

Future Flows Hydrology: an ensemble of daily river flows and monthly groundwater levels for use for climate change impact assessment across Great Britain

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Supplementary Material

Table 1 Future Flows Hydrology river flow sites organised by regions

Region	Station (Hydrometric Register Number)	River Name	Station Name	Catchment area (km ²)	Station (Hydrometric Register Number)	River Name	Station Name	Catchment area (km ²)
SEPA North	2001	Helmsdale	Kilphedir	551.4	9003	Isla	Grange	176.1
	4003	Alness	Alness	201	10002	Ugie	Inverugie	325
	4005	Meig	Glenmeannie	120.5	11001	Don	Parkhill	1273
	6008	Enrick	Mill of Tore	105.9	12002	Dee	Park	1844
	7002	Findhorn	Forres	781.9	12003	Dee	Polhollick	690
	7004	Nairn	Firhall	313	12005	Muick	Invermuick	110
	7005	Divie	Dunphail	165	12008	Feugh	Heugh Head	229
	7006	Lossie	Torwinny	20	90003	Nevis	Claggan	69.2
	7009	Mosset Burn	Wardend Bridge	28.3	92002	Shiel	Shielfoot	256
	8004	Avon	Delnashaugh	542.8	93001	Carron	New Kelso	137.8
	8006	Spey	Boat o Brig	2861.2	94001	Ewe	Poolewe	441.1
	8009	Dulnain	Balnaa Bridge	272.2	95001	Inver	Little Assynt	137.5
	9001	Deveron	Avochie	441.6	97002	Thurso	Halkirk	412.8
	9002	Deveron	Muiresk	954.9				
SEPA East	13001	Bervie	Inverbervie	123	18005	Allan Water	Bridge of Allan	210
	13005	Lunan Water	Kirkton Mill	124	19006	Water of Leith	Murrayfield	107
	13007	North Esk	Logie Mill	732	19011	North Esk	Dalkeith Palace	137
	13008	South Esk	Brechin	488	20001	Tyne	East Linton	307
	13009	West Water	Dalhouse Bridge	127.2	21003	Tweed	Peebles	694
	14001	Eden	Kemback	307.4	21006	Tweed	Boleside	1500
	15006	Tay	Ballathie	4587.1	21009	Tweed	Norham	4390
	15014	Ardle	Kindrogan	103	21012	Teviot	Hawick	323
	15023	Braan	Hermitage	210	21013	Gala Water	Galashiels	207
	15024	Dochart	Killin	239	21015	Leader Water	Earlston	239
	15025	Ericht	Craighall	432	21017	Ettrick Water	Brockhoperig	37.5

Region	Station (Hydrometric Register Number) River Name	Station Name	Catchment area (km ²)	Station (Hydrometric Register Number) River Name	Station Name	Catchment area (km ²)
	16003 Ruchill Water	Cultybraggan	99.5	21021 Tweed	Sprouston	3330
	16007 Ruthven Water	Aberuthven	50	21022 Whiteadder Water	Hutton Castle	503
	17003 Bonny Water	Bonnybridge	50.5	21023 Leet Water	Coldstream	113
	17005 Avon	Polmonthill	195.3	21027 Blackadder Water	Mouth Bridge	159
	17015 North Queich	Lathro	23.1	21031 Till	Etal	648
	17016 Lochty Burn	Whinnyhall	14	21032 Glen	Kirknewton	198.9
	18001 Allan Water	Kinbuck	161			
SEPA West	77002 Esk	Canonbie	495	84003 Clyde	Hazelbank	1092.9
	77003 Liddel Water	Rowanburnfoot	319	84004 Clyde	Sills of Clyde	741.8
	77004 Kirtle Water	Mossknowe	72	84005 Clyde	Blairston	1704.2
	77304 Liddell Water	Newcastleton	207	84012 White Cart Water	Hawkhead	234.9
	78003 Annan	Brydekirk	925	84013 Clyde	Daldowie	1903.1
	78005 Kinnel Water	Bridgemuir	229	84015 Kelvin	Dryfield	235.4
	78006 Annan	Woodfoot	217	84016 Luggie Water	Condorrat	33.9
	78999 Evan Water	Beattock	80	84018 Clyde	Tulliford Mill	932.6
	79002 Nith	Friars Carse	799	84020 Glazert Water	Milton of Campsie	51.9
	79003 Nith	Hall Bridge	155	84022 Duneaton	Maidencots	110.3
	79006 Nith	Drumlanrig	471	84026 Allander Water	Milngavie	32.8
	80005 Dargall Lane	Loch Dee	2.1	84029 Cander Water	Candermill	24.5
	81002 Cree	Newton Stewart	368	84037 Douglas Water	Happendon	97
	81005 Piltanton Burn	Barsolus	34.2	85002 Endrick Water	Gaidrew	219.9
	81007 Water of Fleet	Rusko	77	85003 Falloch	Glen Falloch	80.3
	82001 Girvan	Robstone	245.5	89003 Orchy	Glen Orchy	251.2
	83005 Irvine	Shewalton	380.7	89004 Strae	Glen Strae	36.2
	83007 Lugton Water	Eglinton Castle	54.6	89005 Lochy	Inverlochy	47.7
	83010 Irvine	Newmilns	72.8	89008 Eas Daimh	Eas Daimh	4.5
	83011 Ayr	Wellwood	60	89009 Eas a' Ghail	Succoth	9.7
EA North East	22001 Coquet	Morwick	569.8	27007 Ure	Westwick Lock	914.6
	22004 Aln	Hawkhill	205	27009 Ouse	Skelton	3315
	22009 Coquet	Rothbury	346	27021 Don	Doncaster	1256.2
	23004 South Tyne	Haydon Bridge	751.1	27034 Ure	Kilgram Bridge	510.2
	23006 South Tyne	Featherstone	321.9	27035 Aire	Kildwick Bridge	282.3
	23011 Kielder Burn	Kielder	58.8	27041 Derwent	Buttercrambe	1586
	24002 Gaunless	Bishop Auckland	93	27042 Dove	Kirkby Mills	59.2

Region	Station (Hydrometric Register Number) River Name	Station Name	Catchment area (km ²)	Station (Hydrometric Register Number) River Name	Station Name	Catchment area (km ²)
	24005 Browney	Burn Hall	178.5	27043 Wharfe	Addingham	427
	24009 Wear	Chester le Street	1008.3	27049 Rye	Ness	238.7
	25005 Leven	Leven Bridge	196.3	27055 Rye	Broadway Foot	131.7
	25007 Clow Beck	Croft	78.2	27071 Swale	Crakehill	1363
	25019 Leven	Easby	14.8	27084 Eastburn Beck	Crosshills	43.4
	25020 Skerne	Preston le Skerne	147			
EA Midlands	28008 Dove	Rocester Weir	399	28066 Cole	Coleshill	130
	28018 Dove	Marston on Dove	883.2	54001 Severn	Bewdley	4325
	28022 Trent	North Muskham	8231	54008 Teme	Tenbury	1134.4
	28030 Black Brook	Onebarrow	8.4	54018 Rea Brook	Hookagate	178
	28031 Manifold	Ilam	148.5	54022 Severn	Plynlimon flume	8.7
	28033 Dove	Hollinsclough	8	54036 Isbourne	Hinton on the Green	90.7
	28046 Dove	Izaak Walton	83	54038 Tanat	Llanyblodwel	229
	28055 Ecclesbourne	Duffield	50.4	54057 Severn	Haw Bridge	9895
EA Anglian	30018 Honington Beck	Honington	51.	33063 Little Ouse	Knettishall	101
	31010 Chater	Fosters Bridge	68.9	34002 Tas	Shotesham	146.5
	31020 Morcott Brook	South Luffenham	19.6	34006 Waveney	Needham Mill	370
	33012 Kym	Meagre Farm	137.5	34011 Wensum	Fakenham	161.9
	33014 Lark	Temple	272	34014 Wensum	Swanton Morley Total	397.8
	33018 Tove	Cappenhame Bridge	138.1	34018 Stiffkey	Warham All Saints	87.8
	33019 Thet	Melford Bridge	316	35008 Gipping	Stowmarket	128.9
	33026 Bedford Ouse	Offord	2570	36005 Brett	Hadleigh	156
	33027 Rhee	Wimpole	119.1	36007 Belchamp Brook	Bardfield Bridge	58.6
	33029 Stringside	Whitebridge	98.8	37001 Roding	Redbridge	303.3
	33044 Thet	Bridgham	277.8	37011 Chelmer	Churchend	72.6
	33049 Stanford Water	Buckenham Tofts	43.5	37019 Beam	Bretons Farm	49.7
EA Thames	30018 Witham	Colsterworth	51.3	39057 Crane	Cranford Park	61.7
	38003 Mimram	Panshanger Park	133.9	39076 Windrush	Worsham	296
	38014 Salmon Brook	Edmonton	20.5	39081 Ock	Abingdon	234
	39001 Thames	Kingston	9948	39090 Cole	Inglesham	140
	39006 Windrush	Newbridge	362.6	39092 Dollis Brook	Hendon Lane Bridge	25.1
	39008 Thames	Eynsham	1616.2	39096 Wealdstone Brook	Wembley	21.8
	39016 Kennet	Theale	1033.4	39103 Kennet	Newbury	548.1

Region	Station (Hydrometric Register Number)	River Name	Station Name	Catchment area (km ²)	Station (Hydrometric Register Number)	River Name	Station Name	Catchment area (km ²)
	39034	Evenlode	Cassington Mill	430	39105	Thame	Wheatley	533.8
	39049	Silk Stream	Colindeep Lane	29	39131	Brent	Costons Lane Greenford	146.2
EA Southern	40003	Medway	Teston	1256.1	41011	Rother	Iping Mill	154
	40011	Great Stour	Horton	345	41022	Lod	Halfway Bridge	52
	40017	Dudwell	Burwash	27.5	41026	Cockhaise Brook	Holywell	36.1
	40023	East Stour	South Willesborough	58.8	42012	Anton	Fullerton	185
	43003	Avon	East Mills	1477.8	47008	Thrushel	Tinhay	112.7
	43005	Avon	Amesbury	323.7	47014	Walkham	Horrabridge	44.6
	43006	Nadder	Wilton	220.6	48003	Fal	Tregony	87
	43007	Stour	Throop	1073	49001	Camel	Denby	208.8
EA South West	43021	Avon	Knapp Mill	1706	50002	Torridge	Torrington	663
	44002	Piddle	Baggs Mill	183.1	50006	Mole	Woodleigh	327.5
	45001	Exe	Thorverton	600.9	50007	Taw	Taw Bridge	71.4
	45004	Axe	Whitford	288.5	51001	Doniford Stream	Swill Bridge	75.8
	45005	Otter	Dotton	202.5	52004	Isle	Ashford Mill	90.1
	45009	Exe	Pixton	159.7	52010	Brue	Lovington	135.2
	45011	Barle	Brushford	128	53005	Midford Brook	Midford	147.4
	46003	Dart	Austins Bridge	247.6	53006	Frome(Bristol)	Frenchay	148.9
	46005	East Dart	Bellever	21.5	53017	Boyd	Bitton	47.9
	46006	Erme	Ermington	43.5	53018	Avon	Bathford	1552
	47001	Tamar	Gunnislake	916.9				
EA Wales	55002	Wye	Belmont	1895.9	60002	Cothi	Felin Mynachdy	297.8
	55003	Lugg	Lugwardine	885.8	60004	Dewi Fawr	Glasfryn Ford	36.7
	55004	Irfon	Abernant	72.8	60006	Gwili	Glangwili	129.5
	55007	Wye	Erwood	1282.1	61001	Western Cleddau	Prendergast Mill	197.6
	55029	Monnow	Grosmont	354	62001	Teifi	Glan Teifi	893.6
	56002	Ebbw	Rhiwderyn	216.5	62002	Teifi	Llanfair	510
	56003	Honddu	The Forge Brecon	62.1	63001	Ystwyth	Pont Llolwyn	169.6
	56005	Lwyd	Ponthir	98.1	63004	Ystwyth	Cwm Ystwyth	32.1
	56007	Senni	Pont Hen Hafod	19.9	64001	Dyfi	Dyfi Bridge	471.3
	56013	Yscir	Pontaryscir	62.8	64002	Dysynni	Pont-y-Garth	75.1
	56019	Ebbw	Aberbeeg	71.7	65001	Glaslyn	Beddgelert	68.6
	57004	Cynon	Abercynon	106	65006	Seiont	Peblig Mill	74.4
	58005	Ogmore	Brynmenyn	74.3	66011	Conwy	Cwmlanerch	344.5

Region	North Wales			North West		
	Station (Hydrometric Register Number) River Name	Station Name	Catchment area (km ²)	Station (Hydrometric Register Number) River Name	Station Name	Catchment area (km ²)
North Wales	58007 Llynfi	Coytrahen	50.2	67005 Ceiriog	Brynkinalt Weir	113.7
	58008 Dulais	Cilfrew	43	67010 Gelyn	Cynefail	13.1
	58012 Afan	Marcroft Weir	87.8	67013 Hirnant	Plas Rhiwedog	33.9
	59001 Tawe	Ynystanglws	227.7			
	60009 Sawdde	Felin-y-cwm	77.5			
North West	68001 Weaver	Ashbrook	622	73006 Cunsey Beck	Eel House Bridge	18.7
	68003 Dane	Rudheath	407.1	73009 Sprint	Sprint Mill	34.6
	68005 Weaver	Audlem	207	73011 Mint	Mint Bridge	65.8
	69042 Ding Brook	Naden Reservoir	2.2	73013 Rothay	Miller Bridge House	64
	71001 Ribble	Samlesbury	1145	73014 Brathay	Jeffy Knotts	57.4
	71006 Ribble	Henthorn	456	74001 Duddon	Duddon Hall	85.7
	71009 Ribble	New Jumbles Rock	1053	74005 Ehen	Braystones	125.5
	72004 Lune	Caton	983	74006 Calder	Calder Hall	44.8
	72009 Wenning	Wennington	142	74007 Esk	Crople How	70.2
	72014 Conder	Galgate	28.5	75017 Ellen	Bullgill	96
	72015 Lune	Lunes Bridge	141.5	76005 Eden	Temple Sowerby	616.4
	73003 Kent	Burneside	73.6	76007 Eden	Sheepmount	2286.5
	73005 Kent	Sedgwick	209	76008 Irthing	Greenholme	334.6

Table 2 Future Flows Hydrology groundwater sites

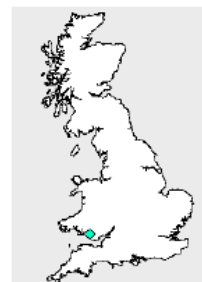
Observation Borehole (Hydrometric Register Number)	Observation Borehole Name	Aquifer
SY68/34	Ashton Farm	Chalk
TA10/63	Aylesby	Chalk
SU81/1	Chilgrove House	Chalk
SU34/8D	Clanville Lodge Gate	Chalk
SE94/5	Dalton Holme	Chalk
ST88/62A	Didmarton 1	Inferior Oolite
SD27/6B	Furness Abbey	Permo-Triassic Sandstone
TL89/37	Grimes Graves	Chalk
SJ62/112	Heathlanes	Permo-Triassic Sandstone
SK17/13	Hucklow South	Carboniferous Limestone
TR14/9	Little Bucket Farm	Chalk
SJ15/13	Llanfair Dyffryn Clwyd	Permo-Triassic Sandstone
TQ41/82	Lower Barn Cottage	Lower Greensand
TF03/37	New Red Lion	Lincolnshire Limestone
NX97/2	Newbridge	Permo-Triassic Sandstone
SU17/57	Rockley	Chalk
NY63/2	Skirwith	Permo-Triassic Sandstone
SU78/45A	Stonor Park	Chalk
NZ21/29	Swan House	Magnesian Limestone
TL33/4	Therfield Rectory	Chalk
TF81/2A	Washpit Farm	Chalk
TQ25/13	Well House Inn	Chalk
TV59/7C	West Dean No. 3	Chalk
SU01/5B	West Woodyates Manor	Chalk

Example of river flow catchment fact sheet - the Llynfi at Coytrahen (58007)

Catchment Fact Sheet 58007 Future Flows and Groundwater Levels

General Information

River Name	Llynfi	Catchment Area (km ²)	50
Station Name	Coytrahen	SAAR (mm) 61-90	1769
Station Number	58007	Mean Annual Rain (mm) 62-91	1781
Grid Reference	SS891855	Mean Annual PE (mm) 62-91	614
EA Region	EA-W	Observed flow record	1970 to 2005



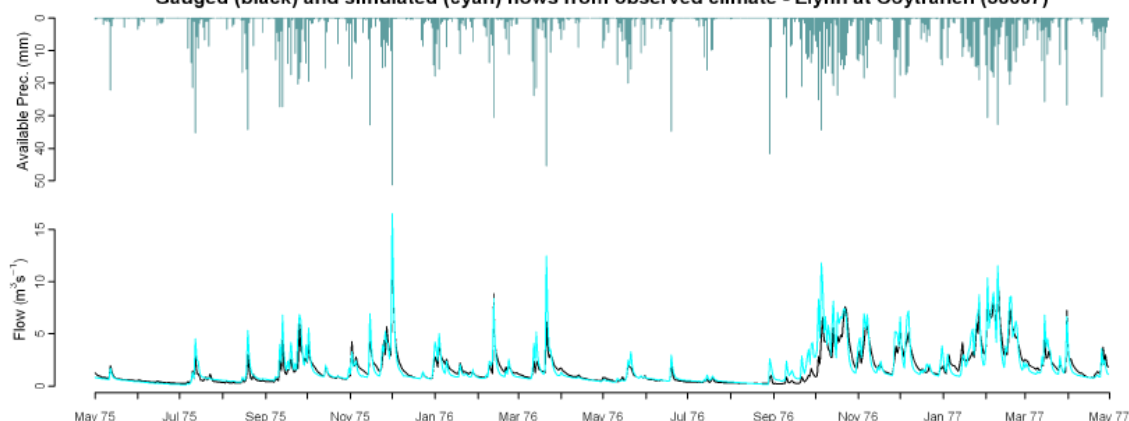
Observed Data

Comparison of gauged and simulated flow

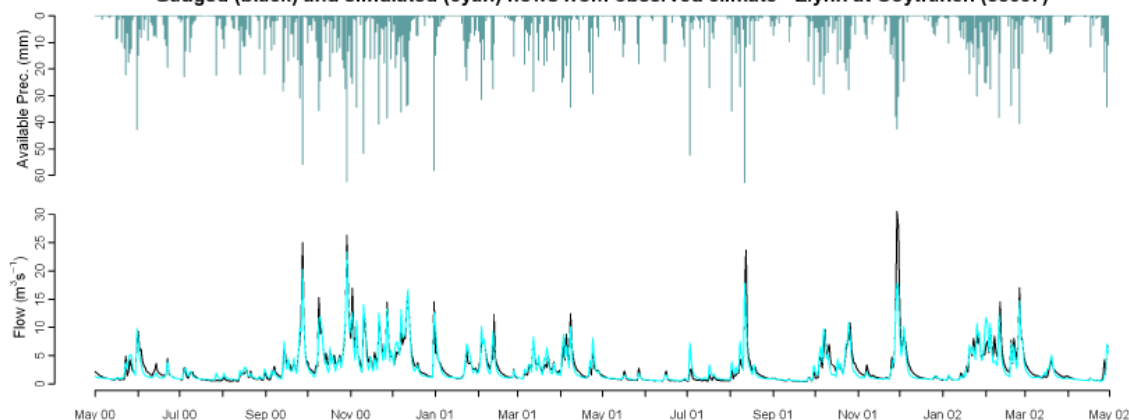
Model used: CERF

	Mean Annual	J	F	M	A	M	J	J	A	S	O	N	D	Nash Sutcliffe
MORECS (1971-2005)	-1.3	-0.1	-4.6	-8.9	-11.4	-6.2	-5.6	1.6	8.3	12.6	5.6	-1.7	-1.7	0.80
Performance Band	1	1	1	1	2	2	1	1	2	2	1	1	1	1
MORECS (1962-1991)	1.4	1.0	-1.7	-6.1	-12.0	-7.8	-1.2	2.3	9.7	24.7	7.1	-0.1	0.8	0.80
	Q90	Q75	Q50	Q25	Q5	RP2	RP5	RP10	RP20					
MORECS (1971-2005)	9.9	5.6	-17.4	-9.5	13.9									
Performance Band	1	1	1	1	1									
MORECS (1962-1991)	9.8	6.4	-17.0	-7.6	16.2									

Gauged (black) and simulated (cyan) flows from observed climate - Llynfi at Coytrahen (58007)

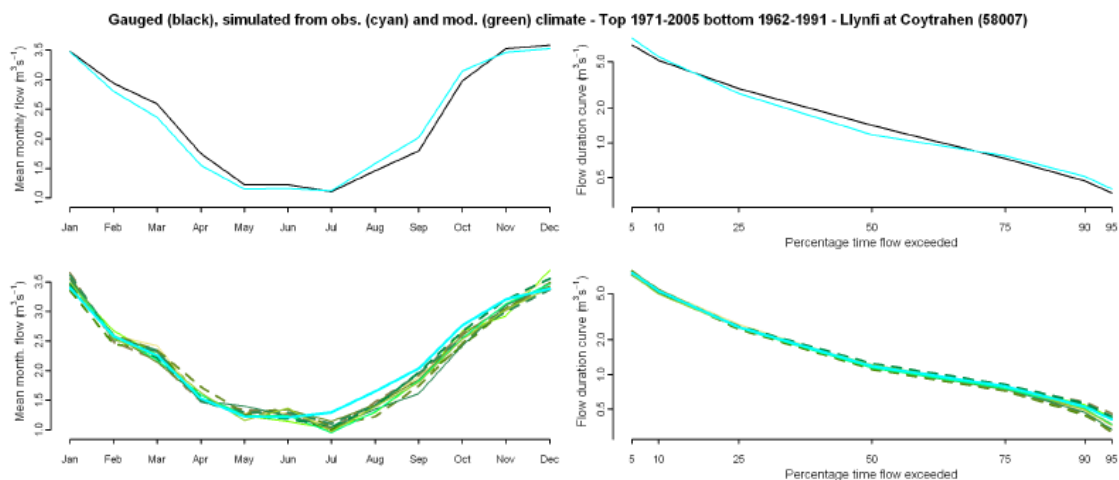


Gauged (black) and simulated (cyan) flows from observed climate - Llynfi at Coytrahen (58007)



Catchment Fact Sheet 58007 Future Flows and Groundwater Levels

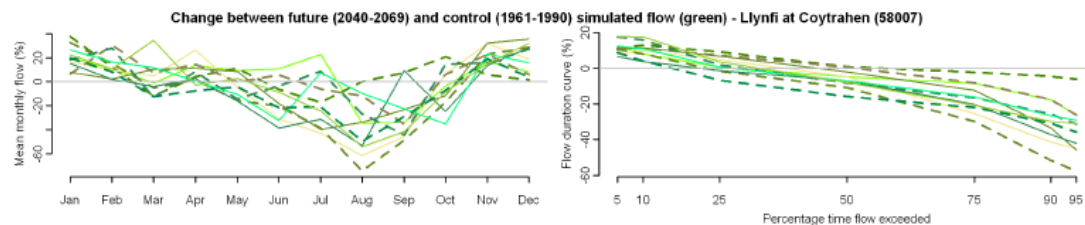
Comparison of gauged and simulated flow (observed and modelled climate)



Percentage difference between flow simulated from observed climate and Future Flows Climate

	afgcx	afixa	afixc	afixh	afixi	afixj	afixk	afixl	afixm	afixo	afixq
Annual	-1	-2	0	0	-2	-1	-3	-1	-3	-2	-2
January	3	-1	8	6	5	4	3	8	3	0	6
April	-1	-1	0	3	1	13	2	0	0	-1	6
July	-22	-18	-13	-17	-17	-14	-19	-11	-25	-22	-25
October	-3	-4	-10	-2	-9	-6	-5	-7	-5	-2	-8
Q90	4	-17	-8	11	-10	-15	-13	2	-6	3	-5
Q75	0	-10	-4	2	-8	-9	-5	0	-6	1	-1
Q50	1	-6	0	3	-4	-3	2	2	-4	4	1
Q25	0	-4	5	0	-3	1	0	2	-3	1	-1
Q5	-3	4	-1	-1	1	2	-4	2	-1	-5	-3
RP2	1	5	2	7	0	-5	4	-4	9	3	5
RP10	1	-1	-1	3	-4	-7	-1	-4	10	-3	-2

Climate change graphs for 2050s



Example of groundwater level catchment fact sheet – Washpit Farm (TF81/2A)

Catchment Fact Sheet TF81/2A Future Flows and Groundwater Levels

General Information

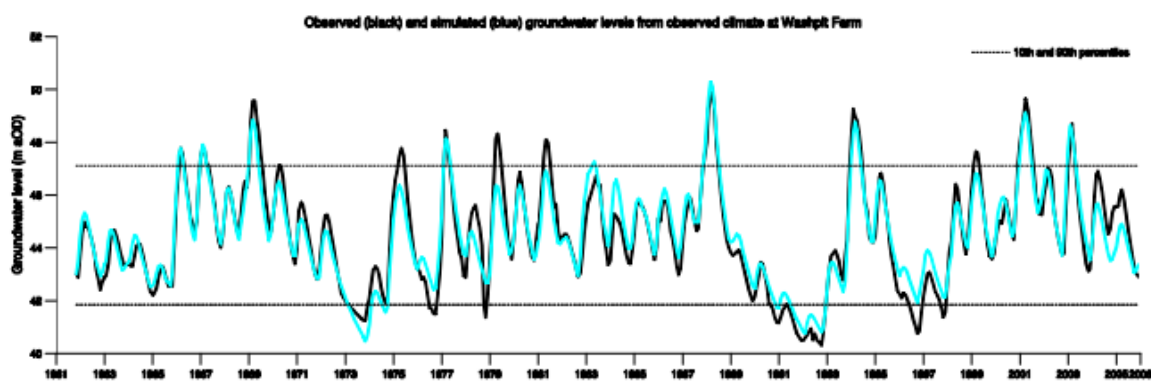
Borehole Name	Washpit Farm	Grid Reference	TF 81351960
Borehole ID	TF81/2A	Mean Annual Rainfall (mm)	730
Principal Aquifer	Chalk Group	Period of observed level data	1961 - 2005
EA Region	Anglian		



Observed Data Comparison of observed and simulated levels (m) Model used: R-Groundwater

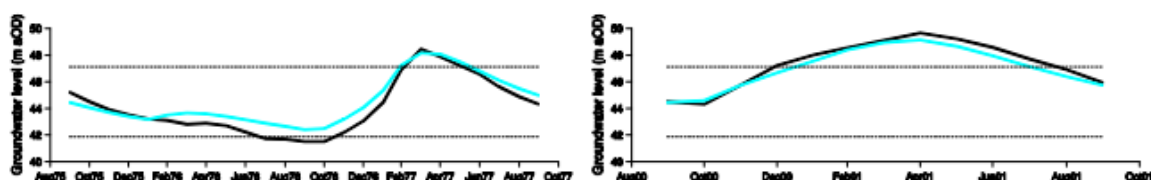
	Mean Annual	J	F	M	A	M	J	J	A	S	O	N	D	NSE	RMSE
1961 - 2005	0.01	0.17	0.12	0.00	-0.09	-0.21	-0.22	-0.15	-0.07	0.04	0.12	0.21	0.18	0.90	0.63
Performance	1	1	1	1	1	1	1	1	1	1	1	1	1	1	

	L90	L75	L50	L25	L10		%
1961 - 2005	0.45	0.21	-0.02	-0.06	-0.30	Error (sim-obs) in range (max-min)	2.91
Performance	1	1	1	1	1	Performance	1

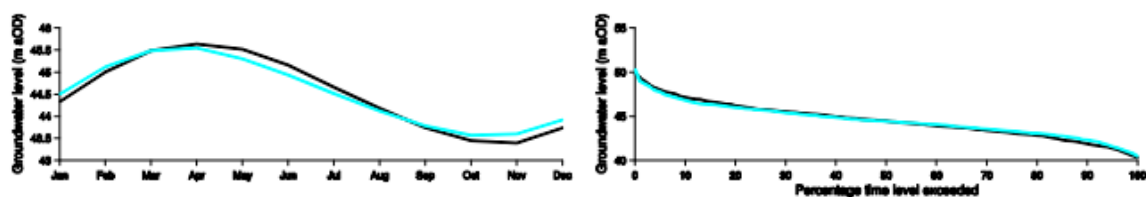


Comparison of observed and simulated levels (observed climate)

Selected observed (black) and simulated (blue) groundwater levels at Washpit Farm



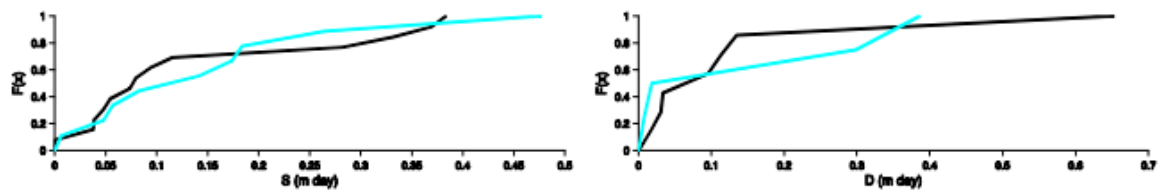
Statistics from observed (black) and simulated (blue) groundwater levels from observed climate at Washpit Farm



Catchment Fact Sheet TF81/2A

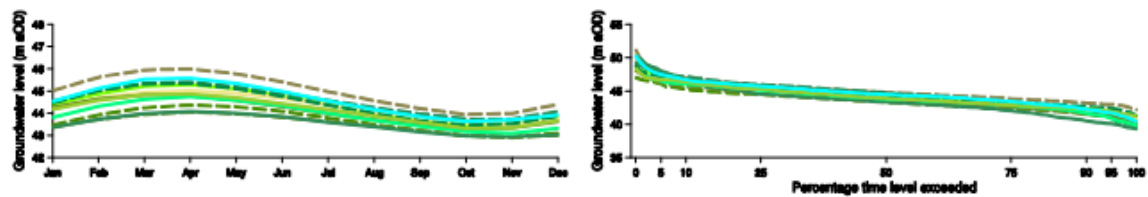
Future Flows and Groundwater Levels

Surplus (S) and Deficit (D) distributions from observed (black) and simulated (blue) groundwater levels from observed climate at Washpit Farm



Difference (m) between levels simulated from observed climate and Future Flows Climate

Comparison of groundwater levels simulated using observed climate (blue) and Future Flows Climate (green)



(m)	afgcx	afixa	afixc	afixh	afixi	afixj	afixk	afixl	afixm	afixo	afixq
Annual	-0.20	-0.92	-0.29	-0.41	-0.50	-1.07	-1.07	-0.01	-0.65	-0.17	-0.45
Jan	-0.16	-1.08	-0.34	0.47	-0.29	-1.18	-1.18	-0.02	-0.73	-0.08	-0.37
Feb	-0.25	-1.21	-0.46	0.48	-0.48	-1.41	-1.40	-0.08	-0.81	-0.12	-0.55
Mar	-0.31	-1.29	-0.59	0.42	-0.71	-1.58	-1.54	-0.18	-0.89	-0.21	-0.70
Apr	-0.30	-1.22	-0.58	0.41	-0.78	-1.55	-1.51	-0.19	-0.85	-0.25	-0.72
May	-0.25	-1.06	-0.45	0.42	-0.75	-1.38	-1.34	-0.16	-0.76	-0.24	-0.65
Jun	-0.20	-0.91	-0.30	0.43	-0.68	-1.17	-1.14	-0.09	-0.65	-0.21	-0.55
Jul	-0.17	-0.78	-0.18	0.42	-0.57	-0.93	-0.97	0.01	-0.56	-0.19	-0.40
Aug	-0.16	-0.68	-0.11	0.40	-0.45	-0.74	-0.78	0.09	-0.48	-0.17	-0.29
Sep	-0.16	-0.63	-0.07	0.36	-0.37	-0.62	-0.69	0.13	-0.43	-0.19	-0.25
Oct	-0.16	-0.67	-0.08	0.30	-0.33	-0.64	-0.66	0.10	-0.46	-0.20	-0.31
Nov	-0.19	-0.78	-0.20	0.29	-0.37	-0.80	-0.76	0.03	-0.60	-0.18	-0.36
Dec	-0.10	-0.83	-0.21	0.47	-0.31	-0.92	-0.90	0.13	-0.61	-0.07	-0.26

Climate change graphs for 2050s

Change between future (2041–2070) and control (1981–1990) simulated levels at Washpit Farm

