School of Civil, Environmental and Mining Engineering

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Case study: Joint dependence of extreme rainfall and storm surge in the coastal zone

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Problem statement

- Flooding in the coastal zone may be due to a combination of:
  - catchment flows (forced by flood-producing rainfall and antecedent conditions, and affected by various catchment features)
  - ocean/estuary level (forced by astronomical tide and storm surge, and affected by local bathymetry)
- Guidance is needed on *methodology* on how to take interactions of the forcing variables into account

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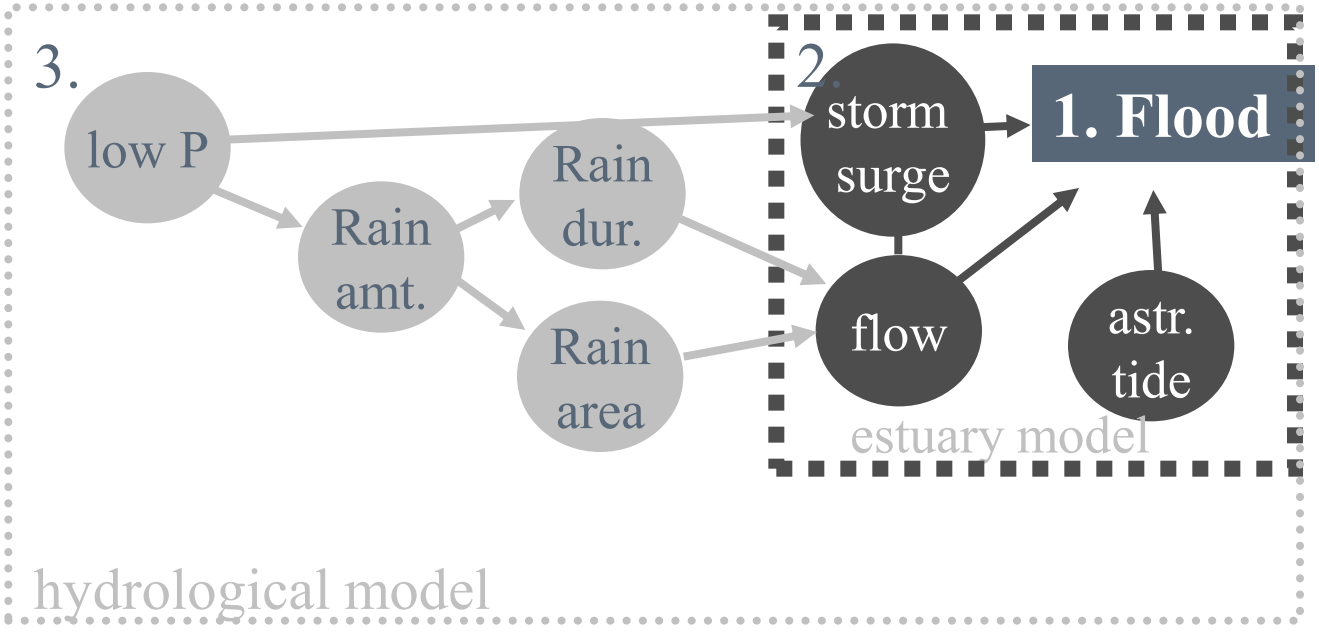
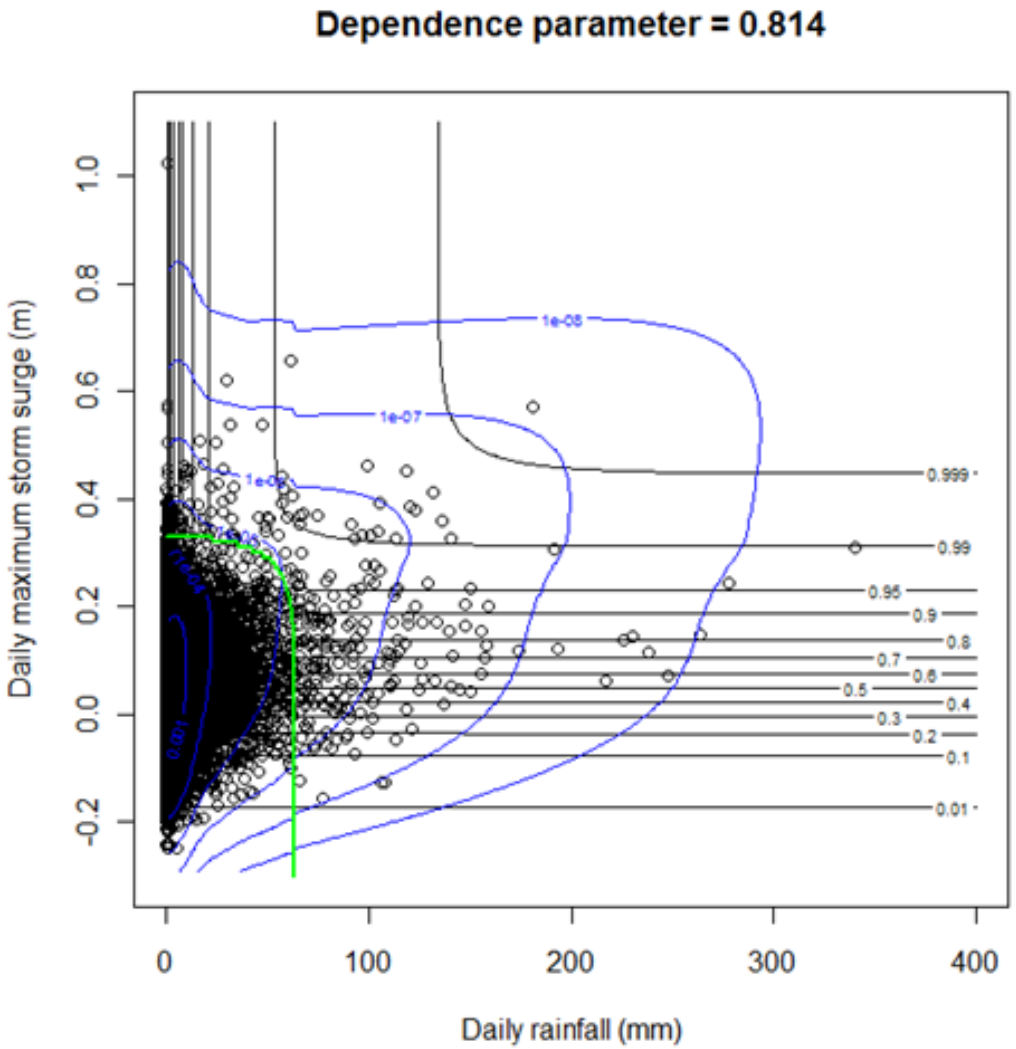
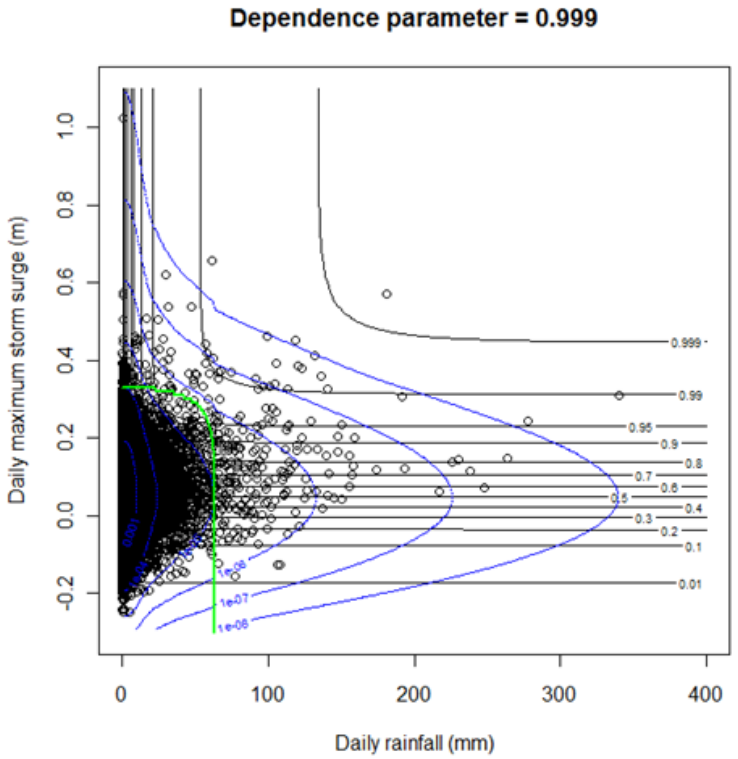
What are we modelling?

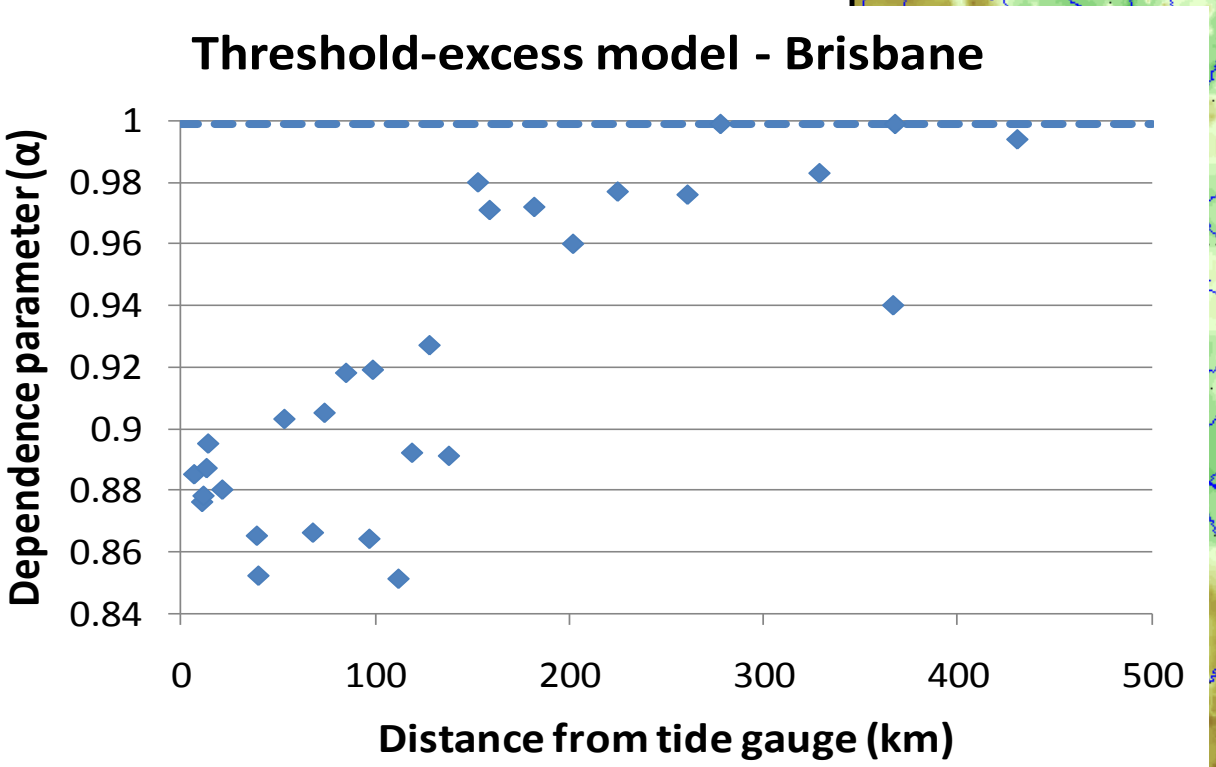


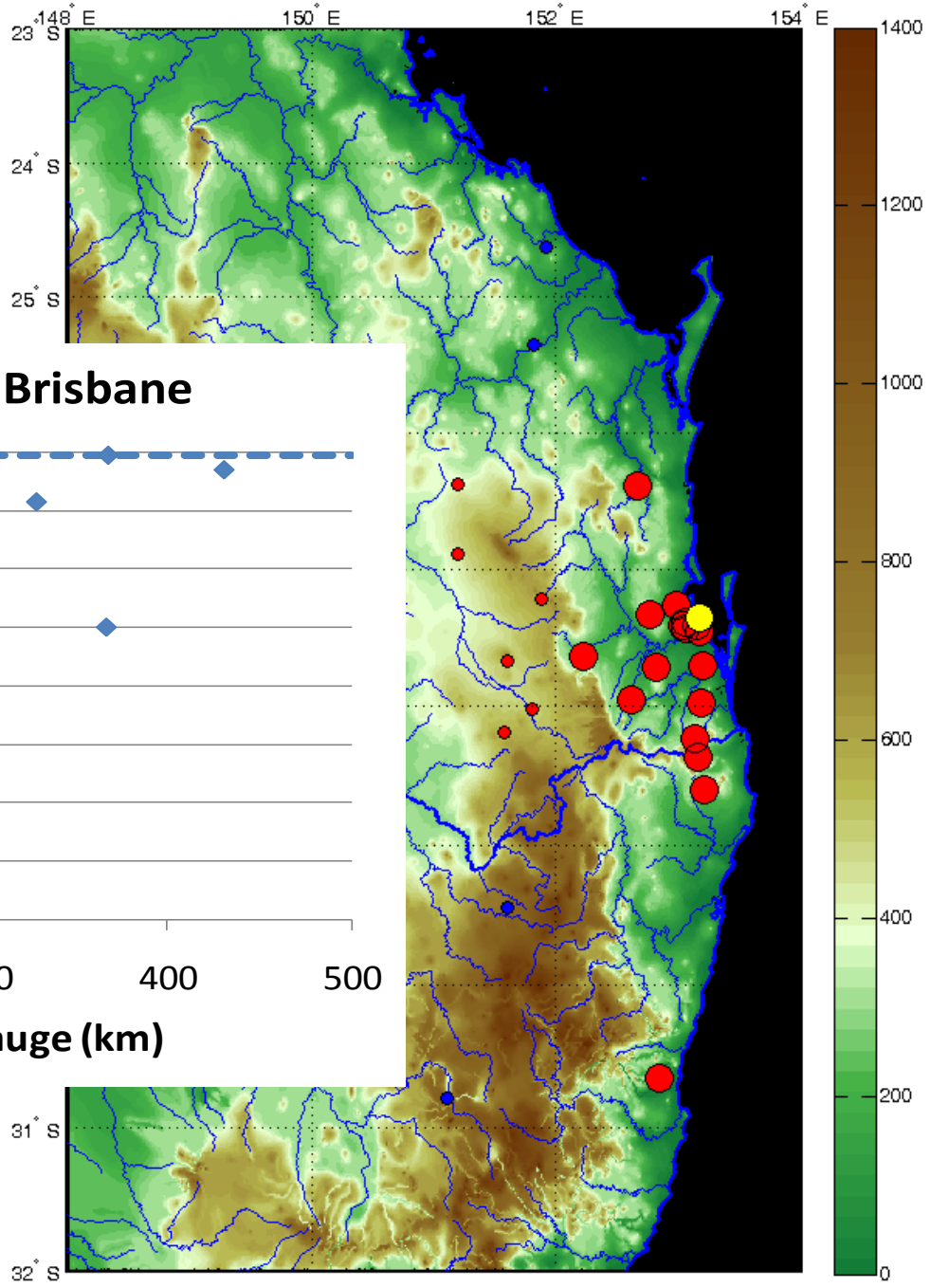
The joint dependence model



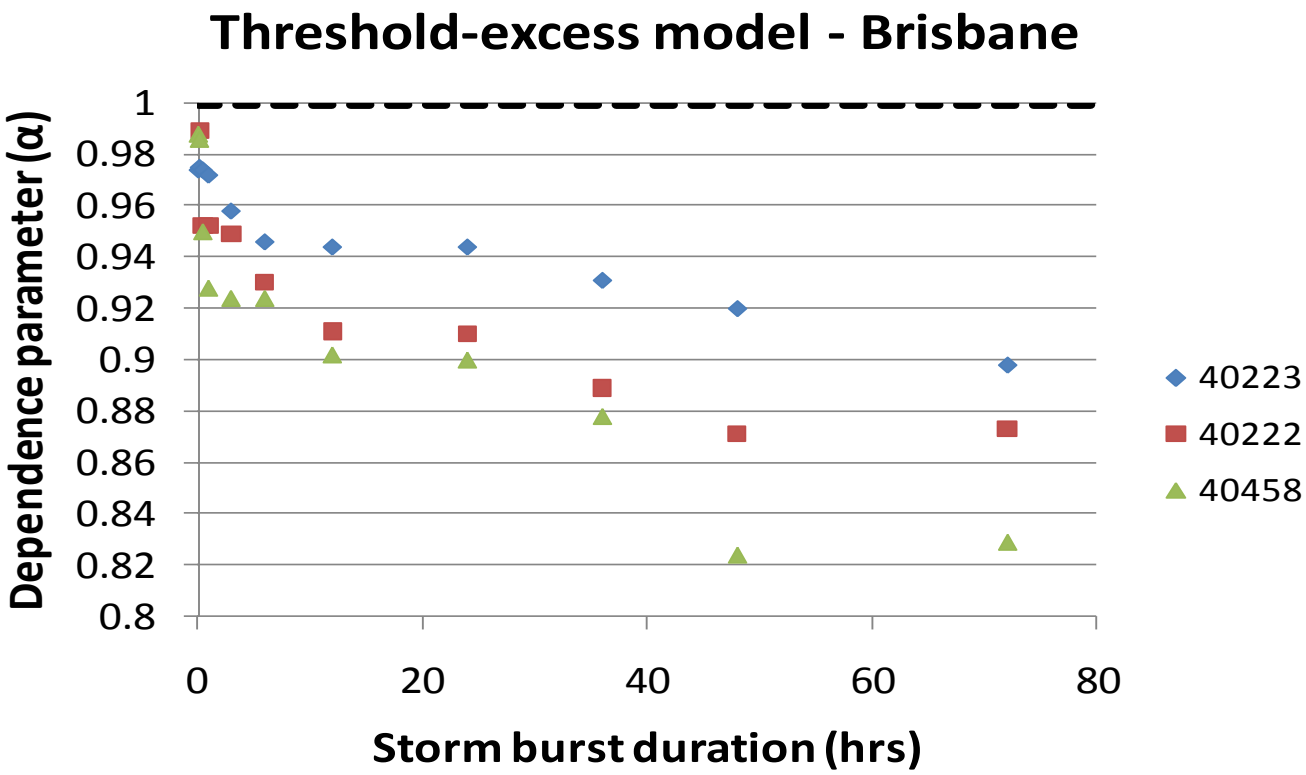


Influence of distance

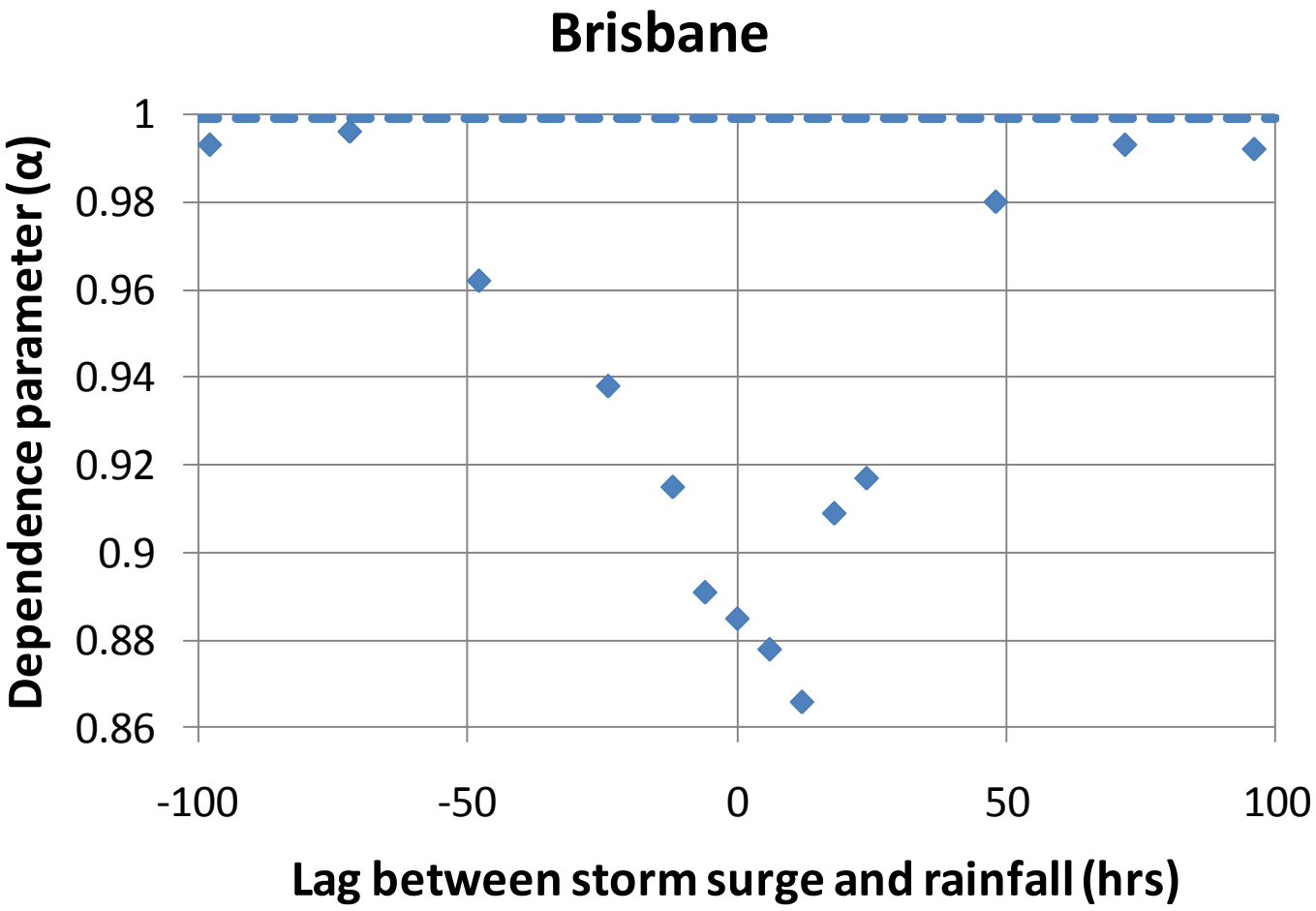




Influence of storm burst duration



Influence of lag



Results of dependence modelling

- Dependence seems to be due to 'synoptic' scale forcing
  - Spatial scale of 100's of kilometres, and time scales of several days
  - Very little dependence for short-duration extreme rainfall
  - This influences the sorts of catchments for which the dependence between extreme rainfall and storm surge needs to be quantified
- How to use this information to quantify flood risk?

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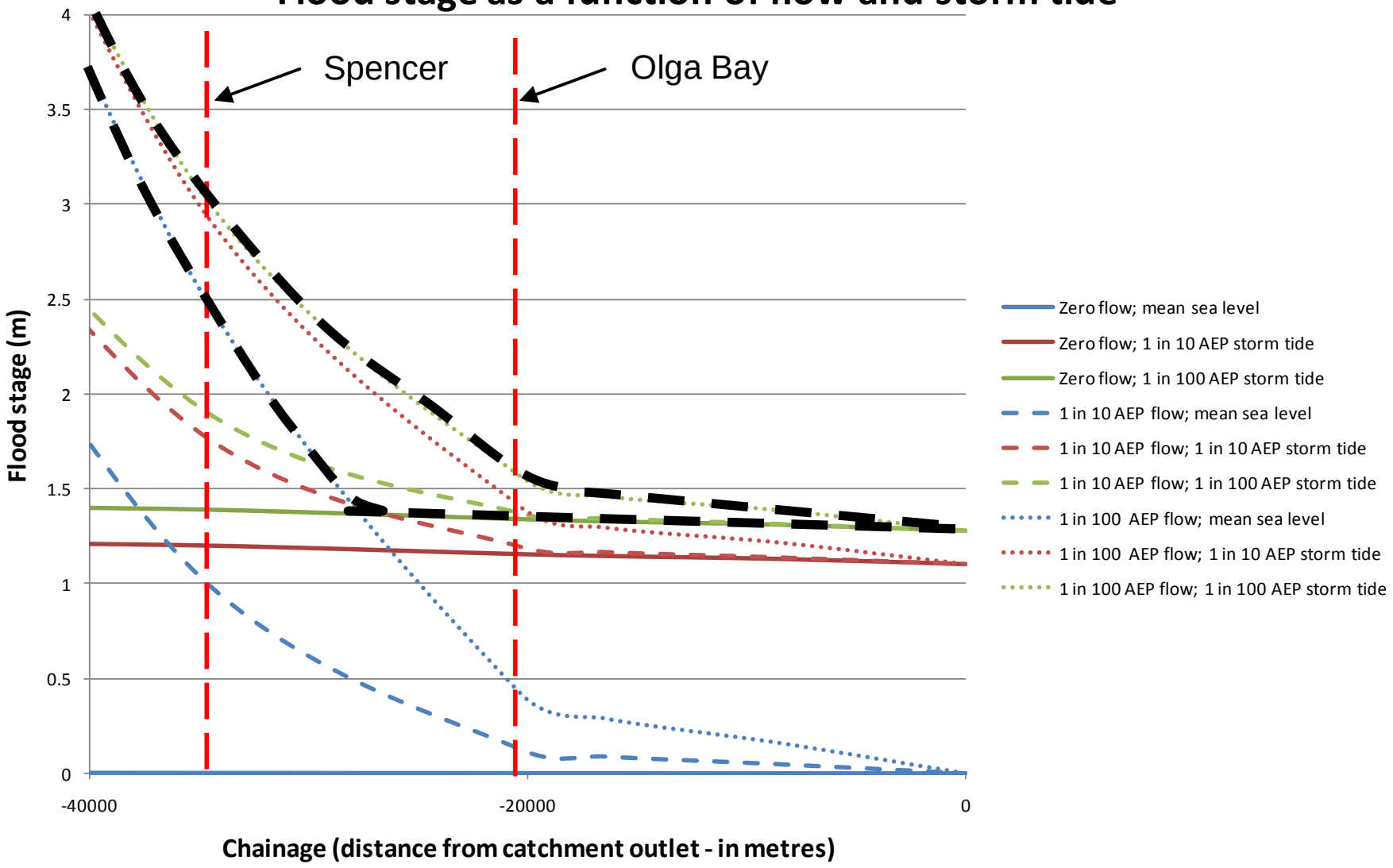
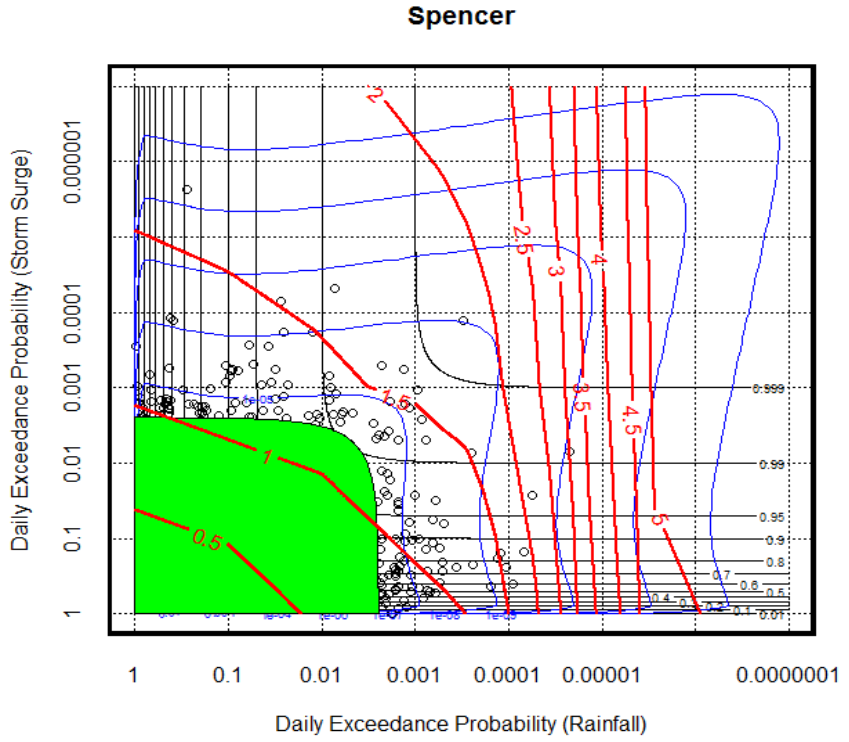
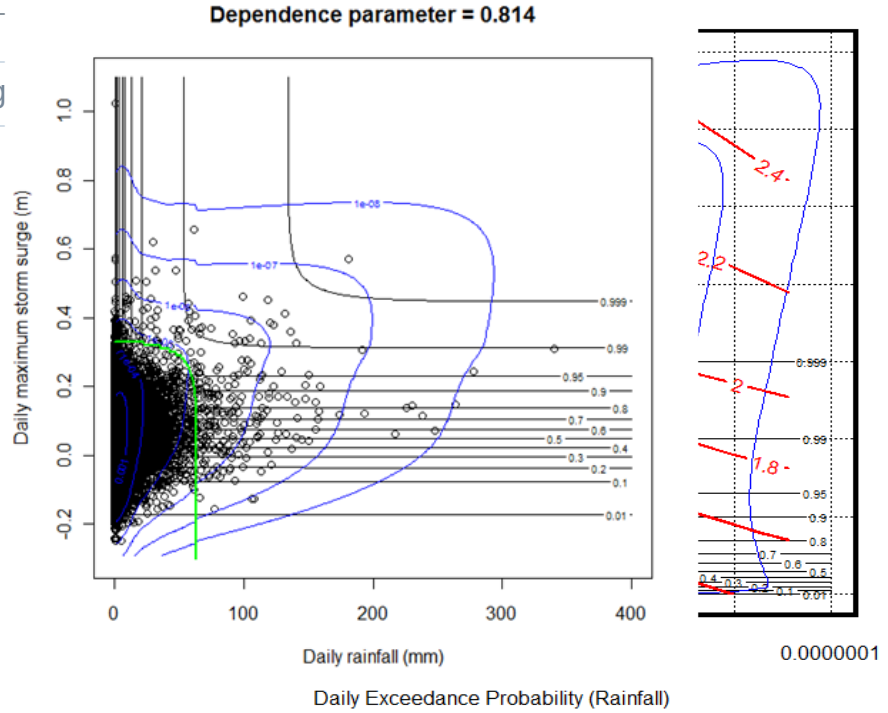
Flood stage as a function of flow and storm tide

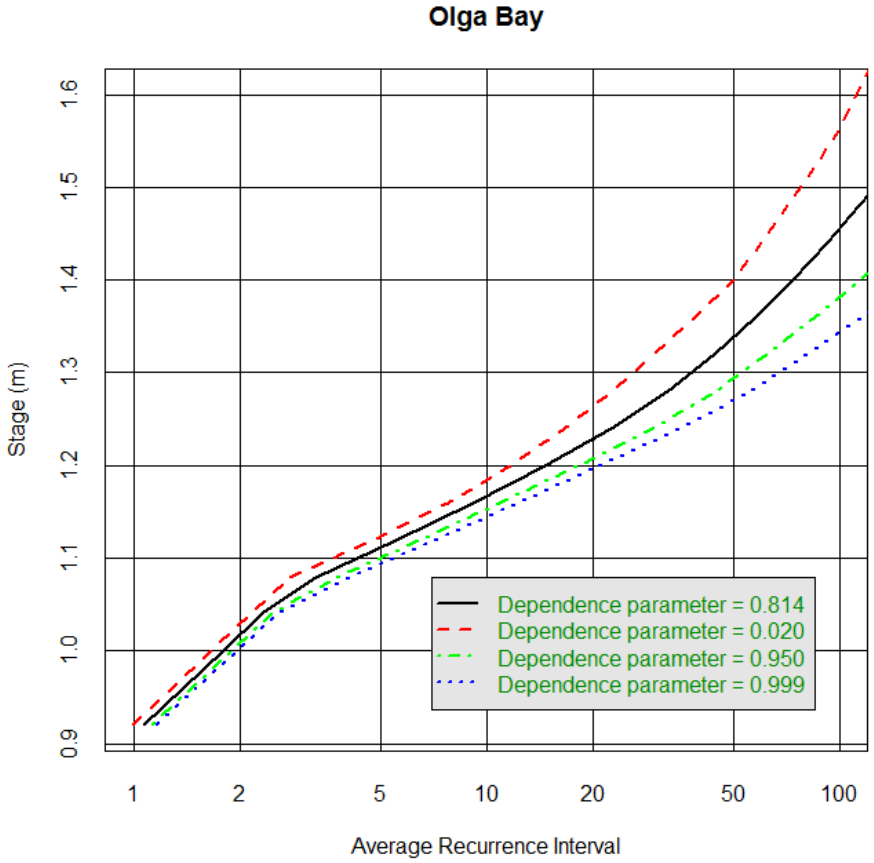


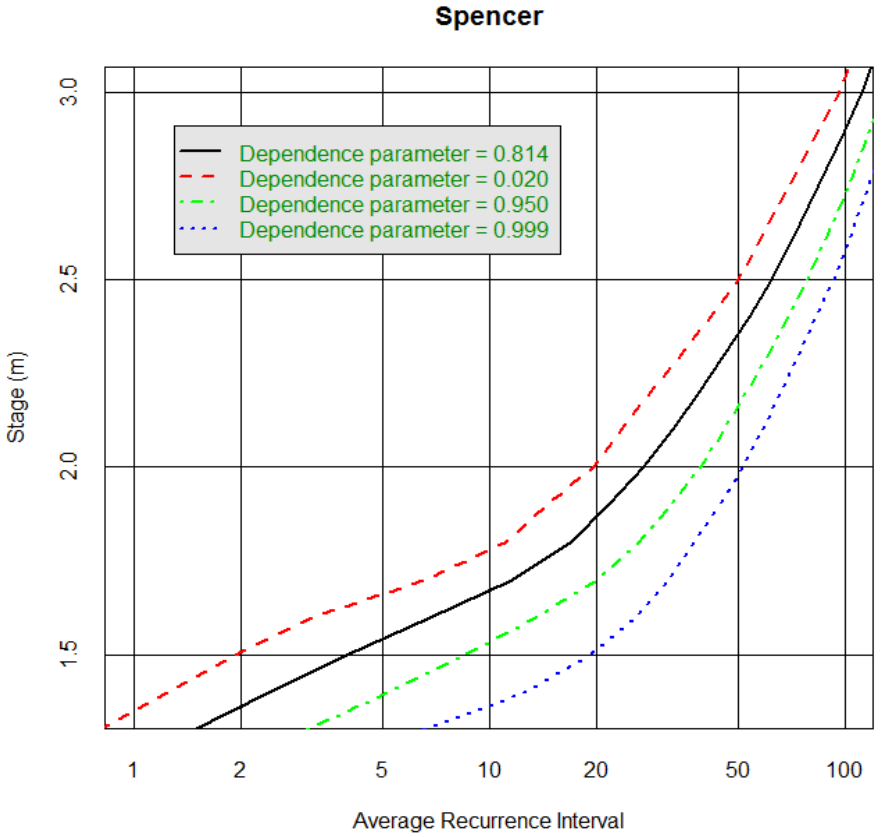


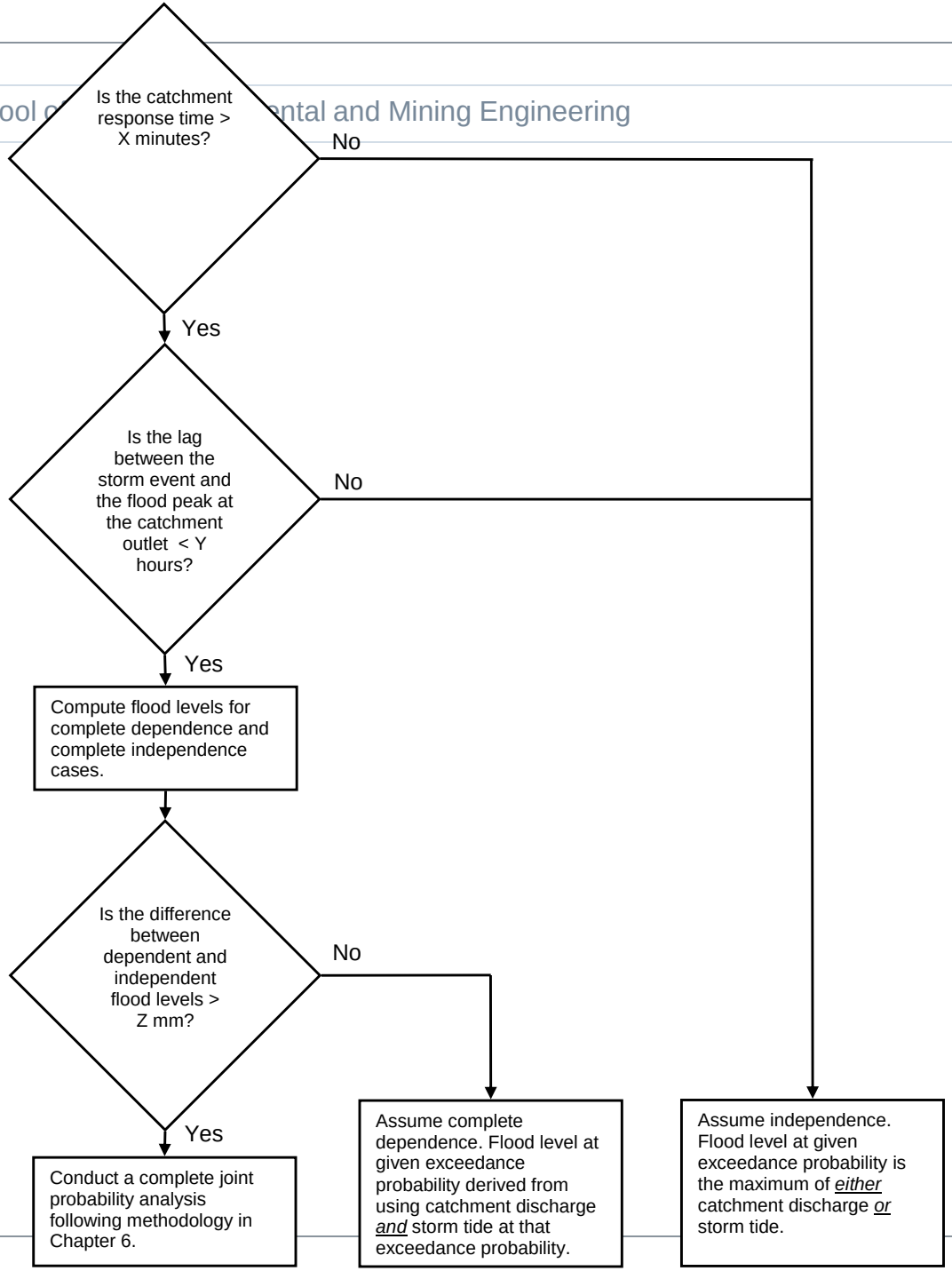


Tide level at entrance:	0m	1m	1.2m	1.4m	1.6m
Approximate ARI of ocean tide:		2.8	50	400	40000
Flow					
No flow	0.002	1.09	1.306	1.519	1.737
5 yr ARI	0.913	1.626	1.782	1.941	2.104
10 yr ARI	1.007	1.694	1.845	2	2.159
20 yr ARI	1.29	1.909	2.049	2.193	2.341
50 yr ARI	1.876	2.374	2.49	2.612	2.737
100 yr ARI	2.497	2.895	2.99	3.089	3.194
200 yr ARI	3.353	3.643	3.714	3.791	3.873
500 yr ARI	4.122	4.345	4.402	4.462	4.526
1000 yr ARI	4.919	5.091	5.134	5.181	5.231
10000 yr ARI	5.083	5.247	5.286	5.334	5.378

Flood levels






Is the catchment response time > X minutes?
No
Yes
Is the lag between the storm event and the flood peak at the catchment outlet < Y hours?
No
Yes
Compute flood levels for complete dependence and complete independence cases.
Is the difference between dependent and independent flood levels > Z mm?
No
Yes
Conduct a complete joint probability analysis following methodology in Chapter 6.
Assume complete dependence. Flood level at given exceedance probability derived from using catchment discharge and storm tide at that exceedance probability.
Assume independence. Flood level at given exceedance probability is the maximum of either catchment discharge or storm tide.

Conclusions

- Methodology aims to capture joint dependence issues in the coastal zone.
- This method aims to balance rigour with pragmatism. However:
  - Antecedent catchment wetness not considered (e.g. to be at 'average' values)
  - Static, not dynamic, tailwater levels
  - Non-stationarity in climate change also not considered
- It *does* aim to:
  - Identify dominant processes which should be considered
  - Enable modelling of the dependence between those processes

Acknowledgments

- This work was funded under Project 18 of the Australian Rainfall and Runoff revision project.
- Further details can be found in the following report:
  - Westra, S., 2012, Australian Rainfall and Runoff Revision Project 18: Interaction of Coastal Processes and Severe Weather Events: Phase 1 – Pilot Study into Joint Probability Modelling of Extreme Rainfall and Storm Surge in the Coastal Zone, 82pp, ISBN: 978-085825-8747, available online from: http://www.arr.org.au/Website_links/ARR_Project18_Stage2_Report_Final.pdf.

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