# National Road Network – Implementing a Strategy for Adapting to Extreme Weather Events and Climate Change – Current Status and Future Challenges

Billy O'Keeffe Senior Geologist TII

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Bonneagar Iompair Éireann
Transport Infrastructure Ireland

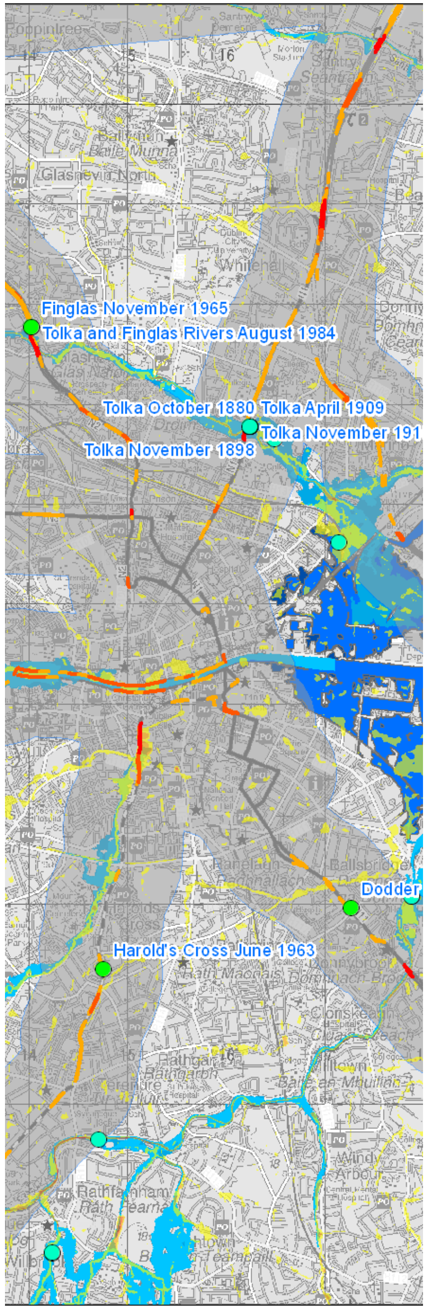
# Main Threats -CEDR Research

- Flooding of road surface
- Erosion of road embankments and foundations
- Landslips and avalanches
- Loss of road structure integrity
- Loss of pavement integrity
- Loss of driving ability due to extreme weather events
- Reduced ability for maintenance

How resilient is the network to *FUTURE* extreme weather events? Fluvial, Pluvial Coastal.

How will climate change influence these events?

Can we take account of these changes in future designs and how is this achievable?




LiDAR DTM


# Establish resilience

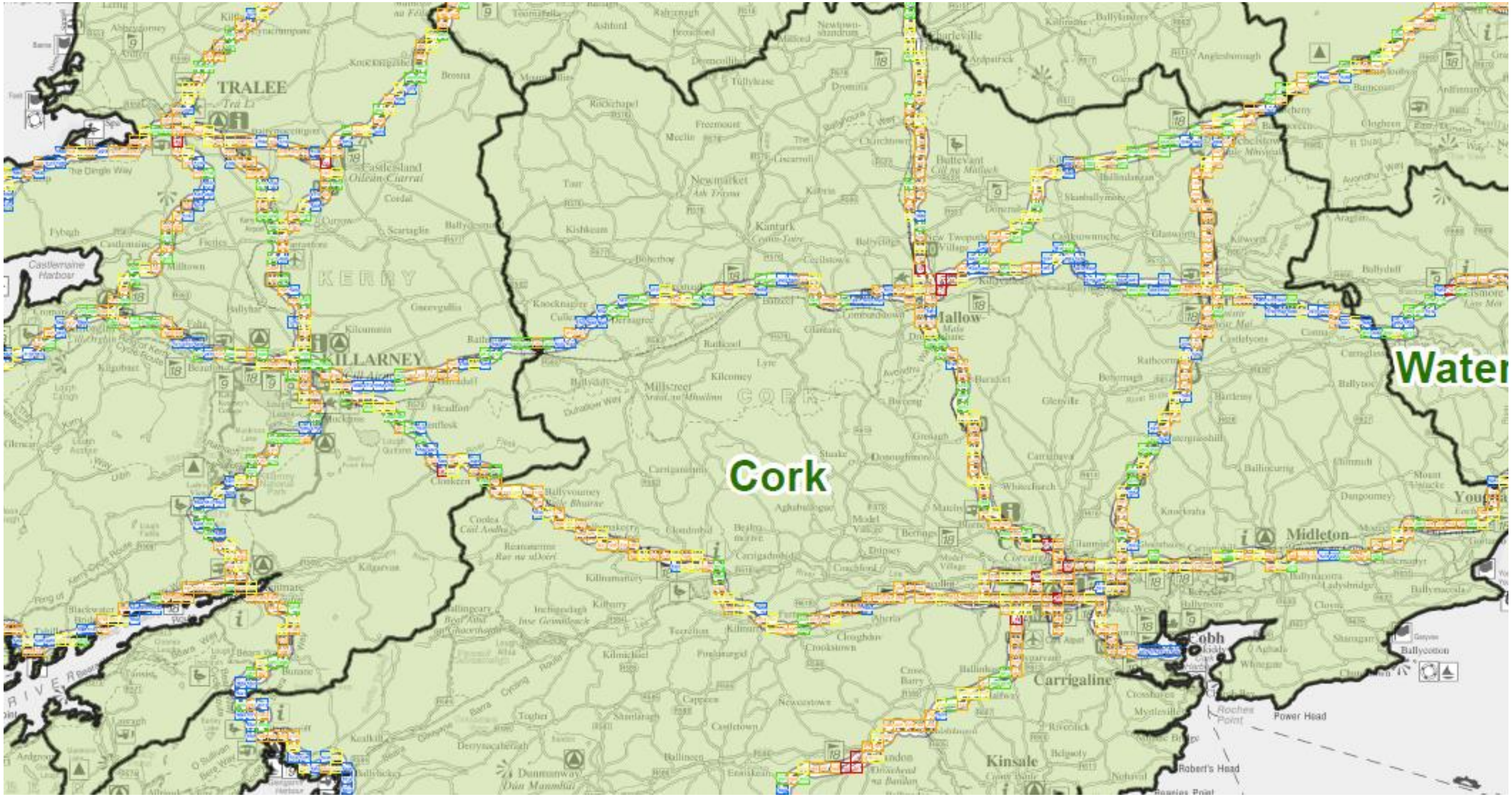
JBA has hydraulically accurate modelling of extreme flooding.

- JFLOW+ software solves the full shallow water flow equations.
- Also derived a Comprehensive Flood Map (CFM) for Ireland, covering fluvial, coastal and extreme surface water for different extreme events.

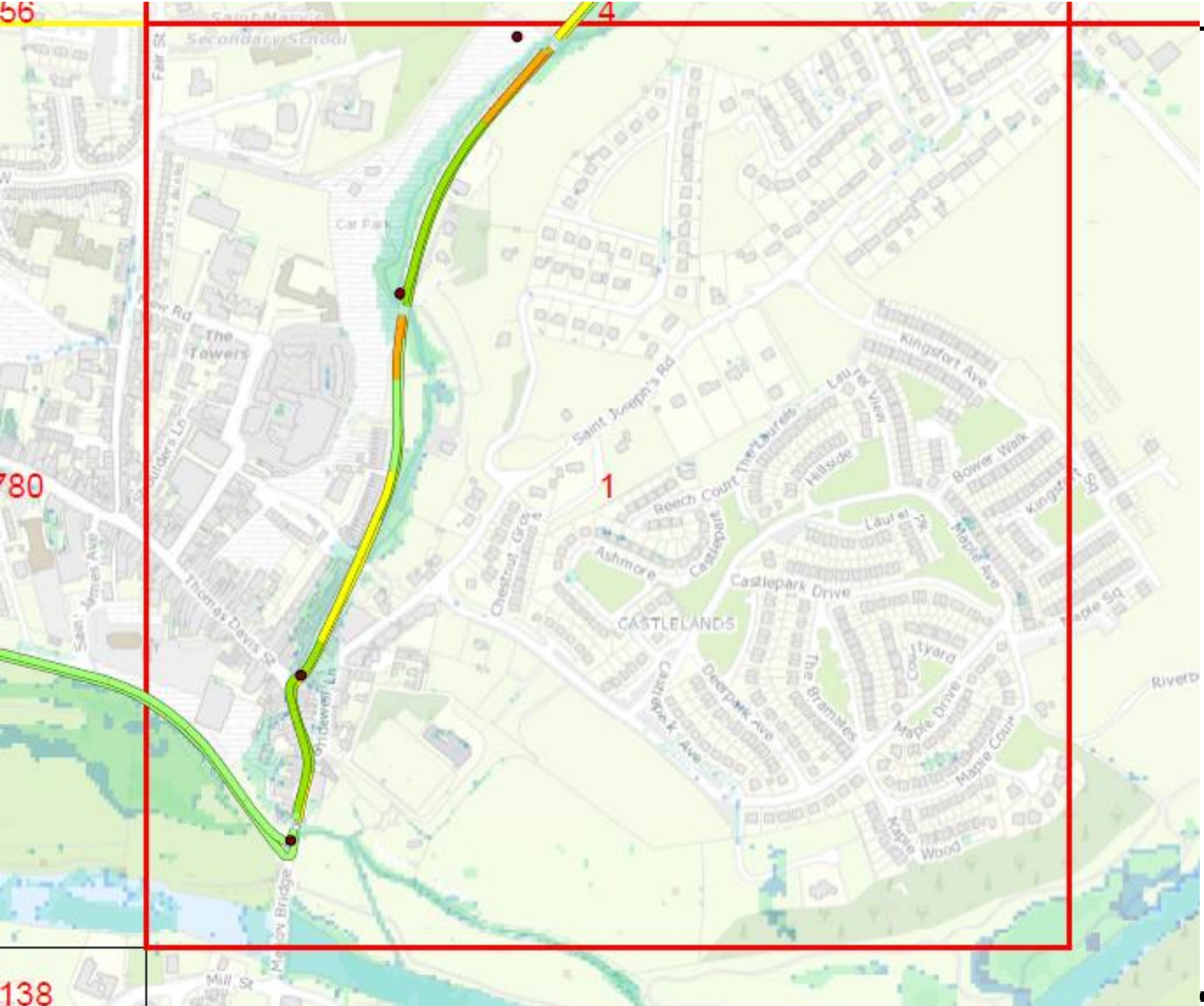
- Solves depth averaged hydraulic equations

- Generates reliable depth grids, velocity grids and hazard

- Has been used to make national maps, typically at 5m resolution



TRALEE
Castleisland
Castlemaine Harbour
The Dingle Way
KERRY
KILLARNEY
Cork
CORK
Charleville
Newmarket
Kantark
Millstreet
Mallow
Buttevant
Midleton
Cobh
Carrigaline
Kinsale
Roches Point
Power Head
Robert's Head
Ballycotton
Water




# LEGEND

**Rank of overall flood risk metric**
WM_Rank_Corrected_V2
- 1 - 1000
- 1001 - 2000
- 2000-6801
- NRA Points
- Road Flooding
- Flooding within 100m

**Original SW map**
cwaytype2010_Length_m
- 100-250
- >250

**Q100 Fluvial JBA CFM**
cwaytype2010_Length_m
- 100-250
- >250

**Q200 Tidal JBA CFM**
cwaytype2010_Length_m
- 100-250
- >250

**Climate change**
ccq200_MAX
- less sensitive
- more sensitive

**Peak Hazard on Carriageway**
Q2V31h_MAX
- 0.00 - 0.30
- 0.31 - 0.75
- 0.76 - 1.50
- 1.51 - 2.50
- >2.5

**Q100 1hr Flood Risk to People**
Q100 1 hour hazard
- <0.3
- 0.3 - 0.75 Caution
- 0.75 - 1.5 Flood Risk to Some
- 1.5-2.5 Danger to Many
- >2.5 Danger to All

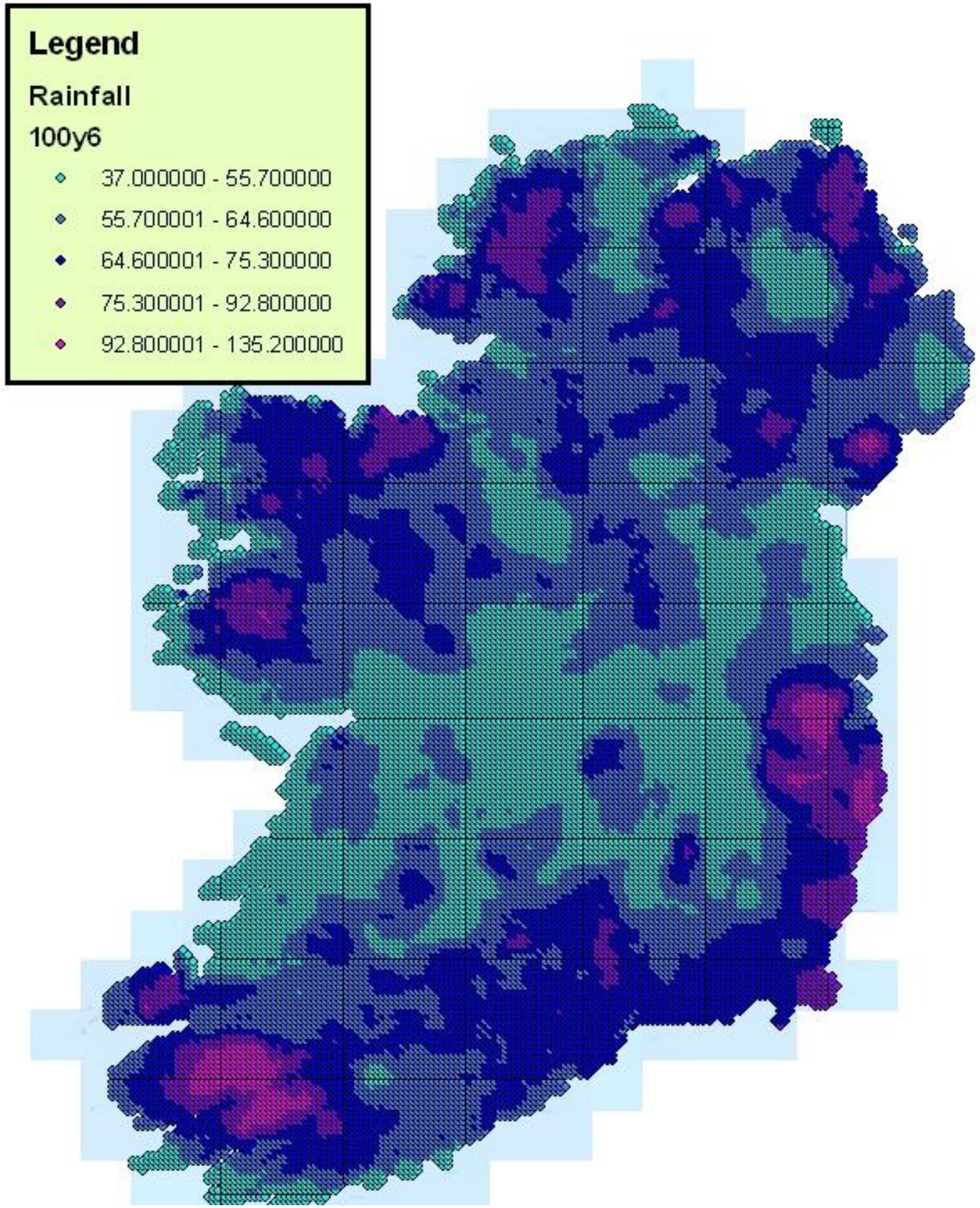
**Q100 1 hr Velocity m/s**
Velocity (m/s)
- 0-0.1
- 0.1-0.5
- 0.5 - 1
- > 1.0

**Q200 1hr Depth**
depth (m)
- 0
- 0.01 - 0.1
- 0.11 - 0.3
- 0.31 - 1
- >1.0

**Q200 6 hour depth**
depth (m)
- 0
- 0.01 - 0.1
- 0.11 - 0.3
- 0.31 - 1
- >1.0

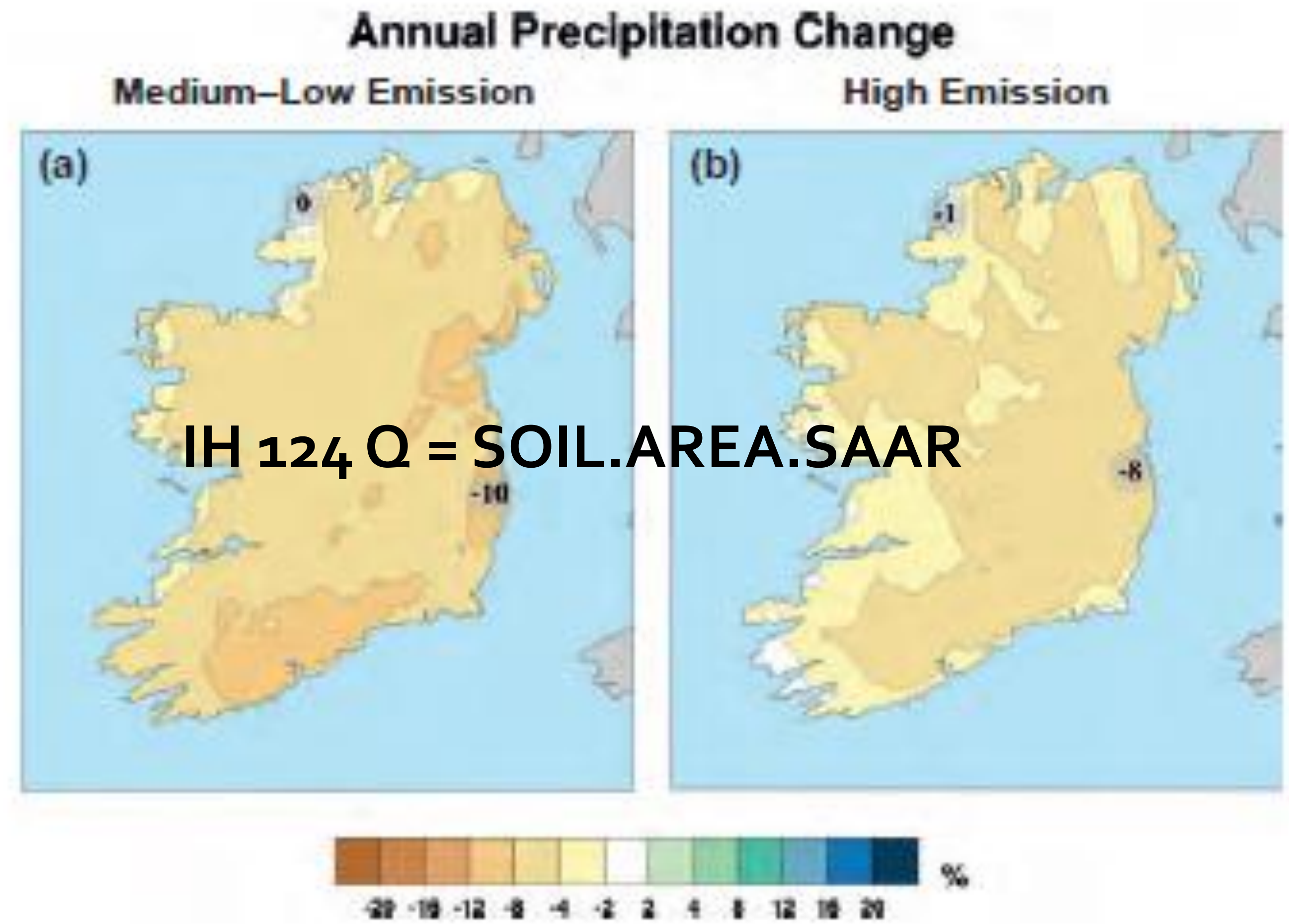
# How will climate change influence these events – Drainage Design

- Sources of rainfall intensity for drainage design
  - Met Eireann – long duration e.g. 100 yr return 6 hr storm
    - Used for design of attenuation systems, wetlands, detention basins, Greenfield runoff
  - Paved = FSR 1975 – short duration <15 mins. 5 yr return.
    - Used for design of carrier pipes on edge of carriageway M5 2min
  - Climate change
    - Current approach – increase rainfall intensities by 20%
  - Examples
    - IH 124 – Discharge f( Area, Soil, SAAR) Area.Soil.SAAR
    - Rational Method – Discharge f ( Coefficient of runoff, i, Area) CiA




| NORTH | EAST | rp2yr_dur0.25hr | rp5yr_dur0.25hr | rp10yr_dur0.25hr | rp20yr_dur0.25hr | rp30yr_dur0.25hr | rp50yr_dur0.25hr | rp100yr_dur0.25hr | rp150yr_dur0.25hr |
|---|---|---|---|---|---|---|---|---|---|
| 18,000 | 94,000 | 8 | 9.7 | 10.9 | 12.2 | 12.9 | 13.9 | 15.4 | 16.3 |
| 18,000 | 96,000 | 8 | 9.7 | 10.9 | 12.1 | 12.9 | 13.9 | 15.4 | 16.3 |
| 20,000 | 92,000 | 8 | 9.7 | 10.9 | 12.1 | 12.8 | 13.8 | 15.2 | 16.2 |
| 20,000 | 94,000 | 8 | 9.8 | 10.9 | 12.1 | 12.9 | 13.9 | 15.3 | 16.2 |
| 20,000 | 96,000 | 8 | 9.7 | 10.9 | 12.1 | 12.9 | 13.9 | 15.3 | 16.2 |
| 20,000 | 98,000 | 8 | 9.7 | 10.9 | 12.1 | 12.9 | 13.9 | 15.3 | 16.2 |
| 22,000 | 72,000 | 8.4 | 10.2 | 11.4 | 12.7 | 13.5 | 14.5 | 16.1 | 17 |
| 22,000 | 74,000 | 8.3 | 10.2 | 11.5 | 12.8 | 13.7 | 14.7 | 16.4 | 17.4 |
| 22,000 | 76,000 | 8.2 | 10 | 11.3 | 12.6 | 13.4 | 14.5 | 16.1 | 17.1 |
| 22,000 | 78,000 | 8.1 | 10 | 11.2 | 12.5 | 13.3 | 14.4 | 15.9 | 16.9 |
| 22,000 | 80,000 | 8.1 | 9.9 | 11.2 | 12.5 | 13.2 | 14.3 | 15.8 | 16.8 |
| 22,000 | 94,000 | 8.1 | 9.8 | 11 | 12.2 | 12.9 | 13.9 | 15.3 | 16.2 |
| 22,000 | 96,000 | 8.1 | 9.8 | 10.9 | 12.2 | 12.9 | 13.9 | 15.3 | 16.2 |
| 22,000 | 98,000 | 8 | 9.7 | 10.9 | 12.1 | 12.8 | 13.8 | 15.3 | 16.2 |
| 22,000 | 100,000 | 8 | 9.7 | 10.9 | 12.1 | 12.8 | 13.8 | 15.3 | 16.2 |
| 22,000 | 102,000 | 8.1 | 10.2 | 11.7 | 13.2 | 14.2 | 15.6 | 17.6 | 18.9 |
| 24,000 | 72,000 | 8.1 | 9.8 | 11 | 12.3 | 13 | 14 | 15.5 | 16.4 |
| 24,000 | 74,000 | 8 | 9.8 | 11.1 | 12.4 | 13.2 | 14.2 | 15.8 | 16.7 |
| 24,000 | 76,000 | 8.3 | 10.1 | 11.4 | 12.8 | 13.6 | 14.7 | 16.3 | 17.3 |
| 24,000 | 78,000 | 8.2 | 10.1 | 11.3 | 12.6 | 13.4 | 14.5 | 16.1 | 17 |
| 24,000 | 80,000 | 8.2 | 10.1 | 11.3 | 12.6 | 13.4 | 14.4 | 16 | 16.9 |

Account for Climate Change by Adding 20% to rainfall intensities.




## IH 124 Q = SOIL.AREA.SAAR

**Ensemble of regional climate model projections for Ireland**

Author: Paul Nolan, Irish Centre for High-End Computing and Meteorology and Climate Centre, School of Mathematical Sciences, University College Dublin

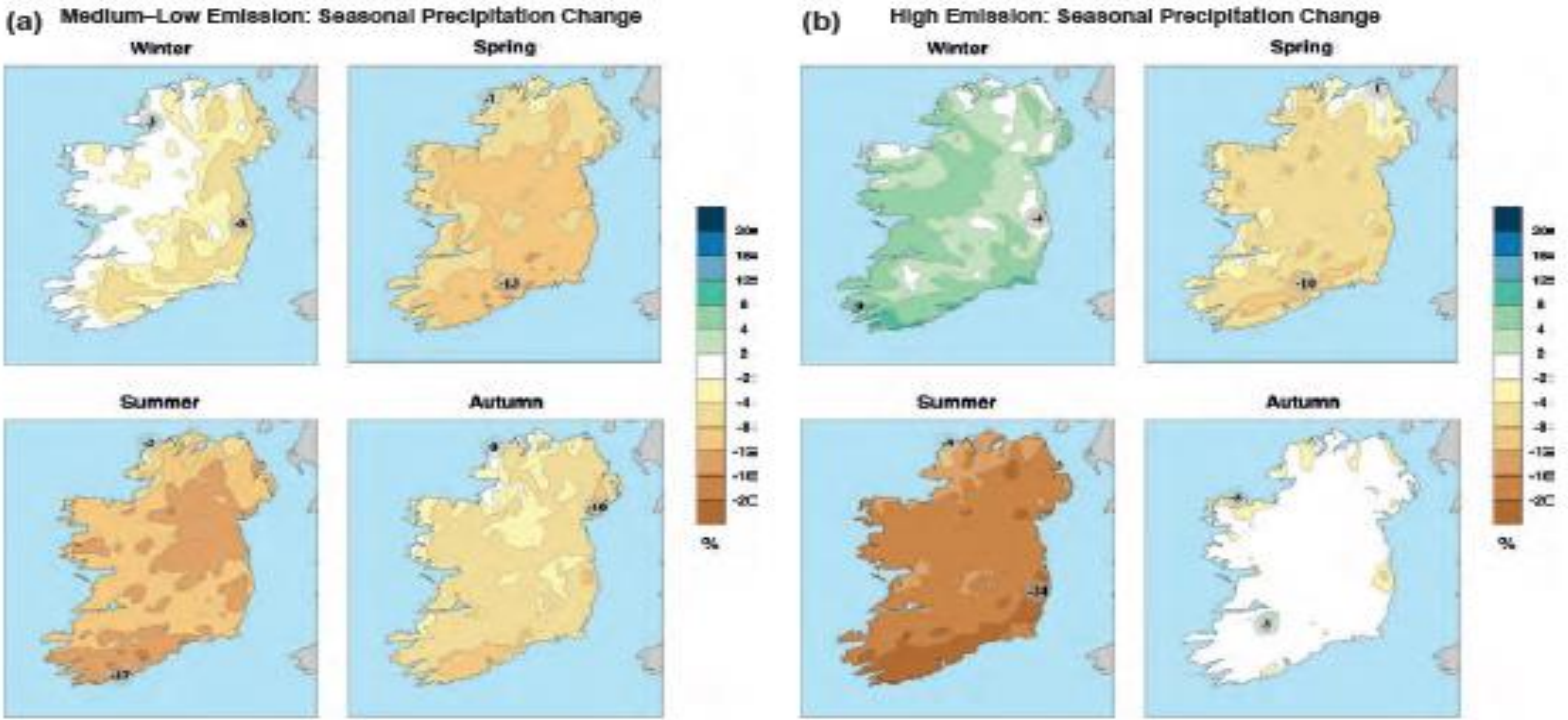
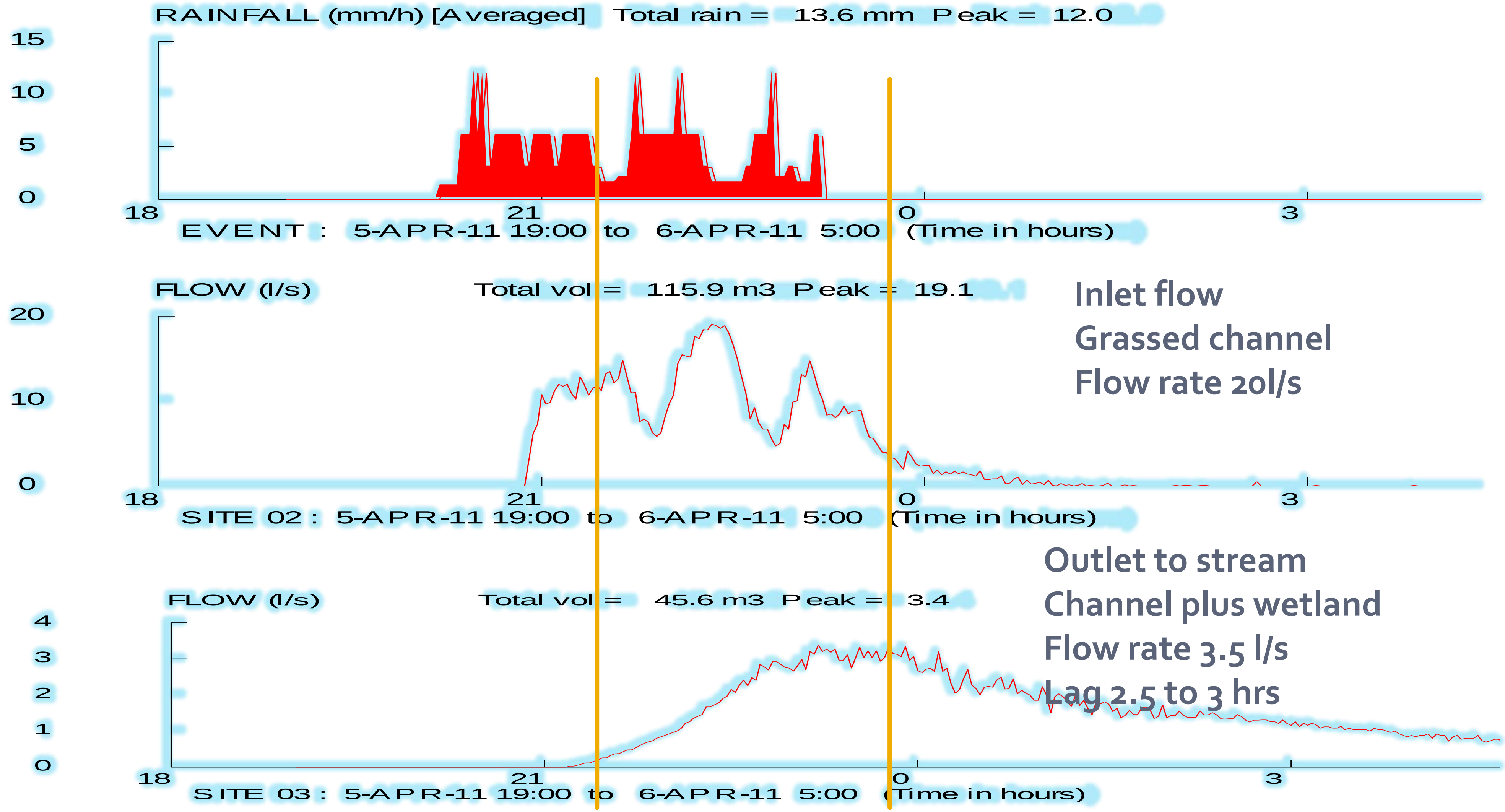



Figure 3.5. Projected changes (%) in seasonal precipitation. (a) Medium- to low-emission scenario; (b) high-emission scenario. In each case, the future period 2041–2060 is compared with the past period 1981–2000.

# How will climate change influence these events Summary 2

- Short duration events more intense
  - Bigger carrier pipes
- Long term
  - Seasonal changes more pronounced
  - Consider changing design approach
- More frequent storm events
  - Return periods

# Can we take account of these changes in future designs and how is this achievable.




Inlet flow
Grassed channel
Flow rate 20l/s

Outlet to stream
Channel plus wetland
Flow rate 3.5 l/s
Lag 2.5 to 3 hrs

# Conclusion

- How resilient is the network to future extreme weather events
  - Focus on flooding – Detailed LIDAR and Modelling
  - Identify vulnerable areas
- How will climate change influence these events
  - Changes in rainfall intensities – pipe sizing – attenuation requirements
- Can we take account of these changes in future designs and how is this achievable.
  - New parameters, Change design