Floodwater depth estimation models

CSIRO Ecosystem Functions project - Science symposium

Presenter: Jin Teng| 16 November 2022

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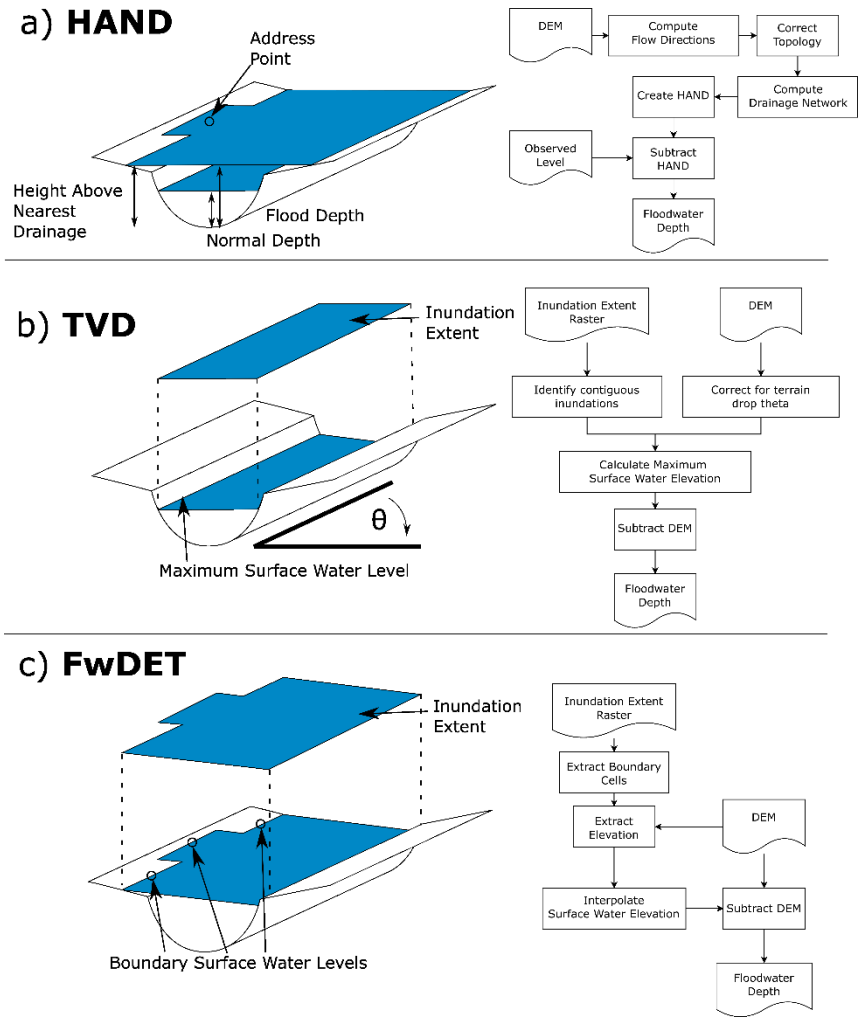
Outline

- Background
- Models assessed
- Findings
  - Accuracy evaluation
  - Influence of
    - Increasing floodwater depth
    - Magnitude of flood events
    - Geomorphology
- Product
- The way we are doing the research

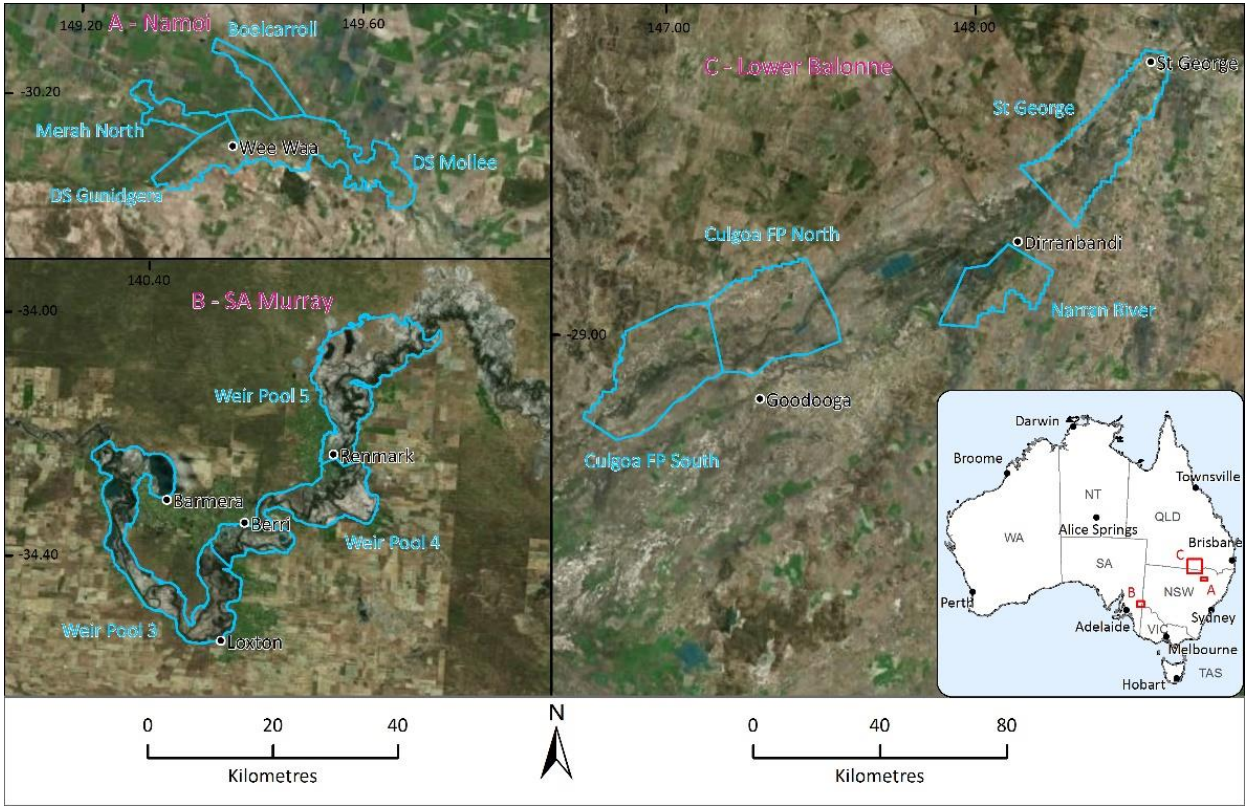
Background

- Floodwater depth estimation is important
- Hydrodynamic models are prohibitively expensive to run for large scale studies
- Advances in remote sensing
- Three models were assessed:
  - Height Above Nearest Drainage (HAND; Nobre et al., 2011)
  - Teng Vaze Dutta (TVD; Teng et al., 2013)
  - Floodwater Depth Estimation Tool (FwDET; Cohen et al., 2018)

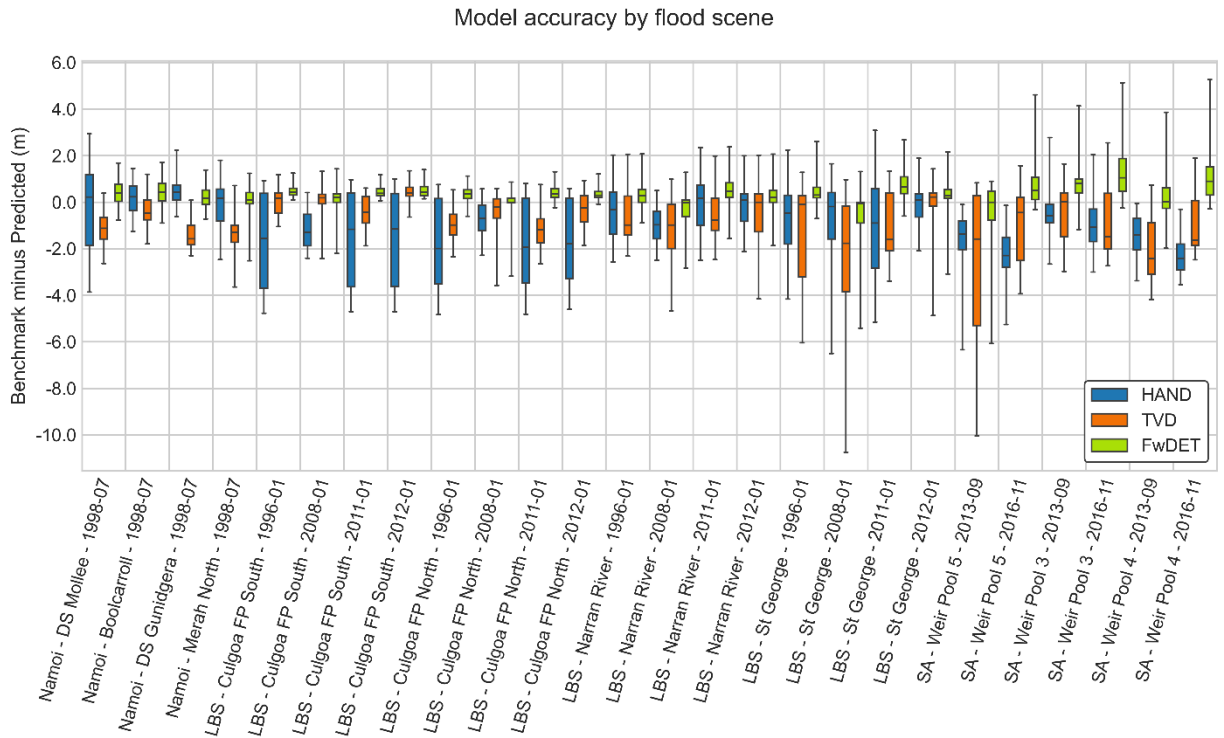
Models assessed



Validation sites

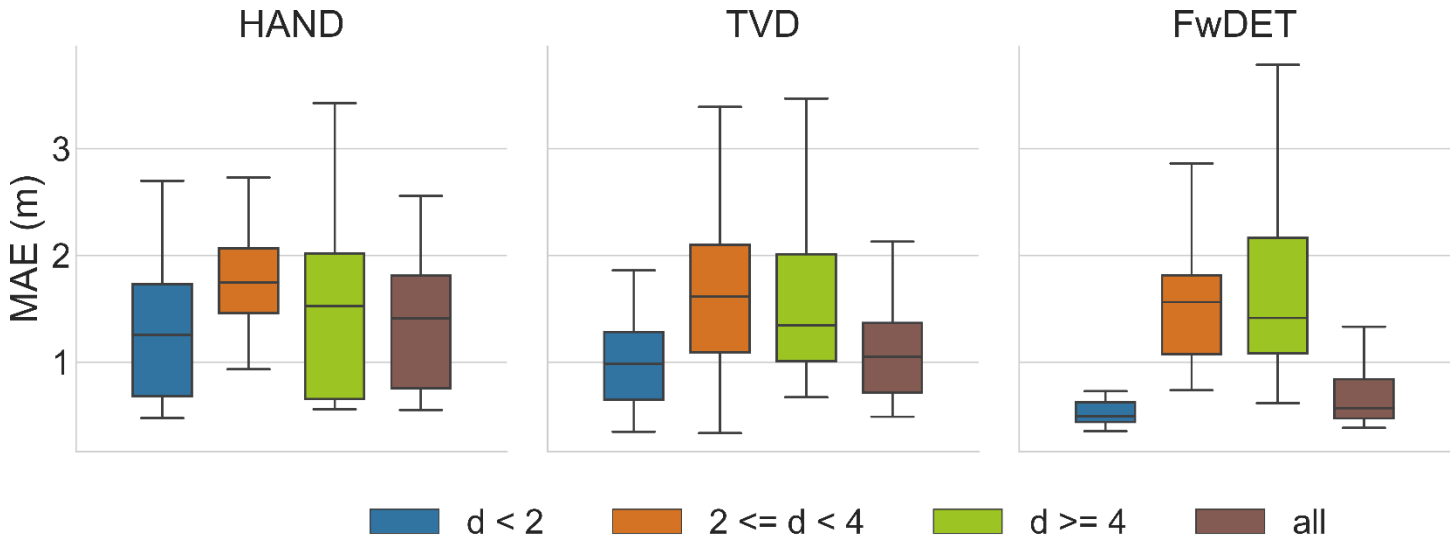


Models accuracy



	RMSE (m)	MAE (m)	25th Perc (m)	50th Perc (m)	75th Perc (m)	Range (25th to 75th perc) (m)
HAND	1.75 (1.21, 2.26)	1.38 (0.96, 1.68)	-1.41 (-1.93, -1.16)	-0.97 (-1.29, -0.46)	-0.01 (-0.61, 0.18)	1.49 (1.02, 2.00)
TVD	1.39 (1.22, 1.52)	1.04 (0.94, 1.21)	-1.49 (-1.61, -1.09)	-0.98 (-1.17, -0.36)	-0.17 (-0.45, 0.14)	1.43 (1.04, 1.73)
FwDET	0.78 (0.73, 1.07)	0.57 (0.50, 0.64)	0.18 (0.00, 0.27)	0.32 (0.24, 0.40)	0.43 (0.37, 0.61)	0.23 (0.15, 0.42)

Model accuracy by depth



Other influencers of model performance

Magnitude of flood events:

- All three models exhibited slight improvement in model performance when return interval increased.

Reach geomorphology:

- It is difficult to select a more suitable model based on the characteristics of the reach/floodplain due to the low correlation.
- It is more difficult to estimate depth in wider rivers (irrespective of the magnitude of flood being modelled).

Different DEM inputs:

- FwDET has the least drop in performance when using a global or national DEM.
- HAND works best with hydrologically conditioned DEM.

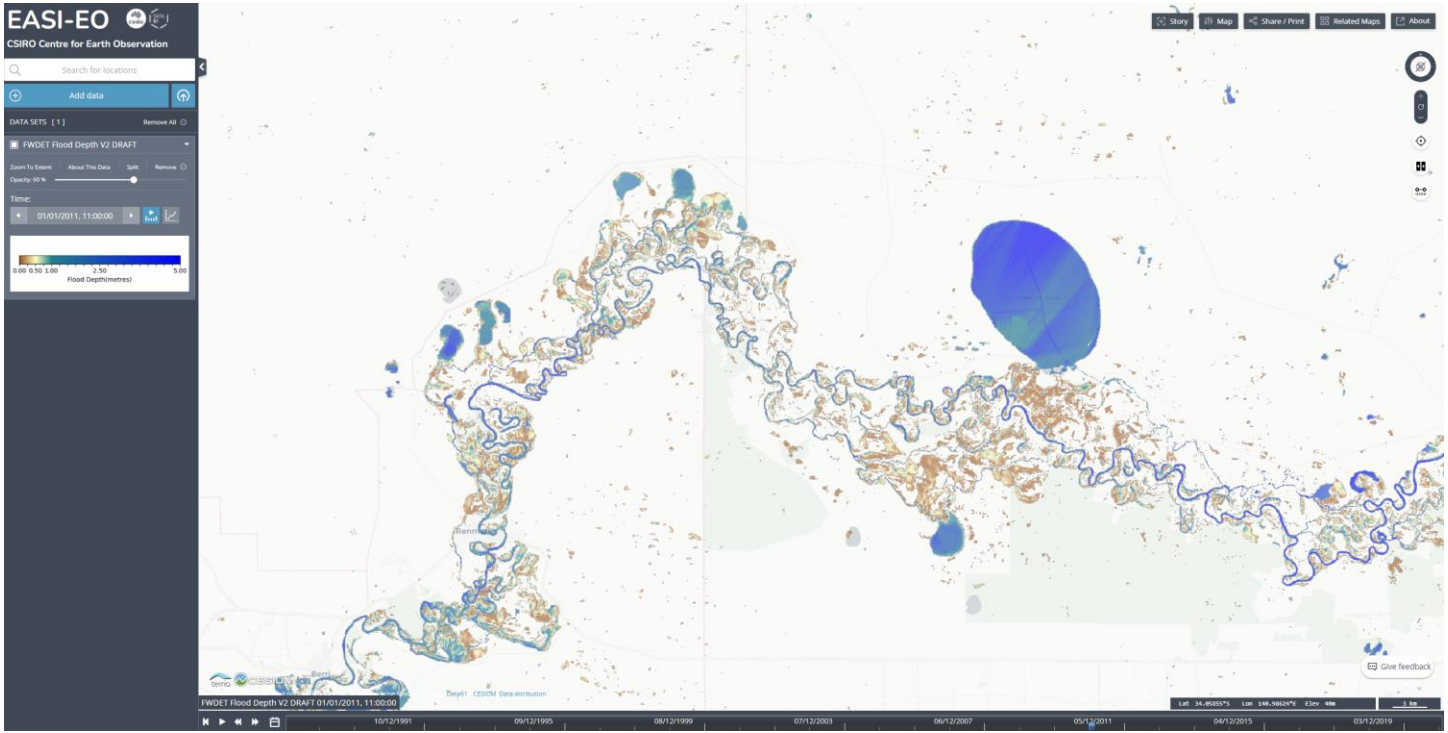
More details can be found in:

Teng, J., Penton, D. J., Ticehurst, C., Sengupta, A., Freebairn, A., Marvanek, S., et al. (2022). A comprehensive assessment of floodwater depth estimation models in semiarid regions. *Water Resources Research*, 58(11), e2022WR032031. https://doi.org/10.1029/2022WR032031

Conclusions

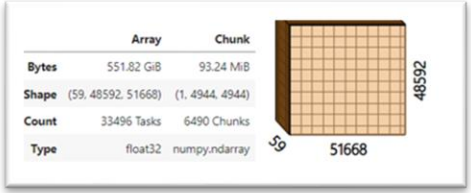
- The results of the study emphasizes the importance of using the appropriate model for the intended application.
- FwDET is the most suitable model for this region and this application.
- HAND is the most useful model when water extent is not available.
- TVD works best for floodplain with consistent slope and a single incised river channel.

Two-monthly maximum water extent and depth maps revealing the inundation history in the MDB (V1-3)

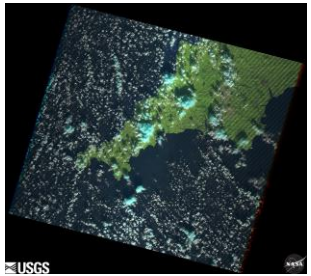


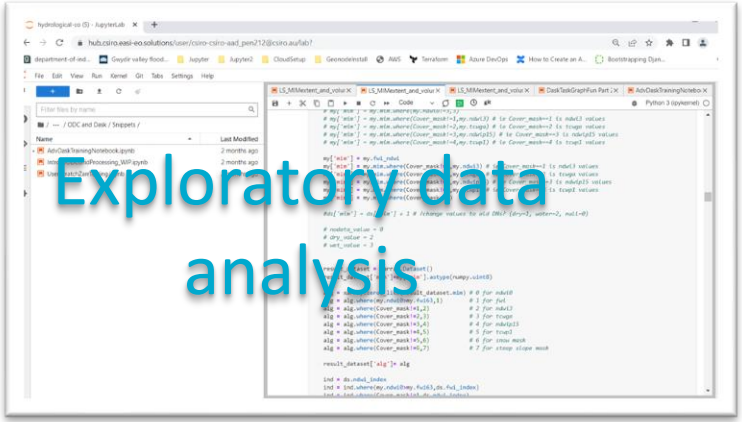
https://map.easi-eo.solutions/#share=s-5gDCU9gh91CmSurBN2uK5gKCCzt

The way we are doing the research

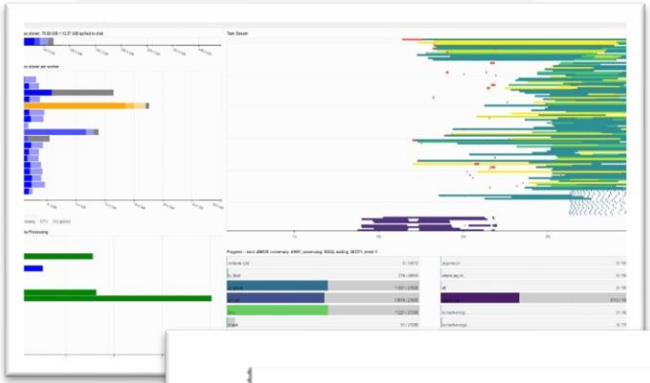


Data

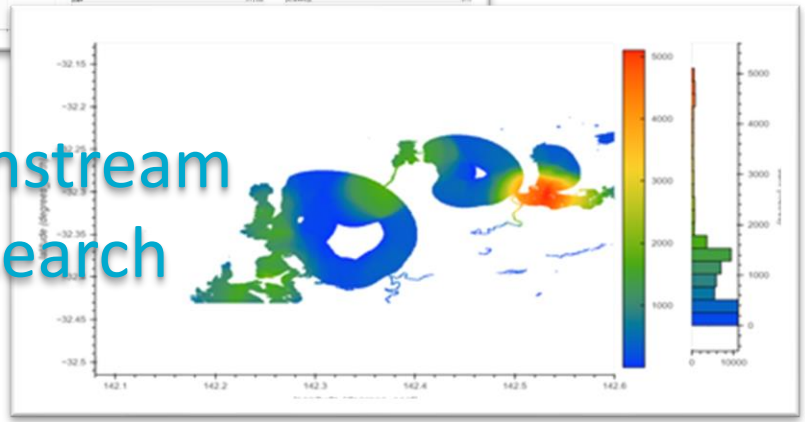




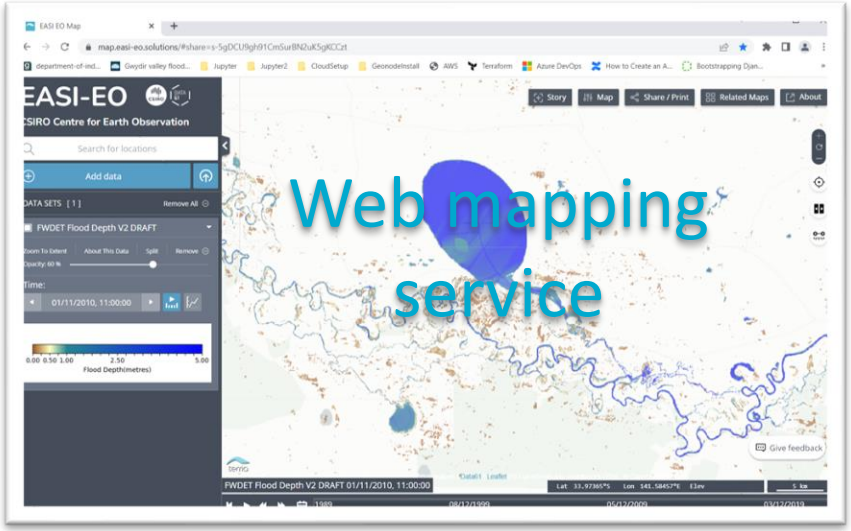
Exploratory data analysis



Dask cluster



Downstream research



Web mapping service

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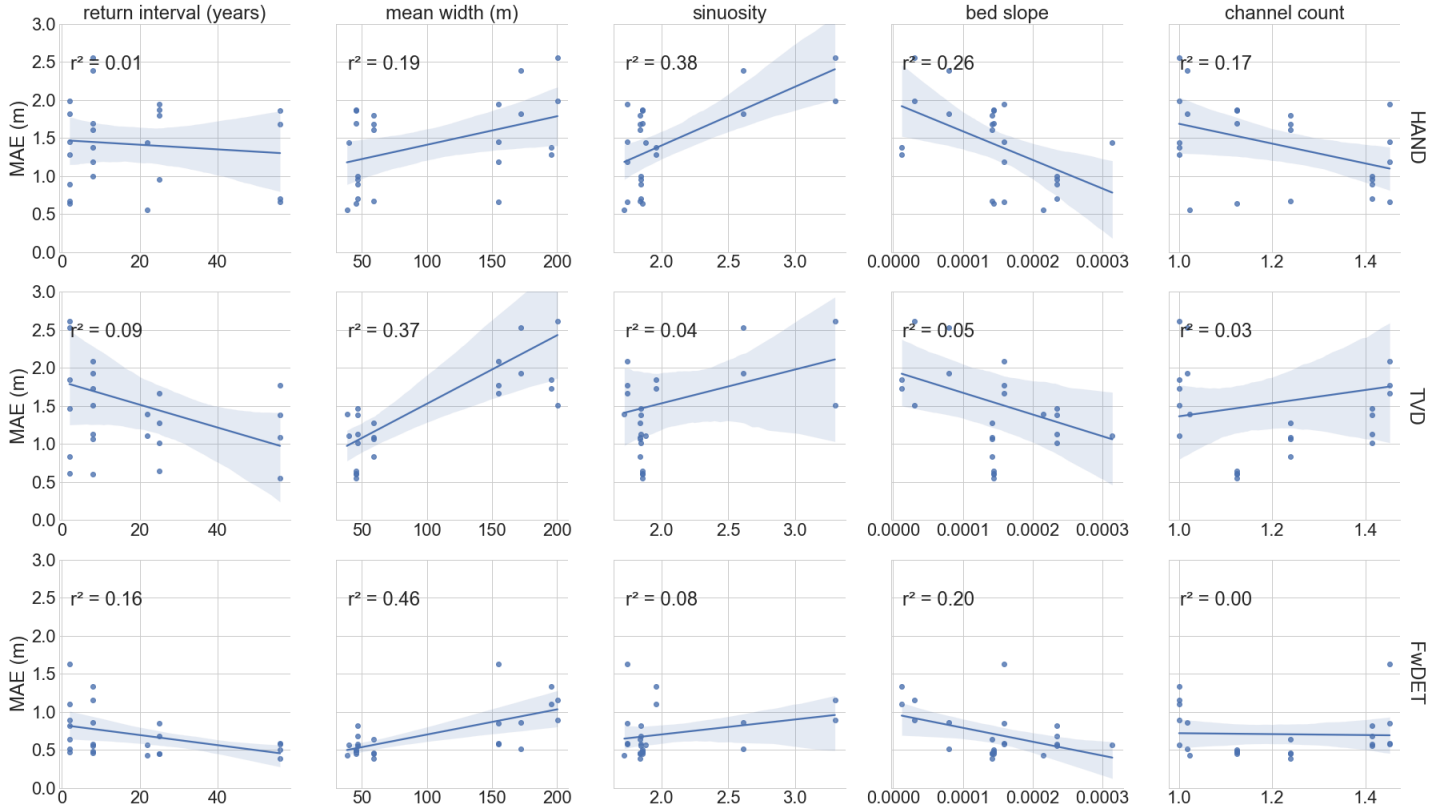
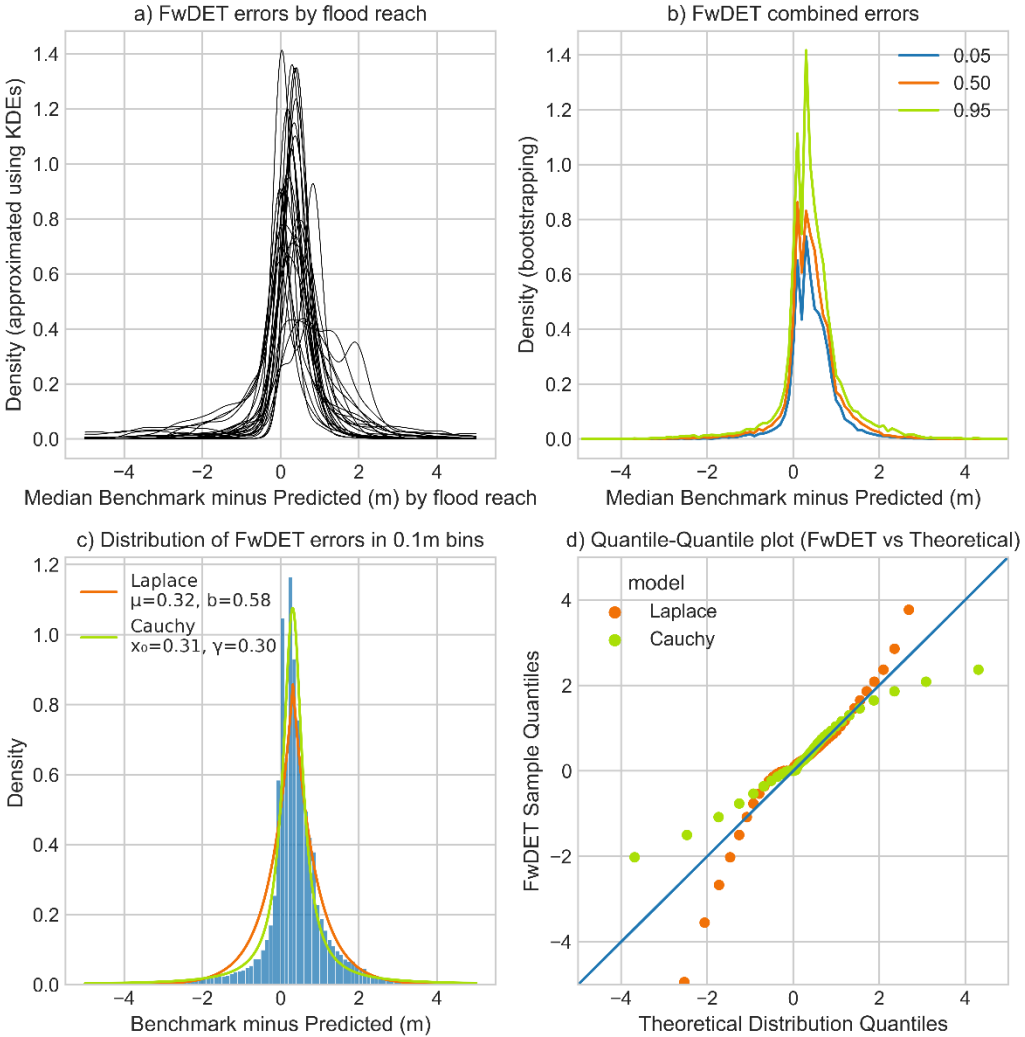
Model accuracy by magnitude to flood and geomorphology

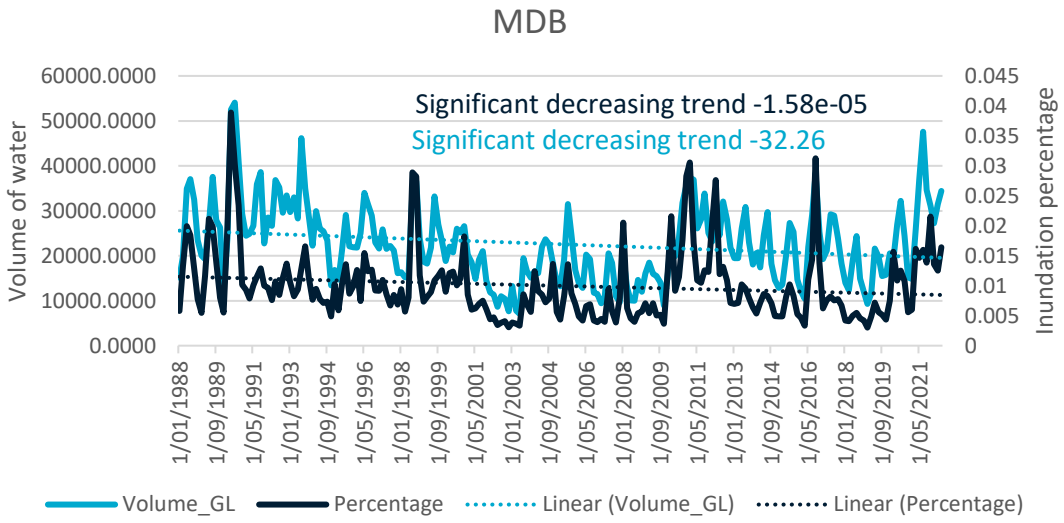


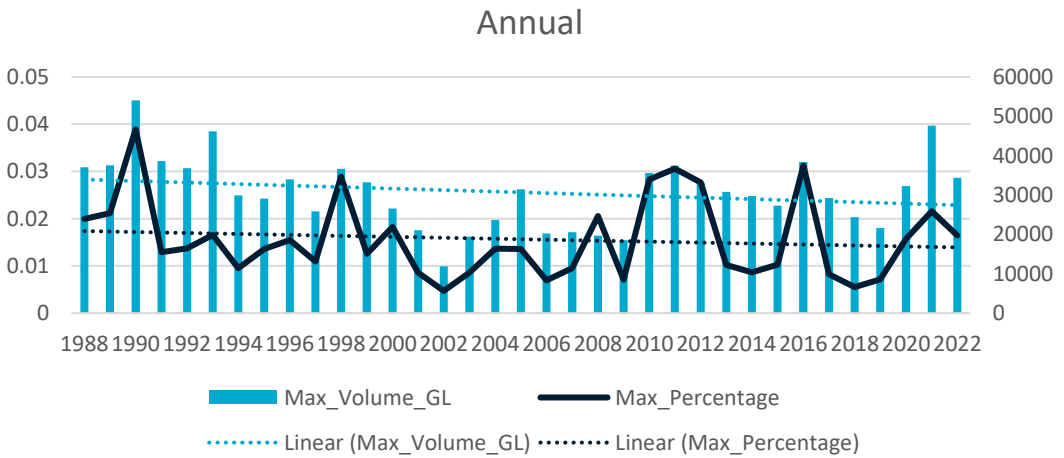
Model accuracy by using different DEMs

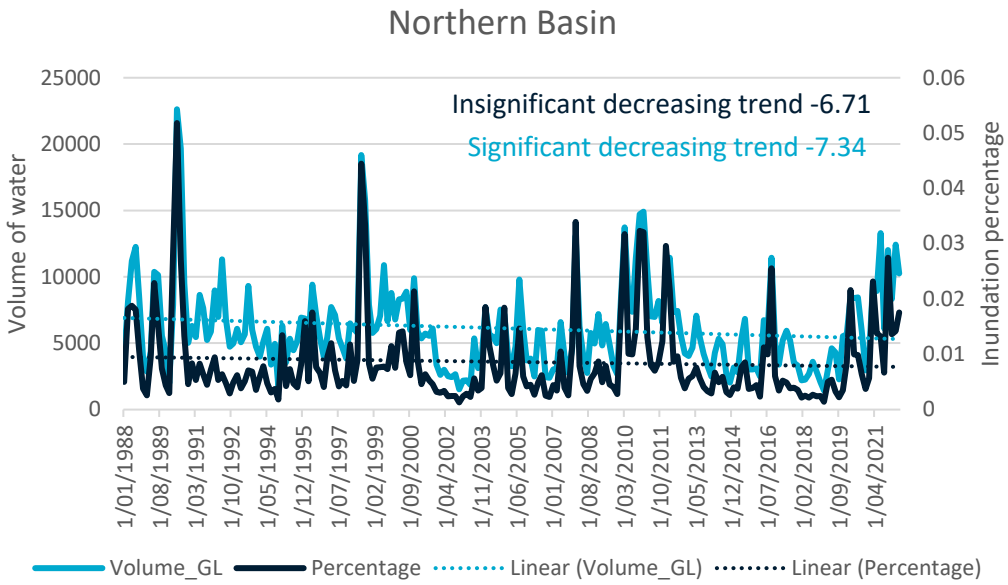
		Median MAE (m)		
DEM inputs	Resolution (m)	HAND	TVD	FwDET
LiDAR DEM	5	1.41	1.05	0.57
FABDEM (Hawker et al., 2022)	~30	2.85	1.12	0.65
DEM-H (Gallant et al., 2011)	~30	1.94	1.67	0.71
MERIT (Yamazaki et al., 2019)	~90	3.02	1.53	0.72

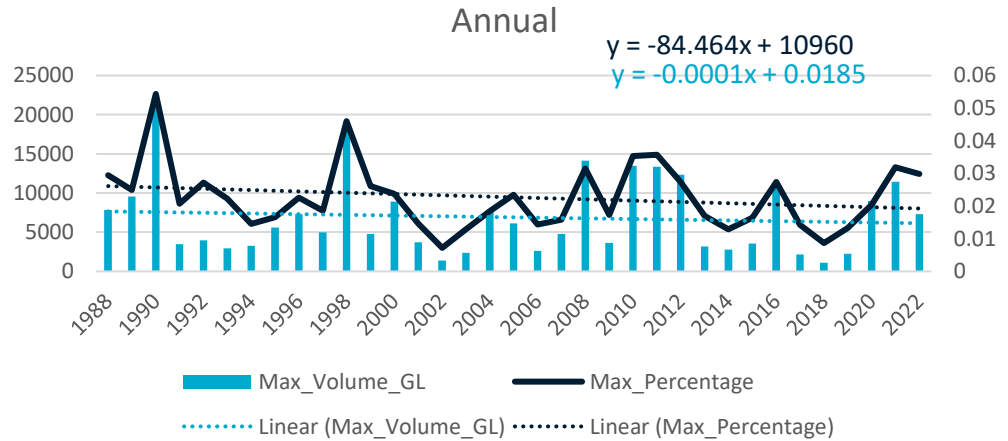
Model errors

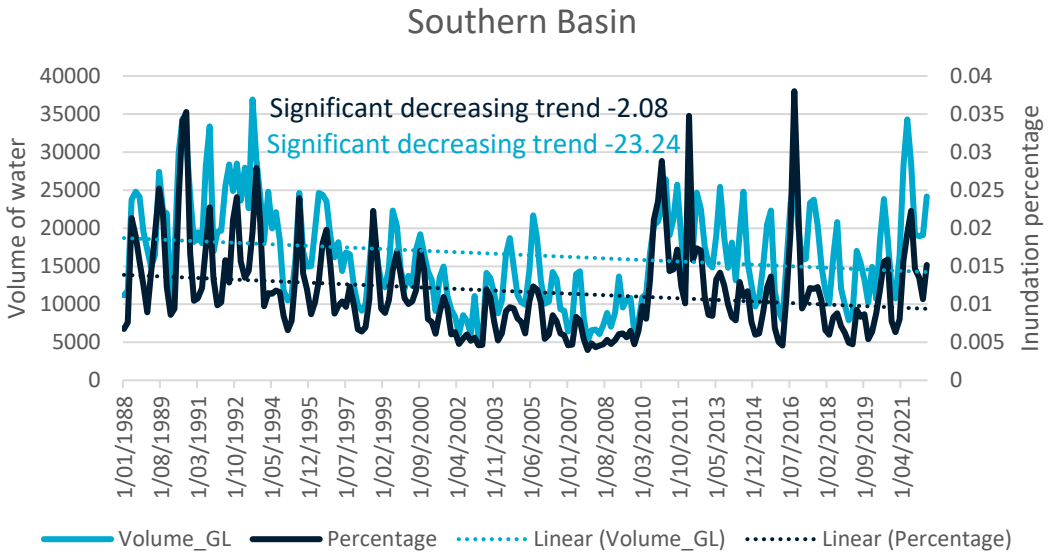


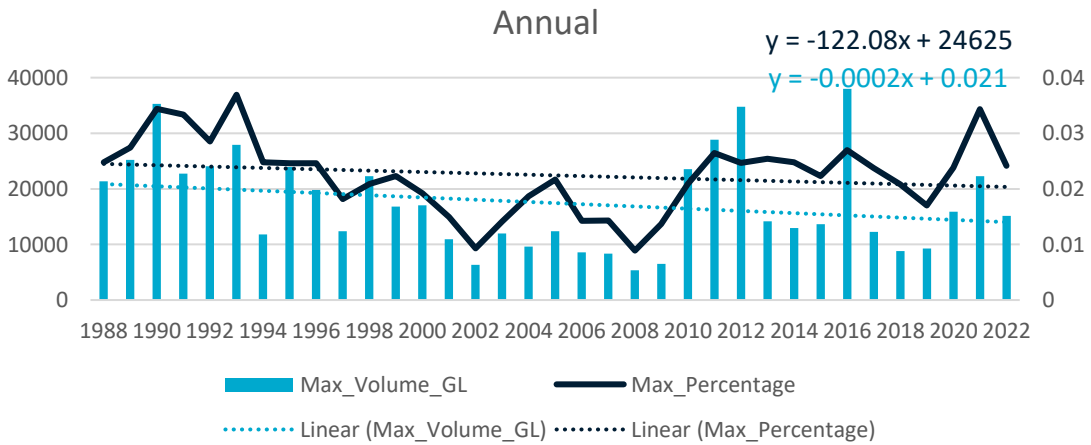

MDB
Significant decreasing trend -1.58e-05
Significant decreasing trend -32.26
Volume of water
Inundation percentage
60000.0000
50000.0000
40000.0000
30000.0000
20000.0000
10000.0000
0.0000
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
1/01/1988
1/09/1989
1/05/1991
1/01/1993
1/09/1994
1/05/1996
1/01/1998
1/09/1999
1/05/2001
1/01/2003
1/09/2004
1/05/2006
1/01/2008
1/09/2009
1/05/2011
1/01/2013
1/09/2014
1/05/2016
1/01/2018
1/09/2019
1/05/2021
Volume_GL
Percentage
Linear (Volume_GL)
Linear (Percentage)


Annual
0.05
0.04
0.03
0.02
0.01
0
60000
50000
40000
30000
20000
10000
0
1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Max_Volume_GL
Max_Percentage
Linear (Max_Volume_GL)
Linear (Max_Percentage)


Northern Basin
Insignificant decreasing trend -6.71
Significant decreasing trend -7.34
Volume of water
Inundation percentage
25000
20000
15000
10000
5000
0
0.06
0.05
0.04
0.03
0.02
0.01
0
1/01/1988
1/08/1989
1/03/1991
1/10/1992
1/05/1994
1/12/1995
1/07/1997
1/02/1999
1/09/2000
1/04/2002
1/11/2003
1/06/2005
1/01/2007
1/08/2008
1/03/2010
1/10/2011
1/05/2013
1/12/2014
1/07/2016
1/02/2018
1/09/2019
1/04/2021
Volume_GL
Percentage
Linear (Volume_GL)
Linear (Percentage)


Annual
y = -84.464x + 10960
y = -0.0001x + 0.0185
25000
20000
15000
10000
5000
0
0.06
0.05
0.04
0.03
0.02
0.01
0
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Max_Volume_GL
Max_Percentage
Linear (Max_Volume_GL)
Linear (Max_Percentage)


Southern Basin
Significant decreasing trend -2.08
Significant decreasing trend -23.24
Volume of water
Inundation percentage
40000
35000
30000
25000
20000
15000
10000
5000
0
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
1/01/1988
1/08/1989
1/03/1991
1/10/1992
1/05/1994
1/12/1995
1/07/1997
1/02/1999
1/09/2000
1/04/2002
1/11/2003
1/06/2005
1/01/2007
1/08/2008
1/03/2010
1/10/2011
1/05/2013
1/12/2014
1/07/2016
1/02/2018
1/09/2019
1/04/2021
Volume_GL
Percentage
Linear (Volume_GL)
Linear (Percentage)


Annual
y = -122.08x + 24625
y = -0.0002x + 0.021
40000
30000
20000
10000
0
0.04
0.03
0.02
0.01
0
1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 2022
Max_Volume_GL
Max_Percentage
Linear (Max_Volume_GL)
Linear (Max_Percentage)