

# **Projected climate change in Ireland and associated risk to water quantity; a review of national policies, governance and plans for future proofing Ireland's water supply**

## **A Policy Brief developed for the Water Forum (An Fóram Uisce)**

**Prepared by Dr Fiachra O'Loughlin and Dr Triona McGrath**

### **CLIMATE CHANGE PROJECTIONS FOR IRELAND AND IMPACTS ON WATER QUANTITY**

- By the middle of this current century, it is expected that the average temperature across Ireland will have increased by between 1°C and 1.6°C from the baseline period (1975- 2005).
- All seasons will experience increases in temperature; however, Summer (June, July, August) and Autumn (September, October, November) will see the largest increases with 3.1°C warming expected during Autumn by the end of the Century (2071-2100) under RCP8.5.
- Extended dry periods (of 5 plus days with less than 1 mm of precipitation recorded) will become more common in Ireland due to climate change.
- There will be large decreases in low flows during summer periods and that by the 2080s Q95 flows (lowest 5 percentile flows) will have reduced by approximately 21%.
- There is an increased risk that droughts will become more regular, longer and with potential for multi-year droughts.
- While the annual precipitation will decrease due to climate change, there will be an increase in the number of heavy and very heavy rainfall that occur (rainfall is in excess of 20 and 30 mm). The North-West of Ireland is expected to experience the worst of these increases with the occurrence increasing by 30%.
- All studies show that higher flows are expected in winter and this corresponds to an increased flood risk, where annual maximum flows could increase by between 12% and 16% for 50- and 100- year return periods and urban runoff in Dublin could increase by 30% in the winter months.

Projections above taken from Fealy et al., 2018; Leahy et al., 2021 and Meresa et al. (2022) and Nolan and Flanagan, 2021.

## Executive Summary

The latest IPCC report (AR6) highlights that climate change is already having significant impacts globally to varying amounts. It also highlights that if warming reaches 1.5°C it will result in unavoidable increases in extreme events, e.g. floods and droughts.

For Ireland, climate change will have two major trends related to water quantity: 1) temperatures will increase with a clear spatial pattern; and 2) the frequency of extreme events will increase. Research shows that by the mid-century temperatures will be between 1 and 1.6°C warmer compared to 1975-2005 but that the East coast will experience larger increase. Research also indicates that while the annual average temperatures will increase, Summer and Autumn temperatures will see the largest increase with increases in excess of 3°C possible in Autumn by 2100.

As temperatures increase, extreme events will also become more frequent. Leahy et al. (2021) highlighted this and noted both regional droughts and large flooding events will become more common. Fealy et al. (2018), Nolan and Flanagan (2021) and Leahy et al. (2021) all note that extended dry periods (5 days with less than 1 mm of precipitation) will become more common due to climate change, with decreases up to 20% in Summer possible.

Ireland can also expect more frequent extreme precipitation and flooding (Fealy et al., 2018) and that the number of heavy (>20mm) and very heavy rainfall (>30mm) days will increase. The North-West will experience the worst of these increases. This may be due to the direct relationship between temperature and rainfall (Clausius-Clapeyron) and increases up to 15% per 1°C warming have been noted.

A review of the Climate Action Plan and relevant adaptation plans, highlights that the impact of climate change on water quantity is either not emphasised sufficiently or uses outdated outputs from climate models. In the Climate Action Plan 2021, Only 7% of the listed Actions mention water quantity and an additional 25% of the Actions would benefit from the inclusion of water quantity to secure supply, protect life and property and increase awareness. The use of outdated model outputs in the sectoral plans also needs to be addressed. Uisce Éireann's National Framework Plan uses climate projections based on AR4 (two generations old) and the Flood Risk Management Plan of the Department of Housing, Local Government and Heritage, suggests using projections from prior to 2011. The latest projections come from more advanced models, updated emission scenarios and better understanding of climate processes and therefore are more accurate.

Across Ireland, seven organisations are responsible for collecting water level and flow and currently there are 1031 active stations. While these have a good spatial distribution, the record lengths are not sufficiently long enough for accurately modelling droughts, as only 17 stations have 75 years or more data and only ~30% have record lengths greater than 50 years.

An analysis of annual average discharge change from hydrological models obtained from <https://cds.climate.copernicus.eu/> highlight the need for the impact of climate change to be investigated on the catchment scale and not regional. The simulations show that irrespective of GHGs pathway (RCP), Ireland will be drier in the future, with the East and South-East more severely impacted. Under RCP 8.5, most of Ireland could be 10% drier by 2100 and some catchments could experience reductions close to 30%.

## Existing Relevant Policy

- The **Climate Action Plan 2021** is the roadmap for meeting Ireland's 2050 national climate objective, with the overall aim to halve Ireland's greenhouse emission by 2030 and be net zero by 2050 at the latest.
- **The Flood Risk Management – Climate Change Sectoral Adaptation Plan 2019**, prepared by the Office of Public Works (OPW), sets out a long-term goal for adaptation in flood risk management, along with a set of objectives and adaptation actions aimed at achieving those objectives.
- **The Water Quality and Water Service Infrastructure – Climate Change Sectoral Adaptation Plan**, developed by the Department of Housing, Local Government and Heritage in 2021, is focused on managing the risks from climate change for water quality and for water services infrastructure and describes the key risks and proposes necessary adaptive measures.
- The **National Water Resources Plan** developed by Uisce Éireann (formerly Irish Water), is a 25-year strategic framework for water supply services. Appendix E of this Plan is a framework for drought, which divides the country into three Operational Region.

## RECOMMENDATIONS

A number of policy recommendations across five themes have arisen from a review of; the current state of knowledge on climate change; the Irish National Hydrometric Monitoring Stations; and Government and Sectoral Plans listed below:

### WATER POLICY

- Throughout Ireland's Climate Action Plan there is a clear under-representation of the role of water quantity. This should be addressed in future revisions with the emphasis to **include water quantity in Climate Action Planning**. Two clear actions where the inclusion of water quantity would have a significant and positive impact are: Action 57 for retrofitting public buildings to include water efficiency to help mitigate the impacts due to future droughts and potential water shortages; Action 58, to mandate the inclusion of green criteria in all procurements using public funds, should include criteria for water efficiency as well as energy.
- Future revisions of the **National Development Plan** and **Housing for All Plan** should consider how **water efficiency** can be improved and **incorporated into new homes and buildings**, to reduce the water per capita demand in order to adapt to future drought conditions and potential water shortages.
- Revisions of the **Flood Risk Management Plan** should include the **latest scientific data** on future projections for Ireland and **details of assessment and investment requirements**. The current "Flood Risk Management – Climate Change Sectoral Adaptation Plan 2019" uses climate change projection prior to 2011 and suggests a national scaling factor to deal with climate change. This needs to be revised. Additionally, the current plan notes the need to consider adaptation in design and preparedness but provides no details.

## MANAGEMENT AND GOVERNANCE

- **National Climate Change Risk Assessment:** While Ireland has a draft National Risk Assessment that covers geopolitical, economic, societal, environmental, and technological risks, it is weak in comparison with the UK's CCRA with regard to climate change and water quantity. The UK's CCRA identifies risks and opportunities across all sectors of life, including water quantity, to help inform adaptation measures and highlight where adaptation measures have not kept pace with the latest climate change projections. The National Risk Assessment should be reviewed and updated to include water related risks, in particular water quantity, that are expected with future climate change.

## WATER RESOURCE PLANNING

- The record length of active gauging stations is too short to be able to undertake a detailed drought analysis on many catchments. The average record length is ~37 years and only two stations have records longer than 100 years. In addition, Uisce Éireann's National Water Resources Plan highlights this deficiency and the need for longer records. The **National Hydrometric Working Group** who reviews and makes recommendations on the existing network, are perfectly positioned, to **ensure longevity in monitoring stations** across a range of catchment sizes throughout the country going forward.
- One of the key recommendations of the Water Quality and Water Service Infrastructure – Climate Change Sectoral Adaptation Plan was the need for **integrated catchment management** and **water resource planning** to ensure the security of supply. As shown in Section 5, the response of catchments to climate change varies significantly from one catchment to the next. In addition, the data used in Section 5 only accounts for changes in meteorological drivers (precipitation and temperature) and ignores the impact of land use change which might occur due to a changing environment which will have implications for the hydrological response of a catchment.

## PLANNING FOR EXTREME EVENTS

- **Drought Management Plans** should be **developed and published for every water resource zone**. The roles and responsibilities of government bodies and agencies who have a role in drought management planning should be publicly available, with a clear timeframe for the development and implementation of the drought management plans.
- **Registry of Extreme Events:** Ireland is a signatory to the UN Sendai Framework for Disaster Risk Reduction in 2015 (Kelman, 2015). One of the priorities is to understand disaster risk and part of this is hazard characterisation. Currently, both the OPW and EPA have databases of historical occurrence of floods and droughts; however, this combined into a single registry, under Met Éireann, including information from other bodies, such as Met Éireann and Uisce Éireann would provide a database of historical and current extreme events. The choice of Met Éireann as the host organisation would be consistent with other countries, where the meteorology services host and compile these registries.

These types of registries are critical to understand if extreme events are changing in frequency but also to fully understand the drivers causing them.

- Both the OPW's guidance and Uisce Éireann's methodology for dealing with climate change are simple deterministic approaches and do not use the latest projections. Deterministic approaches cannot capture the full variable in the system that probabilistic approaches can. There is a need for **more advance methodologies** such as using probabilistic approaches **to help address the uncertainties in climate projections**. Additionally, the use of catchment models would significantly help in addressing the spatial variability that exists. Hall and Murphy (2011) have already noted the need for site specific analysis, as they noted all catchments will behave differently to climate change. This is also a recommendation of the Water Quality and Water Service Infrastructure – Climate Change Sectoral Adaptation Plan which stated the “need for integrated catchment management”, i.e. Catchment models.

## RISK COMMUNICATION

- **Education** is key for risk communication. Augustenborg et al. (2022) noted based on the 2018 droughts, that delayed media coverage and poor advice may have hampered water conservation efforts. They also found that the role of climate change in intensifying drought was both under and mis-represented. This hampers any positive behavioural changes that might have occurred. This could be addressed through updates of the Climate Action Plan if water quantity and the sustainable use of water was explicitly mentioned in actions regarding education and awareness, such as in Actions 13 and 38.



## KEY LEARNINGS:

For each section in the main report, a number of key findings were identified and these are listed below:

### CURRENT STATE OF KNOWLEDGE:

- By the middle of this current century, it is expected that the average temperature across Ireland will have increased by between 1°C and 1.6°C from the baseline period (1975-2005),
- All seasons will experience increases in temperature; however, Summer (June, July, August) and Autumn (September, October, November) will see the largest increases with 3.1°C warming expected during Autumn by the end of the century (2071-2100) under RCP8.5.
- Extended dry periods, of 5 plus days with less than 1 mm of precipitation recorded, will become more common in Ireland due to climate change.
- There is an increased risk that droughts will become more regular, longer and with potential for multi-year droughts.
- While the annual precipitation will decrease due to climate change, there will be an increase in the number of heavy and very heavy rainfall events that occur (rainfall in excess of 20 and 30 mm). The North-West of Ireland is expected to experience the worst of these increases with the occurrence of extreme events projected to increase by 30%.
- All studies show that higher flows are expected in winter, and this corresponds to an increased flood risk, where annual maximum flows could increase by between 12% and 16% for 50- and 100- year return periods and urban runoff in Dublin could increase by 30% in the winter months.

### REVIEW OF NATIONAL POLICIES:

- The Climate Action Plan 2021 does not adequately address the impact of climate change on water quantity in Ireland. Only 7% of the listed Actions mention water quantity and an additional 25% of the Actions would benefit from the inclusion of water quantity to secure supply, protect life and property and increase awareness.
- The Sectoral Plans reviewed do not use the most up-to-date climate analysis. For example, Irish Water's Framework Plan uses climate projections based on the IPCC's 4<sup>th</sup> Assessment Report (AR4), which is two generations old.
- The Flood Risk Management plan deals with adaptation to the impact of climate change and flood risk. However, it provides no details on how to undertake this despite stating that the design and construction of flood relief schemes must include the assessment and investment for climate change adaptation.

### REVIEW OF THE IRISH NATIONAL HYDROMETRIC MONITORING STATIONS:

- Seven different organisations are responsible for collecting water level and flow across the Ireland of Ireland. The OPW, EPA and River Agency NI are the three largest.

- Currently there are 1031 active stations across. These have a good spatial distribution across the island. However, the majority of these are not on the largest or smallest rivers and therefore, not representative of all catchment sizes.
- Record length of the active stations show significant variations with only 17 stations with records greater than 75 years and only ~30% of the active stations have record lengths greater than 50 years. This is a significant issue for modelling droughts where longer term records are critical. This was also highlighted in Uisce Éireann's National Water Resource Plan.
- Ireland currently has a National Hydrometric Working Group that is led by the EPA with the objective to coordinate the actions of organisation monitoring river discharge or water level. This Working Group determines if stations should close or if new ones are needed, The National Hydrometric Working Group should ensure longevity in monitoring stations across a range of catchment sizes throughout the country going forward. and should be supported as required to ensure gaps in hydrometric monitoring are identified for accurate modelling of water quantity.

### CHANGE IN WATER QUANTITY ACROSS IRISH CATCHMENTS:

- Regardless of which Representative Concentration Pathway (RCP) of greenhouse gas concentrations is considered, most of Ireland will be drier in the future. Under RCP 4.5 (the intermediate emission trend identified by the IPCC), while on average Ireland will only be slightly drier, some catchments will experience in excess of 10% reductions in annual average discharge. This has the potential to occur by 2040. Under RCP 8.5 (where emissions continue to rise through the 21<sup>st</sup> century), Ireland gets significantly drier in the future, where in the 2011-2040 scenario the average reduction in annual average discharge is only ~1%, but by the end of the century this rises to ~10%. There will be significant region to region and even catchment to catchment variations in annual average discharge. All results indicate that the East and South-East will be more heavily impacted than elsewhere.
- Under RCP 4.5, for both 2011-2040 and 2070-2100 periods, catchments along the west coast (from Donegal to Cork) may experience slightly wetter conditions, with an increase in annual average discharge up to 15%, potentially creating increased flood risk implications. There are very few wetter catchments, even on the west coast under RCP 8.5.
- The impact of these changes and spatial variations on different sectors are not fully understood. However, these changes will have significant impacts on water supply, agriculture, and ecosystems.



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