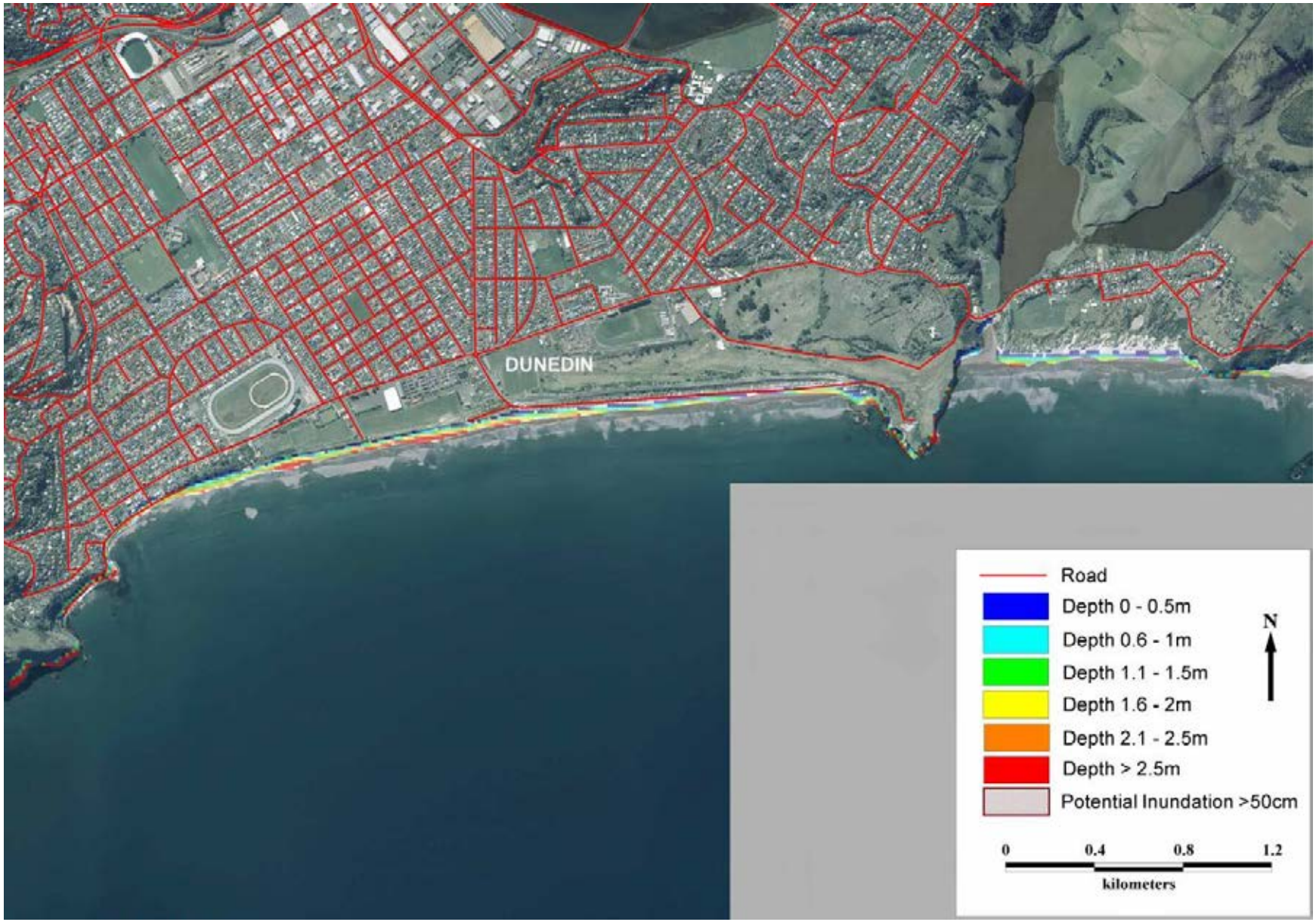

Figure A58. Maximum water depth for inundated land at St Kilda, St Clair and Tomahawk beaches during a Puysegur tsunami at MHWS

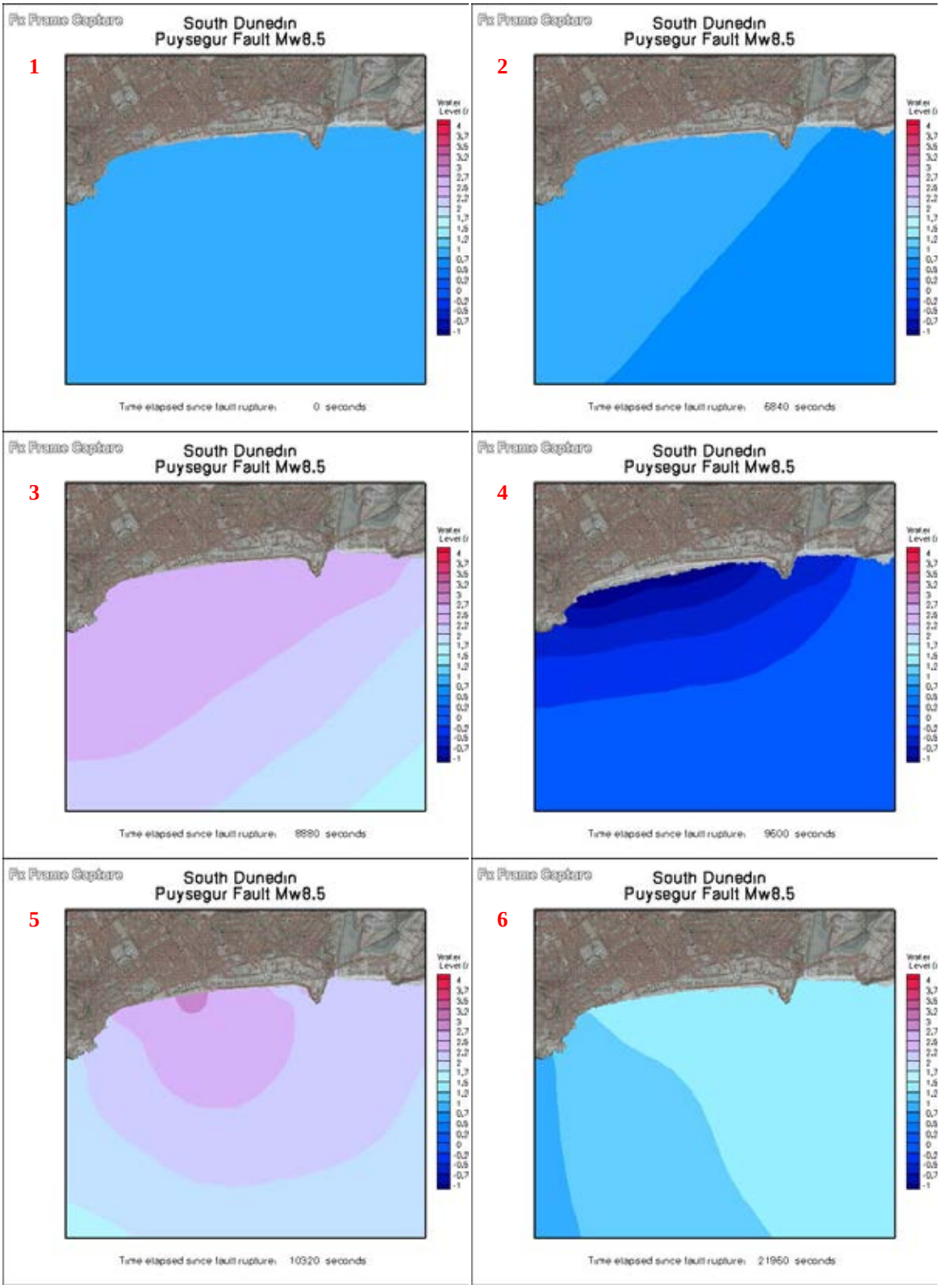

Figure A59. Time series showing changes in water level during the modelled Puysegur Fault tsunami at South Dunedin

1 At fault rupture: The undisturbed level of the sea is at MHWS (0.9m).
2 1 hour 44 mins after the earthquake: The first retreat of waves occurs.
3 2 hours 28 mins: The first wave peaks at South Dunedin.
4 2 hours 38 mins: Immediately after the first wave, the ocean retreats.
5 2 hours 52 mins: Another wave is modelled to impact South Dunedin.
6 6 hours 6 mins: Waves and strong currents are still impacting South Dunedin.

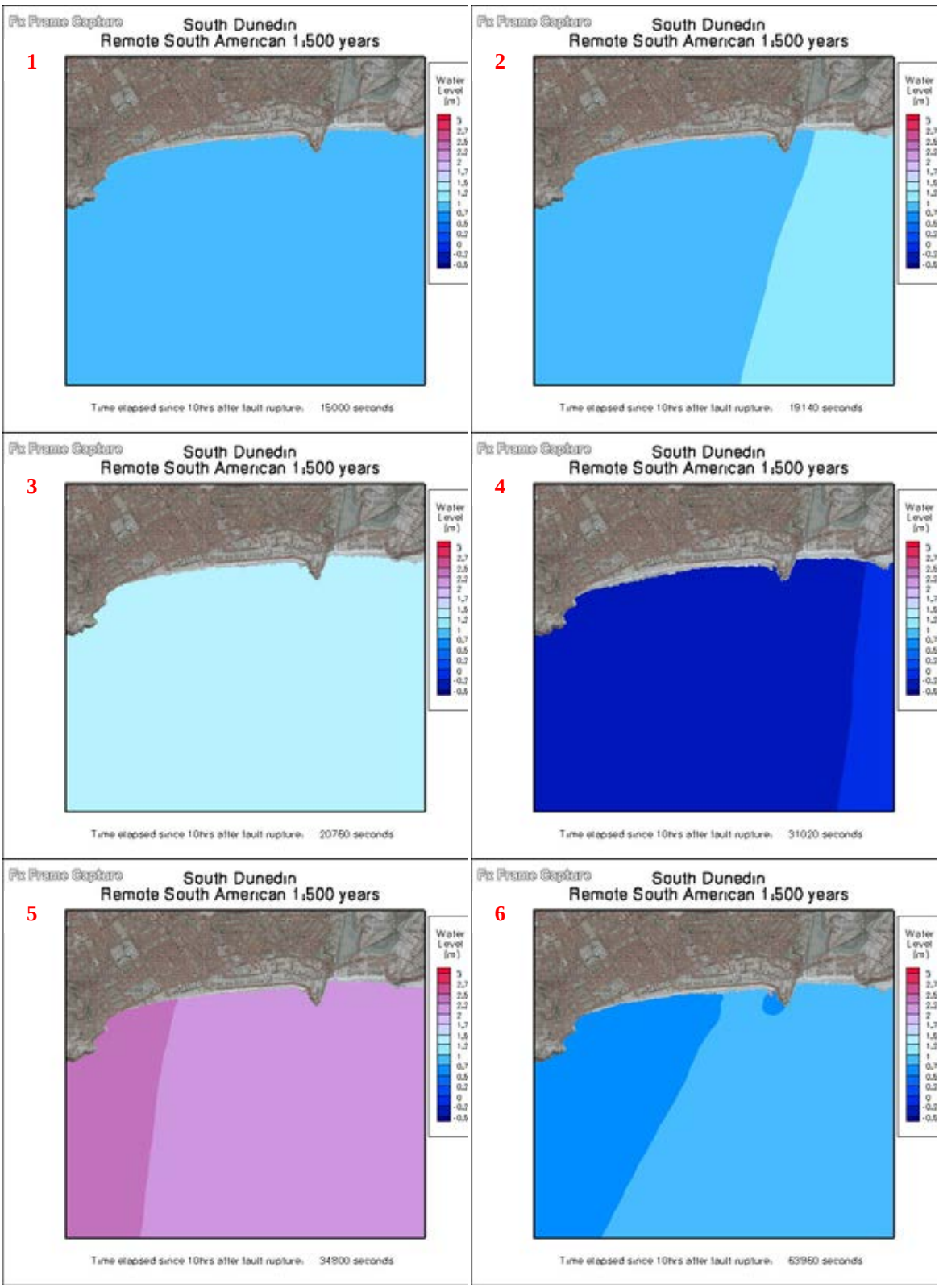

Figure A60. Time series showing changes in water level during the modelled South American 1:500-year tsunami at South Dunedin

1 At fault rupture: The undisturbed level of the sea is at MHWS (0.9m).
2 15 hours 19 mins after earthquake: The first rise in sea level impacts the coast.
3 15 hours 46 mins: The first wave peaks along the coast.
4 18 hours 37 mins: The ocean retreats.
5 19 hours 40 mins: The largest modelled wave impacts the coast.
6 27 hours 46 mins: Waves and strong currents still impact the coast.

Figure A61. Location of cross section A-B through the South Dunedin area

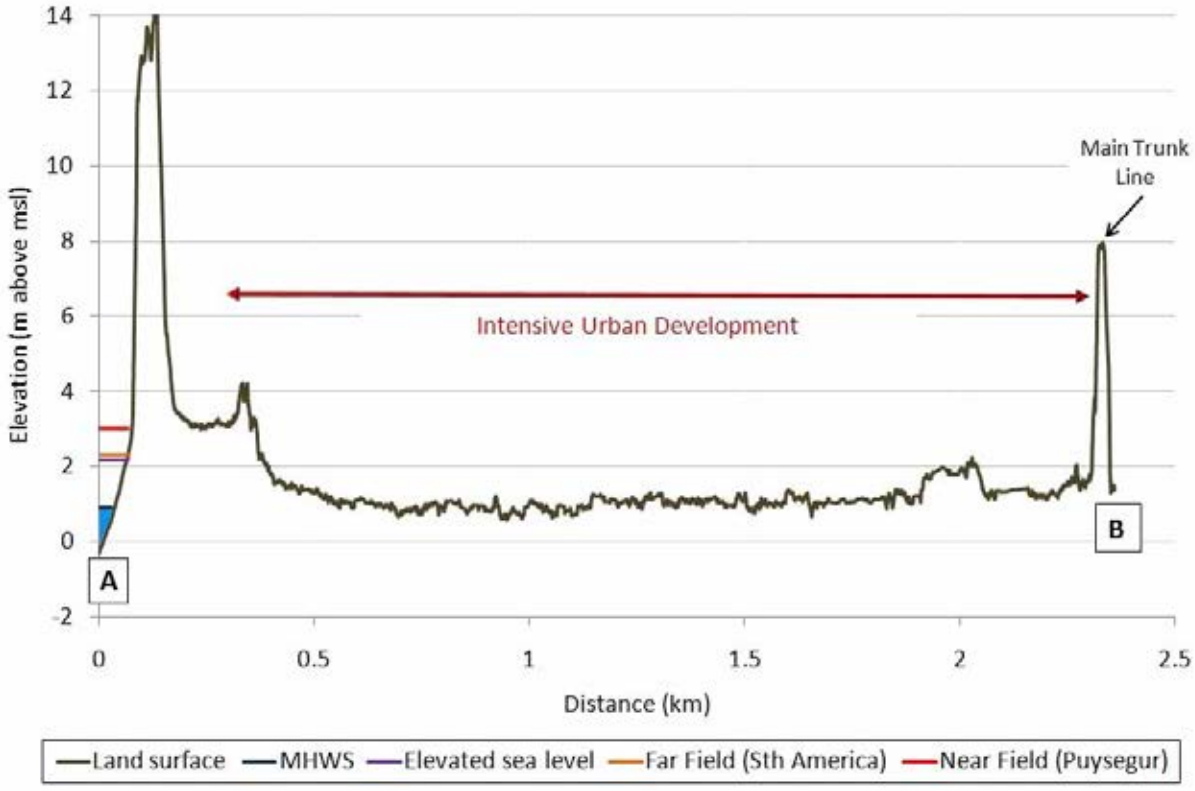

Figure A62. Cross section A-B through the South Dunedin area, showing the greatest extent of run-up at the coast from 1:500-year South American and 1:600-year Puysegur tsunami, and a 1:500-year elevated sea level event

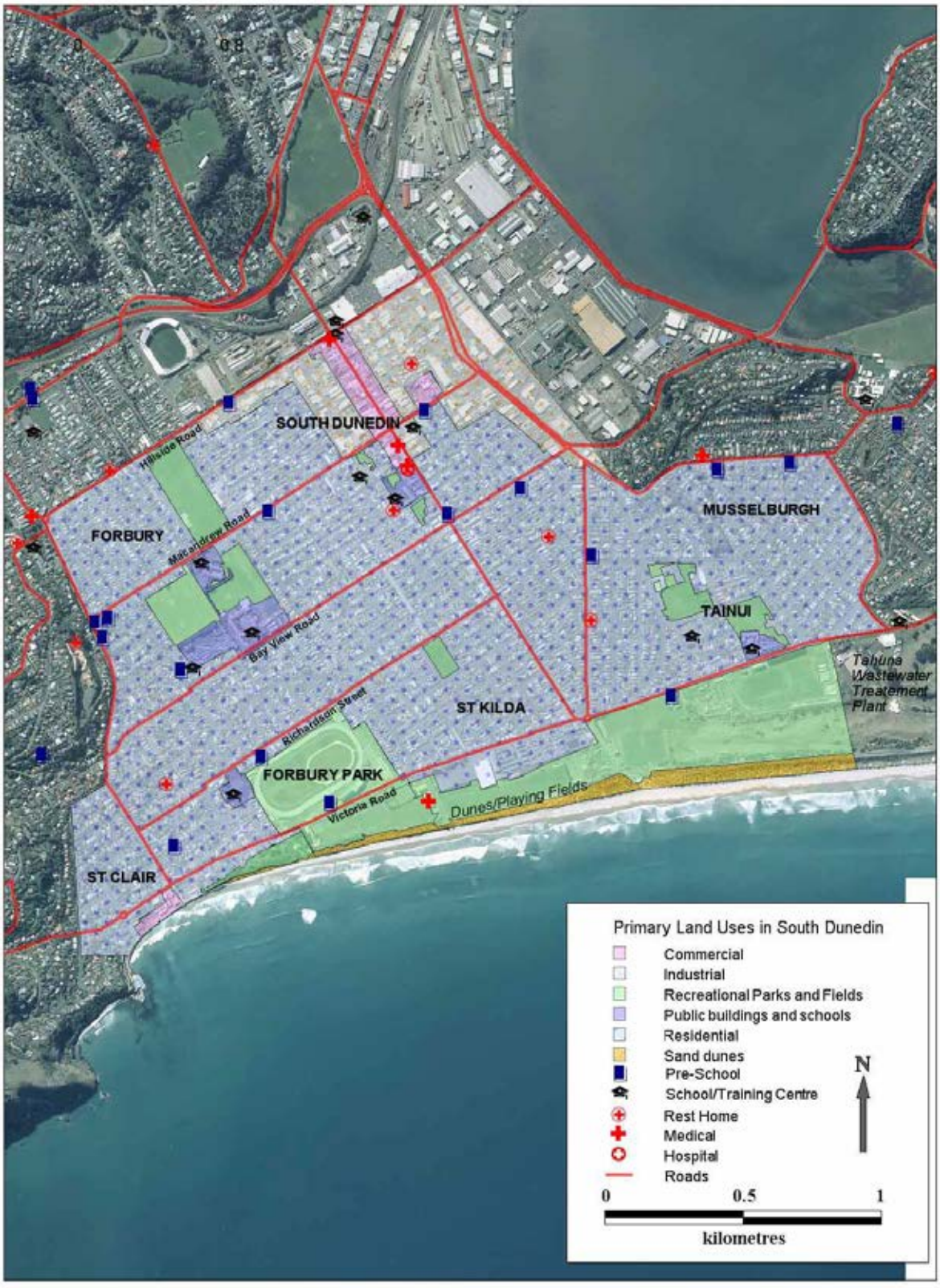

Figure A63. Primary land-use types in the South Dunedin area (as described in the main report). The locations of education and health facilities are also shown

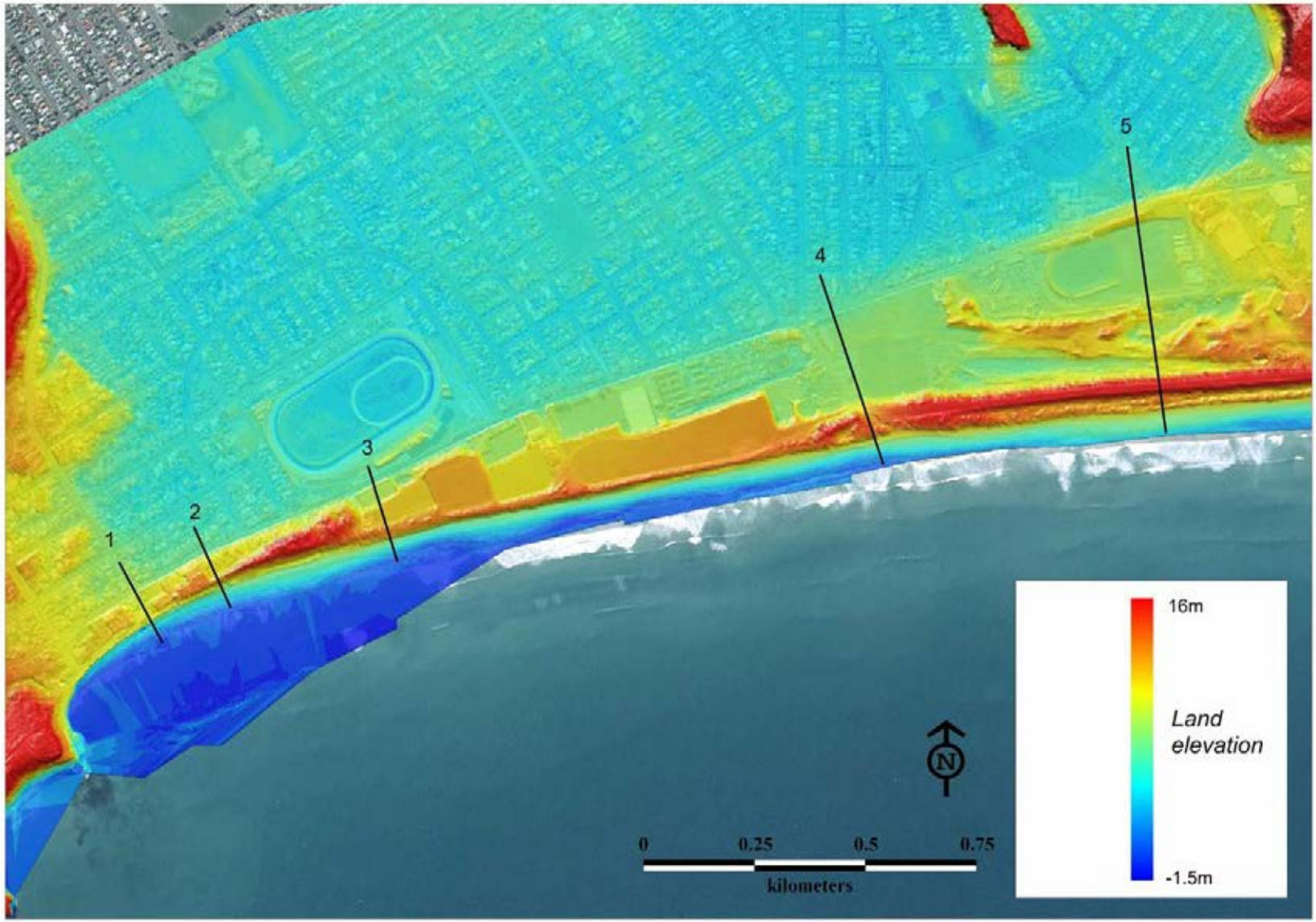

Figure A64. **Composite LiDAR and aerial photo map of the St Kilda/St Clair beaches and urban areas. The location of cross sections 1 to 5 (Figure A65 to Figure A69) are shown as black lines. Heights are in metres above mean sea level**

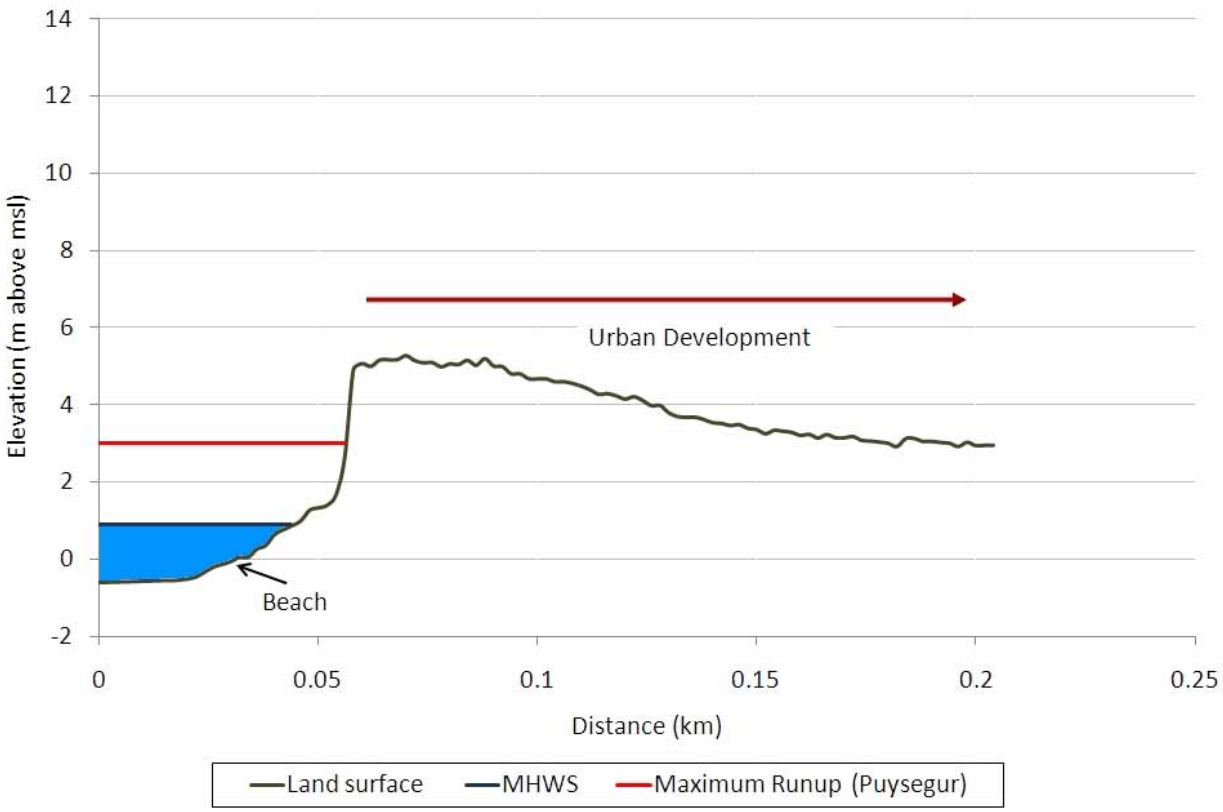

Figure A65. Cross section 1, through sea wall to urban St Clair

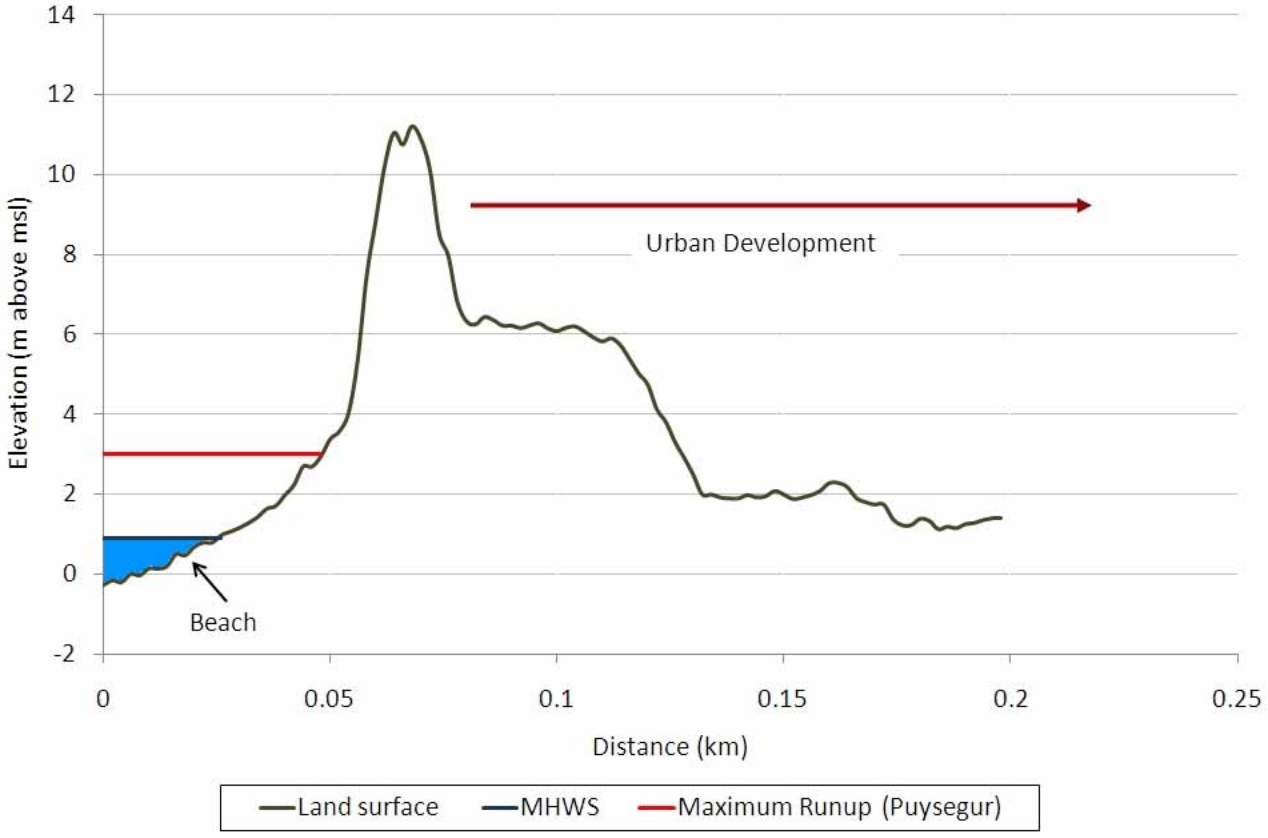

Figure A66. Cross section 2, through sea wall to urban St Clair

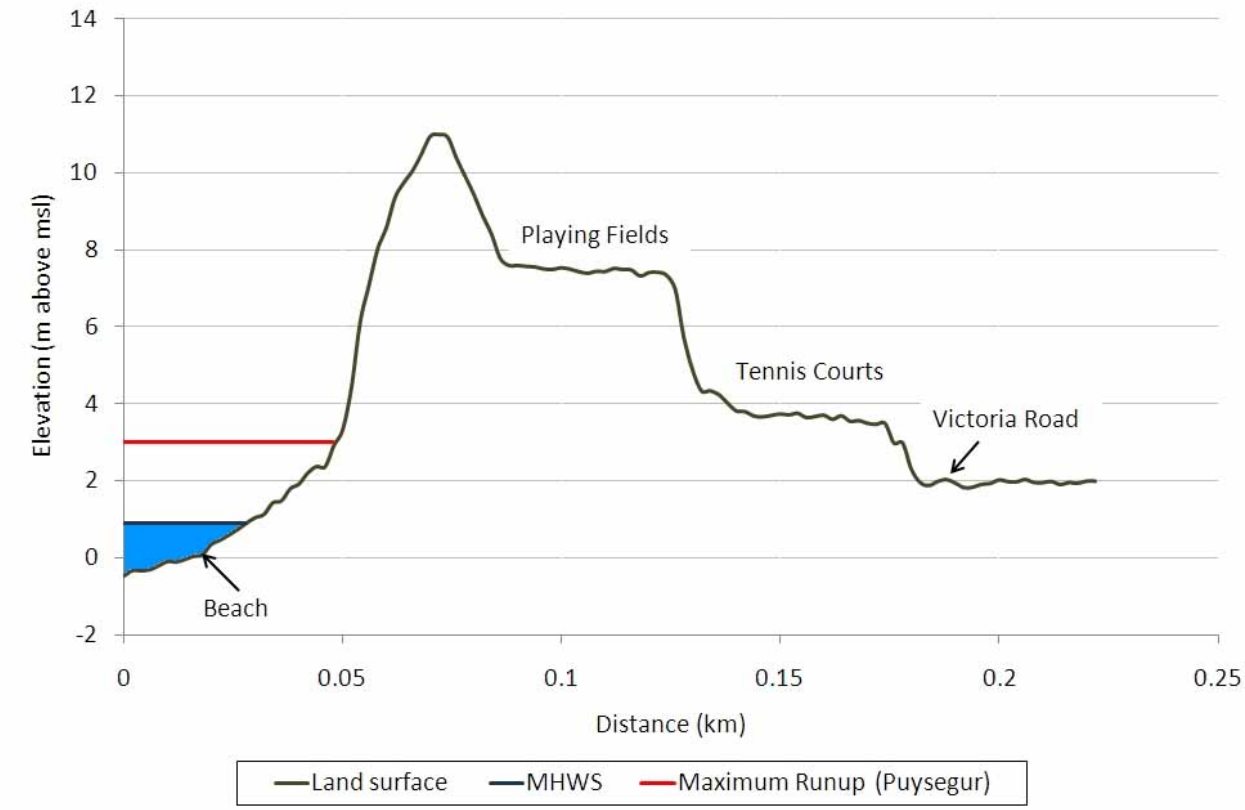

Figure A67. Cross section 3, through dunes and playing fields to Forbury Raceway

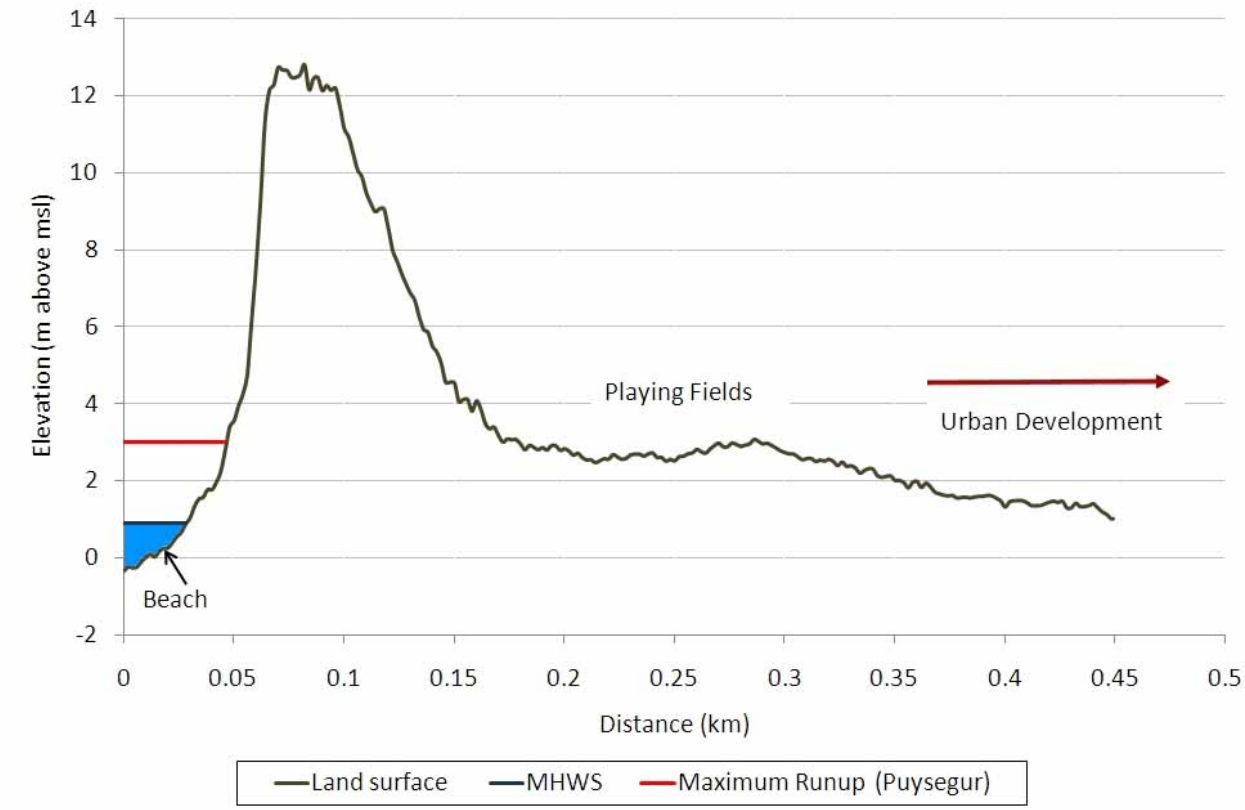

Figure A68. Cross section 4, through dunes and playing fields to urban St Kilda

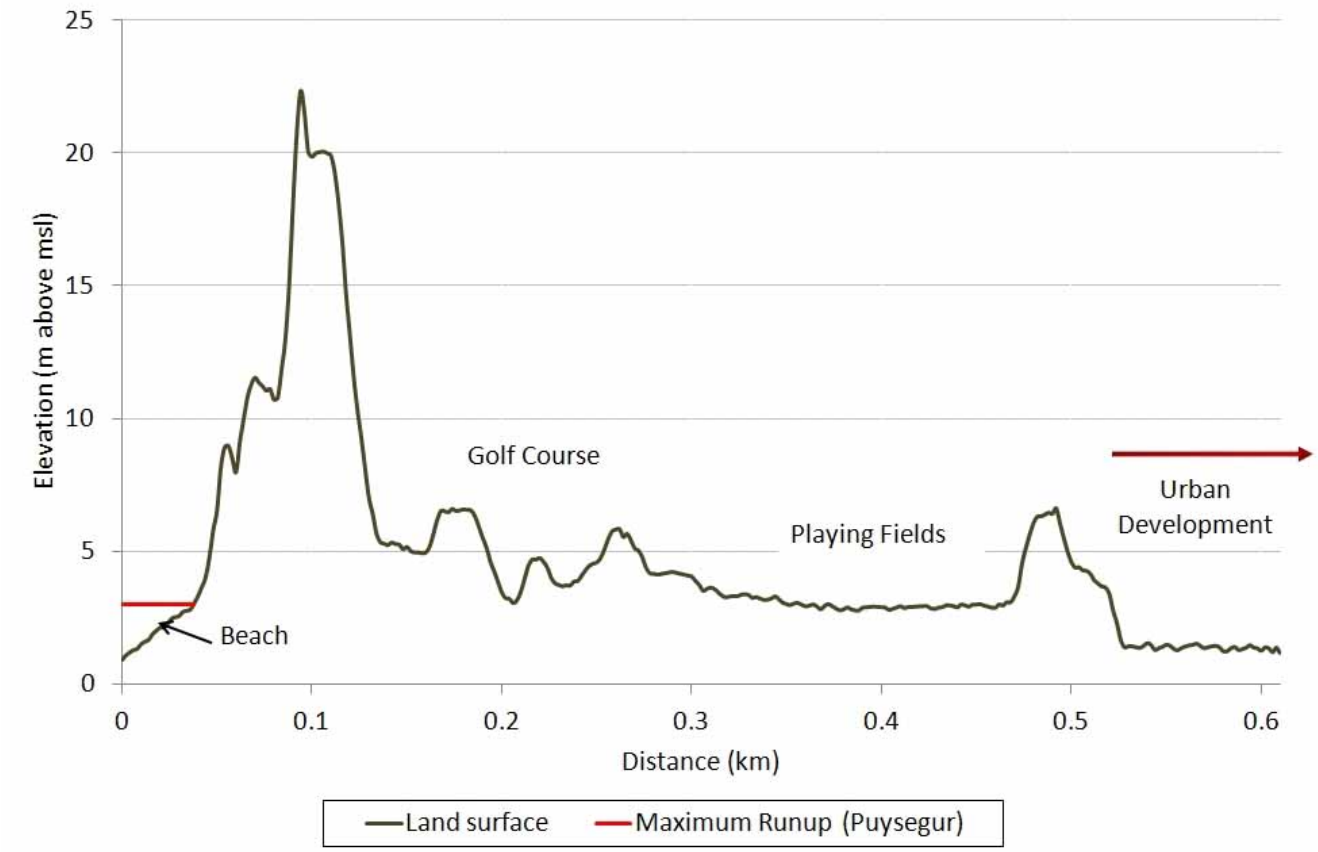

Figure A69. Cross section 5, through dunes, golf course and playing fields to urban Tainui

9. Otago Harbour

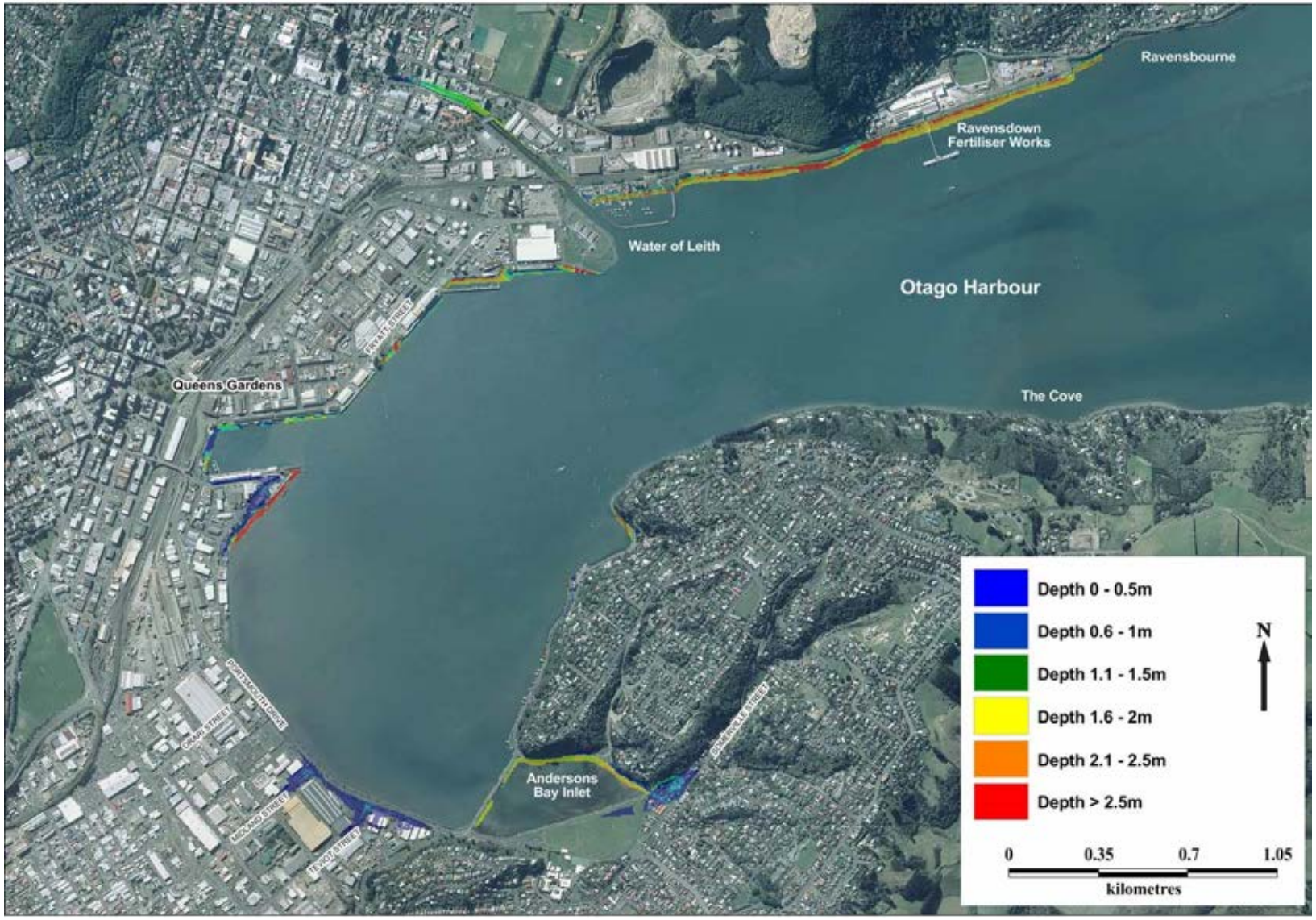

Figure A70. Maximum water depth for inundated land in the upper Otago Harbour during a 1:500-year extreme sea level event at MHWS

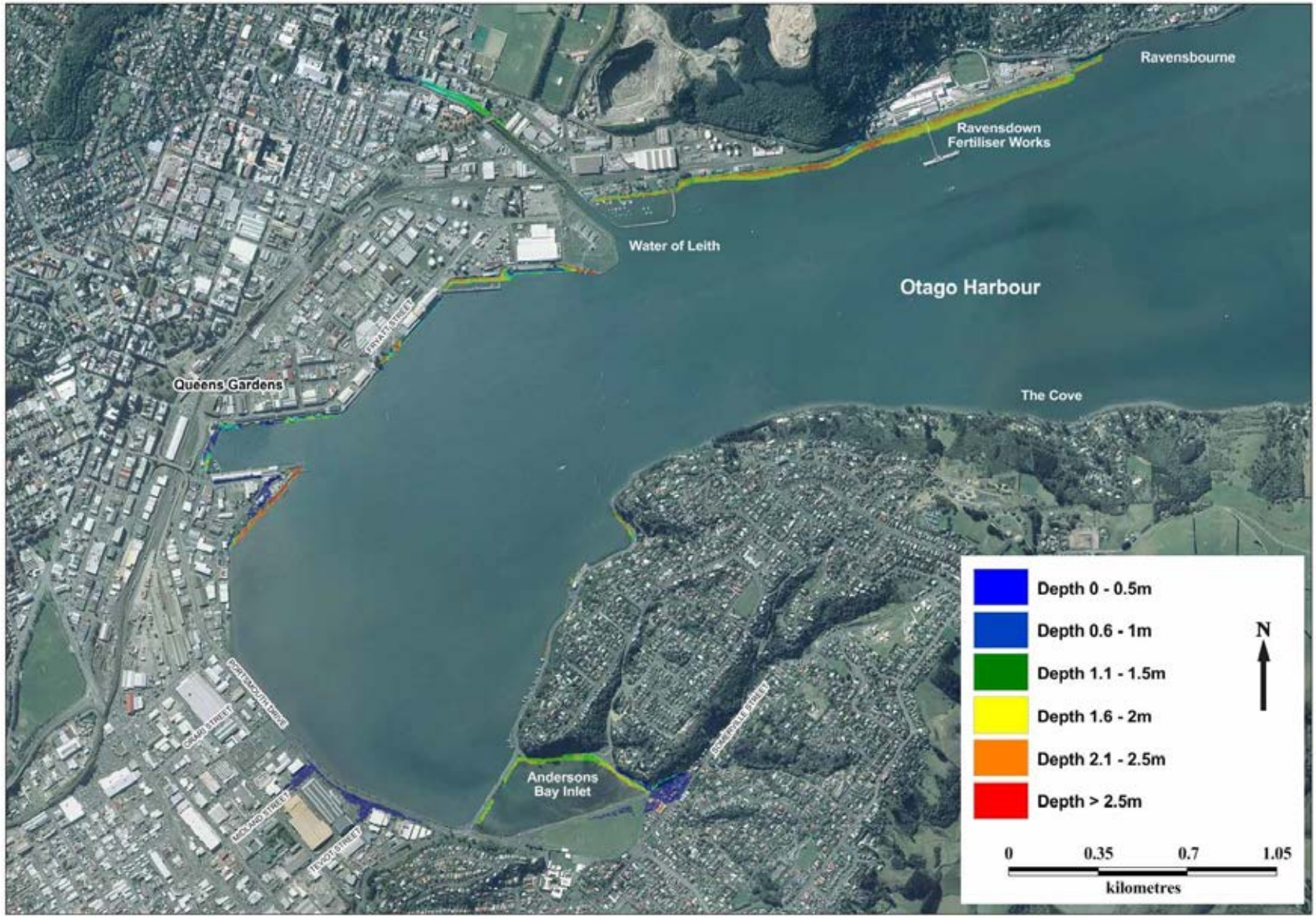

Figure A71. Maximum water depth for inundated land in the upper Otago Harbour during a 1:20-year extreme sea level event at MHWS

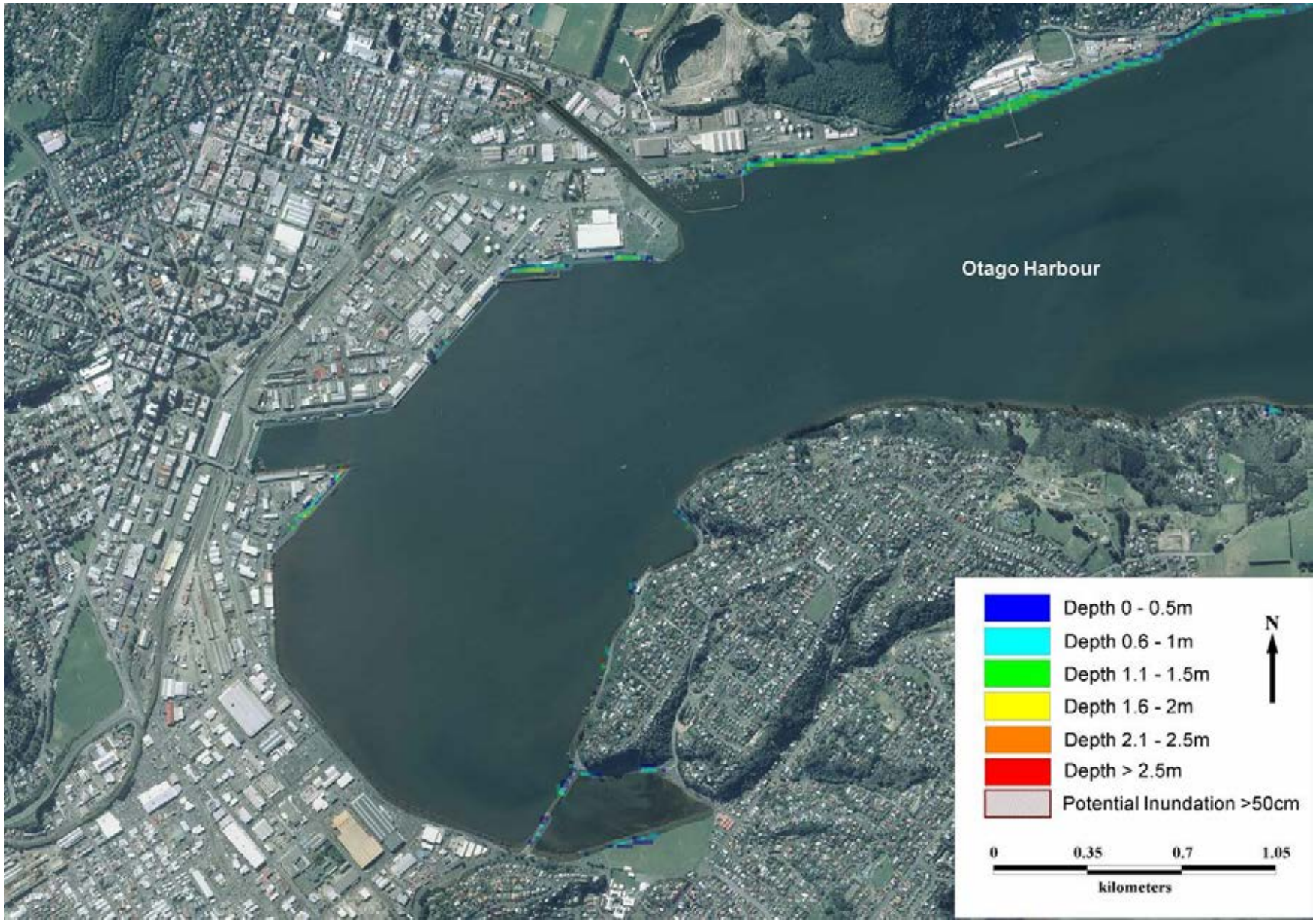

Figure A72. Maximum water depth for inundated land in the upper Otago Harbour during the modelled 1:500-year South American tsunami at MHWS

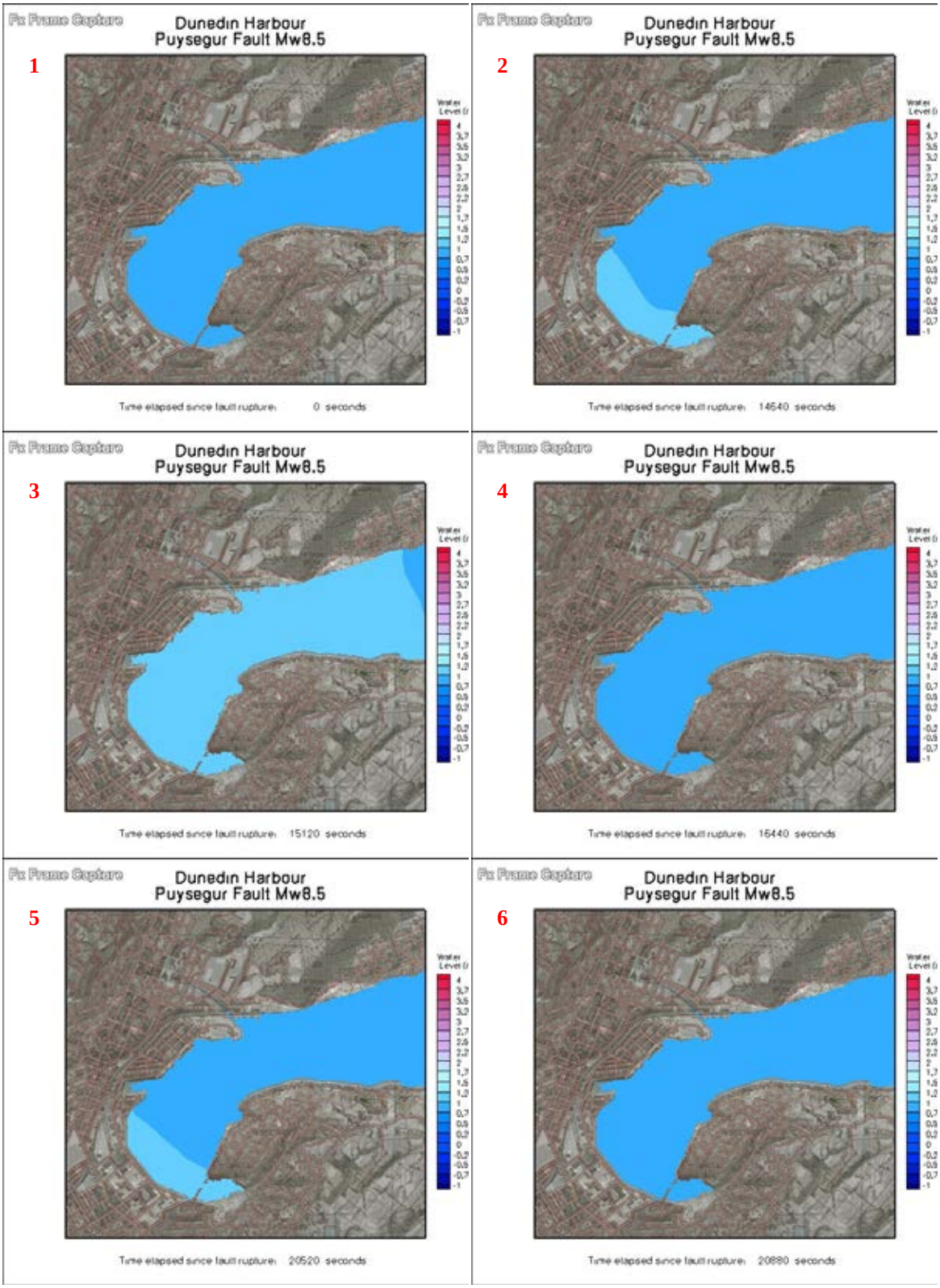

Figure A73. Time series showing changes in water level during the modelled Puysegur Fault tsunami at Otago Harbour

1 At fault rupture: The undisturbed level of the sea is at MHWS (0.9m).
2 4 hours 1 min after the earthquake: A small rise in sea level is noticed in the upper harbour.
3 4 hours 12 mins: The first rise peaks.
4 4 hours 34 mins: Levels are back to normal.
5 5 hours 42 mins: Another rise occurs.
6 5 hours 48 mins: Sea level restores back to normal.

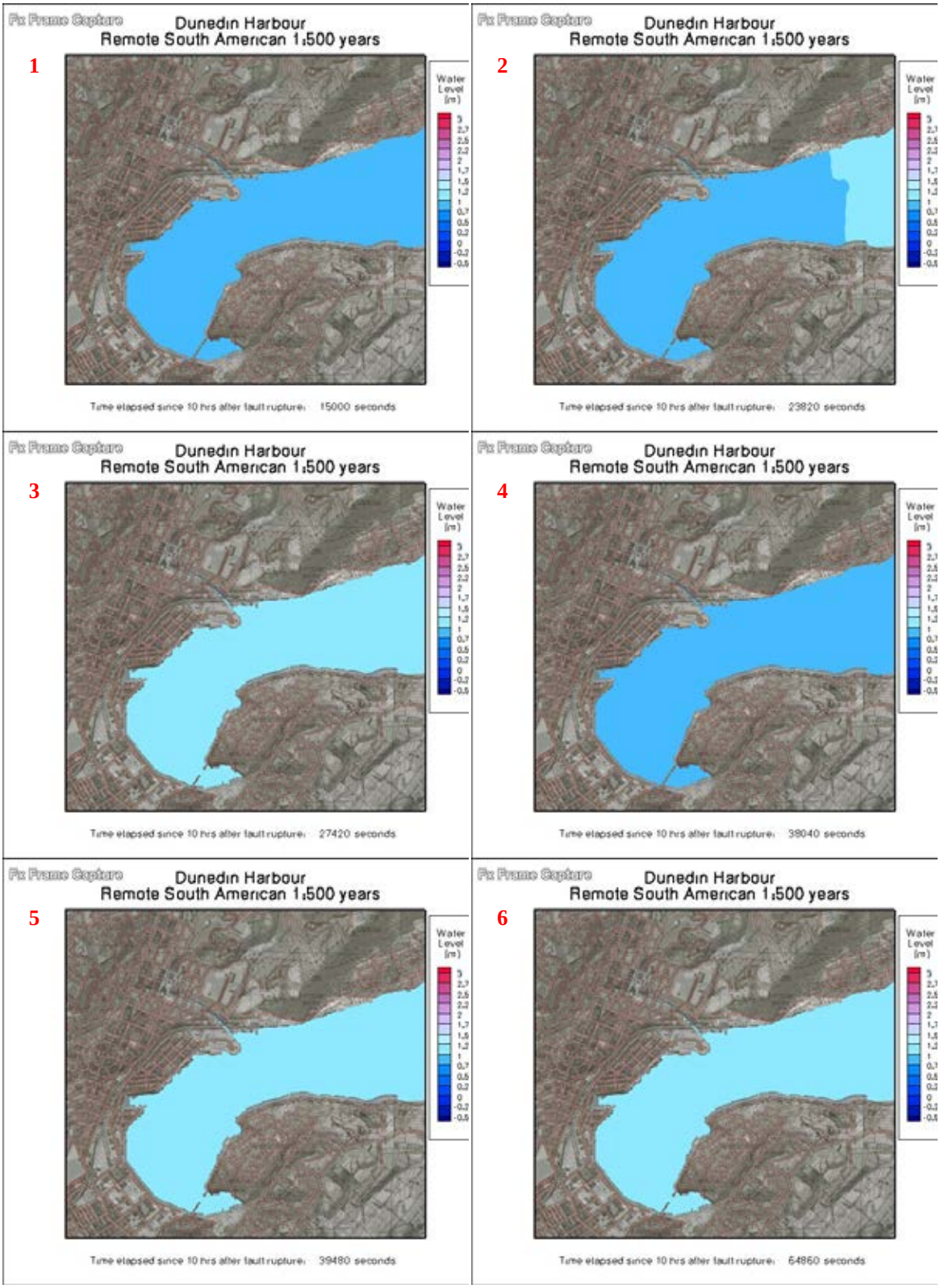

Figure A74. Time series showing changes in water level during the modelled 1:500-year South American tsunami at Otago Harbour

1 At fault rupture: The undisturbed level of the sea is at MHWS (0.9m).
2 16 hours 37 mins after earthquake: The first rise in sea level reaches Dunedin City.
3 17 hours 37 mins: Sea level maintained at an elevated level.
4 20 hours 34 mins: Elevated sea level subsides.
5 20 hours 58 mins: Sea level rises again.
6 28 hours: Sea level continues to fluctuate in the harbour.

Figure A75. Location of cross section A-B along Kitchener Street and Portsmouth Drive

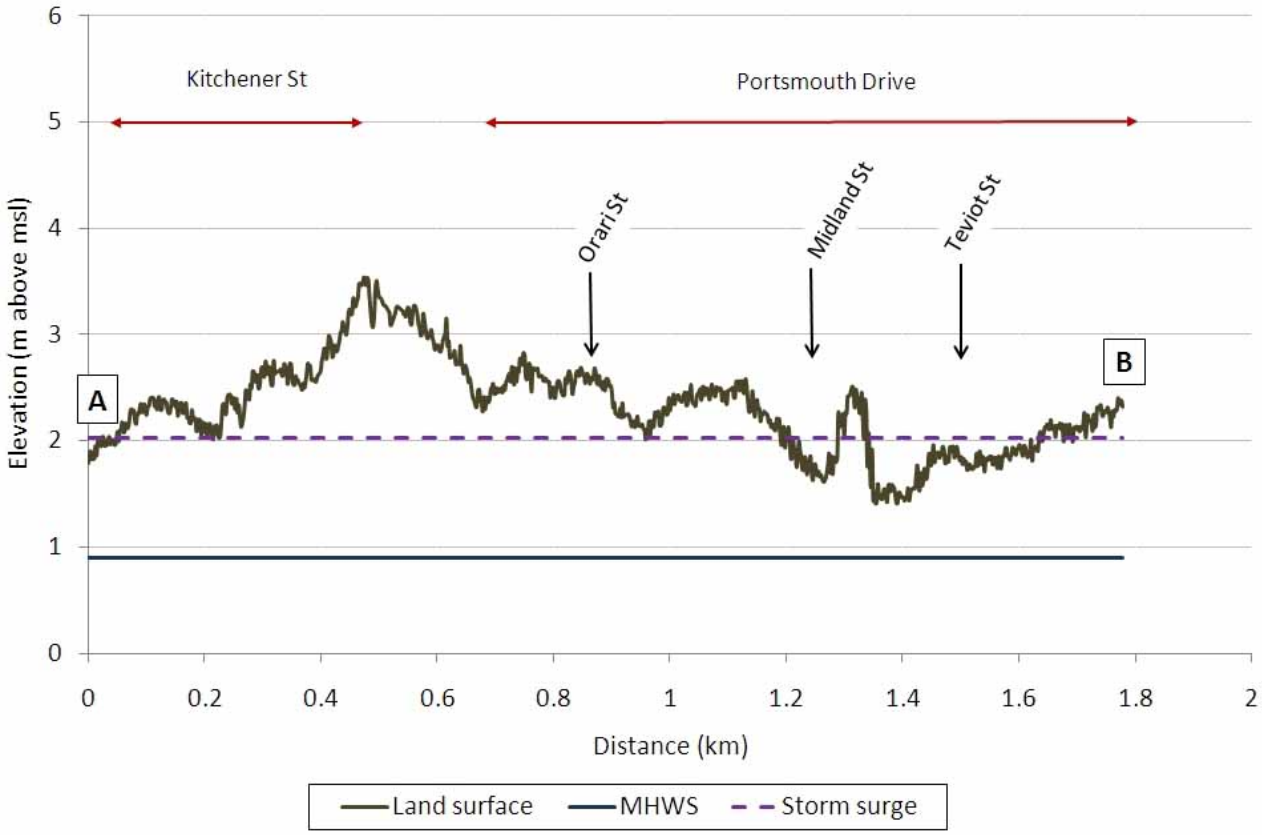

Figure A76. Cross section A-B along Kitchener Street and Portsmouth Drive. The current level of MHWS and the maximum level of a 1:500-year storm surge event are also shown

10. Long Beach, Purakanui, Aramoana and Harwood

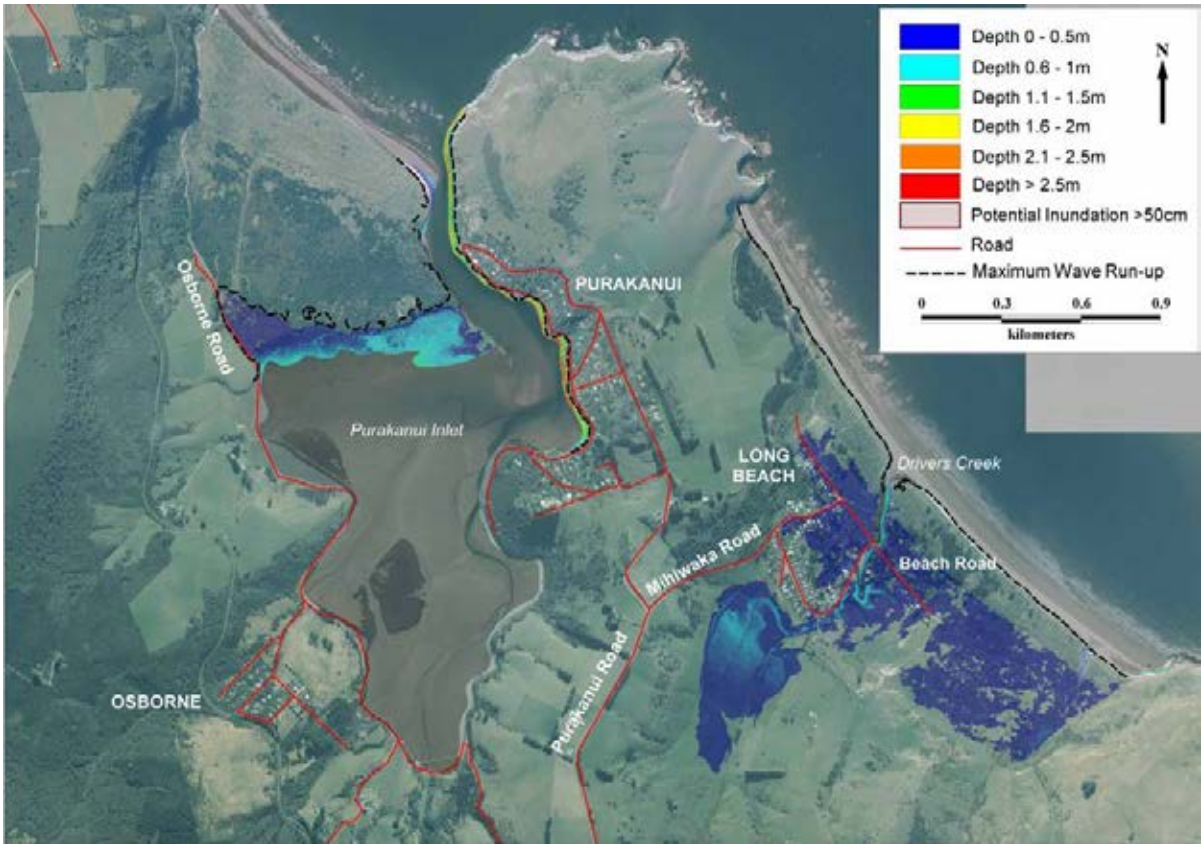

Figure A77. Maximum water depth for inundated land at Long Beach and Purakanui during the modelled 1:500-year extreme sea level event at MHWS

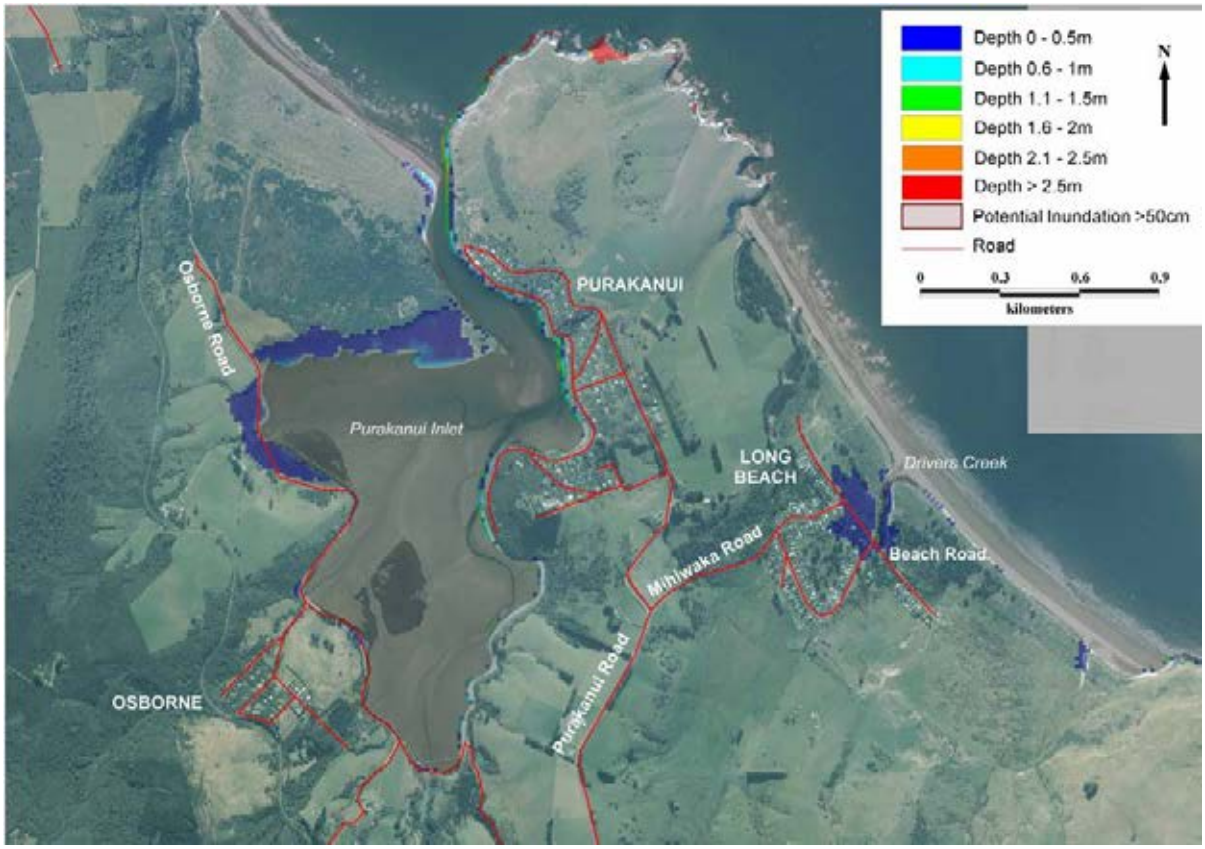

Figure A78. Maximum water depth for inundated land at Long Beach and Purakanui during the modelled 1:500-year South American tsunami at MHWS

Figure A79. Elevation map of the Aramoana area (height in metres above mean sea level)

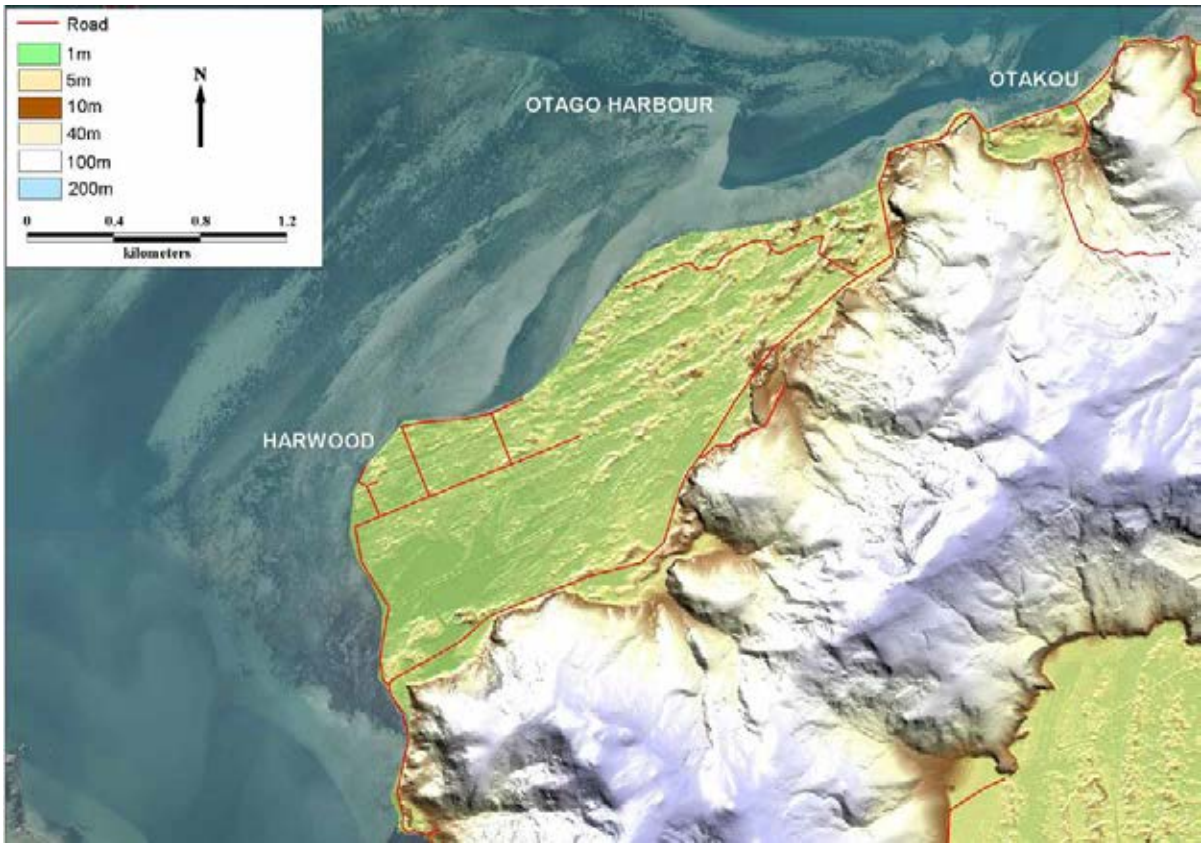

Figure A80. Elevation map of the Harwood area (height in metres above mean sea level)

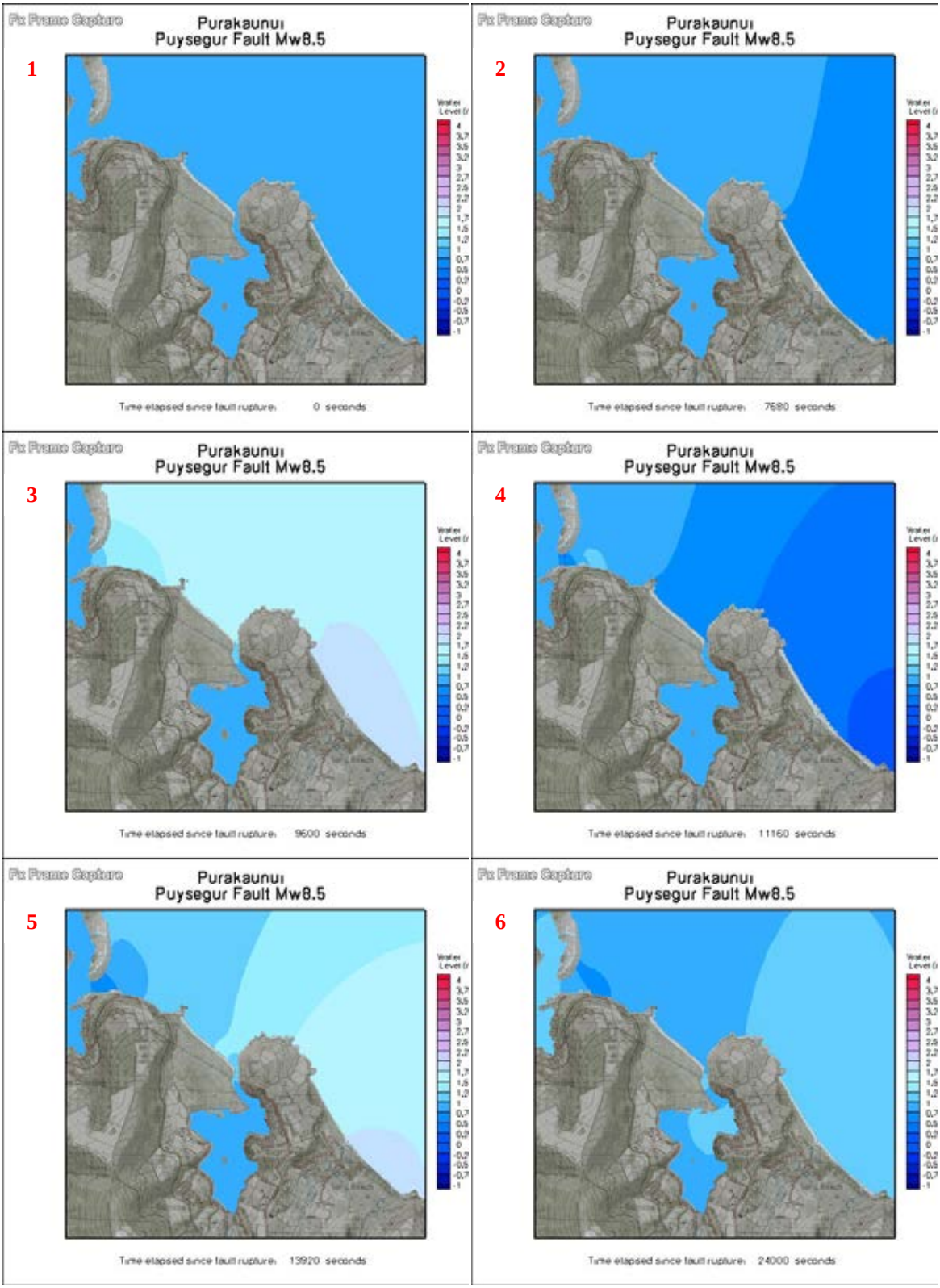

Figure A81. Time series showing changes in water level during the modelled Puysegur Fault tsunami at Long Beach and Purakanui

1 At fault rupture: The undisturbed level of the sea is at MHWS (0.9m)
2 2 hours 8 mins after the earthquake: The first retreat of waves occurs.
3 2 hours 40 mins: The first wave peaks at Long Beach occur.
4 3 hours 6 mins: The ocean retreats.
5 3 hours 52 mins: Another wave impacts the Long Beach coast.
6 6 hours 40 mins: Waves and strong currents are still impacting the area.

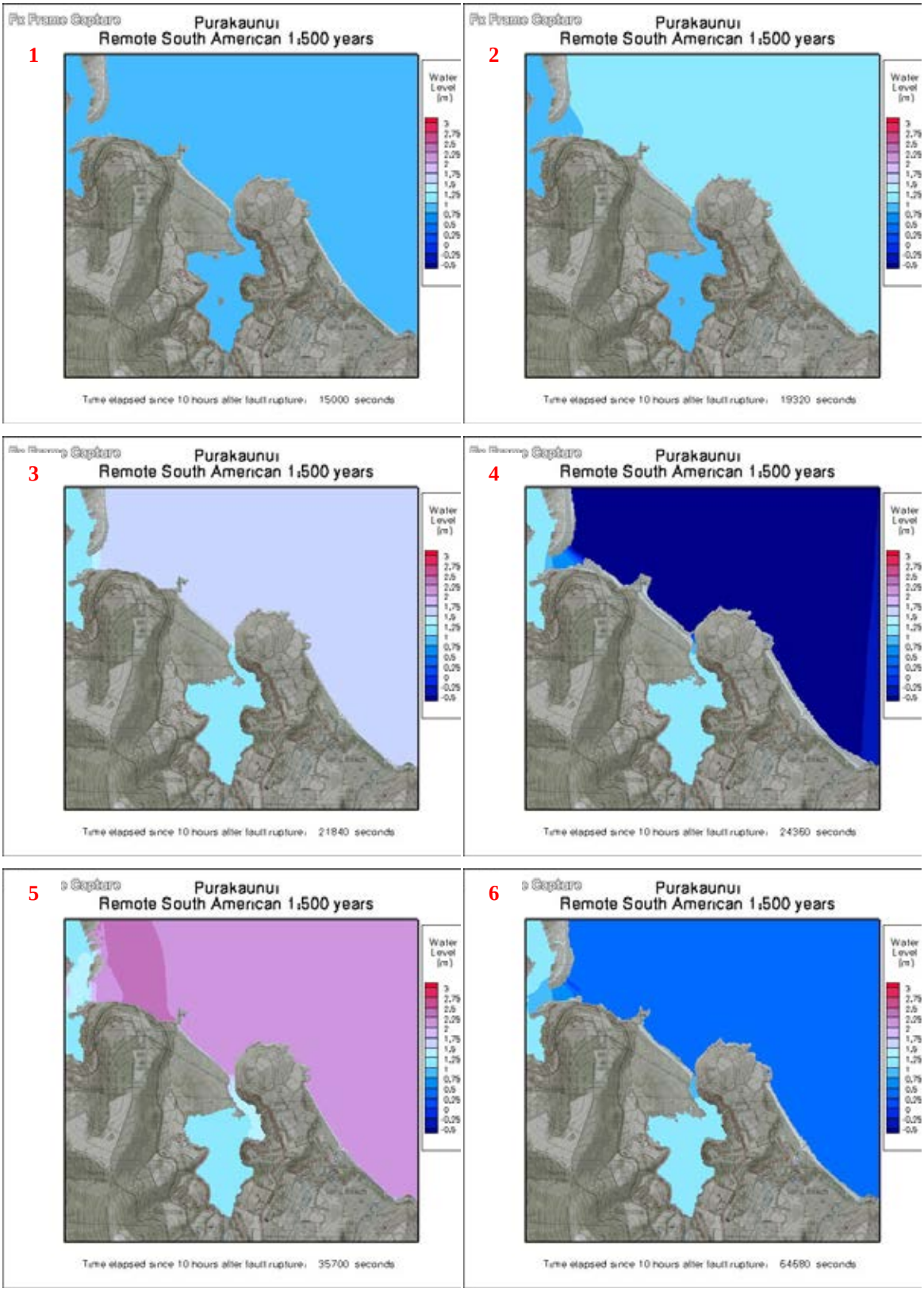

Figure A82. Time series showing changes in water level during the modelled 1:500-year South American tsunami at Long Beach and Purakanui

1 At fault rupture: The undisturbed level of the sea is at MHWS (0.9m).
2 15 hours 22 mins after earthquake: The first rise in sea level impacts the coast.
3 16 hours 4 mins: The first wave peaks along the coast.
4 18 hours 43 mins: The ocean retreats.
5 19 hours 55 mins: The largest modelled wave impacts the coast.
6 28 hours: Waves and strong currents still impact the coast.

Figure A83. Location of cross section A-B through Aramoana

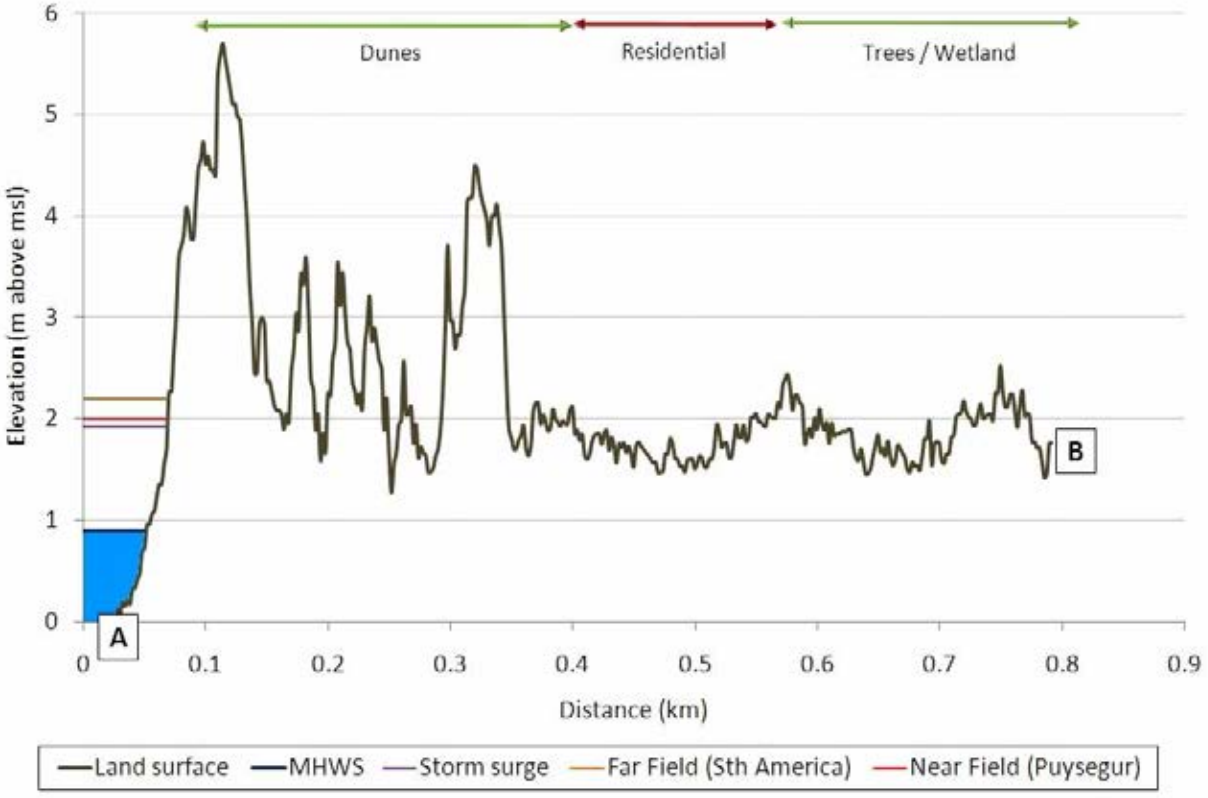

Figure A84. Cross section A-B through Aramoana, showing the greatest extent of run-up at the coast from 1:500-year South American and 1:600-year Puysegur tsunami, and a 1:500-year storm surge event

Figure A85. Location of cross section A-B through Long Beach

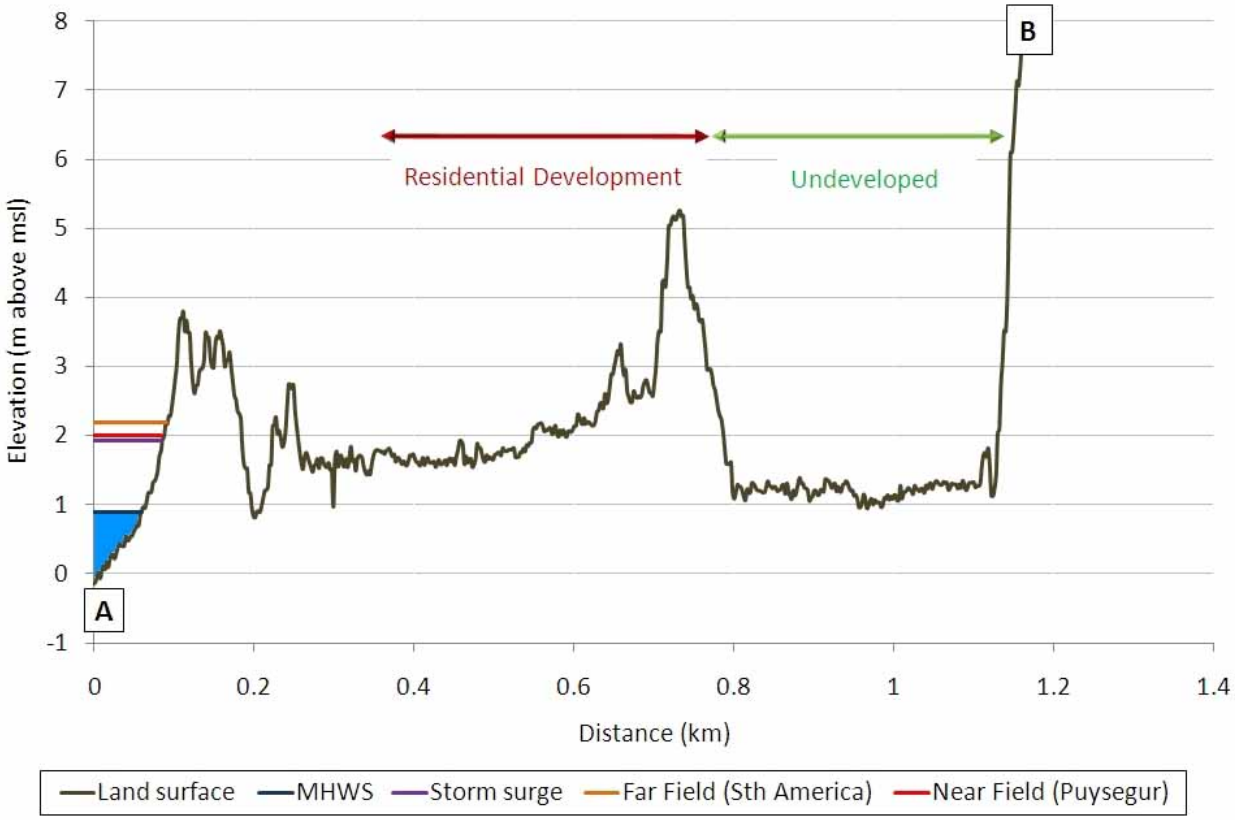

Figure A86. Cross section A-B through Long Beach, showing the greatest extent of run-up at the coast from 1:500-year South American and 1:600-year Puysegur tsunami, and a 1:500-year storm surge event

11. Warrington and Blueskin Bay

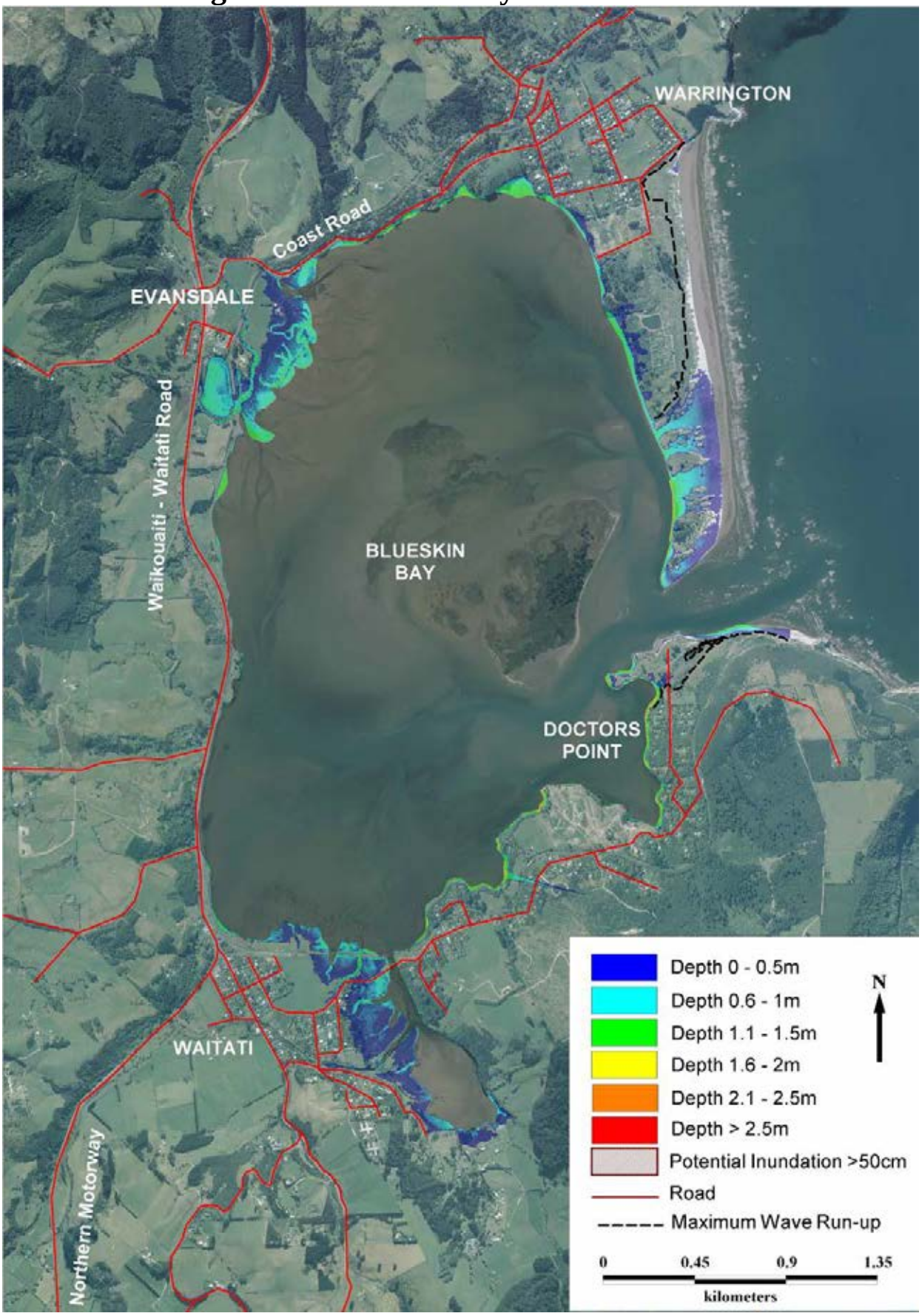

Figure A87. Maximum water depth for inundated land at Blueskin Bay during a 1:500-year elevated sea level event at MHWS

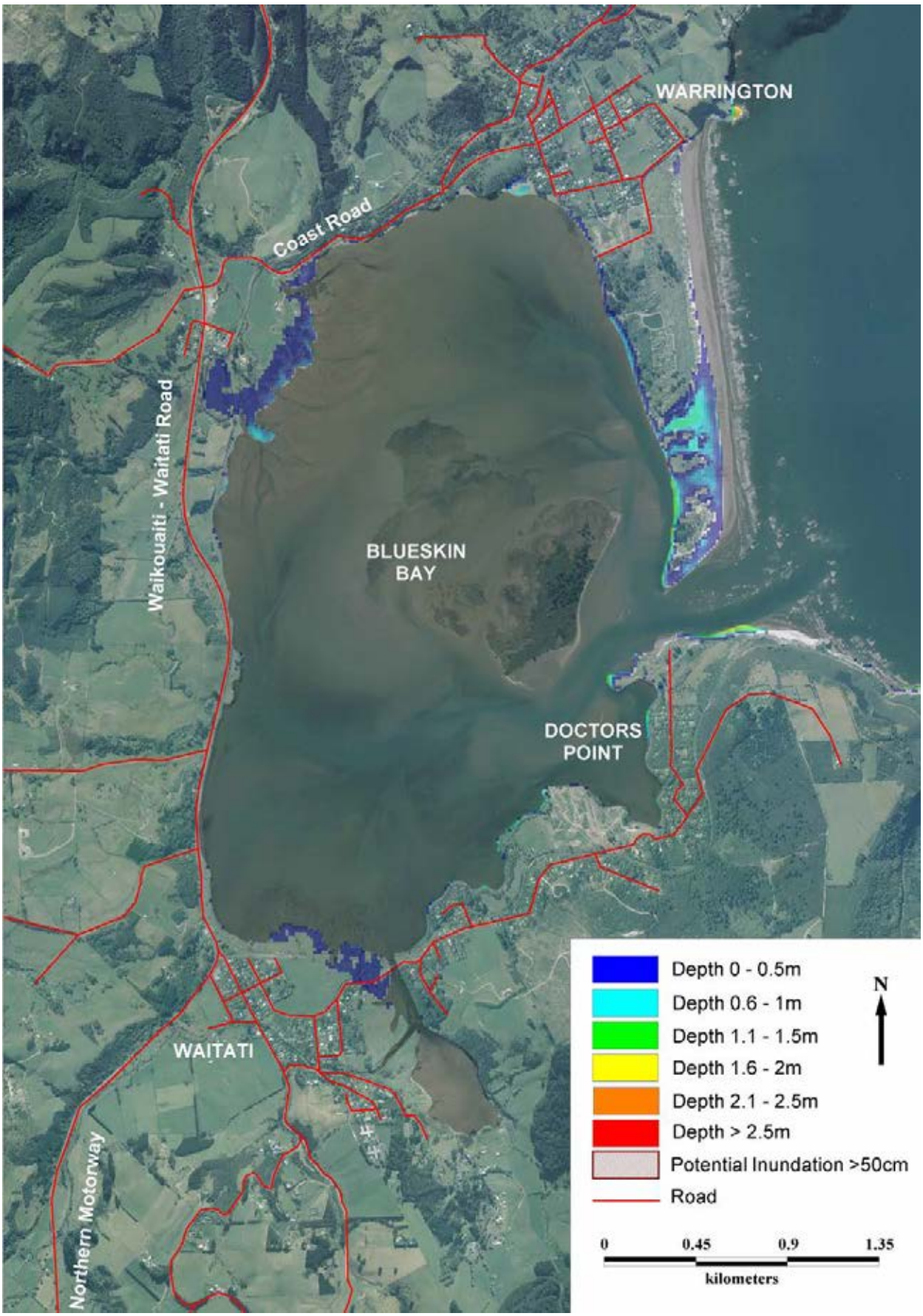

Figure A88. Maximum water depth for inundated land at Blueskin Bay during the modelled 1:500-year South American tsunami at MHWS

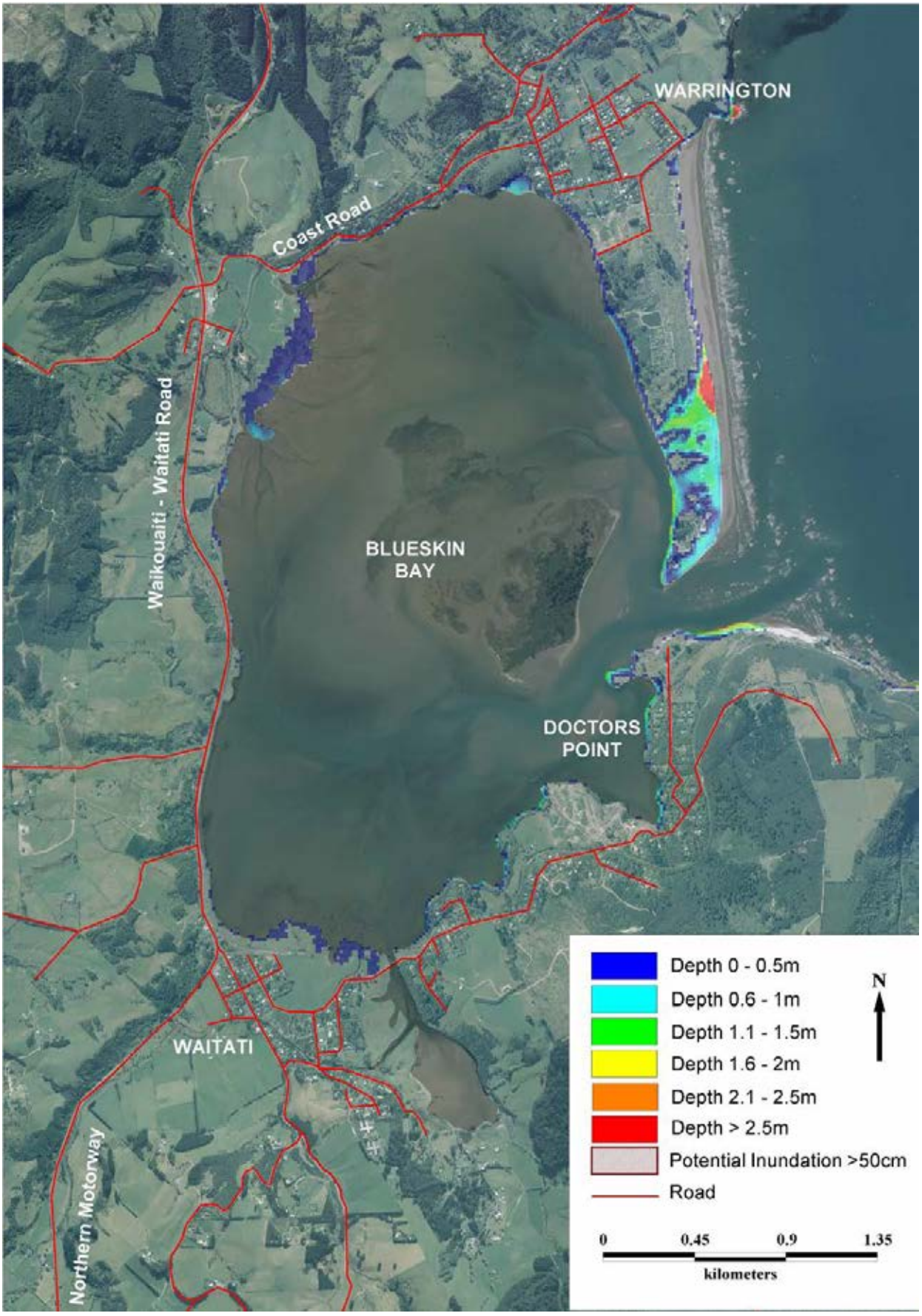

Figure A89. Maximum water depth for inundated land at Blueskin Bay during a Puysegur tsunami at MHWS

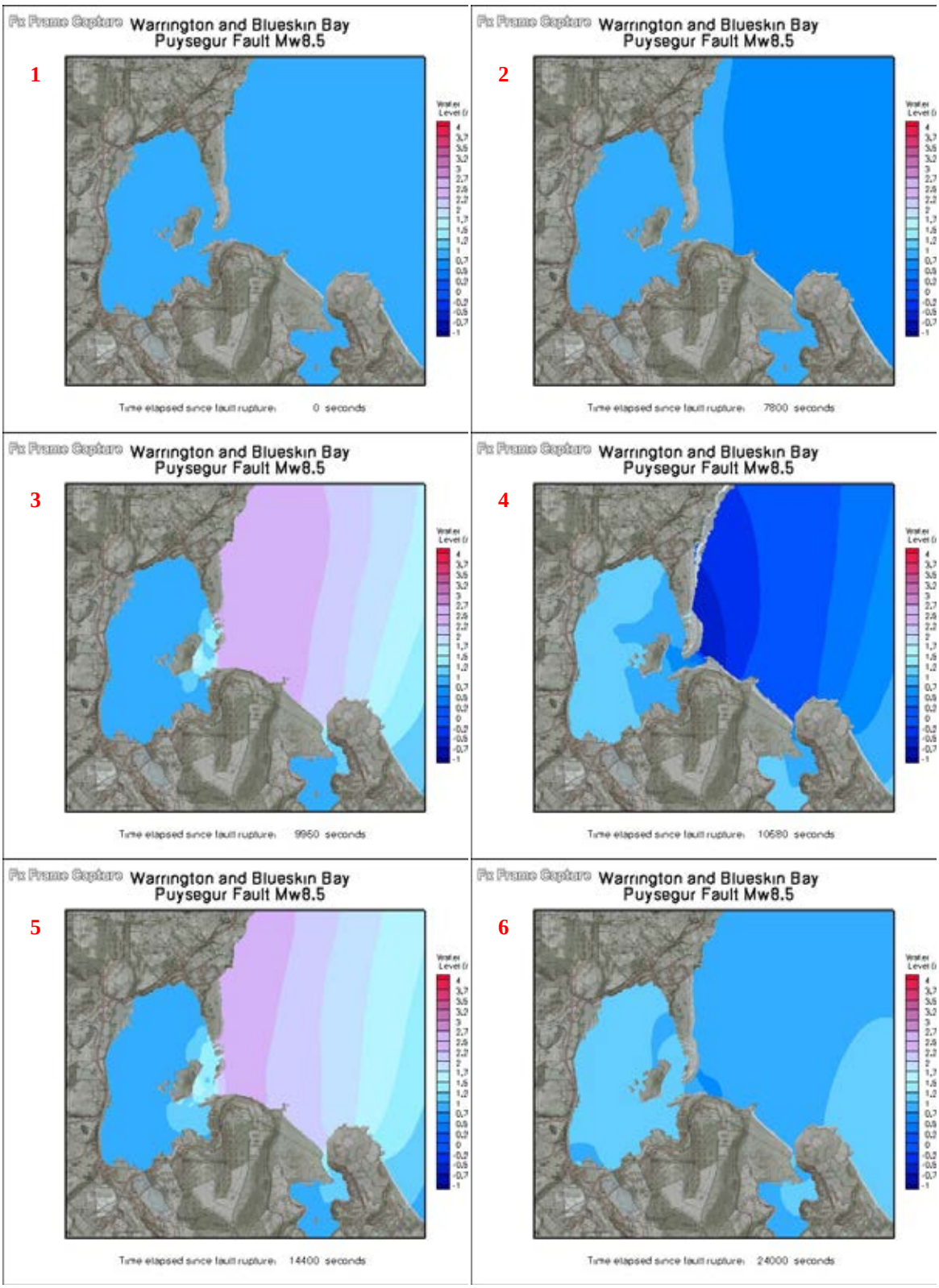

Figure A90. Time series showing changes in water level during the modelled Puysegur Fault tsunami at Blueskin Bay

1 At fault rupture: The undisturbed level of the sea is at MHWS (0.9m).
2 2 hours 10 mins after earthquake: The first retreat of sea level occurs.
3 2 hours 46 mins: The first wave peaks at Blueskin Bay.
4 2 hours 58 mins: The ocean retreats considerably.
5 4 hours: Another wave impacts the coast.
6 6 hours 40 mins: Waves and strong currents are still impacting the area.

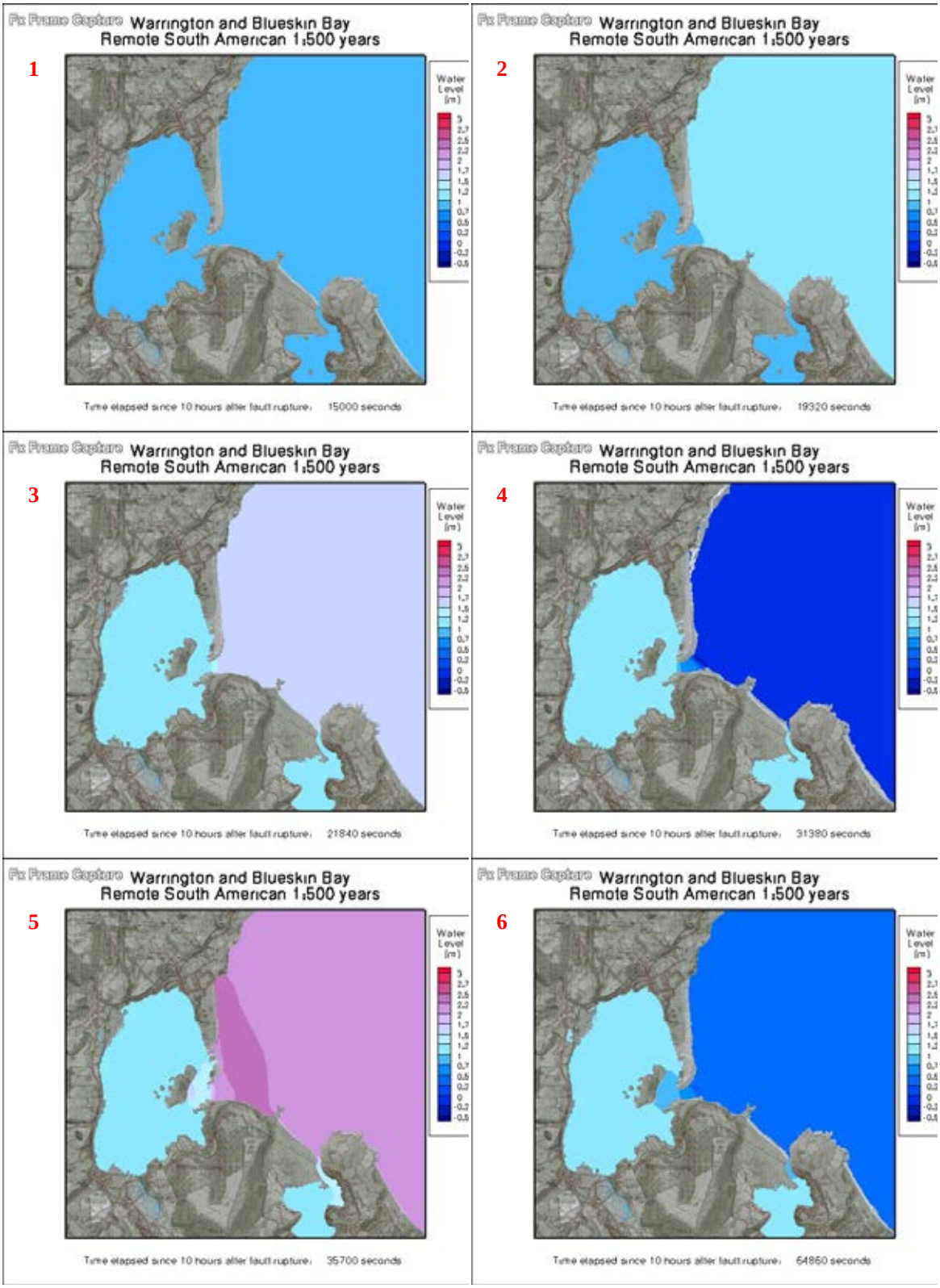

Figure A91. Time series showing changes in water level during the modelled 1:500-year South American tsunami at Blueskin Bay

1 At fault rupture: The undisturbed level of the sea is at MHWS (0.9m).
2 15 hours 22 mins after earthquake: The first rise in sea level impacts the coast.
3 16 hours 4 mins: The first wave peaks along the coast.
4 18 hours 43 mins: The ocean retreats.
5 19 hours 55 mins: The largest modelled wave impacts the coast.
6 28 hours: Waves and strong currents still impact the coast.

12. Karitane and Waikouaiti

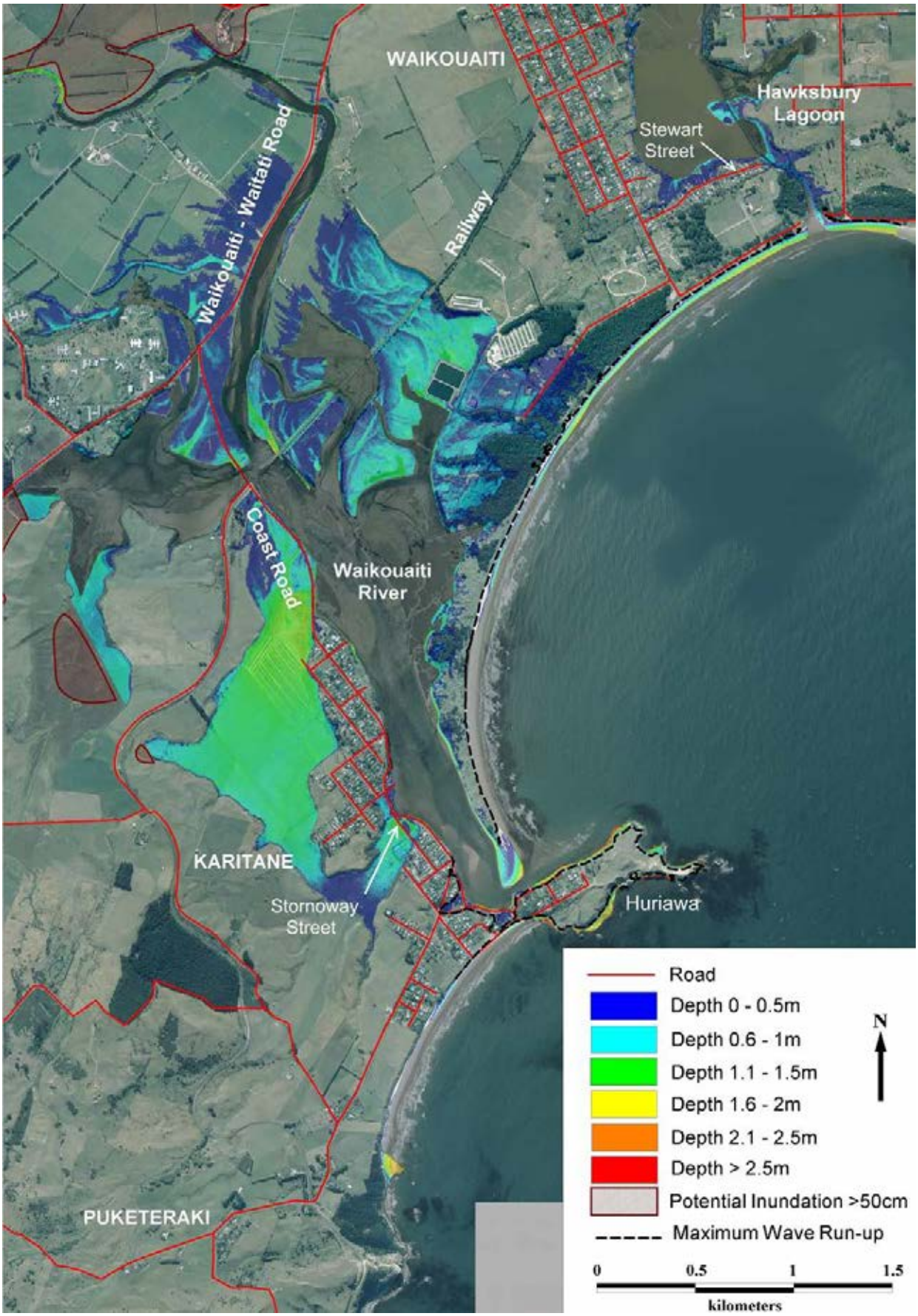

Figure A92. Maximum water depth for inundated land at Karitane and Waikouaiti during a 1:500-year extreme sea level event at MHWS

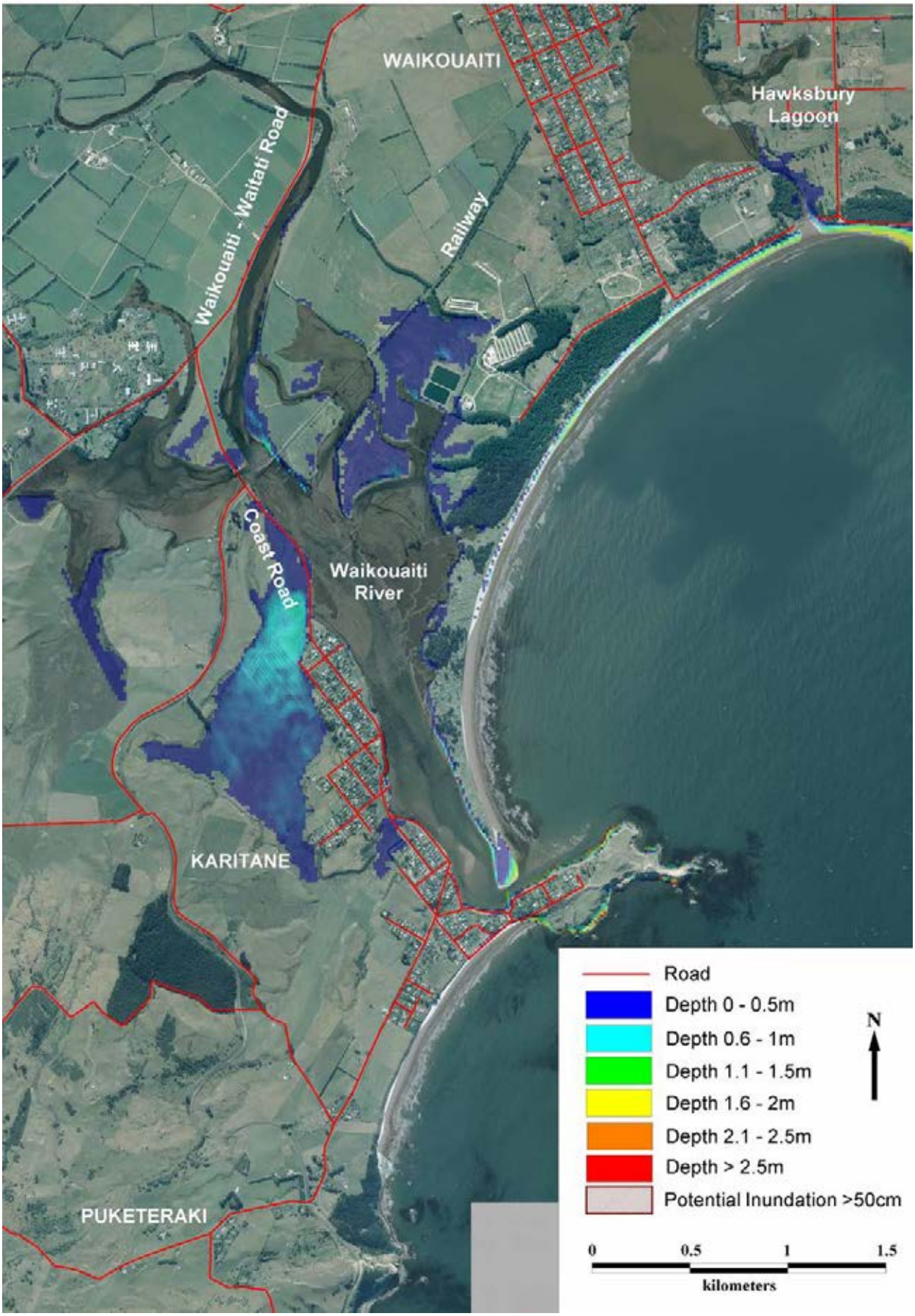

Figure A93. **Maximum water depth for inundated land at Karitane and Waikouaiti during the modelled 1:500-year South American tsunami at MHWS**

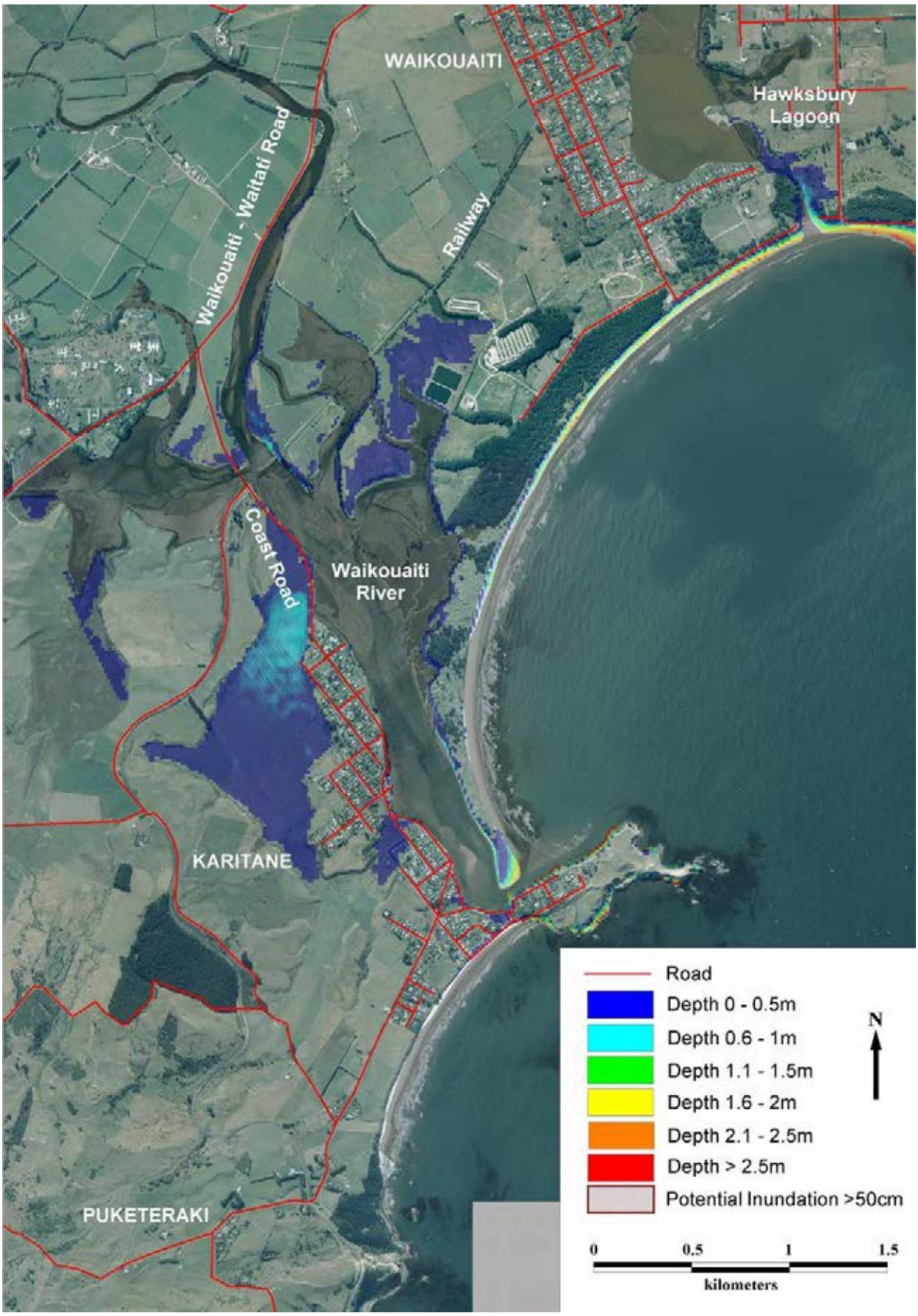

Figure A94. Maximum water depth for inundated land at Karitane and Waikouaiti during a Puysegur tsunami at MHWS

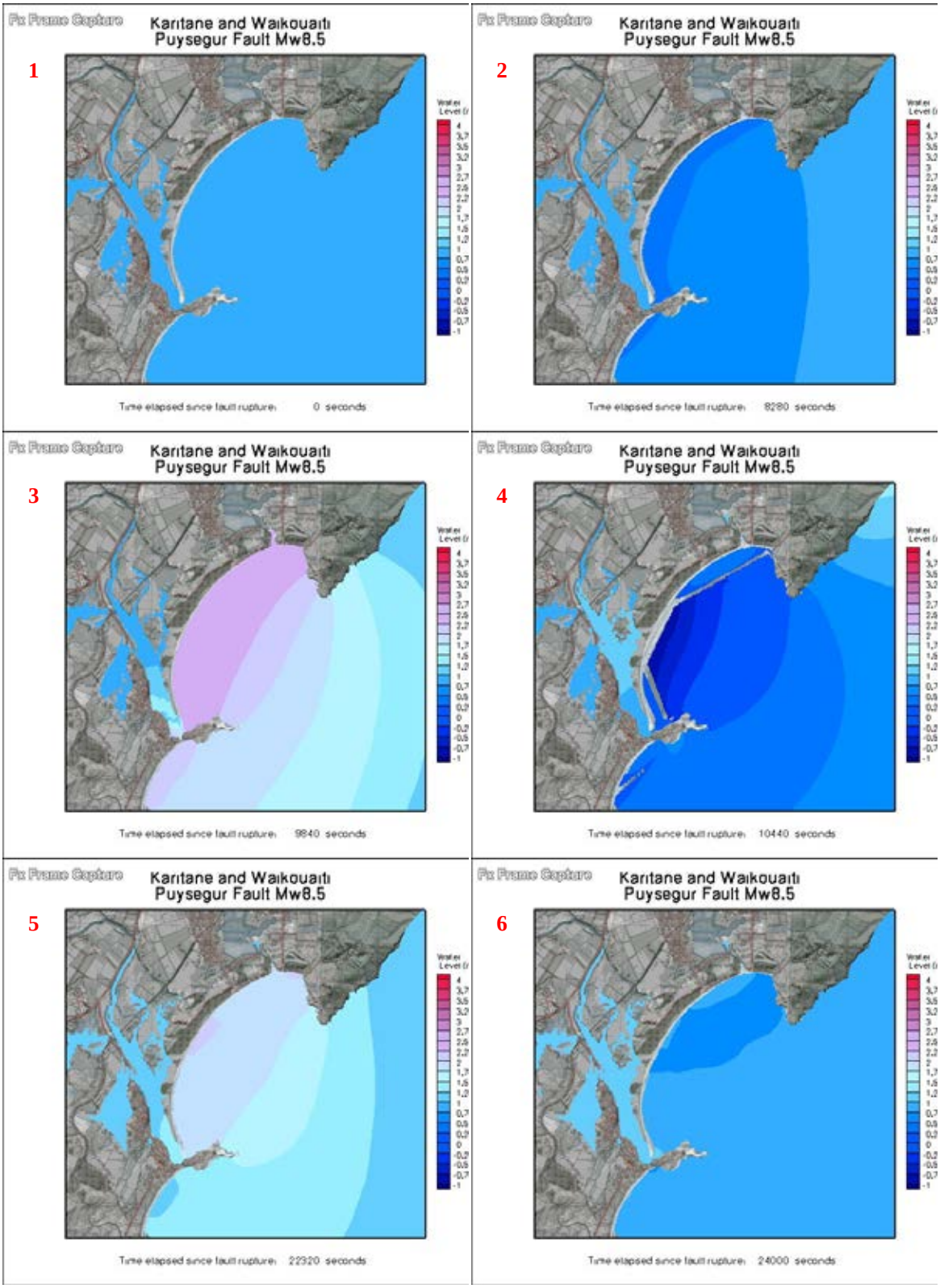

Figure A95. Time series showing changes in water level during the modelled Puysegur Fault tsunami at Karitane and Waikouaiti

1 At fault rupture: The undisturbed level of the sea is at MHWS (0.9m).
2 2 hours 18 mins after earthquake: The first retreat of sea level occurs.
3 2 hours 44 mins: The first wave peaks at Karitane Estuary.
4 2 hours 54 mins: The ocean retreats considerably.
5 5 hours 12 mins: Waves are still impacting the coast.
6 6 hours 40 mins: Waves and strong currents are still impacting the area.

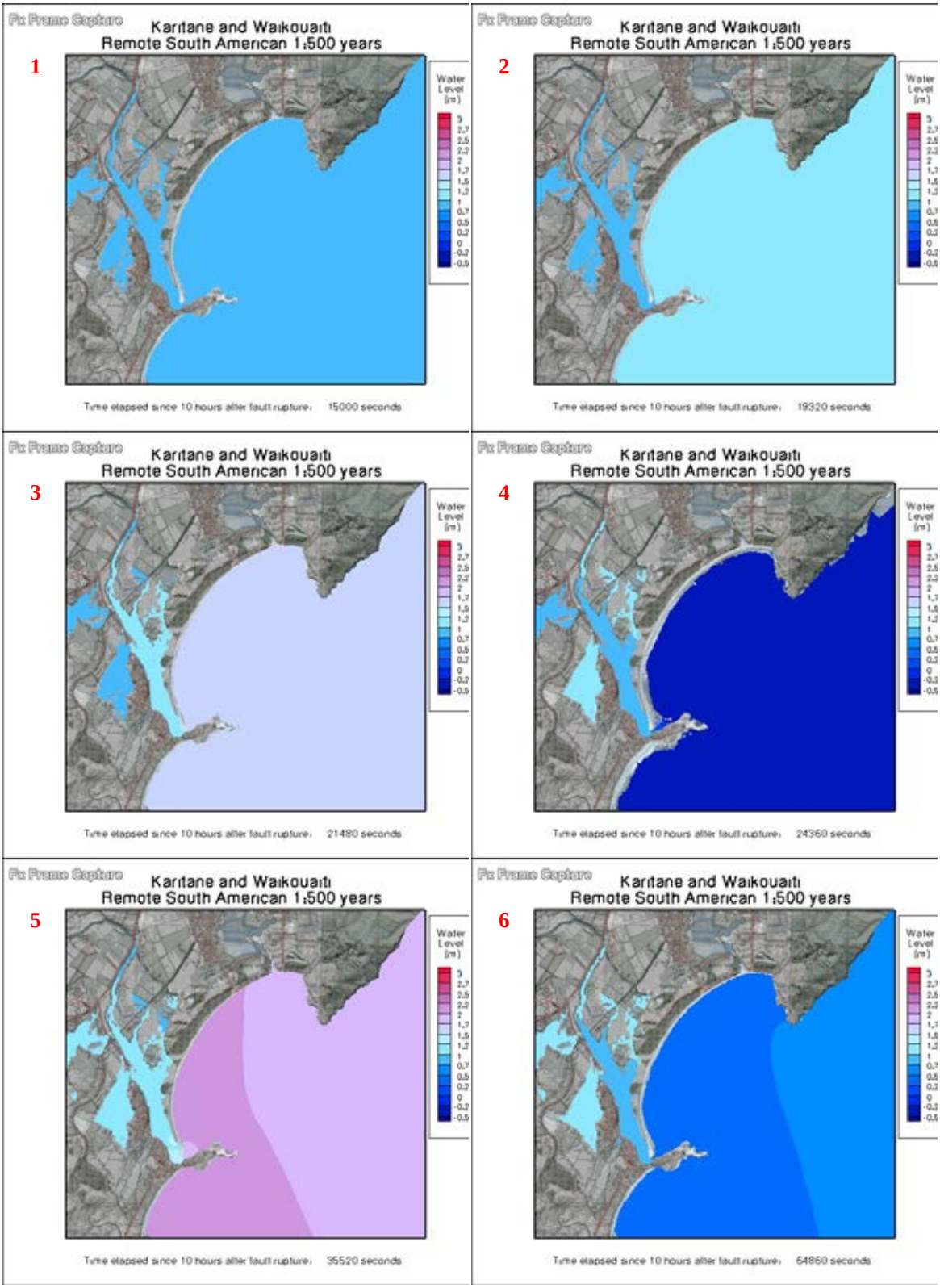

Figure A96. Time series showing changes in water level during the modelled 1:500-year South American tsunami at Karitane and Waikouaiti

1 At fault rupture: The undisturbed level of the sea is at MHWS (0.9m).
2 15 hours 22 mins after earthquake: The first rise in sea level impacts the coast.
3 15 hours 58 mins: The first wave peaks along the coast.
4 16 hours 46 mins: The ocean retreats.
5 19 hours 52 mins: The largest modelled wave impacts the coast.
6 28 hours: Waves and strong currents still impact the coast.

Figure A97. Location of cross section A-B through Karitane

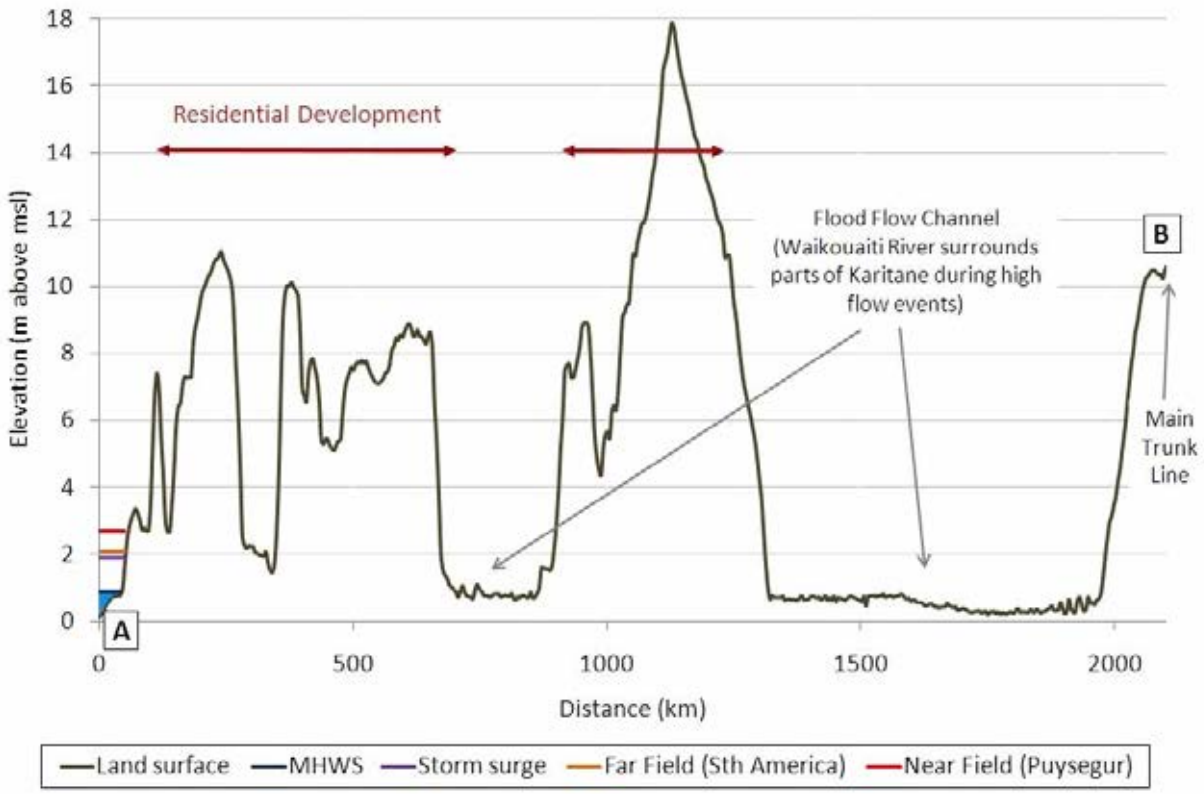

Figure A98. Cross section A-B through Karitane, showing the greatest extent of run-up at the coast from 1:500-year South American and 1:600-year Puysegur tsunami, and a 1:500-year storm surge event

Figure A99. Location of cross section A-B through Waikouaiti

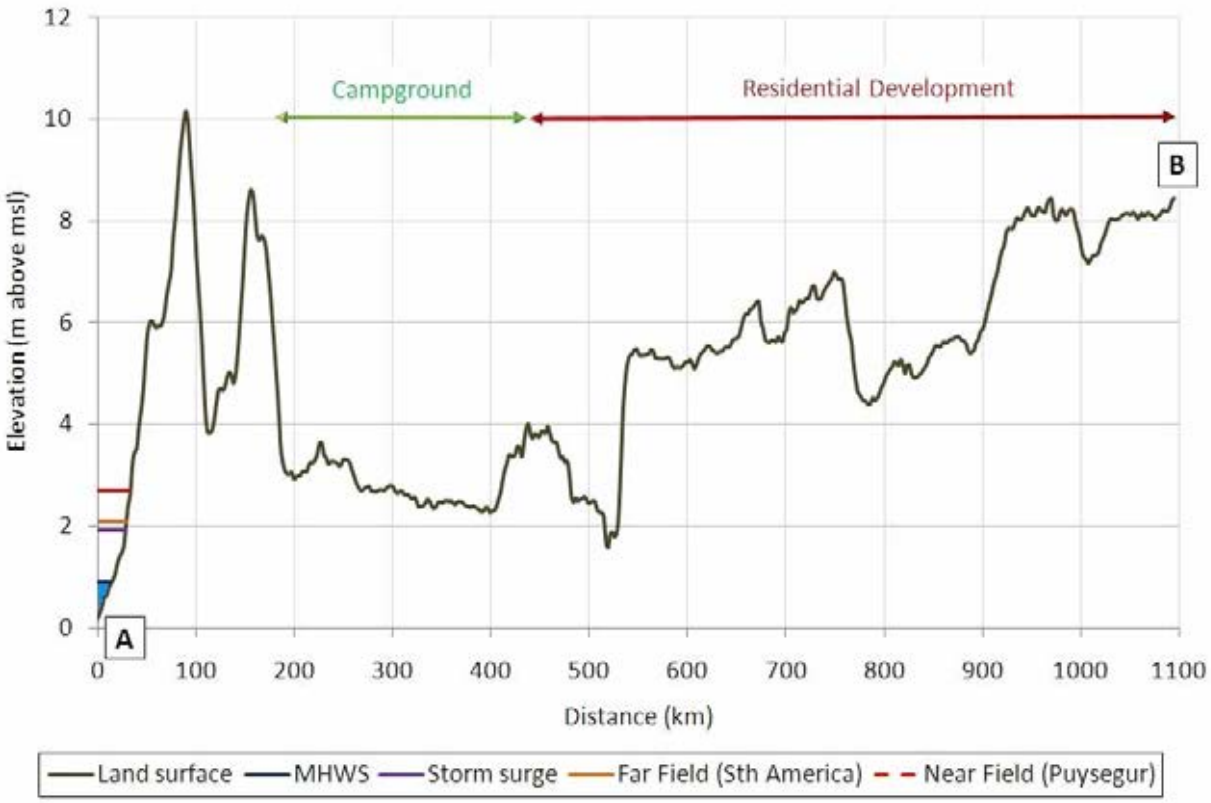

Figure A100. Cross section A-B through Waikouaiti, showing the greatest extent of run-up at the coast from 1:500-year South American and 1:600-year Puysegur tsunami, and a 1:500-year storm surge event

13. Taranui and Kakanui

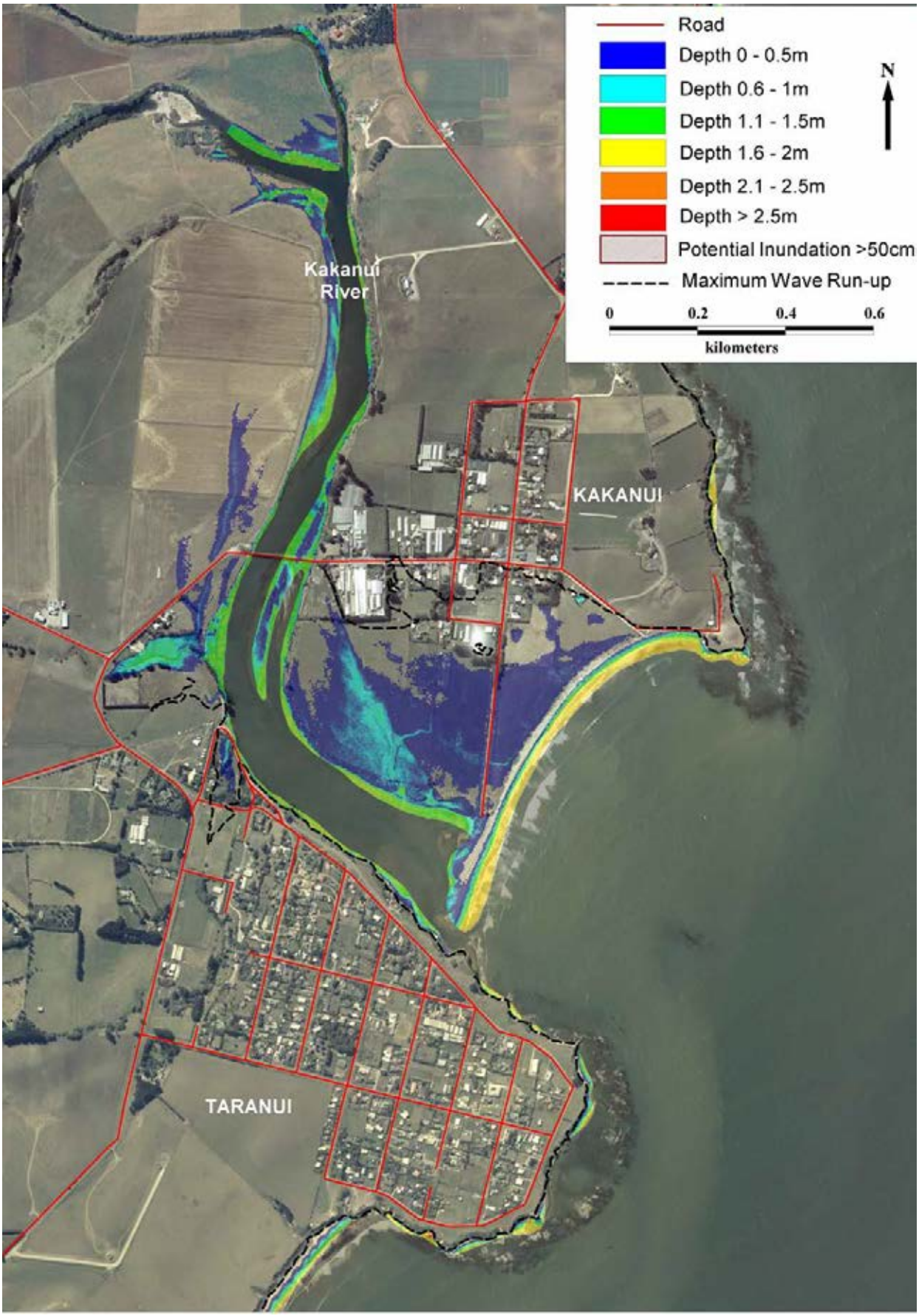

Figure A101. Maximum water depth for inundated land at Kakanui during a 1:500-year elevated sea level event at MHWS

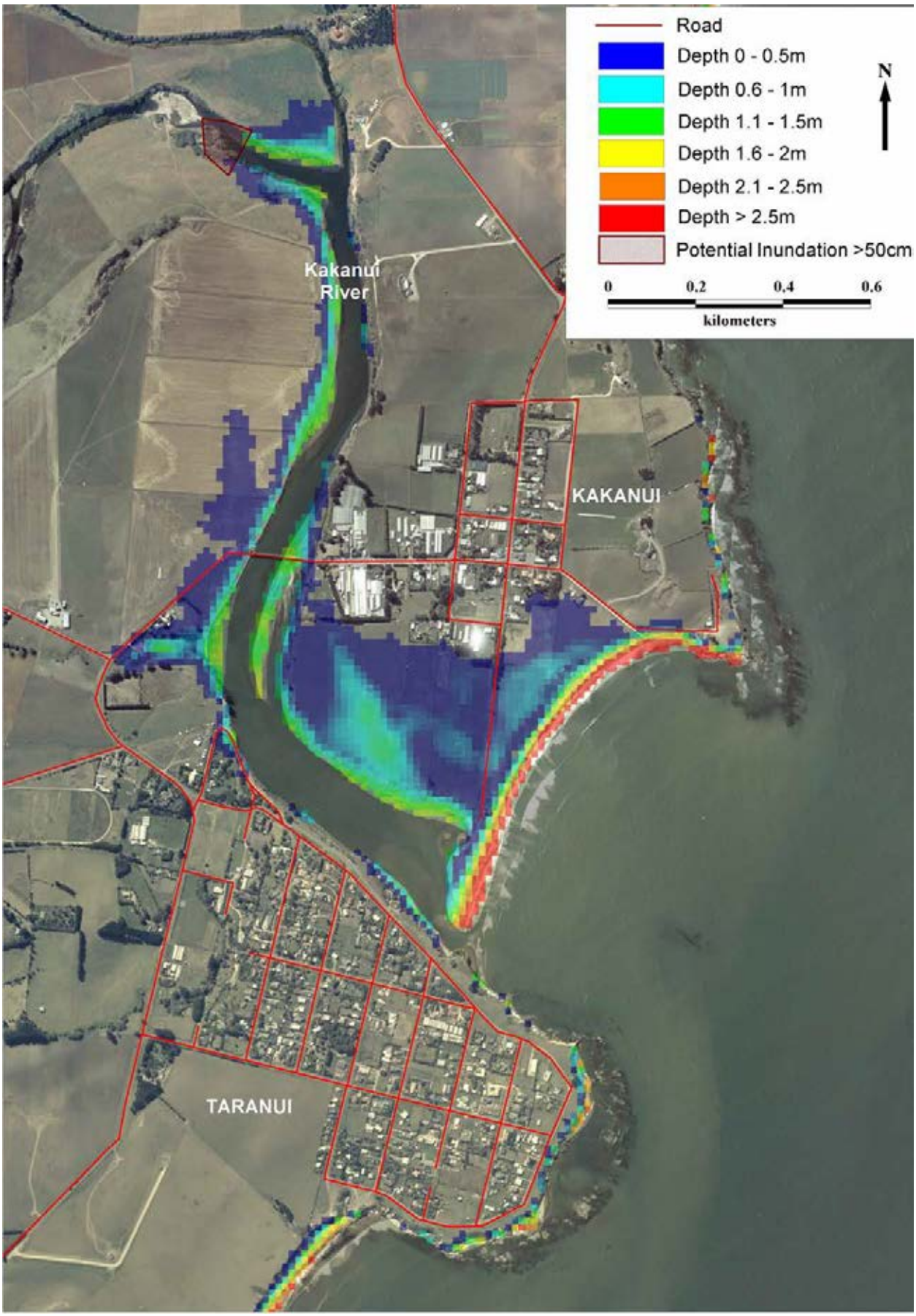

Figure A102. Maximum water depth for inundated land at Kakanui during the modelled 1:500-year South American tsunami at MHWS

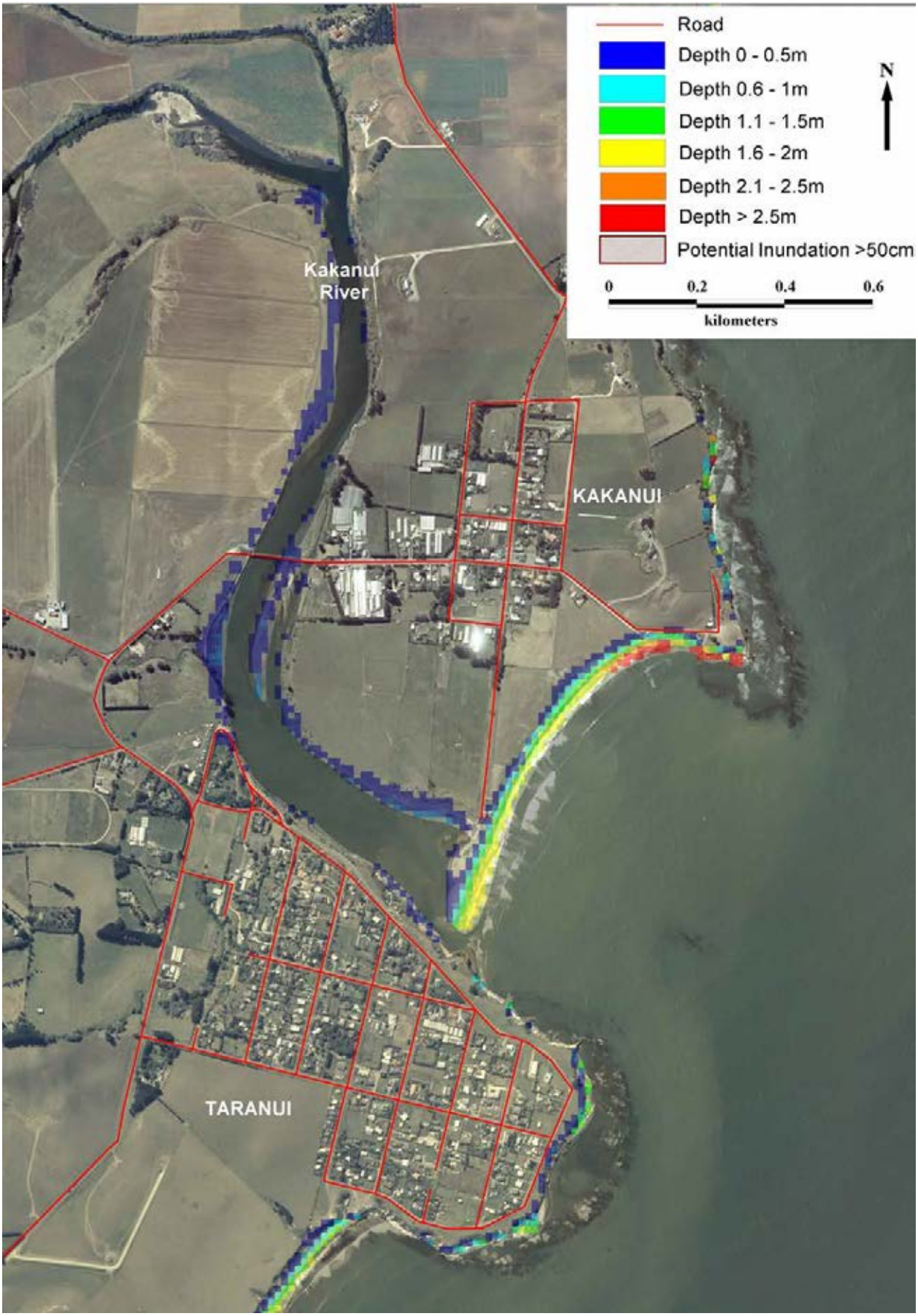

Figure A103. Maximum water depth for inundated land at Kakanui during a Puysegur tsunami at MHWS

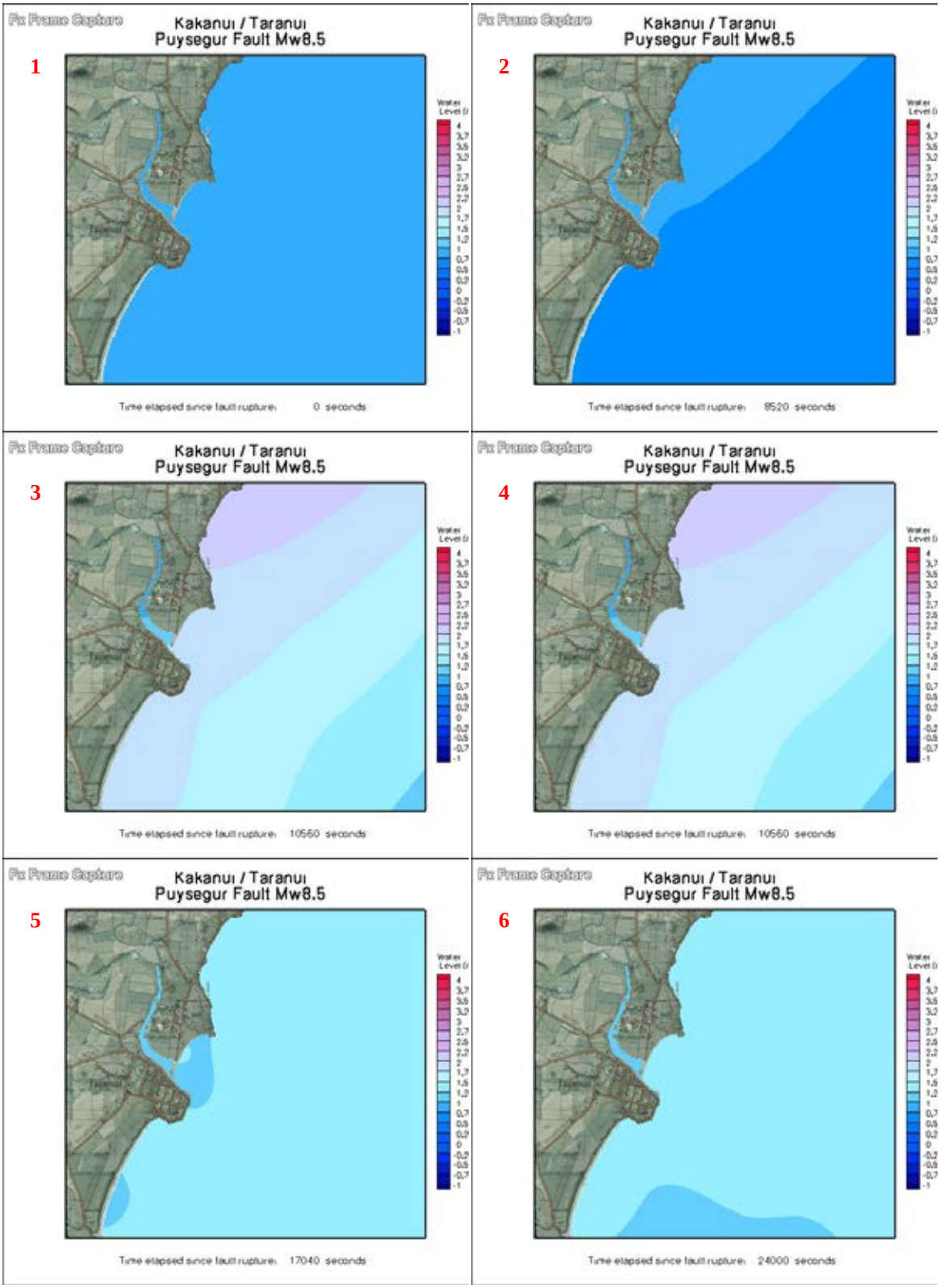

Figure A104. Time series showing changes in water level during the modelled Puysegur Fault tsunami at Kakanui

1 At fault rupture: The undisturbed level of the sea is at MHWS (0.9m).
2 2 hours 22 mins after earthquake: The first retreat of sea level occurs.
3 2 hours 56 mins: The first wave peaks at Kakanui Estuary.
4 4 hours 8 mins: The ocean retreats.
5 4 hours 44 mins: Modelled waves are still impacting the coast.
6 6 hours 40 mins: Waves and strong currents are still impacting the area.

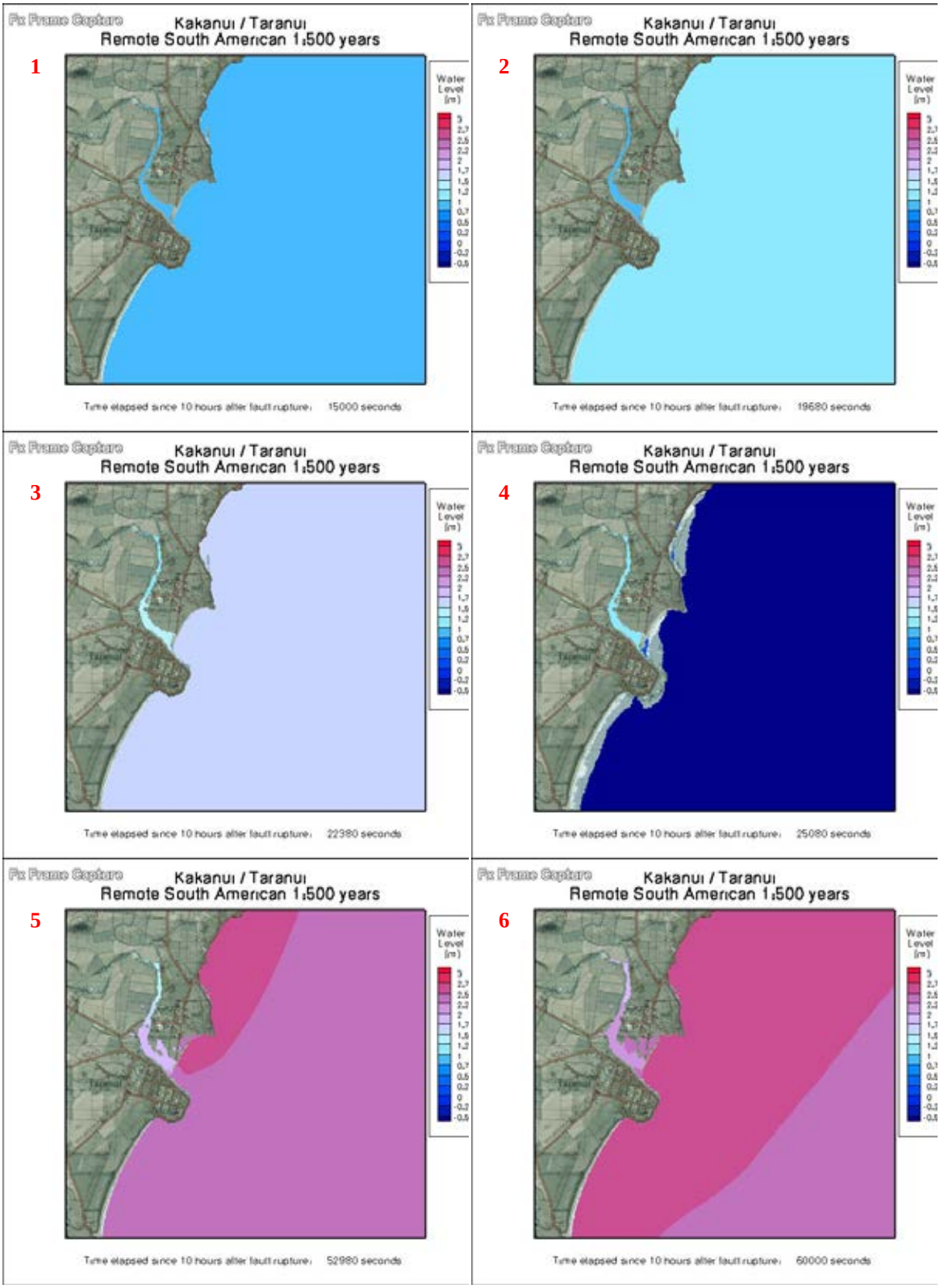

Figure A105. Time series showing changes in water level during the modelled 1:500-year South American tsunami at Kakanui

1 At fault rupture: The undisturbed level of the sea is at MHWS (0.9m).
2 15 hours 28 mins after earthquake: The first rise in sea level impacts the coast.
3 16 hours 13 mins: The first wave peaks along the coast.
4 16 hours 58 mins: The ocean retreats.
5 24 hours 41 mins: A large wave impacts the coast.
6 26 hours 40 mins: The largest modelled wave impacts the coast.

14. Oamaru

Figure A106. Maximum water depth for inundated land at Oamaru during a 1:500-year elevated sea level event at MHWS

Figure A107. Maximum water depth for inundated land at Oamaru during the modelled 1:500-year South American tsunami at MHWS

Figure A108. Maximum water depth for inundated land at Oamaru during a Puysegur tsunami at MHWS

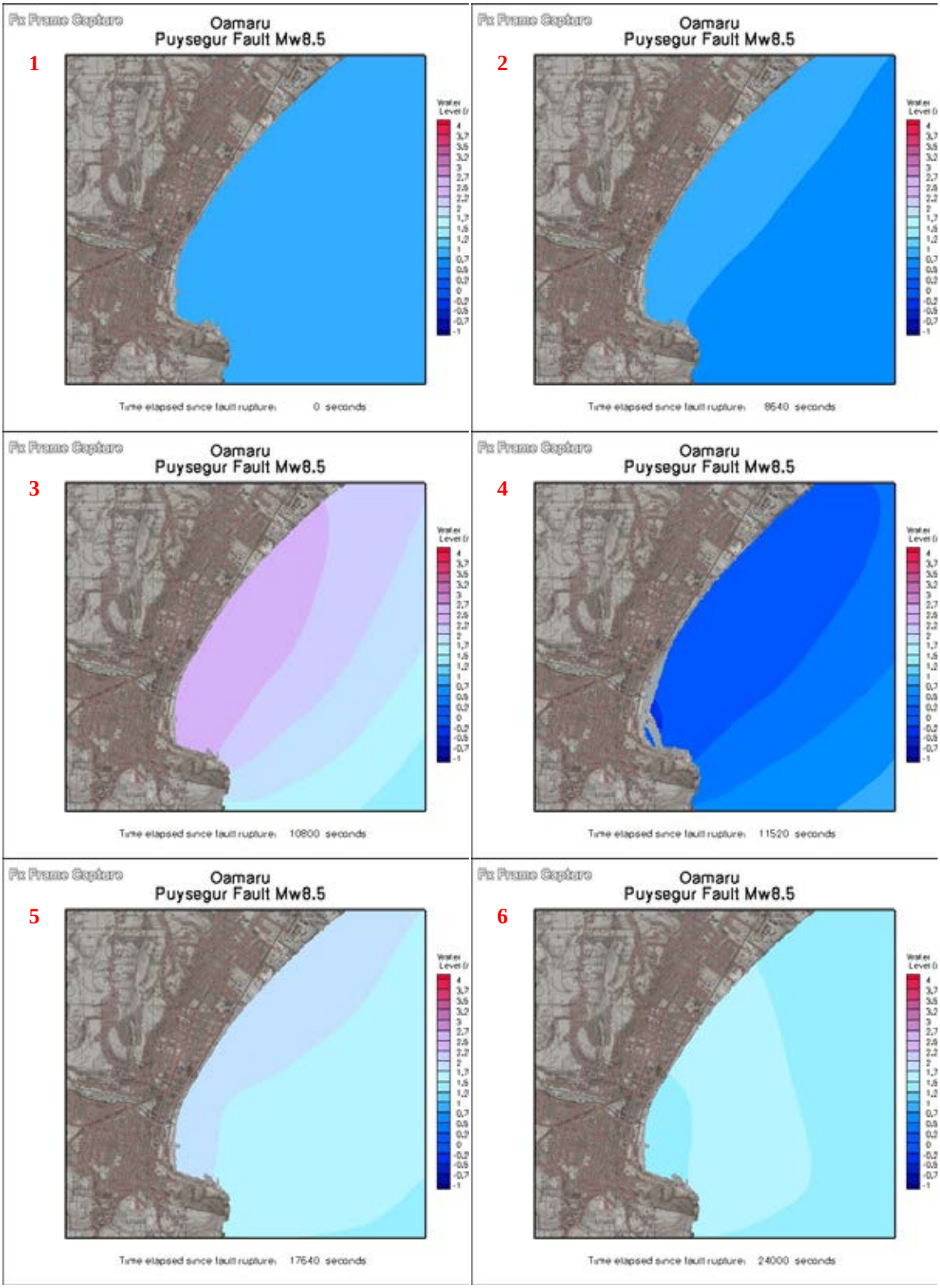

Figure A109. Time series showing changes in water level during the modelled Puysegur Fault tsunami at Oamaru

1 At fault rupture: The undisturbed level of the sea is at MHWS (0.9m).
2 2 hours 24 mins after earthquake: The first retreat of sea level occurs.
3 3 hours: The first wave peaks at Oamaru.
4 3 hours 12 mins: The ocean retreats.
5 4 hours 54 mins: Modelled waves are still impacting the coast.
6 6 hours 40 mins: Waves and strong currents are still impacting the area.

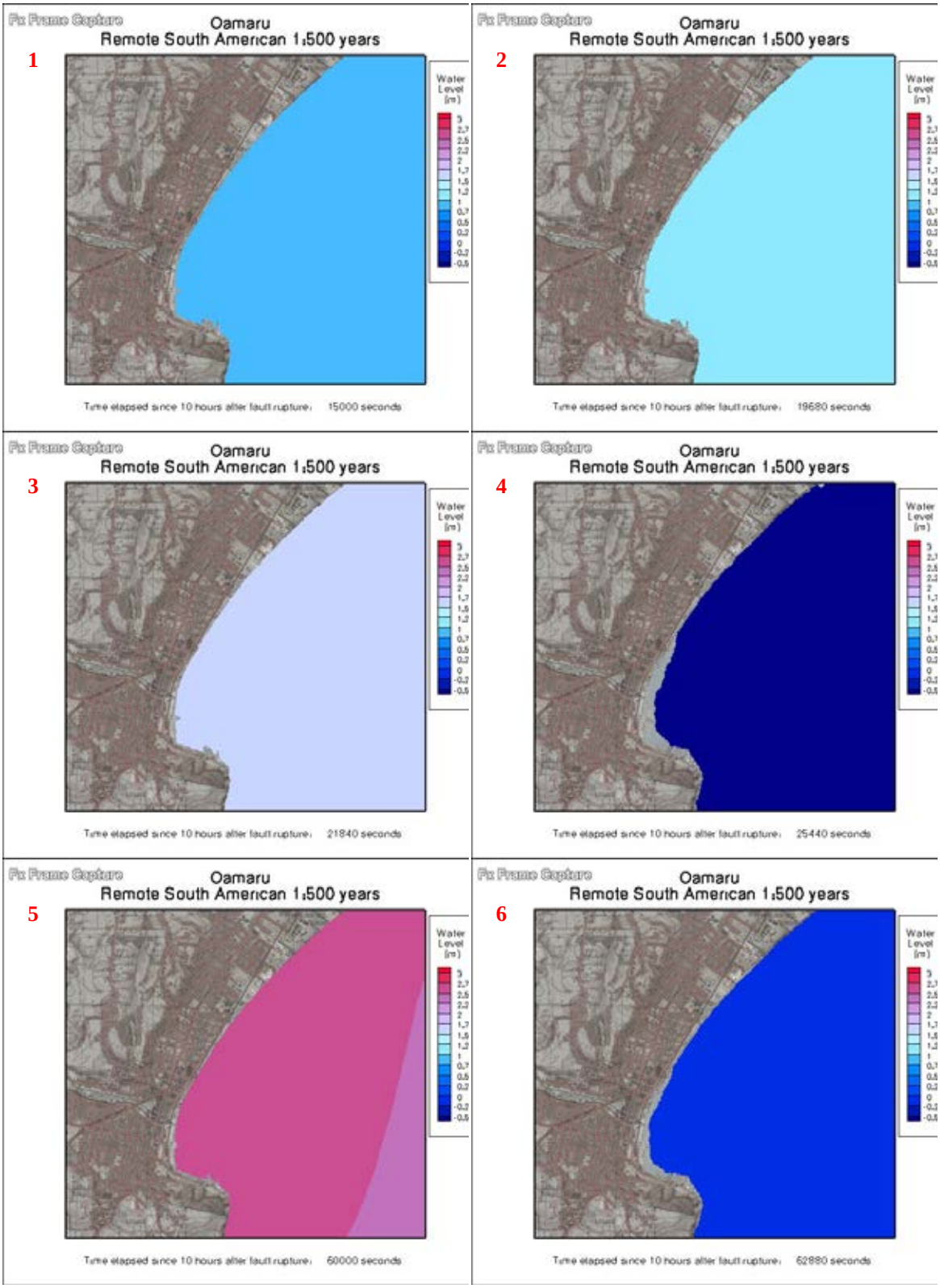

Figure A110. Time series showing changes in water level during the modelled 1:500-year South American tsunami at Oamaru

1 At fault rupture: The undisturbed level of the sea is at MHWS (0.9m).
2 15 hours 28 mins after earthquake: The first rise in sea level impacts the coast.
3 16 hours 4 mins: The first wave peaks along the coast.
4 17 hours 4 mins: The ocean retreats.
5 26 hours 40 mins: A large wave impacts the coast.
6 27 hours 28 mins: The ocean retreats.