

University of Bath Coal Tip Update

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UNIVERSITY OF
BATH

Team Members



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Challenges

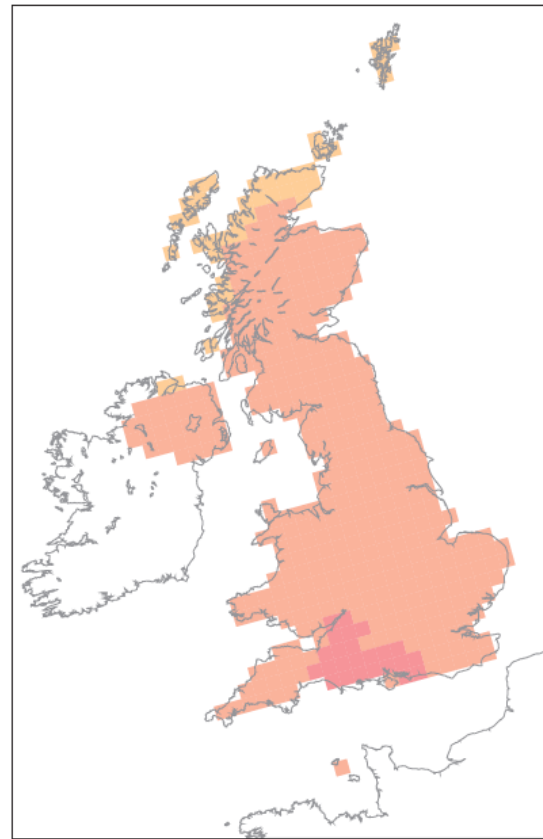
Climate

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graph TD; A[Climate] --> B[Geotechnical uncertainty]; B --> C[Consequence of failures];
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Geotechnical uncertainty

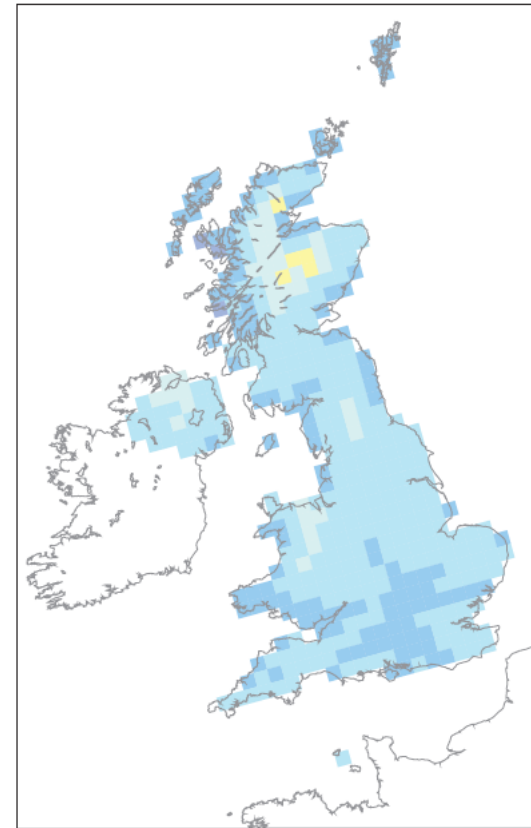
Consequence of failures

Local climate projections



0 1 2 3 4 5 6 7 8 9 10
Change in mean temperature (°C)

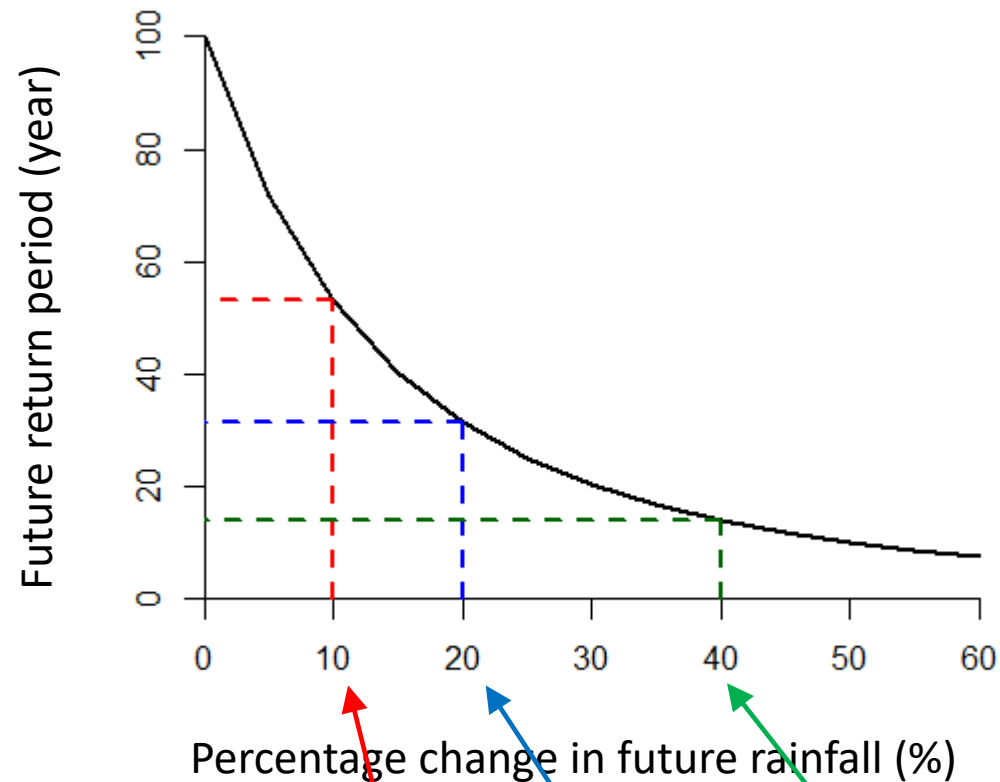
Summer, 2080



-70 -50 -30 -10 0 10 30 50 70
Change in precipitation (%)

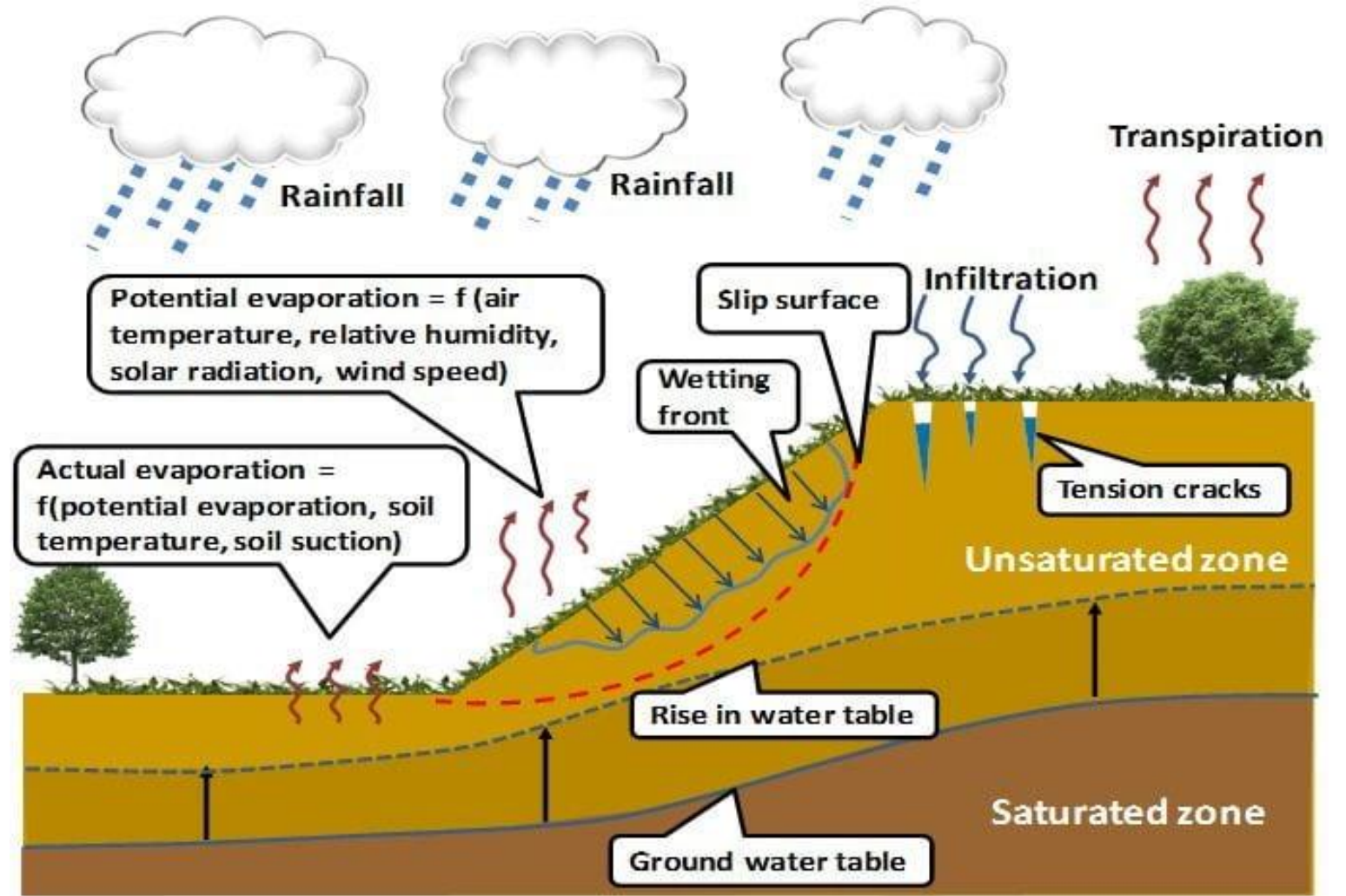
Winter, 2080

Extreme rainfall is changing - Defra guidance

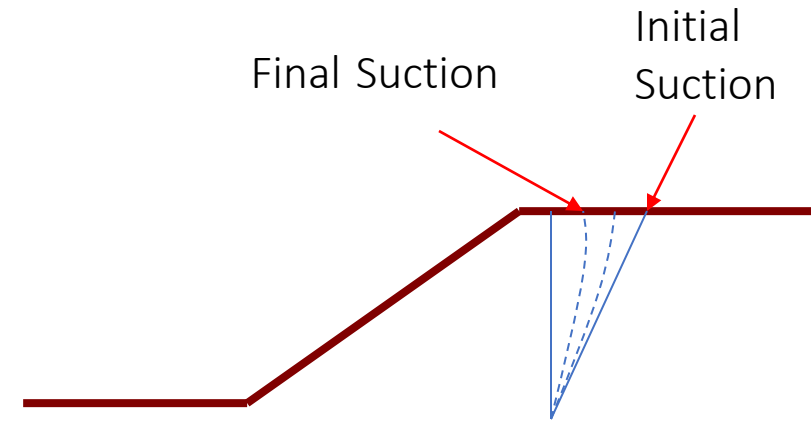
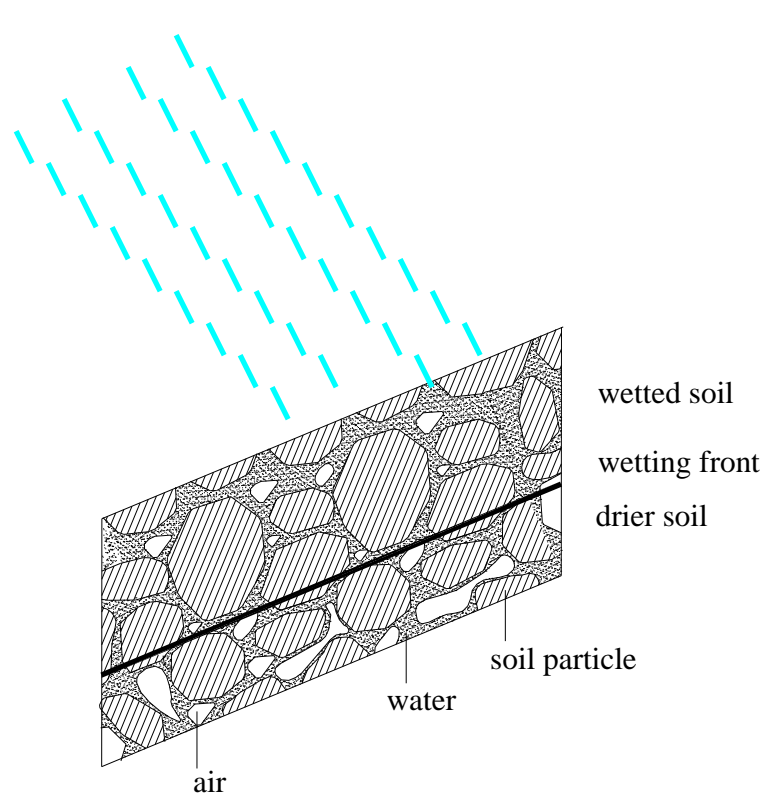


Applies across all of England	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper end	10%	20%	40%
Central	5%	10%	20%

General slope stability issues

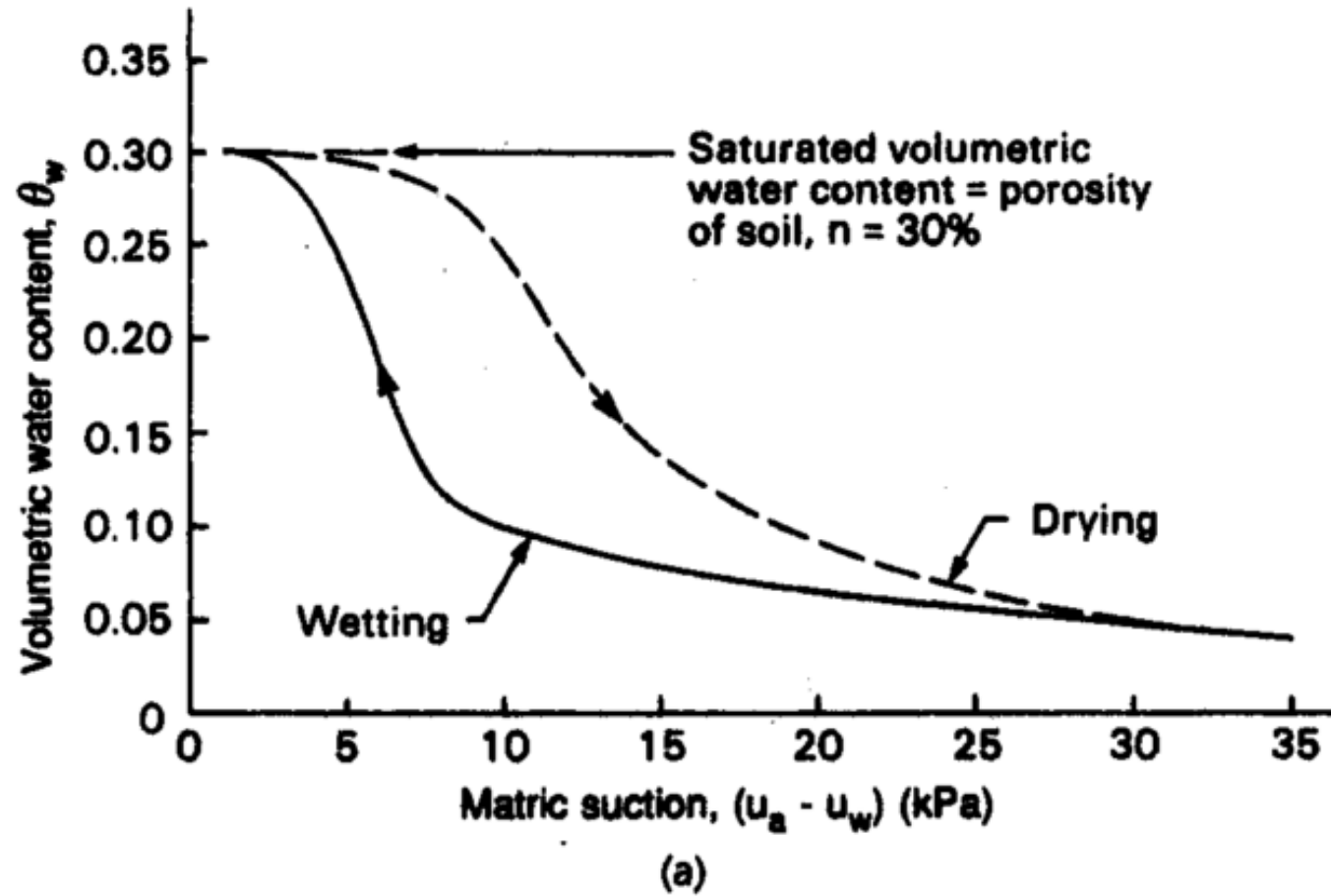


Stability is affected by rainfall



As rain falls, suctions reduce.
A wetting front develops as
the ground becomes *almost*
saturated from the top down

SWCC

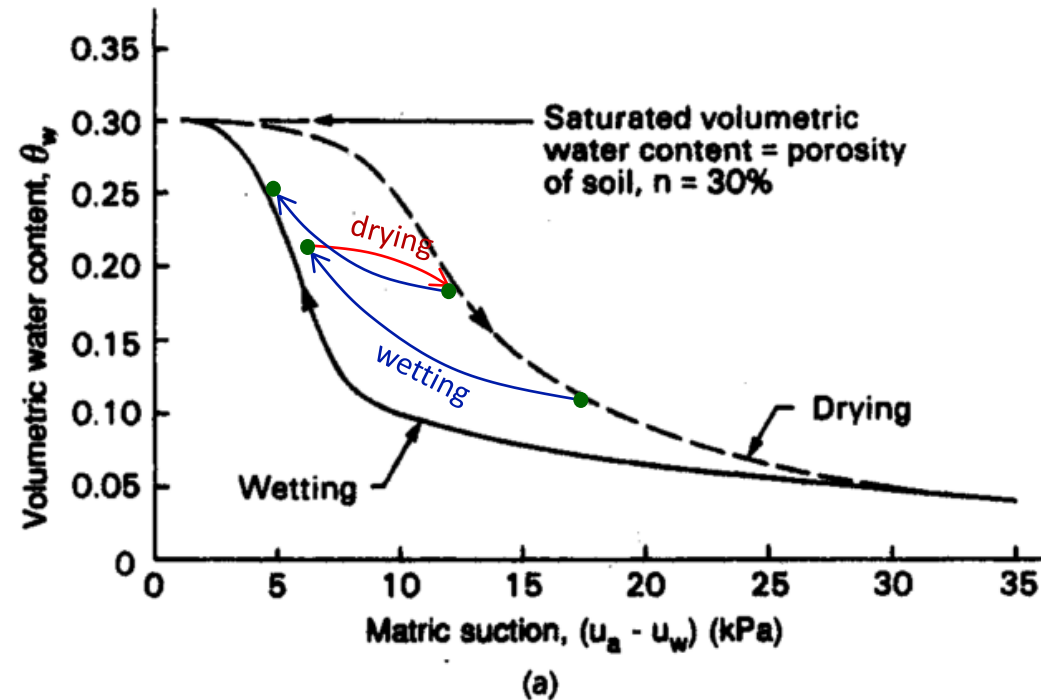


Scanning curves

In the real world, unsaturated soil never starts off as fully dry or fully wet

Scanning curves describe the relation between suction and soil moisture when not starting fully wet or fully dry

These always lie between the **wetting** and **drying** curves (extreme cases)

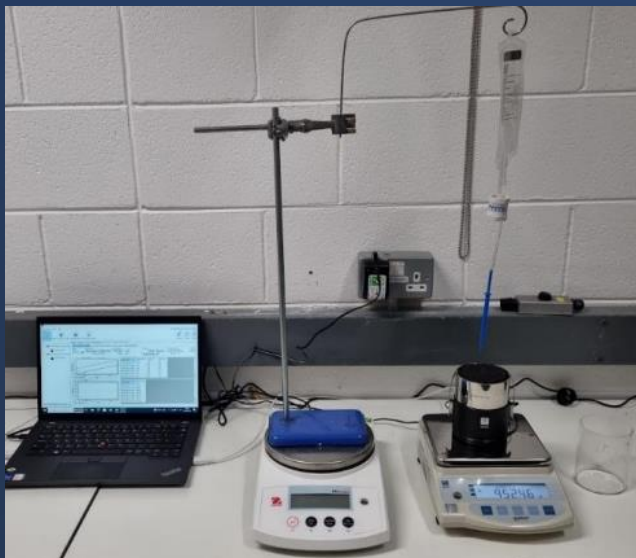
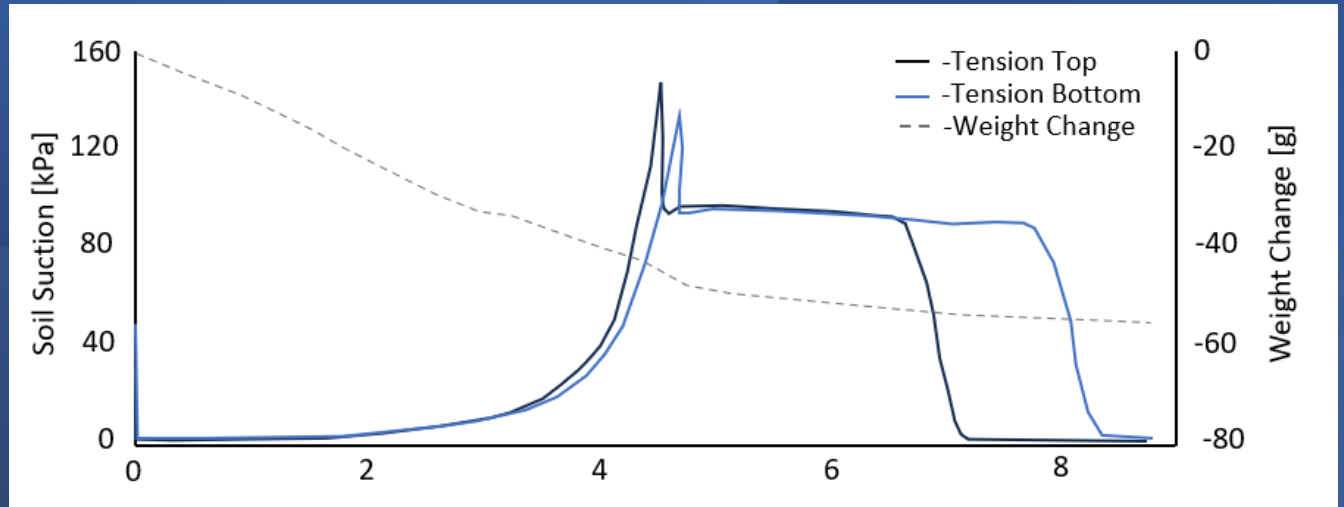


Measuring SWCC

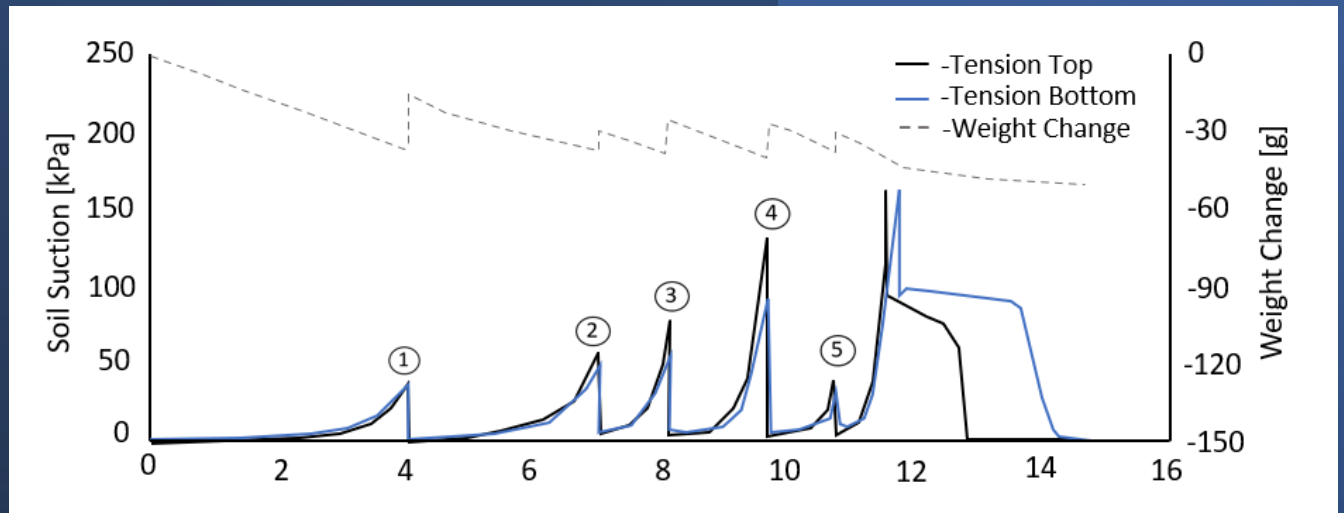




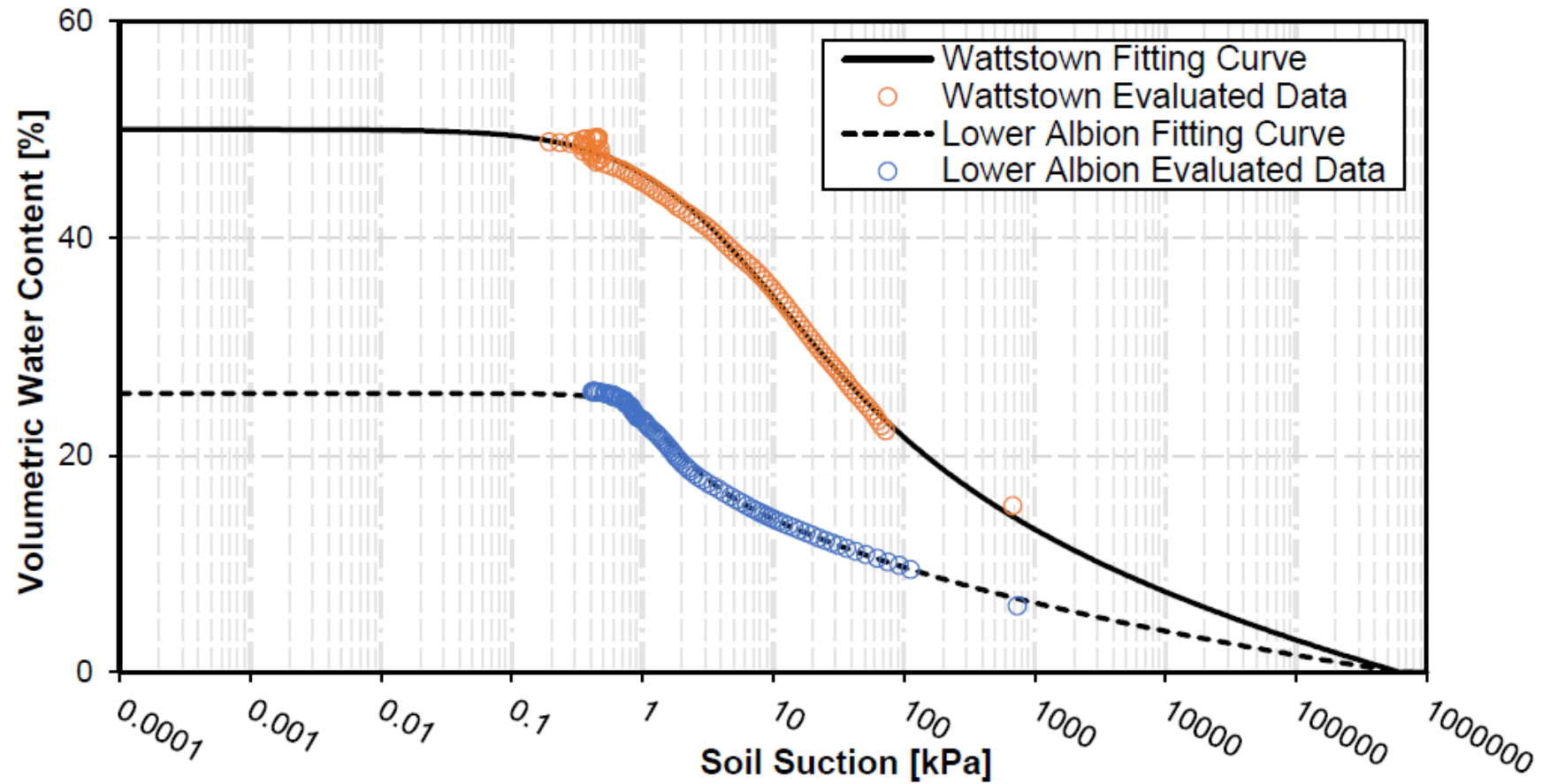
Drying



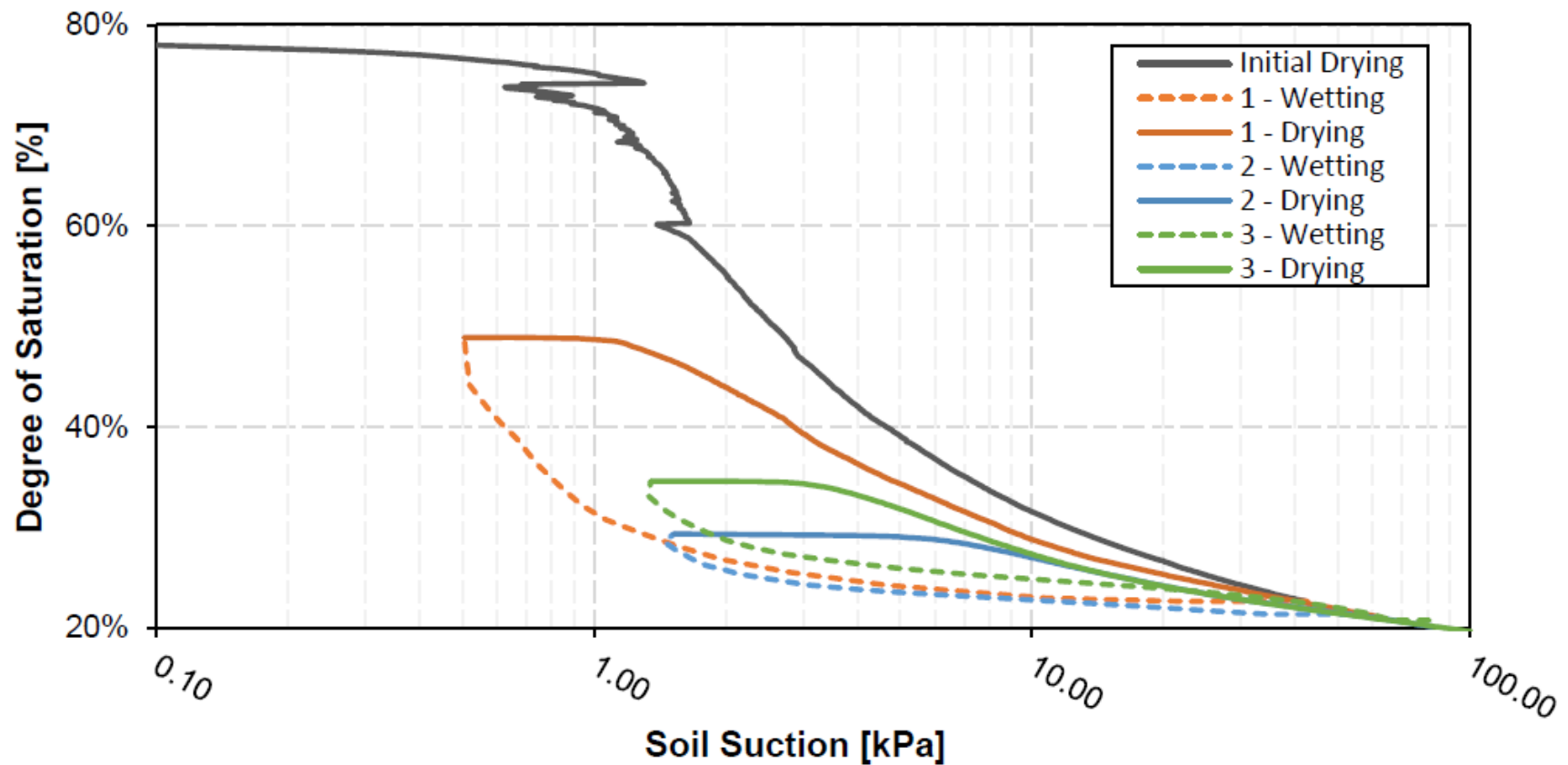
Rainfall



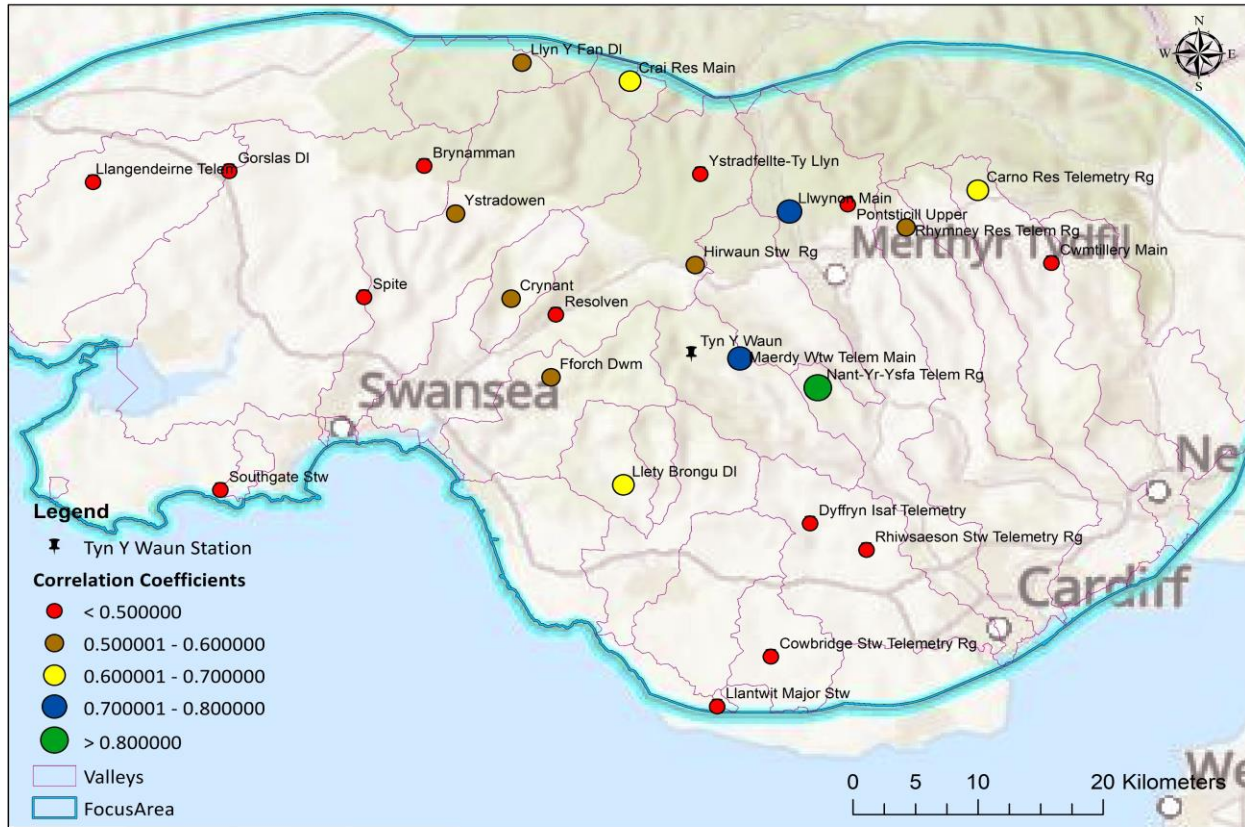
Drying Curves



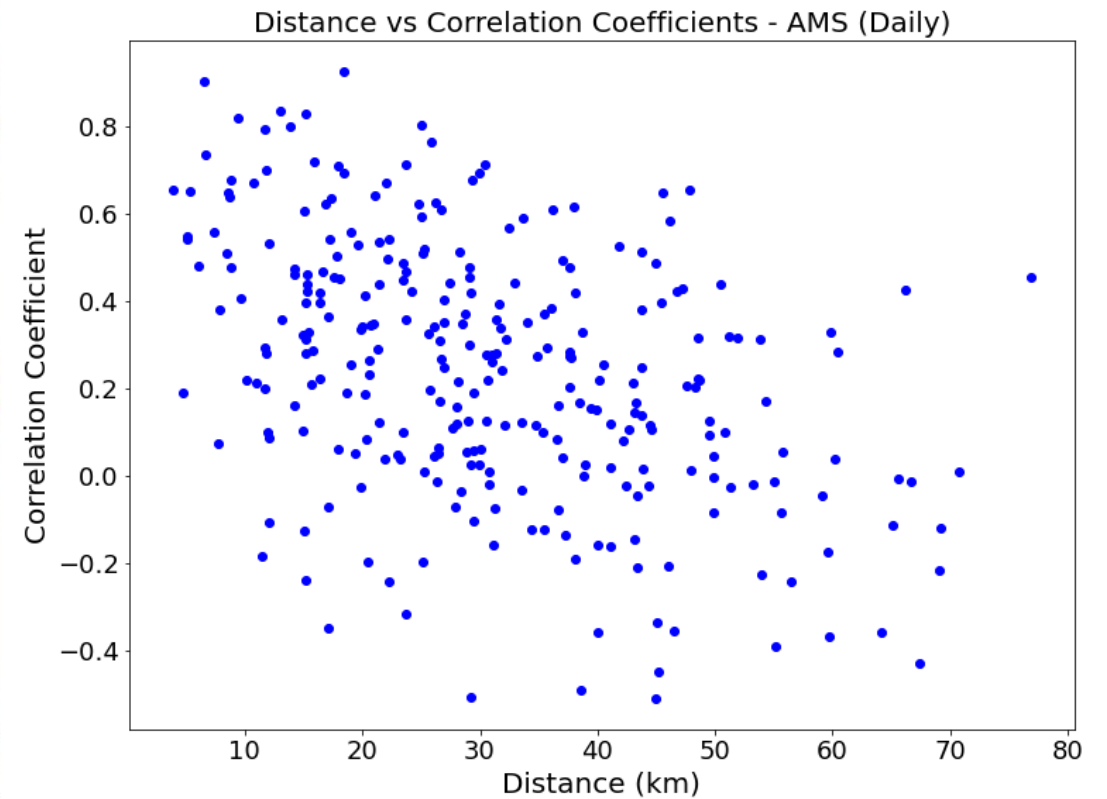
Wetting and Drying Cycles – Lower Albion



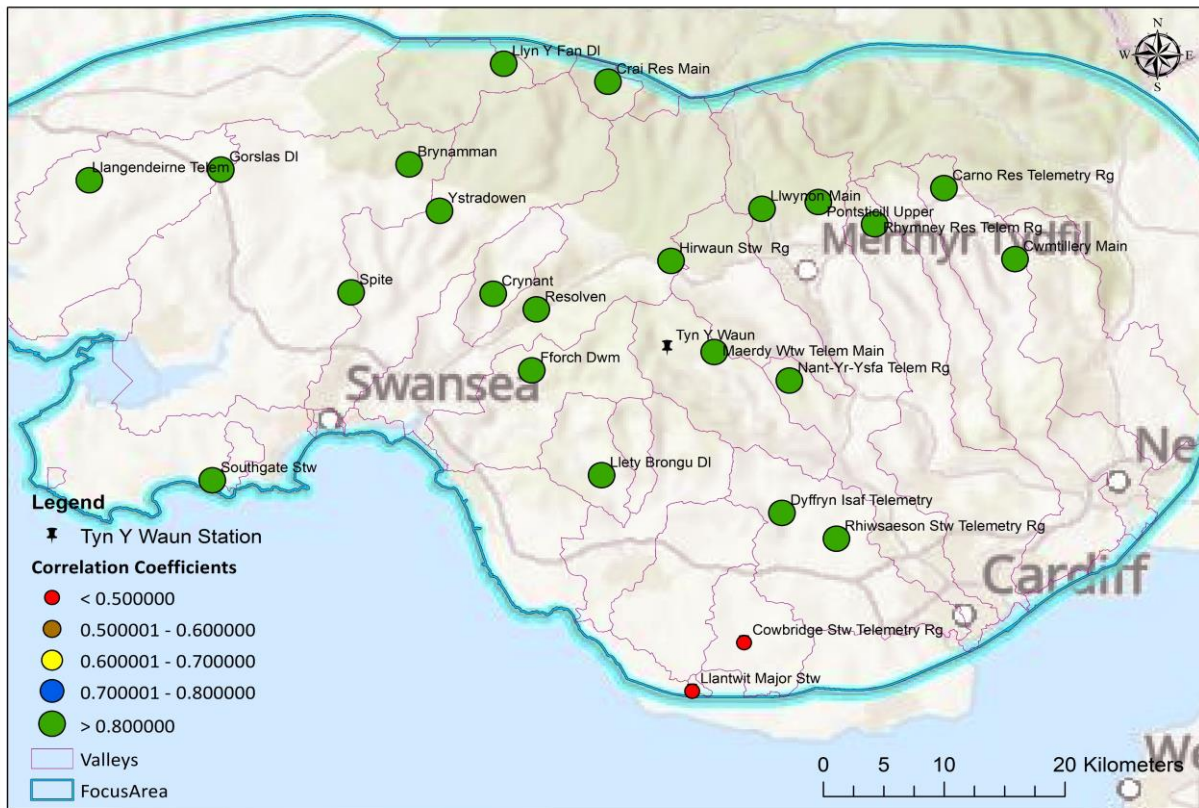
Rainfall Correlation Distance - Annual



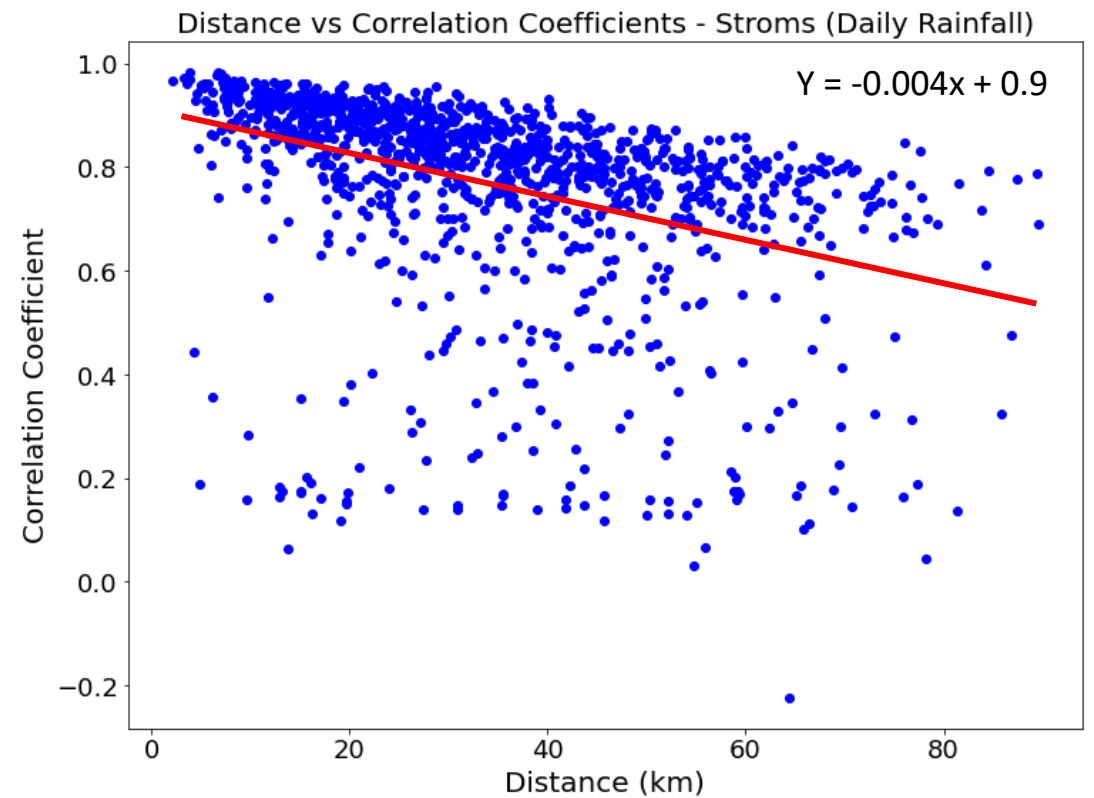
Map of distance-correlation based on Annual Maximum (Daily) Rainfall



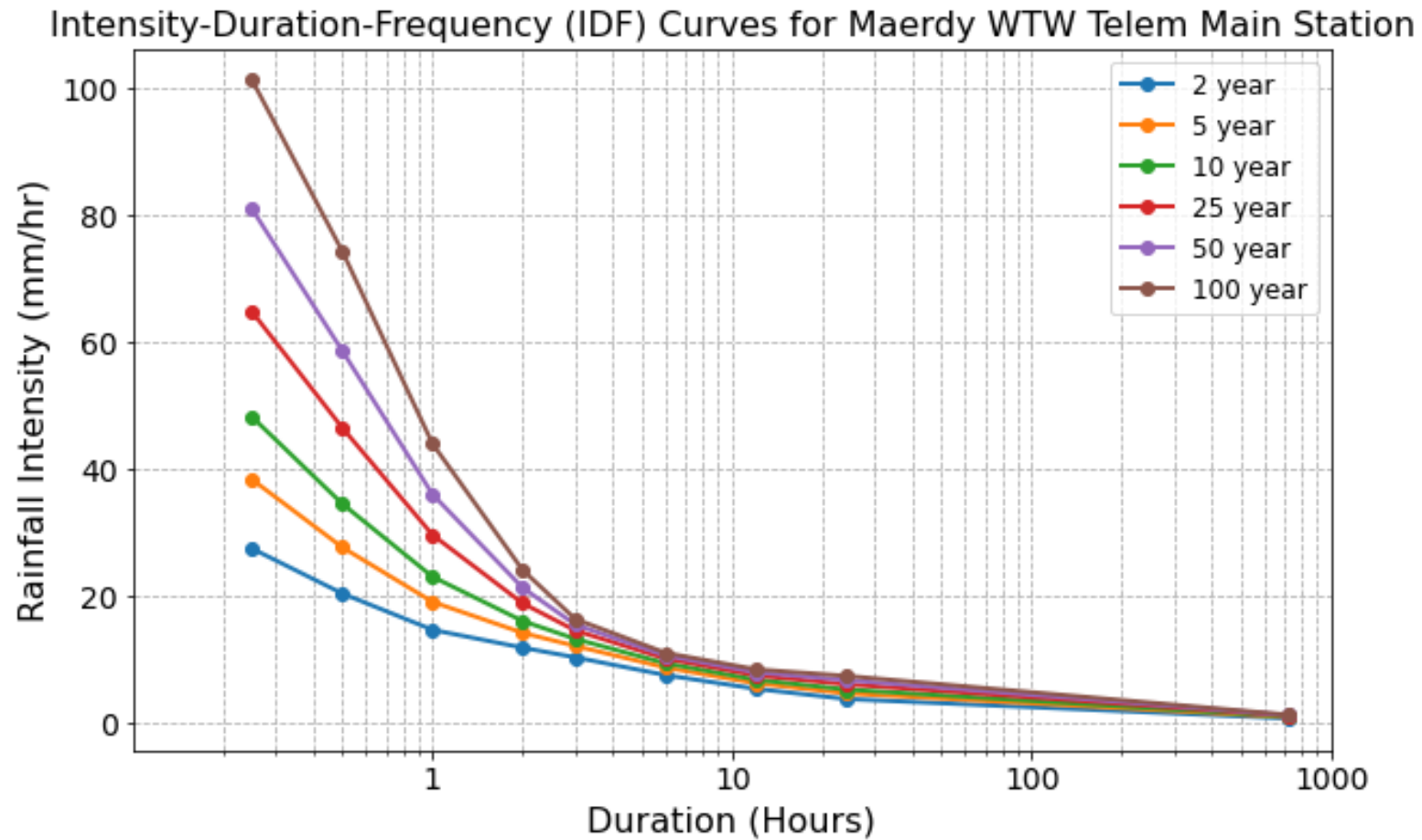
Rainfall Correlation Distance – Storm



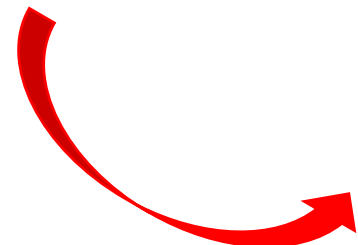
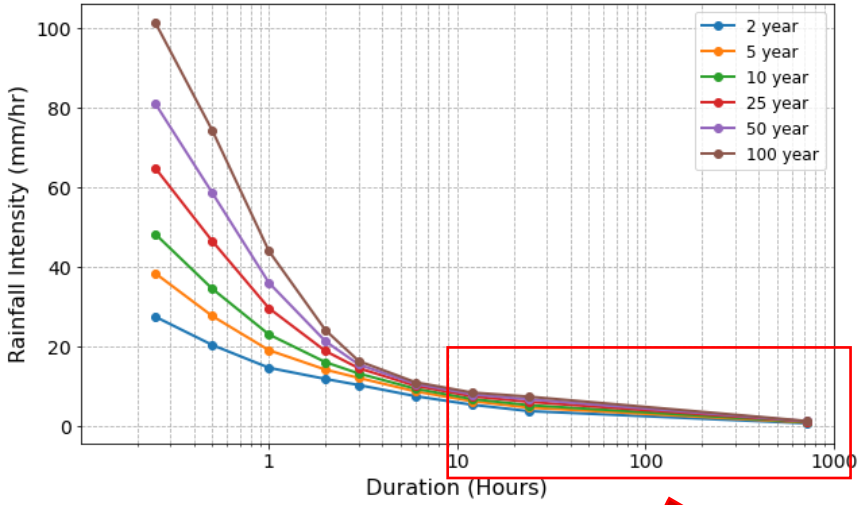
Map of distance-correlation based on storm data (Daily)



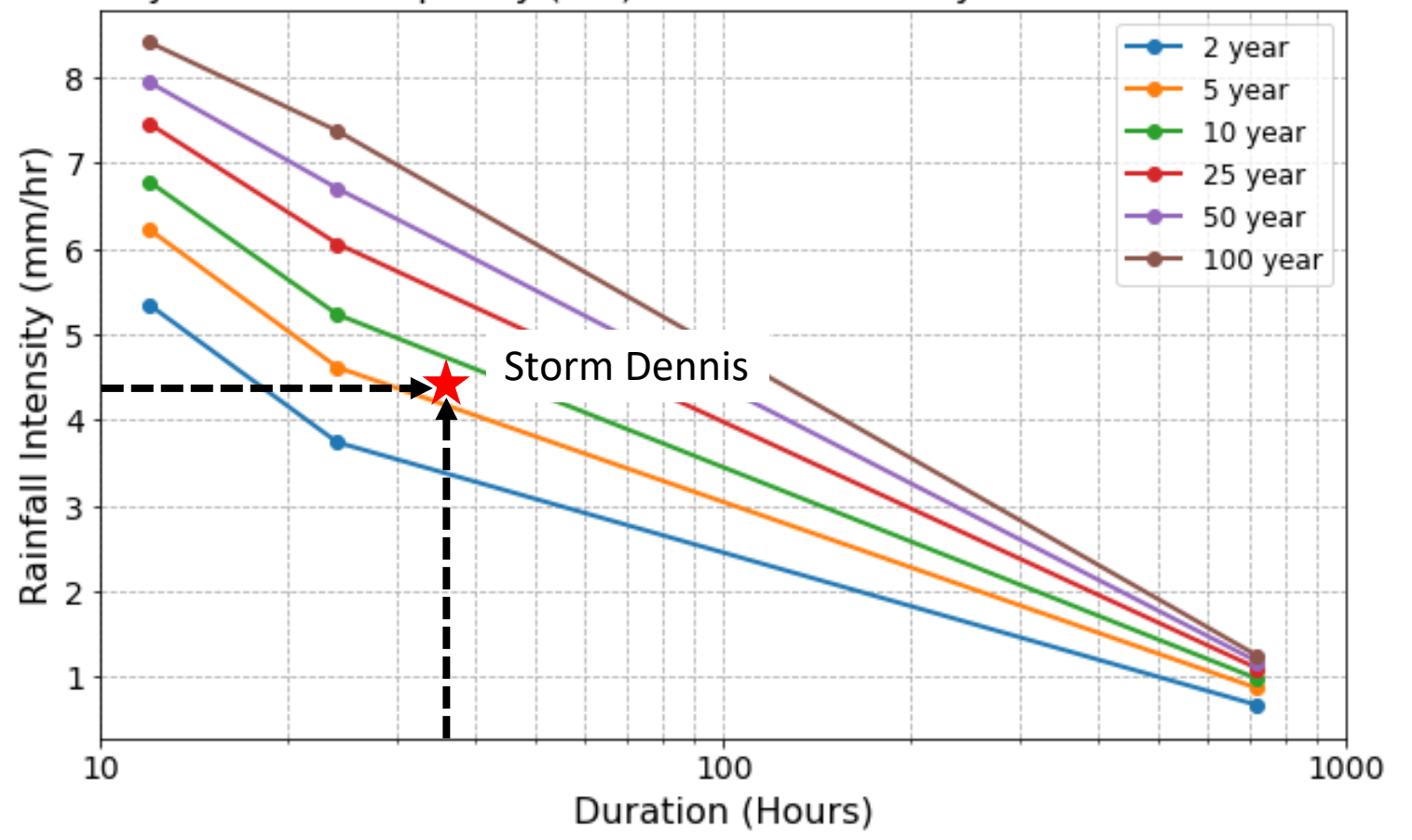
Development of IDF curves



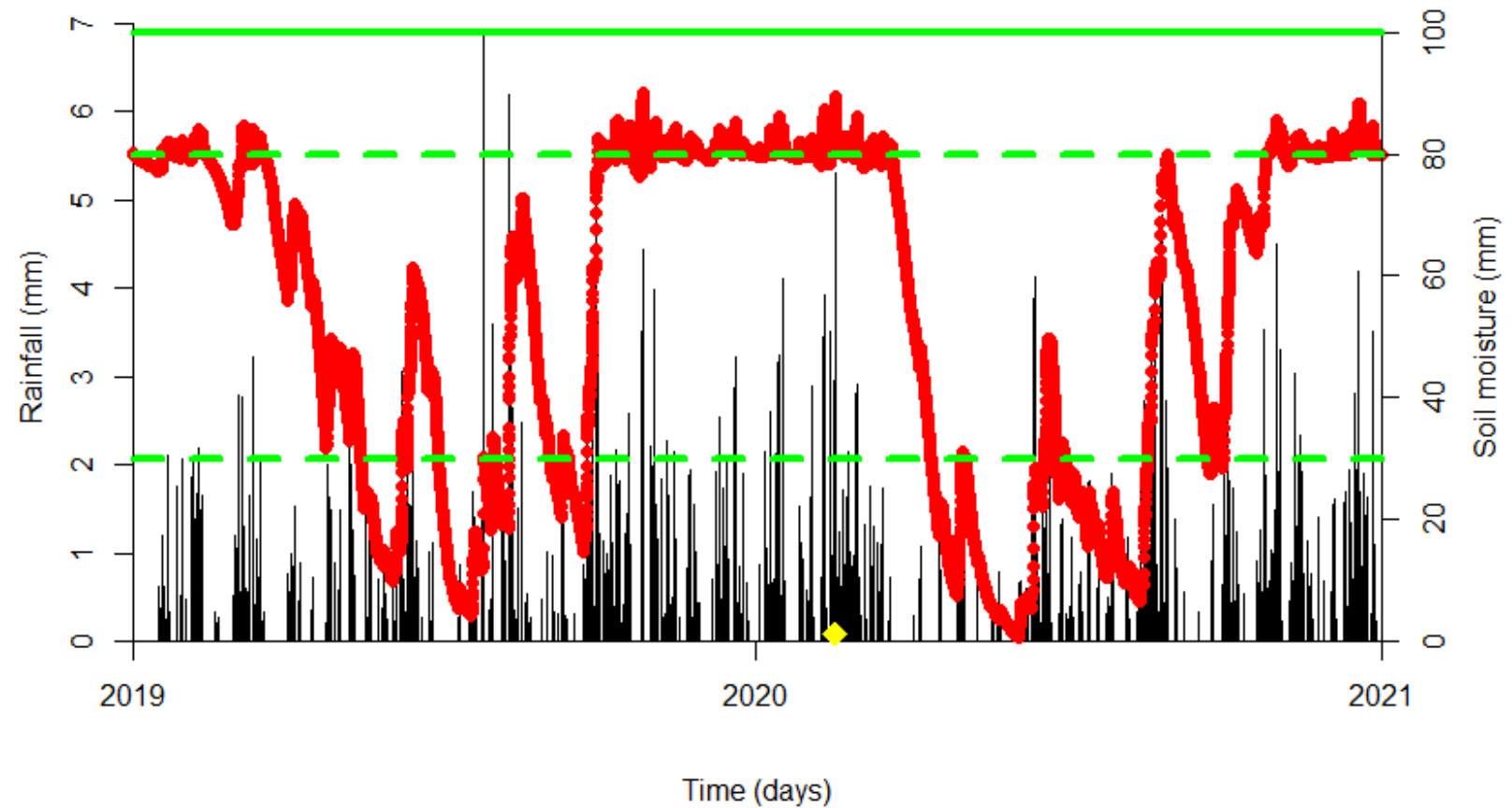
Intensity-Duration-Frequency (IDF) Curves for Maerdy WTW Telem Main Station



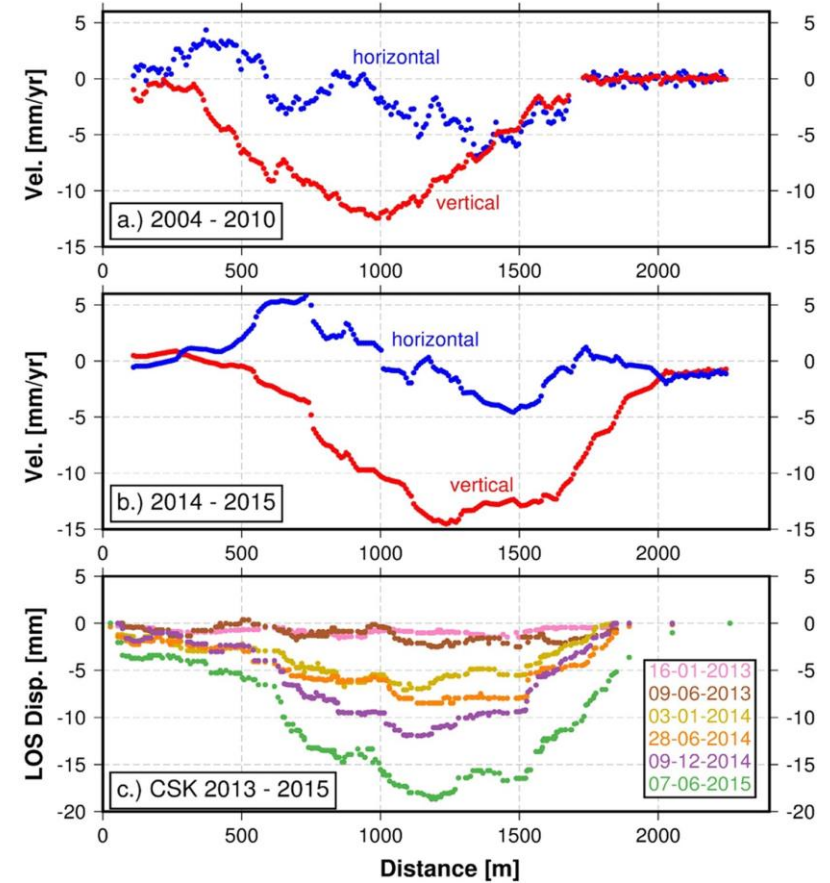
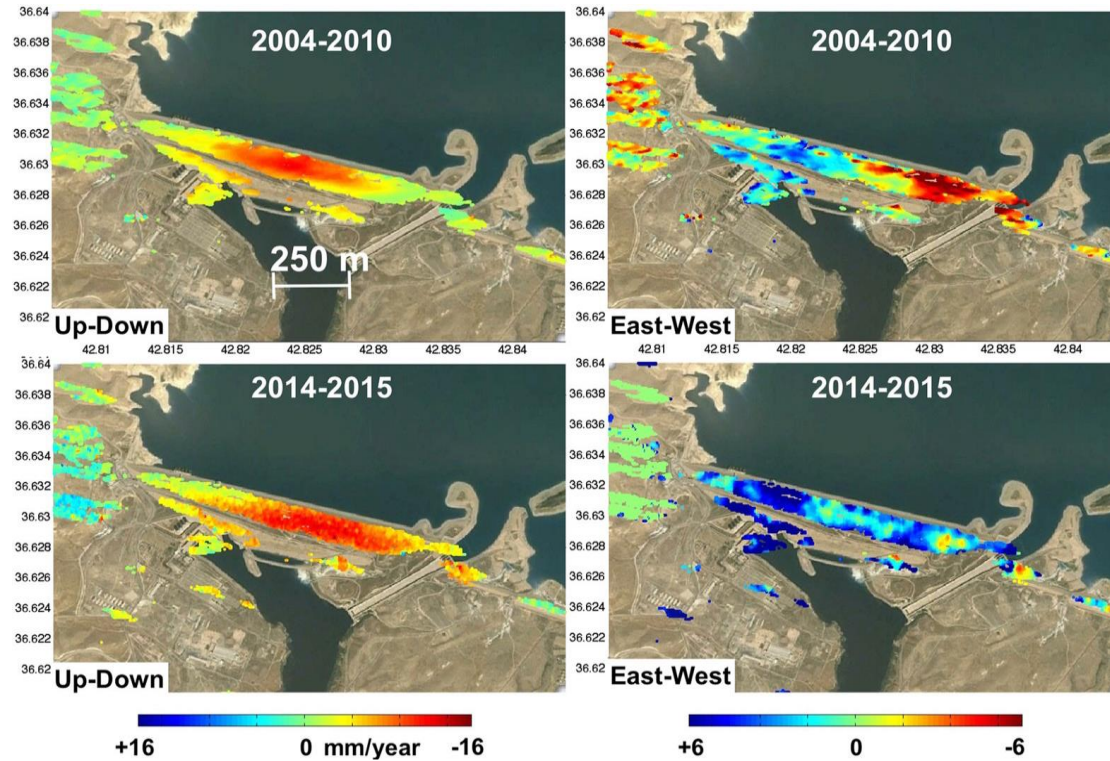
Intensity-Duration-Frequency (IDF) Curves for Maerdy WTW Telem Main Station



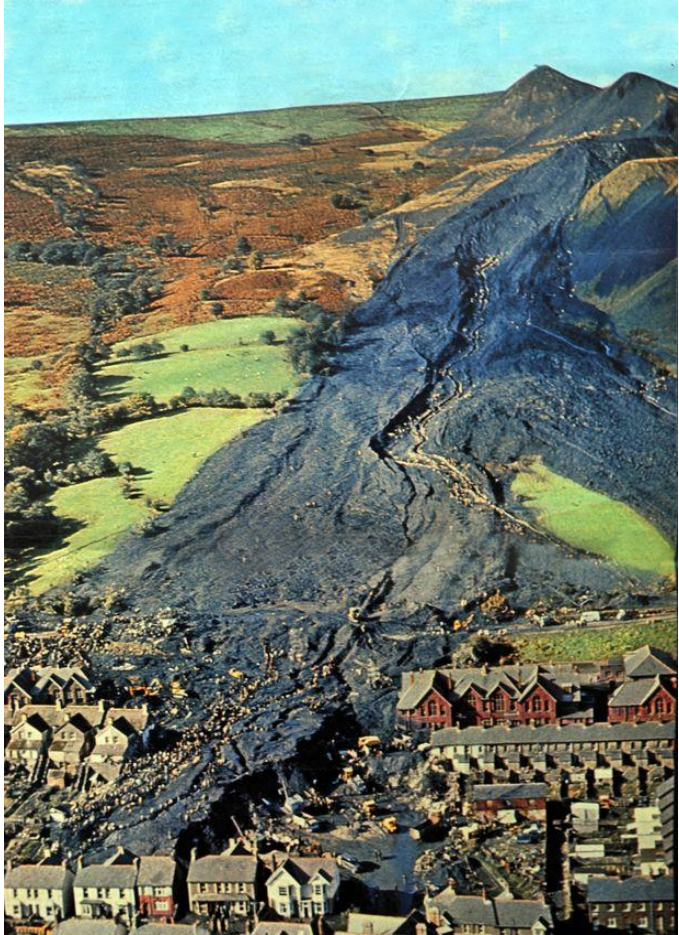
Predicted Soil Moisture



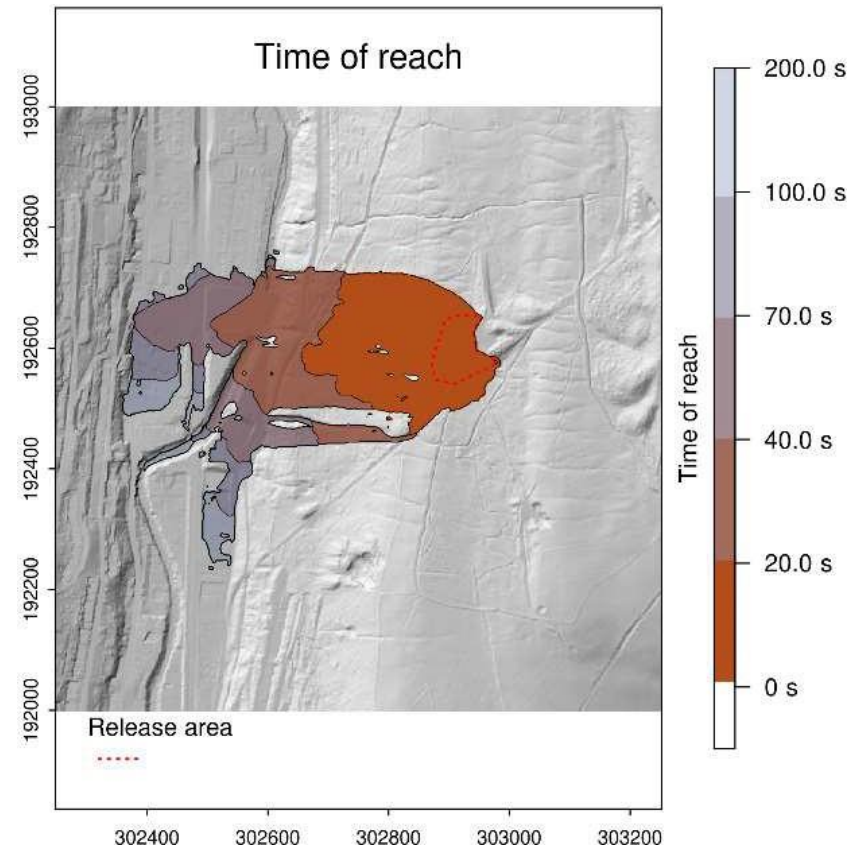
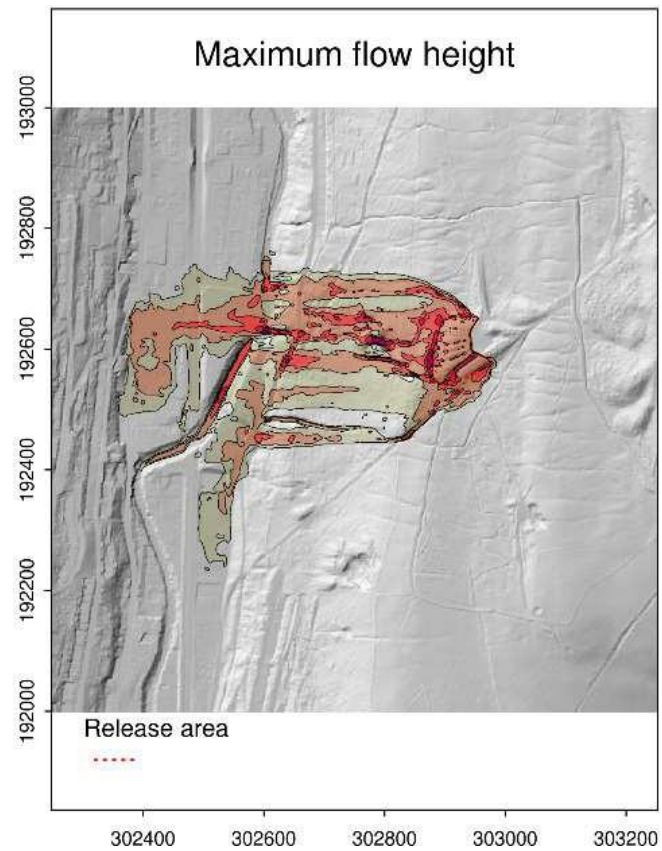
Satellite deformation monitoring



Consequence



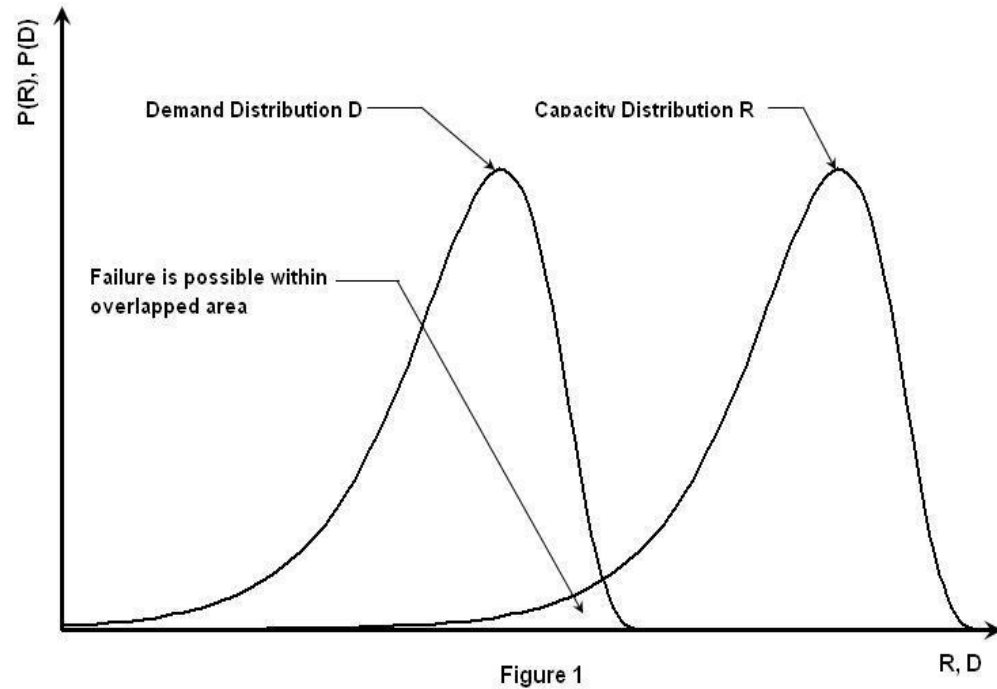
Runout Modelling





Planned activities

Quantitative versus Qualitative



Likelihood	Very Likely	4	8	12	16
	Likely	3	6	9	12
	Possible	2	4	6	8
	Not Likely	1	2	3	4
		Negligible	Marginal	Critical	Catatstrophic

Impact

Unacceptable risks:

Red

$8 \leq \text{Risk} \leq 16$

Undesirable risks:

Yellow

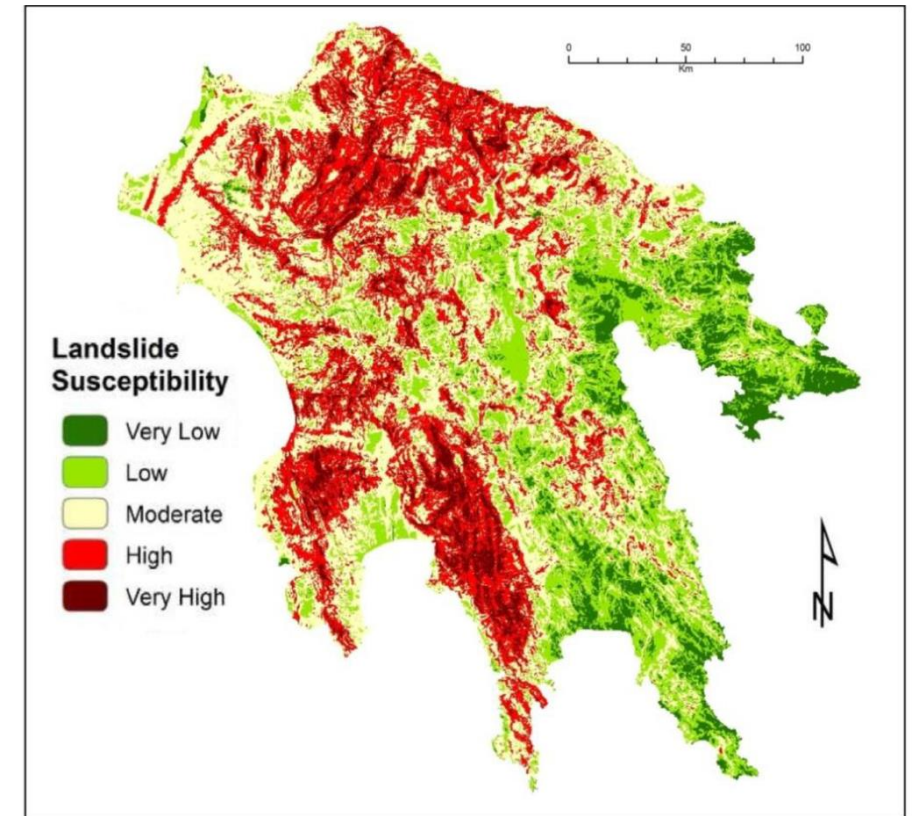
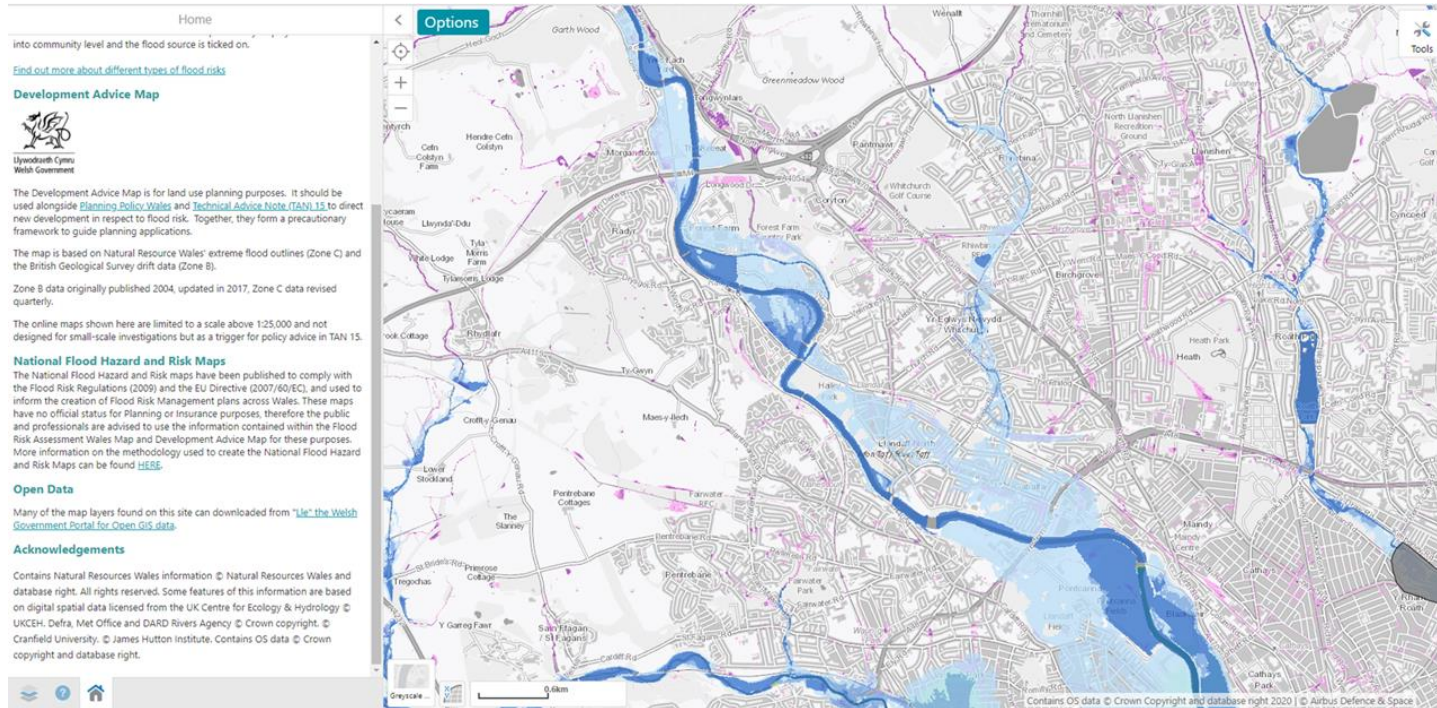
$4 \leq \text{Risk} \leq 7$

Acceptable risks:

Blue

$0 \leq \text{Risk} \leq 3$

Risk Mapping



Soil behaviour testing





Field Monitoring: Calibration

Grant Submission

£1.9 Grant submitted to UKRI last Tuesday with EP Wales, Welsh Government Coal Tip Task Force, RCTBCC, Dept of Economics, Dept of Psychology

“Climate-Adaptative Risk Assessment and Management of High-Risk Coal Tips in South Wales “

Decision late November