



Floods in Queensland

- Key Topics:
- flood [2]
 - forecasting [3]
 - remote sensing [4]


Improving flood forecast skill using remote sensing data [5]
This project investigated the use of remote sensing data to improve modelled flood forecast skill and value. It developed optimal ways to constrain and update hydrologic flood models using remotely sensed soil moisture data. The project also proposed an algorithm for the monitoring of floods under vegetation, and investigated optimal ways to use remote sensing-derived inundation extent and level to implement and calibrate the hydraulic model. The results of this project enable improved predictions of flow depth, extent and velocity in the floodplain.

Project: detail Notabs

Research team

Research leader


[6]



A/Prof Valentijn Pauwels

[6]


RESEARCH LEADER



[7]

Research team

[8]




Dr Ashley Wright

[8]

RESEARCH TEAM

[9]



Prof Jeffrey Walker

[9]

RESEARCH TEAM

[7]



[7]



[10]



Dr Stefania Grimaldi
[10]
RESEARCH TEAM



[7]

End User representatives

[11]



Chris Leahy
[12]
END-USER



[13]

[14]



Elliott Simmons
[14]
END-USER



[15]

[16]



Fang Yuan
[17]
END-USER



[18]

[19]



Norman Mueller
[19]
END-USER



[18]

Description

Floods are among the most damaging natural disasters in Australia. Over the last 40 years, the average annual cost of floods was estimated to be \$377 million per year. The 2010-2011 floods in Brisbane and South-East Queensland alone resulted in 35 confirmed deaths and \$2.38 billion damage. The floods in June 2016 in Queensland, New South Wales, and Tasmania, resulted in five confirmed casualties. The floods in North Queensland in January-February 2019 resulted in four confirmed fatalities and an estimated total direct cost of 1.3 billion dollars. In order to limit the personal and economic damage caused by floods, operational water and emergency managers rely on flood forecasting systems.

These systems consist of a hydrologic and a hydraulic model to predict the extent and level of floods. Using observed and predicted rainfall, the hydrologic model calculates the amount of water that is flowing through the river network, while the hydraulic model computes water depth and velocity in the river and in the floodplain. In recent decades, the accuracy and reliability of these flood forecasting systems has significantly improved. However, it remains difficult to provide accurate and precise flood warnings. This is a result of errors and/or uncertainties in model structures, model parameters, input data, and/or meteorological forcing (mainly rainfall). The hypothesis of this project is that remote sensing data can be used to improve modelled flood forecast skill and value.

More specifically, this project developed optimal ways to constrain and update the hydrologic model using remotely sensed soil moisture data. The significance of soil moisture is its direct impact on the partitioning of rainfall into surface runoff and infiltration. Second, this project proposed an algorithm for the monitoring of floods under vegetation. Finally, the research team investigated optimal ways to use remote sensing-derived inundation extent and level to implement and calibrate the hydraulic model. The results of this project enable improved predictions of flow depth, extent and velocity in the floodplain.

[Read the final report here.](#) [20]

Related News



15 DEC 2020

New online - December 2020
COMMUNICATION, EMERGENCY MANAGEMENT

[21]



14 AUG 2020

New online - August 2020
COMMUNICATION, LOCAL KNOWLEDGE

[22]



Special edition Monographs share AFAC19 science
EMERGENCY MANAGEMENT, LAND MANAGEMENT

11 DEC 2019

[23]



New online - August 2019
DECISION MAKING, EMERGENCY MANAGEMENT

22 AUG 2019

[24]



New online - June 2019
COMMUNITIES, EMERGENCY MANAGEMENT

27 JUN 2019

[25]



Remote sensing flood data is filling the gaps
FLOOD, FORECASTING

09 MAY 2016

[26]



River bed mapping to help flood forecasting
FLOOD, FORECASTING

12 FEB 2016

[27]

Publications

Year	Type	Citation
2020	Journal Article	Grimaldi, S. [10], Xu, J. [28], Li, Y. [29] & Walker, J. [9] Flood mapping under vegetation using single SAR acquisitions [30]. <i>Remote Sensing of Environment</i> 237 , (2020). DOI [31] Google Scholar [32]
2020	Report	Pauwels, V. [6], Walker, J. [9], Grimaldi, S. [10], Wright, A. [8] & Li, Y. [29] Improving flood forecast skill using remote sensing data – final project report [20]. (Bushfire and Natural Hazards CRC, 2020). DOI [21] Google Scholar [22] BibTeX [23] EndNote XML [24]
2020	Report	Pauwels, V. [6], Walker, J. [9], Grimaldi, S. [10], Wright, A. [8] & Li, Y. [29] Guidelines on the optimal use of remote sensing data to improve the accuracy of hydrologic and hydraulic models [38]. (Bushfire and Natural Hazards CRC, 2020). DOI [39] Google Scholar [40] BibTeX [41] EndNote XML [42]
2019	Conference Paper	Wright, A. [8], Grimaldi, S. [10], Li, Y. [29], Walker, J. [9] & Pauwels, V. [6] Improving flood forecasting skill using remotely sensed data [42]. <i>Bushfire and Natural Hazards CRC Research Day AFAC17</i> (Bushfire and Natural Hazards CRC, 2019). DOI [43] Google Scholar [44] BibTeX [45] EndNote XML [46]
2019	Journal Article	Grimaldi, S. [10], Schumann, G. [47], Shokri, A. [48], Walker, J. [9] & Pauwels, V. [6] Challenges, Opportunities, and Pitfalls for Global Coupled Hydrologic Hydraulic Modeling of Floods [49]. <i>Water Resources Research</i> 55 , (2019). DOI [50] Google Scholar [51] BibTeX [52] EndNote XML [53]
2019	Journal Article	Hilton, J. [54] <i>et al.</i> River reconstruction using a conformal mapping method [55]. <i>Environmental Modelling & Software</i> 119 , 197-213 (2019). DOI [56] Google Scholar [57] BibTeX [58] EndNote XML [59]
2019	Report	Pauwels, V. [6], Walker, J. [9], Grimaldi, S. [10], Wright, A. [8] & Li, Y. [29] Improving flood forecast using remote sensing data - annual report 2018-2019 [60]. (Bushfire and Natural Hazards CRC, 2019). DOI [61] Google Scholar [62] BibTeX [63] EndNote XML [64]
2018	Conference Paper	Wang, A. [64] <i>et al.</i> Evaluation of TanDEM-X and DEM-H digital elevation models over the Condamine-Balonne catchment [65]. <i>Hydrology and Water Resources Symposium (HWRS 2018): Water Resources Research</i> 54 , (2018). DOI [66] Google Scholar [67] BibTeX [68] EndNote XML [69]
2018	Journal Article	Li, Y. [29], Grimaldi, S. [10], Pauwels, R. N. [70] & Walker, J. [9] Hydrologic model calibration using remotely sensed soil moisture and discharge measurements: The impact on predictions at gauging stations [71]. <i>Water Resources Research</i> 54 , (2018). DOI [72] Google Scholar [73] BibTeX [74] EndNote XML [75]
2018	Journal Article	Grimaldi, S. [10], Li, Y. [29], Walker, J. [9] & Pauwels, V. [6] Effective Representation of River Geometry in Hydraulic Flood Forecast Models [75]. <i>Water Resources Research</i> 54 , (2018). DOI [76] Google Scholar [77] BibTeX [78] EndNote XML [79]
2018	Journal Article	Liu, S. [80], Li, Y. [29], Pauwels, V. [6] & Walker, J. [9] Impact of rain gauge quality control and interpolation on streamflow simulation: an application to the Warwick Catchment, Australia [81]. <i>Water Resources Research</i> 54 , (2018). DOI [82] Google Scholar [83] BibTeX [84] EndNote XML [85]
2018	Journal Article	Wright, A. [8], Walker, J. [9] & Pauwels, V. [6] Identification of hydrologic models, optimized parameters, and rainfall inputs consistent with in situ streamflow and rainfall and remotely sensed data [86]. <i>Water Resources Research</i> 54 , (2018). DOI [87] Google Scholar [88] BibTeX [89] EndNote XML [90]
2017	Conference Paper	Rumsewicz, M. [91] Research proceedings from the 2017 Bushfire and Natural Hazards CRC and AFAC Conference [92]. <i>Bushfire and Natural Hazards CRC & AFAC annual conference 2017 (Bushfire and Natural Hazards CRC, 2017). DOI [93] Google Scholar [94] BibTeX [95] EndNote XML [96]</i>
2017	Conference Paper	Li, Y. [29], Grimaldi, S. [10], Wright, A. [8], Walker, J. [9] & Pauwels, V. [6] Improving flood forecast skill using remote sensing data [96]. <i>AFAC17</i> (Bushfire and Natural Hazards CRC, 2017). DOI [97] Google Scholar [98] BibTeX [99] EndNote XML [100]
2017	Journal Article	Wright, A. [8], Walker, J. [9] & Pauwels, V. [6] A comparison of the discrete cosine and wavelet transforms for hydrologic model input data reduction [100]. <i>Hydrology and Earth System Science</i> 121 , 115-127 (2017). DOI [101] Google Scholar [102] BibTeX [103] EndNote XML [104]
2017	Journal Article	Wright, A. [8], Walker, J. [9] & Pauwels, V. [6] Estimating rainfall time series and model parameter distributions using model data reduction and inversion techniques [105]. <i>AGU</i> (2017). at <https://www.agu.org/pubs/abstract/2017/AGU2017-1107-1/abstract.html>
2017	Report	Pauwels, V. [6], Walker, J. [9], Li, Y. [29], Grimaldi, S. [10] & Wright, A. [8] Improving flood forecast skill using remote sensing data: annual report 2016-17 [110]. (Bushfire and Natural Hazards CRC, 2017). DOI [111] Google Scholar [112] BibTeX [113] EndNote XML [114]
2016	Conference Paper	Li, Y. [29], Grimaldi, S. [10], Wright, A. [8], Walker, J. [9] & Pauwels, V. [6] Improving flood forecast skill using remote sensing data [114]. <i>AFAC16</i> (Bushfire and Natural Hazards CRC, 2016). DOI [115] Google Scholar [116] BibTeX [117] EndNote XML [118]
2016	Journal Article	Li, Y. [29], Grimaldi, S. [10], Walker, J. [9] & Pauwels, V. [6] Application of Remote Sensing Data to Constrain Operational Rainfall-Driven Flood Forecasting: A Review [117]. <i>Remote Sensing</i> 8 , (2016). DOI [119] Google Scholar [120] BibTeX [121] EndNote XML [122]
2016	Journal Article	Grimaldi, S. [10], Li, Y. [29], Pauwels, V. [6] & Walker, J. [9] Remote Sensing-Derived Water Extent and Level to Constrain Hydraulic Flood Forecasting Models: Opportunities and Challenges [123]. <i>Water Resources Research</i> 52 , (2016). DOI [124] Google Scholar [125] BibTeX [126] EndNote XML [127]
2016	Magazine Article	Jones, F. [127] Remote-sensing flood data is filling the gaps [128]. <i>The Australian Journal of Emergency Management</i> 31 , (2016). DOI [129] Google Scholar [129] BibTeX [130] EndNote XML [131]
2016	Report	Pauwels, V. [6], Walker, J. [9], Li, Y. [29], Grimaldi, S. [10] & Wright, A. [8] Improving flood forecast skill using remote sensing: Annual project report 2015-2016 [132]. (Bushfire and Natural Hazards CRC, 2016). DOI [133] Google Scholar [134] BibTeX [135] EndNote XML [136]
2015	Conference Paper	Li, Y. [29], Grimaldi, S. [10], Pauwels, V. [6], Walker, J. [9] & Wright, A. [8] Combining hydrologic and hydraulic models for real time flood forecasting - non peer reviewed extended abstract [136]. <i>AFAC15</i> (Bushfire and Natural Hazards CRC, 2015). DOI [137] Google Scholar [138] BibTeX [139] EndNote XML [140]
2015	Report	Pauwels, V. [6] Improving Flood Forecast Skill Using Remote Sensing Data Annual Report 2014 [140]. (2015). DOI [141] Google Scholar [141] BibTeX [142] EndNote XML [143]
2015	Report	Pauwels, V. [6], Walker, J. [9], Li, Y. [29], Grimaldi, S. [10] & Wright, A. [8] Improving flood forecast skill using remote sensing data: Annual project report 2014-2015 [144]. (Bushfire and Natural Hazards CRC, 2015). DOI [145] Google Scholar [146] BibTeX [147] EndNote XML [148]

Presentations & Resources

DATE [148]	TITLE [149]	DOWNLOAD	KEY TOPICS
21 Mar 2014	Monitoring and prediction [150]	7.35 MB	[151] (7.35 MB), modelling [152], multi-hazard [153]
04 Dec 2014	Improving flood forecasting using remote sensing data - user perspective [154]	1.06 MB	[155] (1.06 MB), forecasting [3]
09 Dec 2014	Improving flood forecasting using remote sensing data [156]	1.5 MB	[157] (1.5 MB), forecasting [3]
03 Apr 2016	Monitoring and prediction - cluster overview [158]	0 bytes	[159] (0 bytes), forecasting [3], multi-hazard [153], scenario analysis [160]
30 Aug 2016	Improving flood forecast skill using remote sensing data - Stefania Grimaldi [161]	5.05 MB	[162] (5.05 MB), ring [163], flood [2], remote sensing [4]
17 May 2017	Remote sensing offers better forecasting of riverine floods [164]	277.44 KB	[165] (277.44 KB), hydrology [166], remote sensing [4]
07 Jul 2017	Water, water everywhere: living with flood and coastal threats [167]	3.98 MB	[168] (3.98 MB), severe weather [169], storm surge [170]
07 Sep 2017	Observationally-constrained flood forecasting [171]	1.64 MB	[172] (1.64 MB), forecasting [3], remote sensing [4]
31 Oct 2017	Improving flood forecast skill using remote sensing data [173]	1.9 MB	[174] (1.9 MB), forecasting [3], remote sensing [4]
27 Aug 2019	Improving flood forecast skill using remote sensing data [175]	3.83 MB	[176] (3.83 MB), sensing [4]

Posters

A poster titled 'Improving flood forecasting skill using remote sensing data' with a map of Europe and various charts.

[177]

23 AUG 2014

Improving flood forecasting skill using remote sensing data

[177]

Accurate, timely and precise Forecast precipitation is the "holy grail" of flood forecasting; this project...

A poster titled 'Improving flood forecasting skills using remote sensing data: precipitation retrieval' with a map of Europe and various charts.

[178]

18 AUG 2015

Improving flood forecasting skills using remote sensing data: precipitation retrieval

[178]

FLOOD [2], FORECASTING [3]

Accurate, timely and precise forecast precipitation is the "Holy Grail" of flood forecasting; this project...

A poster titled 'Improving Flood Forecast Skill Using Remote Sensing Data - Hydraulic Component' with a map of Europe and various charts.

[179]

16 AUG 2015

Improving Flood Forecast Skill Using Remote Sensing Data - Hydraulic Component

[179]

FLOOD [2], FORECASTING [3]

Accurate flood forecast is essential to save lives and reduce damages.How far can we get using remote sensing...

A poster titled 'Improving Flood Forecasting Skill Using Remote Sensing Data - Hydrological Component' with a map of Europe and various charts.

[180]

18 AUG 2015

Improving Flood Forecasting Skill Using Remote Sensing Data - Hydrological Component

[180]

FLOOD [2], FORECASTING [3]

Flood forecasts suffer from various SOURCES of uncertainties. This project investigates the benefit of using...

A poster titled 'Improving flood forecast skill using remote sensing data' with a map of Europe and various charts.

[181]

14 AUG 2016

Improving flood forecast skill using remote sensing data

[181]

REMOTE FLOOD [2], SENSING [4]

The use of remote sensing data in operational flood forecasting is currently receiving increasing attention.



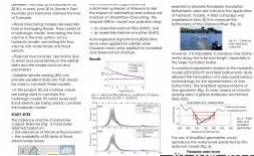
[182] 30 JUN 2017

Improving flood forecasting skill using remote sensing data: rainfall estimation

[182]

FLOOD [2], HYDROLOGY [166]

This project aims to use hydrologic models and data assimilation theory to estimate catchment wide rainfall.



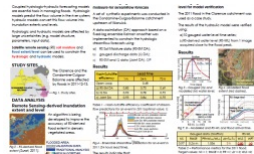
[183] 30 JUN 2017

Improving flood forecast skill using remote sensing data: model/remotely sensing data fusion

[183]

FLOOD [2], HYDROLOGY [166]

This project investigates the use of remotely sensed soil moisture data and flood extent/level to improve...



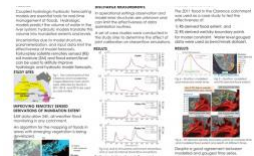
[184] 19 JUL 2016

Improving flood forecast skill using Remote Sensing data

[184]

FLOOD [2], FORECASTING [3]

"The outcomes from this research will provide information for us to use remotely sensed data to improve our..."



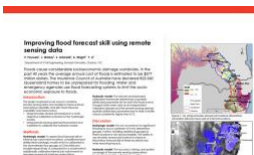
[185] 27 AUG 2019

Improving flood forecast skill using remote sensing data

[185]

REMOTE
FLOOD [2], SENSING [4]

This project investigates the use of remotely sensed soil moisture and inundation extent to improve the...



[186] 31 AUG 2020

Improving flood forecast skill using remote sensing data

[186]

FLOOD [2], FORECASTING [3]

Key findings: Remotely sensed data can improve flood forecasting capability in poorly gauged catchments

Linked Projects

Resilience to clustered disaster events on the coast - storm surge
[187]

FLOOD AND COASTAL MANAGEMENT [188]

Dr Scott Nichol
Geoscience Australia [18]



[18]

Developing better predictions for extreme water levels
[189]

FLOOD AND COASTAL MANAGEMENT [188]

Prof Charitha Pattiaratchi
University of Western Australia [190]



[190]

Improving flood forecast skill using remote sensing data



Mapping bushfire hazard and impacts
[191]

BUSHFIRE PREDICTIVE SERVICES [192]



Fire surveillance and hazard mapping
[194]

BUSHFIRE PREDICTIVE SERVICES [192]



Source URL:<https://www.bnhcrc.com.au/node/258/generate-pdf>
Links

[1] <https://www.bnhcrc.com.au/files/istock000019955974webjpg> [2] <https://www.bnhcrc.com.au/research/topics/flood> [3] <https://www.bnhcrc.com.au/research/topics/forecasting> [4] <https://www.bnhcrc.com.au/research/topics/remote-sensing> [5] <https://www.bnhcrc.com.au/research/floodforecasting> [6] <https://www.bnhcrc.com.au/people/vpauwels> [7] <https://www.bnhcrc.com.au/organisations/monash> [8] <https://www.bnhcrc.com.au/people/awright> [9] <https://www.bnhcrc.com.au/people/walker> [10] <https://www.bnhcrc.com.au/people/sgrimaldi> [11] <https://www.bnhcrc.com.au/people/chrisleahy> [12] <https://www.bnhcrc.com.au/people/chris.leahy> [13] <https://www.bnhcrc.com.au/organisations/bom> [14] <https://www.bnhcrc.com.au/people/esimmons> [15] <https://www.bnhcrc.com.au/organisations/nswses> [16] <https://www.bnhcrc.com.au/people/fang-yuan> [17] <https://www.bnhcrc.com.au/people/Fang-Yuan> [18] <https://www.bnhcrc.com.au/organisations/ga> [19] <https://www.bnhcrc.com.au/people/nmueller> [20] <https://www.bnhcrc.com.au/publications/biblio/bnh-7694> [21] <https://www.bnhcrc.com.au/news/2020/new-online-december-2020> [22] <https://www.bnhcrc.com.au/news/2020/new-online-august-2020> [23] <https://www.bnhcrc.com.au/news/2019/special-edition-monographs-share-afac19-science-0> [24] <https://www.bnhcrc.com.au/news/2019/new-online-august-2019> [25] <https://www.bnhcrc.com.au/news/2019/new-online-june-2019> [26] <https://www.bnhcrc.com.au/news/2016/remotely-sensing-flood-data-filling-gaps> [27] <https://www.bnhcrc.com.au/news/2016/river-bed-mapping-help-flood-forecasting> [28] <https://www.bnhcrc.com.au/publications/biblio?f%5Bauthor%5D=1750> [29] <https://www.bnhcrc.com.au/people/yli> [30] <https://www.bnhcrc.com.au/publications/biblio/bnh-6266> [31] <http://dx.doi.org/10.1016/j.rse.2019.111582> [32] http://scholar.google.com/scholar?btnG=Search%2BScholar&as_q=%22Flood%2Bmapping%2Bunder%2Bvegetation%2Busing%2BSingle%2BSAR%2Bacquisitions%22&as_sauthors=Grimaldi&as_occt=any&as_epq=&as_oq=&as_eq=&as_eq=8 [33] <https://www.bnhcrc.com.au/publications/biblio/export/bibtex/6266> [34] <https://www.bnhcrc.com.au/publications/biblio/export/xml/6266> [35] http://scholar.google.com/scholar?btnG=Search%2BScholar&as_q=%22Improving%2BFlood%2Bforecast%2Bskill%2Busing%2Bremote%2Bsensing%2Bdata%2B%E2%80%93%2Bfinal%2Bproject%22&as_sauthors=Pauwels&as_occt=any&as_epq=&as_oq=&as_eq=&as_eq=36 [36] <https://www.bnhcrc.com.au/publications/biblio/export/bibtex/7694> [37] <https://www.bnhcrc.com.au/publications/biblio/export/xml/7694> [38] <https://www.bnhcrc.com.au/publications/biblio/bnh-7198> [39] http://scholar.google.com/scholar?btnG=Search%2BScholar&as_q=%22Guidelines%2Bon%2Bthe%2Boptimal%2Buse%2Bof%2Bremote%2Bsensing%2Bdata%2Bto%2Bimprove%2Bthe%2Baccuracy%2Bof%2Bhydrologic%2BAnd%2Bhydraulic%2Bmodels%22 [40] <https://www.bnhcrc.com.au/publications/biblio/export/bibtex/7198> [41] <https://www.bnhcrc.com.au/publications/biblio/export/xml/7198> [42] <https://www.bnhcrc.com.au/publications/biblio/bnh-6399> [43] <https://knowledge.aidr.org.au/resources/australian-journal-of-emergency-management-monograph-series/> [44] http://scholar.google.com/scholar?btnG=Search%2BScholar&as_q=%22Improving%2BFlood%2Bforecasting%2Bskill%2Busing%2Bremote%2Bsensed%2Bdata%22&as_sauthors=Wright&as_occt=any&as_epq=&as_oq=&as_eq=&as_eq=45 [45] <https://www.bnhcrc.com.au/publications/biblio/export/bibtex/6399> [46] <https://www.bnhcrc.com.au/publications/biblio/export/xml/6399> [47] <https://www.bnhcrc.com.au/publications/biblio/f%5Bauthor%5D=1663> [48] [https://www.bnhcrc.com.au/publications/biblio/bnh-5720](https://www.bnhcrc.com.au/publications/biblio/f%5Bauthor%5D=1664) [50] <http://dx.doi.org/10.1029/2018WR024289> [51] [https://www.bnhcrc.com.au/publications/biblio/bnh-5646](http://scholar.google.com/scholar?btnG=Search%2BScholar&as_q=%22Challenges%2C%2Bopportunities%2C%2BAnd%2BPitfalls%2Bfor%2BGlobal%2BCoupled%2Bhydrologic%E2%80%93%2Bhydraulic%2BModeling%2Bof%2BFloods%22&as_sauthors=G) [56] <http://dx.doi.org/10.1016/j.envsoft.2019.06.006> [57] http://scholar.google.com/scholar?btnG=Search%2BScholar&as_q=%22River%2BReconstruction%2Busing%2Ba%2Bconformal%2Bmapping%2Bmethod%22&as_sauthors=Hilton&as_occt=any&as_epq=&as_oq=&as_eq=&as_eq=58 [58] <https://www.bnhcrc.com.au/publications/biblio/export/bibtex/5646> [59] <https://www.bnhcrc.com.au/publications/biblio/export/xml/5646> [60] <https://www.bnhcrc.com.au/publications/biblio/bnh-5744> [61] http://scholar.google.com/scholar?btnG=Search%2BScholar&as_q=%22Improving%2BFlood%2Bforecast%2Busing%2Bremote%2Bsensing%2Bdata%2B-%2BAnnual%2BReport%2B2018-2019%22&as_sauthors=Pauwels&as_occt=any&as_epq=&as_oq=&as_eq=&as_eq=59 [62] <https://www.bnhcrc.com.au/publications/biblio/export/bibtex/5744> [63] <https://www.bnhcrc.com.au/publications/biblio/export/xml/5744> [64] <https://www.bnhcrc.com.au/publications/biblio/bnh-5396> [66] <https://search.informit.com.au/documentSummary;dn=134740719984631;res=I-LENG> [67] http://scholar.google.com/scholar?btnG=Search%2BScholar&as_q=%22Evaluation%2Bof%2BTandDEM-X%2BAnd%2BDEM-H%2Bdigital%2Belevation%2Bmodels%2Bover%2Bthe%2BCandamine-Balonne%2Bcatchment%22&as_sauthors=Wang&as_occt=any&as_epq=&as_oq=&as_eq=&as_eq=68 [69] <https://www.bnhcrc.com.au/publications/biblio/export/bibtex/5396> [70] <https://www.bnhcrc.com.au/publications/biblio/export/xml/5396> [71] [https://www.bnhcrc.com.au/publications/biblio/bnh-4462](https://www.bnhcrc.com.au/publications/biblio/f%5Bauthor%5D=1269) [72] http://scholar.google.com/scholar?btnG=Search%2BScholar&as_q=%22Hydrologic%2Bmodel%2Bcalibration%2Busing%2Bremote%2Bsensed%2Bsoil%2Bmoisture%2BAnd%2Bdischarge%2Bmeasurements%3A%2BThe%2Bimpact%2Bon%2Bpredictions%22 [73] <https://www.bnhcrc.com.au/publications/biblio/export/bibtex/4462> [74] <https://www.bnhcrc.com.au/publications/biblio/export/xml/4462> [75] <https://www.bnhcrc.com.au/publications/biblio/bnh-4461> [76] <http://dx.doi.org/10.1002/2017WR021765> [77] http://scholar.google.com/scholar?btnG=Search%2BScholar&as_q=%22Effective%2BRepresentation%2Bof%2BRiver%2BGeometry%2Bin%2BHydraulic%2BFlood%2BForecast%2BModels%22&as_sauthors=Grimaldi&as_occt=any&as_epq=&as_oq=&as_eq=&as_eq=78 [78] <https://www.bnhcrc.com.au/publications/biblio/export/bibtex/4461> [79] <https://www.bnhcrc.com.au/publications/biblio/export/xml/4461> [80] [https://www.bnhcrc.com.au/publications/biblio/bnh-5150](https://www.bnhcrc.com.au/publications/biblio/f%5Bauthor%5D=1499) [82] <http://dx.doi.org/10.3389/feart.2017.00114> [83] [http://dx.doi.org/10.1175/JHM-D-17-0240.1](http://scholar.google.com/scholar?btnG=Search%2BScholar&as_q=%22Impact%2Bof%2BBrain%2BGauge%2BQuality%2BControl%2BAnd%2BInterpolation%2Bon%2BStreamflow%2Bsimulation%3A%2BAn%2BApplication%2Bto%2Bthe%2BWarwick%2BCatchme) [88] http://scholar.google.com/scholar?btnG=Search%2BScholar&as_q=%22Identification%2Bof%2BHydrologic%2Bmodels%2C%2Boptimized%2Bparameteres%2C%2BAnd%2BBrainfall%2Binputs%2Bconsistent%2Bwith%2BIn%2Bsitu%2BStreamflow%2BAnd%2BBrain [89] <https://www.bnhcrc.com.au/publications/biblio/export/bibtex/5146> [90] <https://www.bnhcrc.com.au/publications/biblio/export/xml/5146> [91] <https://www.bnhcrc.com.au/people/michael-rumsewicz> [92] <https://www.bnhcrc.com.au/publications/researchproceedings2017> [93] http://scholar.google.com/scholar?btnG=Search%2BScholar&as_q=%22Research%2Bproceedings%2Bfrom%2Bthe%2B2017%2BBushfire%2BAnd%2BNatural%2BHazards%2BCRC%2BAnd%2BAFAC%2BConference%22&as_sauthors=Rumsewicz&as_occt=any&as_epq=&as_oq=&as_eq=&as_eq=94 [94] <https://www.bnhcrc.com.au/publications/biblio/export/bibtex/3946> [95] <https://www.bnhcrc.com.au/publications/biblio/export/xml/3946> [96] <https://www.bnhcrc.com.au/publications/biblio/bnh-3903> [97] http://scholar.google.com/scholar?btnG=Search%2BScholar&as_q=%22Improving%2BFlood%2Bforecast%2Bskill%2Busing%2Bremote%2Bsensing%2Bdata%22&as_sauthors=Li&as_occt=any&as_epq=&as_oq=&as_eq=&as_eq=98 [98] <https://www.bnhcrc.com.au/publications/biblio/export/bibtex/3903> [99] <https://www.bnhcrc.com.au/publications/biblio/export/xml/3903> [100] <https://www.bnhcrc.com.au/publications/biblio/bnh-4627> [101] <http://dx.doi.org/10.5194/hess-21-3827-2017> [102] http://scholar.google.com/scholar?btnG=Search%2BScholar&as_q=%22A%2Bcomparison%2Bof%2Bthe%2Bdiscrete%2Bcosine%2BAnd%2Bwavelet%2Btransforms%2Bfor%2Bhydrologic%2Bmodel%2Binput%2Bdata%2BReduction%22&as_sauthors=Wrig [103] <https://www.bnhcrc.com.au/publications/biblio/export/bibtex/4627> [104] <https://www.bnhcrc.com.au/publications/biblio/export/xml/4627> [105] <https://www.bnhcrc.com.au/publications/biblio/bnh-4626> [106] <https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1002/2017WR020442> [107] http://scholar.google.com/scholar?btnG=Search%2BScholar&as_q=%22Estimating%2BRainfall%2BTime%2Bseries%2BAnd%2Bmodel%2Bparameter%2Bdistributions%2Busing%2Bmodel%2Bdata%2BReduction%2BAnd%2Binversion%2Btechniques%22&as_sauthors=Grimaldi&as_occt=any&as_epq=&as_oq=&as_eq=&as_eq=108 [108] <https://www.bnhcrc.com.au/publications/biblio/export/bibtex/4626> [109] <https://www.bnhcrc.com.au/publications/biblio/export/xml/4626> [110] <https://www.bnhcrc.com.au/publications/biblio/bnh-4200> [111] http://scholar.google.com/scholar?btnG=Search%2BScholar&as_q=%22Improving%2BFlood%2Bforecast%2Bskill%2Busing%2Bremote%2Bsensing%2Bdata%3A%2BAnnual%2BReport%2B2016-17%22&as_sauthors=Pauwels&as_occt=any&as_epq=&as_oq=&as_eq=&as_eq=109 [112] <https://www.bnhcrc.com.au/publications/biblio/export/xml/4200> [113] <https://www.bnhcrc.com.au/publications/biblio/export/xml/4200> [114] <https://www.bnhcrc.com.au/publications/biblio/bnh-2946> [115] <https://www.bnhcrc.com.au/publications/biblio/export/bibtex/2946> [116] <https://www.bnhcrc.com.au/publications/biblio/export/xml/2946> [117] <https://www.bnhcrc.com.au/publications/biblio/bnh-3420> [118] <http://dx.doi.org/10.3390/rs8060456> [119] http://scholar.google.com/scholar?btnG=Search%2BScholar&as_q=%22Application%2Bof%2Bremote%2Bsensing%2Bdata%2Bto%2BConstrain%2BOperational%2BRainfall-Driven%2BFlood%2BForecasting%3A%2BA%2BReview%22&as_sauthors=Li&as_occt=any&as_epq=&as_oq=&as_eq=&as_eq=120 [120] <https://www.bnhcrc.com.au/publications/biblio/export/bibtex/3420> [121] <https://www.bnhcrc.com.au/publications/biblio/export/xml/3420> [122] <https://www.bnhcrc.com.au/publications/biblio/bnh-3546> [123] <http://dx.doi.org/10.1007/s10712-016-9378-y> [124] http://scholar.google.com/scholar?btnG=Search%2BScholar&as_q=%22Remote%2Bsensing-Derived%2BWater%2BExtent%2BAnd%2BLevel%2Bto%2BConstrain%2BHydraulic%2BFlood%2BForecasting%2BModels%3A%2Bopportunities%2BAnd%2BChallenges%22&as_sauthors=Grimaldi&as_occt=any&as_epq=&as_oq=&as_eq=&as_eq=125 [125] <https://www.bnhcrc.com.au/publications/biblio/export/bibtex/3546> [126] <https://www.bnhcrc.com.au/publications/biblio/export/xml/3546> [127] <https://www.bnhcrc.com.au/publications/biblio/f%5Bauthor%5D=955> [128] <https://www.bnhcrc.com.au/publications/biblio/bnh-2857> [129] http://scholar.google.com/scholar?btnG=Search%2BScholar&as_q=%22Remote-sensing%2BFlood%2Bdata%2Bfilling%2Bthe%2Bgaps%22&as_sauthors=Jones&as_occt=any&as_epq=&as_oq=&as_eq=&as_eq=129 [130] <https://www.bnhcrc.com.au/publications/biblio/export/bibtex/2857> [131] <https://www.bnhcrc.com.au/publications/biblio/export/xml/2857> [132] <https://www.bnhcrc.com.au/publications/biblio/bnh-3101> [133] http://scholar.google.com/scholar?btnG=Search%2BScholar&as_q=%22Improving%2BFlood%2Bforecast%2Bskill%2Busing%2Bremote%2Bsensing%3A%2BAnnual%2BProject%2BReport%2B2015-

2016%22&as_sauthors=Pauwels&as_occt=any&as_epq=&as_oq=&as_eq=&as_publication=&as_ylo=&as_yhi=&as_sdtAAP=1&as_sdtP=1 [134]
<https://www.bnhcrc.com.au/publications/biblio/export/bibtex/3101> [135] <https://www.bnhcrc.com.au/publications/biblio/export/xml/3101> [136] <https://www.bnhcrc.com.au/publications/biblio/bnh-2101> [137]
http://scholar.google.com/scholar?btnG=Search%2BScholar&as_q=%22Combining%2Bhydrologic%2BAnd%2Bhydraulic%2Bmodels%2Bfor%2Breal%2Btime%2Bflood%2Bforecasting%2B-%2Bnon%2Bpeer%2Breviewed%2Bextended%2Babstract%22&as_sauthors=Li&as_occt=any&as_epq=&as_oq=&as_eq=&as_publication=&as_ylo=&as_yhi=&as_sdtAAP=1&as_sdt
[138] <https://www.bnhcrc.com.au/publications/biblio/export/bibtex/2101> [139] <https://www.bnhcrc.com.au/publications/biblio/export/xml/2101> [140] <https://www.bnhcrc.com.au/publications/biblio/bnh-1543> [141]
http://scholar.google.com/scholar?btnG=Search%2BScholar&as_q=%22Improving%2BFlood%2BForecast%2BSkill%2BUsing%2BRemote%2BSensing%2BData%2BAnnual%2BReport%2B2014%22&as_sauthors=Pauwels&as_occt=any&as_epq=
[142] <https://www.bnhcrc.com.au/publications/biblio/export/bibtex/1543> [143] <https://www.bnhcrc.com.au/publications/biblio/export/xml/1543> [144] <https://www.bnhcrc.com.au/publications/biblio/bnh-2334> [145]
http://scholar.google.com/scholar?btnG=Search%2BScholar&as_q=%22Improving%2BFlood%2BForecast%2BSkill%2BUsing%2BRemote%2BSensing%2BData%3A%2BAnnual%2BProject%2BReport%2B2014-2015%22&as_sauthors=Pauwels&as_occt=any&as_epq=&as_oq=&as_eq=&as_publication=&as_ylo=&as_yhi=&as_sdtAAP=1&as_sdtP=1 [146]
<https://www.bnhcrc.com.au/publications/biblio/export/bibtex/2334> [147] <https://www.bnhcrc.com.au/publications/biblio/export/xml/2334> [148] https://www.bnhcrc.com.au/node/258/generate-pdf?order=field_date_release&sort=asc
[149] <https://www.bnhcrc.com.au/node/258/generate-pdf?order=title&sort=asc> [150] <https://www.bnhcrc.com.au/resources/presentation-slideshow/431> [151] <https://www.bnhcrc.com.au/file/523/download?token=oNBraY1d> [152]
<https://www.bnhcrc.com.au/research/topics/modelling> [153] <https://www.bnhcrc.com.au/research/topics/multi-hazard> [154] <https://www.bnhcrc.com.au/resources/presentation-slideshow/1490> [155]
<https://www.bnhcrc.com.au/file/4807/download?token=9WNvWpoV> [156] <https://www.bnhcrc.com.au/resources/presentation-slideshow/1489> [157] https://www.bnhcrc.com.au/file/4806/download?token=9_tSvAL [158]
<https://www.bnhcrc.com.au/resources/presentation-audio-video/3044> [159] <https://www.bnhcrc.com.au/file/6536/download?token=Uwy21qSG> [160] <https://www.bnhcrc.com.au/research/topics/scenario-analysis> [161]
<https://www.bnhcrc.com.au/resources/presentation-slideshow/3014> [162] <https://www.bnhcrc.com.au/file/6505/download?token=at41Dt7d> [163] <https://www.bnhcrc.com.au/research/topics/engineering> [164]
<https://www.bnhcrc.com.au/hazardnotes/29> [165] <https://www.bnhcrc.com.au/file/7350/download?token=Yrm8SPHY> [166] <https://www.bnhcrc.com.au/research/topics/hydrology> [167]
<https://www.bnhcrc.com.au/resources/presentation-slideshow/3772> [168] <https://www.bnhcrc.com.au/file/7585/download?token=TbBAJ5em> [169] <https://www.bnhcrc.com.au/research/topics/severe-weather> [170]
<https://www.bnhcrc.com.au/research/topics/storm-surge> [171] <https://www.bnhcrc.com.au/resources/presentation-slideshow/3982> [172] <https://www.bnhcrc.com.au/file/7838/download?token=ymYcjWkS> [173]
<https://www.bnhcrc.com.au/resources/presentation-audio-video/3044> [159] <https://www.bnhcrc.com.au/file/6536/download?token=Uwy21qSG> [160] <https://www.bnhcrc.com.au/research/topics/scenario-analysis> [161]
<https://www.bnhcrc.com.au/file/10378/download?token=7x0NzeQz> [177] <https://www.bnhcrc.com.au/resources/poster/1237> [178] <https://www.bnhcrc.com.au/resources/poster/1975> [179]
<https://www.bnhcrc.com.au/resources/poster/2044> [180] <https://www.bnhcrc.com.au/resources/poster/2058> [181] <https://www.bnhcrc.com.au/resources/poster/2884> [182] <https://www.bnhcrc.com.au/resources/poster/3714> [183]
<https://www.bnhcrc.com.au/resources/poster/3715> [184] <https://www.bnhcrc.com.au/resources/poster/4891> [185] <https://www.bnhcrc.com.au/resources/poster/5878> [186] <https://www.bnhcrc.com.au/resources/poster/7710> [187]
<https://www.bnhcrc.com.au/research/stormsurge> [188] <https://www.bnhcrc.com.au/research/cluster/flood-coastal-management> [189] <https://www.bnhcrc.com.au/research/waterlevels> [190]
<https://www.bnhcrc.com.au/organisations/uwa> [191] <https://www.bnhcrc.com.au/research/bushfireimpacts> [192] <https://www.bnhcrc.com.au/research/cluster/bushfire-predictive-services> [193]
<https://www.bnhcrc.com.au/organisations/anu> [194] <https://www.bnhcrc.com.au/research/firesurveillance> [195] <https://www.bnhcrc.com.au/organisations/rmit>