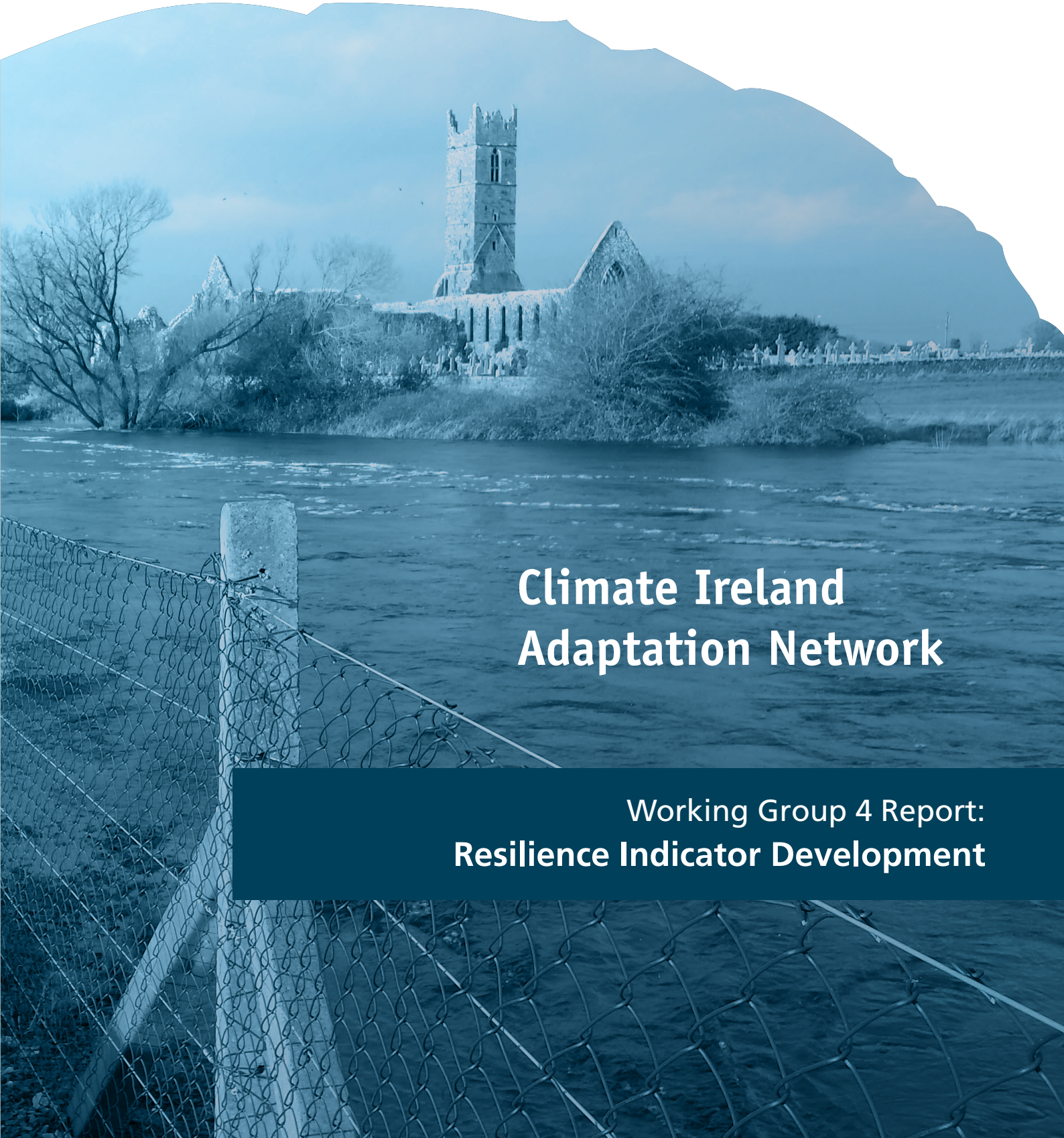
Climate Ireland



Climate Ireland Adaptation Network

Working Group 4 Report:

Resilience Indicator Development

Environmental Protection Agency

The EPA is responsible for protecting and improving the environment as a valuable asset for the people of Ireland. We are committed to protecting people and the environment from the harmful effects of radiation and pollution.

The work of the EPA can be divided into three main areas:

- **Regulation:** Implementing regulation and environmental compliance systems to deliver good environmental outcomes and target those who don't comply.
- **Knowledge:** Providing high-quality, targeted and timely environmental data, information and assessment to inform decision making.
- **Advocacy:** Working with others to advocate for a clean, productive and well-protected environment and for sustainable environmental practices.

Our responsibilities include:

LICENSING

- Large-scale industrial waste and petrol storage activities;
- Urban wastewater discharges;
- The contained use and controlled release of genetically modified organisms;
- Sources of ionising radiation;
- Greenhouse gas emissions from industry and aviation through the EU Emissions Trading Scheme.

NATIONAL ENVIRONMENTAL ENFORCEMENT

- Audit and inspection of EPA-licensed facilities;
- Drive the implementation of best practice in regulated activities and facilities;
- Oversee local authority responsibilities for environmental protection;
- Regulate the quality of public drinking water and enforce urban wastewater discharge authorisations;
- Assess and report on public and private drinking water quality;
- Coordinate a network of public service organisations to support action against environmental crime;
- Prosecute those who flout environmental law and damage the environment.

WASTE MANAGEMENT AND CHEMICALS IN THE ENVIRONMENT

- Implement and enforce waste regulations including national enforcement issues;
- Prepare and publish national waste statistics and the National Hazardous Waste Management Plan;
- Develop and implement the National Waste Prevention Programme;
- Implement and report on legislation on the control of chemicals in the environment.

WATER MANAGEMENT

- Engage with national and regional governance and operational structures to implement the Water Framework Directive;
- Monitor, assess and report on the quality of rivers, lakes, transitional and coastal waters, bathing waters and groundwaters, and measurement of water levels and river flows.

CLIMATE SCIENCE AND CLIMATE CHANGE

- Publish Ireland's greenhouse gas emission inventories and projections;
- Provide the Secretariat to the Climate Change Advisory Council and support to the National Dialogue on Climate Action;
- Support National, EU and UN climate science and policy development activities.

ENVIRONMENTAL MONITORING AND ASSESSMENT

- Design and implement national environmental monitoring systems: technology, data management, analysis and forecasting;
- Produce the State of Ireland's Environment and Indicator Reports;
- Monitor air quality and implement the EU Clean Air for Europe Directive, the Convention on Long Range Transboundary Air Pollution and the National Emissions Ceiling Directive;
- Oversee the implementation of the Environmental Noise Directive;
- Assess the impact of proposed plans and programmes on the Irish environment.

ENVIRONMENTAL RESEARCH AND DEVELOPMENT

- Coordinate and fund national environmental research activity to identify pressures, inform policy and provide solutions;
- Collaborate with national and EU environmental research activity.

RADIOLOGICAL PROTECTION

- Monitoring radiation levels and assess public exposure to ionising radiation and electromagnetic fields;
- Assist in developing national plans for emergencies arising from nuclear accidents;
- Monitor developments abroad relating to nuclear installations and radiological safety;
- Provide, or oversee the provision of, specialist radiation protection services.

GUIDANCE, AWARENESS RAISING, AND ACCESSIBLE INFORMATION

- Provide independent evidence-based reporting, advice and guidance to government, industry and the public on environmental and radiological protection topics;
- Promote the link between health and wellbeing, the economy and a clean environment;
- Promote environmental awareness including supporting behaviours for resource efficiency and climate transition;
- Promote radon testing in homes and workplaces and encourage remediation where necessary.

PARTNERSHIP AND NETWORKING

- Work with international and national agencies, regional and local authorities, non-governmental organisations, representative bodies and government departments to deliver environmental and radiological protection, research coordination and science-based decision making.

MANAGEMENT AND STRUCTURE OF THE EPA

The EPA is managed by a full-time Board, consisting of a Director General and five Directors. The work is carried out across five Offices:

- Office of Environmental Sustainability
- Office of Environmental Enforcement
- Office of Evidence and Assessment
- Office of Radiation Protection and Environmental Monitoring
- Office of Communications and Corporate Services

The EPA is assisted by advisory committees who meet regularly to discuss issues of concern and provide advice to the Board.

Climate Ireland

Climate Ireland Adaptation Network

Working Group 4 Report:
Resilience Indicator Development

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Disclaimer

This Climate Ireland Adaptation Network (CIAN) working group report summarises discussions from working group meetings and written contributions from CIAN members. It is intended to reflect a range of perspectives shared from the group and should be treated as a working document and not interpreted as representing the official views or endorsement of individual contributors or the Environmental Protection Agency (EPA). The EPA, the CIAN working group members and the authors do not accept any responsibility whatsoever for loss or damage occasioned, or claimed to have been occasioned, in part or in full, as a consequence of any person acting, or refraining from acting, as a result of a matter contained in this publication. All or part of this publication may be reproduced without further permission, provided the source is acknowledged.

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Contents

Executive summary

The planet is warming, with Europe warming twice as fast as the global average and extreme weather events becoming more frequent and intense. In this context, there is a need to protect ecosystems, communities, and businesses from the impacts of climate change through adaptation and build resilience into the future. While adaptation refers to the actions taken to adjust to climate impacts, resilience describes the capacity of systems to withstand, absorb, recover, and learn from those impacts.

The role of the Climate Ireland Adaptation Network (CIAN), which was established by the Environmental Protection Agency (EPA) in 2023, is to provide a forum which encourages individuals and organisations to work together to deliver improvements in implementing adaptation measures. It also acts as a space where individuals share experiences, seek help from each other and learn from their peers. Following the CIAN seminar in October 2024, four working groups were convened to advance understanding of critical topics in climate adaptation and resilience: technical definitions of resilience, just resilience, resilient decision-making, and indicator development.

The working groups were designed as collaborative, co-production spaces that enabled participants to openly share their views, practices, and perspectives. A core goal of the CIAN working groups was to enhance communication between stakeholders, build stronger links across Ireland's adaptation community, and provide a forum to discuss adaptation topics and identify practitioner needs and knowledge gaps. The meetings and workshops themselves were an important outcome, bringing people together, strengthening relationships, and advancing collective learning across the adaptation community.

This report summarises the output of Working Group 4, which focused on developing meaningful, scalable indicators to track resilience across sectors and scales. The report is designed to capture current perspectives, opinions, challenges, and opportunities related to the working group's topic. It serves as a shared reference for stakeholders, supporting adaptation planning and practice by consolidating insights and framing key considerations for future action. By presenting practitioner-informed views, the report aims to strengthen understanding and encourage dialogue across sectors.

The group explored five key topics:

1. Indicator hierarchy
2. Human indicators
3. Environmental indicators
4. Capacity and resource needs
5. Private sector adaptation indicators

The five areas mentioned aim to explore how to embed resilience measurement into national frameworks, sectoral plans, and local authority strategies, ensuring adaptation measures are robust, equitable, and responsive to future climate risks.

The working group identified a number of cross-cutting issues, including the need for a consistent indicator framework to track hazards, exposure, vulnerability, and response while reflecting demographic realities such as aging populations and digital skills. Indicators are essential for monitoring progress, identifying gaps, and ensuring adaptation strategies remain effective over time. Without robust indicators, resilience planning risks becoming aspirational rather than actionable. Environmental indicators, particularly for Nature-based Solutions (NbS), require better visibility, standardisation, and community involvement. Gaps in data quality and compatibility hinder planning, making investment in centralised data systems and collaboration with agencies like Central Statistics Office (CSO) and Tailte Éireann critical. Indicators must also account for interdependencies between systems such as energy, health, and environment. Capacity limitations remain a major barrier, especially for local authorities and small organisations, leading to uneven implementation and reliance on external consultants. Private sector adaptation adds complexity, requiring alignment with international standards (ESRS, IFRS, CDP, ISO) while remaining accessible for Small and Medium Sized Enterprises (SMEs). For the private sector, adaptation is fundamentally a risk management exercise, aimed at identifying, reducing and managing material climate-related risks to operations, supply chains, assets and financial performance.

The report of the working group concludes that Ireland's approach to climate resilience, as implemented through the National Adaptation Framework (NAF) and sectoral adaptation plans, would benefit from a national indicator hierarchy to track adaptation progress across sectors. Policy priorities include creating standardised indicators aligned with national and EU frameworks, supported by cross-sector collaboration, technical training for local authorities, and cross-border, all-island coordination. Equity must be embedded through justice metrics and inclusive engagement. Private sector adaptation should be facilitated by harmonising international standards with accessible guidance for SMEs. Investment planning must consider both economic and non-economic benefits such as health, biodiversity, and social cohesion while addressing financial barriers through reforms in insurance and risk-sharing. Finally, resilience planning should integrate foresight tools, scenario-based approaches, and transparent communication strategies to ensure decisions are actionable, inclusive, and responsive to evolving climate risks.

1. Introduction

Purpose of the report

Following the CIAN seminar in October 2024, four working groups were convened to examine in more detail the following key adaptation and resilience topics:

- Working Group 1: Technical definitions of resilience
- Working Group 2: Just resilience
- Working Group 3: Resilient decision-making
- Working Group 4: Indicator development

The aims of the working groups were to:

1. Provide a forum to share, discuss, and summarise the current understanding and perspectives of sectors in relation to important climate resilience topics
2. To identify practitioner (i.e. public agencies, semi-state bodies, private companies, academia, and civil society) needs and knowledge gaps.
3. To build stronger links between those involved in adaptation practices in Ireland.

Each working group was tasked with preparing a concise report summarising the work of the group.

Background on the CIAN Working Group 4

The purpose of this working group was to explore how to develop meaningful, scalable indicators that can track resilience across sectors and scales, drawing on international frameworks and national plans. Indicators are essential for monitoring progress, identifying gaps, and ensuring that adaptation strategies remain effective over time. Without robust indicators, resilience planning risks becoming aspirational rather than actionable, making it difficult to measure success or adjust strategies in response to emerging risks.

This topic was selected because indicators provide the foundation for evidence-based decision-making and accountability. By considering multidimensional indicators including social, environmental, structural, and digital domains the group aims to reflect vulnerability, adaptive capacity, and just resilience, particularly for at-risk communities. The approach is informed by practitioner perspectives gathered through engagement, ensuring that proposed indicators are practical, inclusive, and aligned with real-world data and capacity constraints.

The working group explored five key topics:

1. Indicator hierarchy
2. Human indicators
3. Environmental indicators
4. Capacity and resource needs
5. Private sector adaptation indicators

A key focus was practical implementation, including data availability, capacity needs, and collaboration across sectors to ensure indicators are actionable, inclusive, and support long-term adaptation planning. Exploring these key topics will improve understanding to better enable Ireland to move from ambition to implementation by embedding resilience measurement into national frameworks, sectoral plans, and local authority strategies, ensuring that adaptation measures are robust, equitable, and responsive to future climate risks.

Scope and intended use of the report

This summary report is designed to capture current perspectives, opinions, challenges, and opportunities related to the working group's topic. It serves as a shared reference for stakeholders, supporting adaptation planning and practice by consolidating insights and framing key considerations for future action. By presenting practitioner-informed views, the report aims to strengthen understanding and encourage dialogue across sectors.

2. Methodology

he EPA facilitated the development of this report in partnership with members of the CIAN working group. This group consisted of representatives from diverse sectors and organisations, including public agencies, semi-state entities, private companies, academic institutions, and non-profit organisations.

The EPA organised three working group meetings in collaboration with working group members between April and October 2025 to assist in report drafting (see Figure 1 for the co-production process). An initial Table of Contents (ToC) was created through group discussions and was revised iteratively during the first two workshops based on participants' written and verbal feedback. This feedback was compiled and shared for further refinement in later meetings, with consensus being sought in each session. Consensus was established through structured discussion of each section, iterative revisions based on collective feedback, and confirmation of agreement from all participants during meetings. Where differing views arose, these were documented and considered in subsequent drafts to ensure transparency.

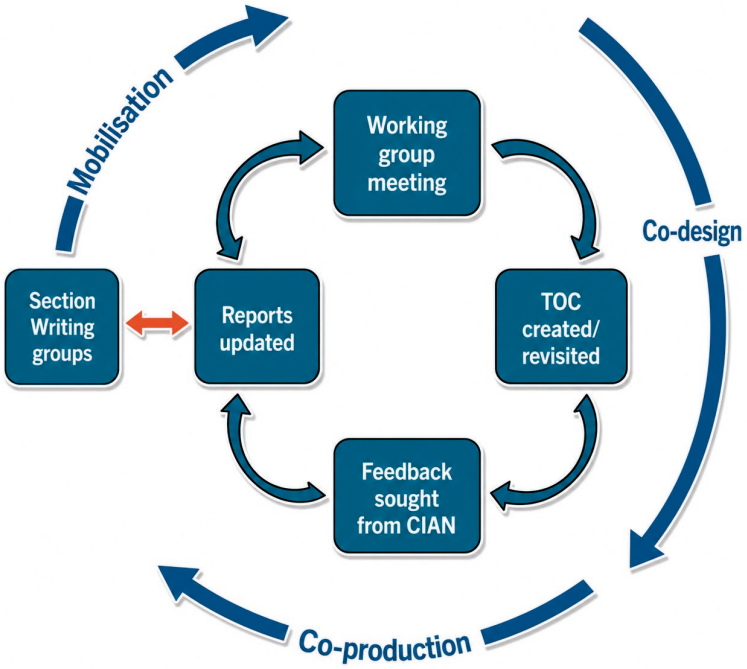

Figure 1: Co-production process with CIAN working group members. Starting with working group meetings there were three iterations of the cycle prior to the drafts being finalised.

Key themes that emerged from working group meetings were shared in the CIAN 2025 seminar, during which focused workshop sessions were organised to gather final input. This input was incorporated into the final report to guarantee it represented the combined knowledge and viewpoints of practitioners within the climate adaptation community.

3. Indicator hierarchy

As a starting point, consideration was made of the existing hierarchy applied in the Irish context as outlined in the report *"Policy Coherency in Adaptation Studies: Selecting and Using Indicators of Climate Resilience"* (Flood et al, 2021)and applied in *"Implementation of Climate Adaptation Indicators: Lessons Learned from the Transport Sector"* (Dwyer et al , 2024). The use of an indicator typology is outlined in Figure 2 below.

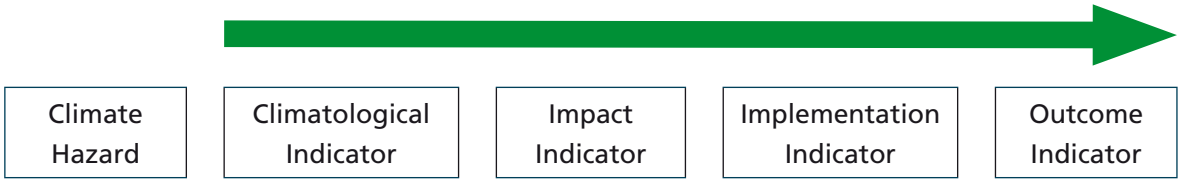

Figure 2: Indicator typology.

Source: Flood et al. Policy Coherency in Adaptation Studies: Selecting and Using Indicators of Climate Resilience (2021)

A climate hazard is defined here as a physical process or event that can harm human health, livelihoods or natural systems. Climatological indicators capture information about observed climatic conditions, e.g. temperature, rainfall and extreme events. Impact indicators capture information about the observed impacts of climate variability and change on socio-ecological systems, e.g. the number of properties damaged by floods. Implementation indicators provide information to help track the implementation of adaptation actions or strategies. Outcome indicators provide information to help track the outcome of results of adaptation actions or strategies.

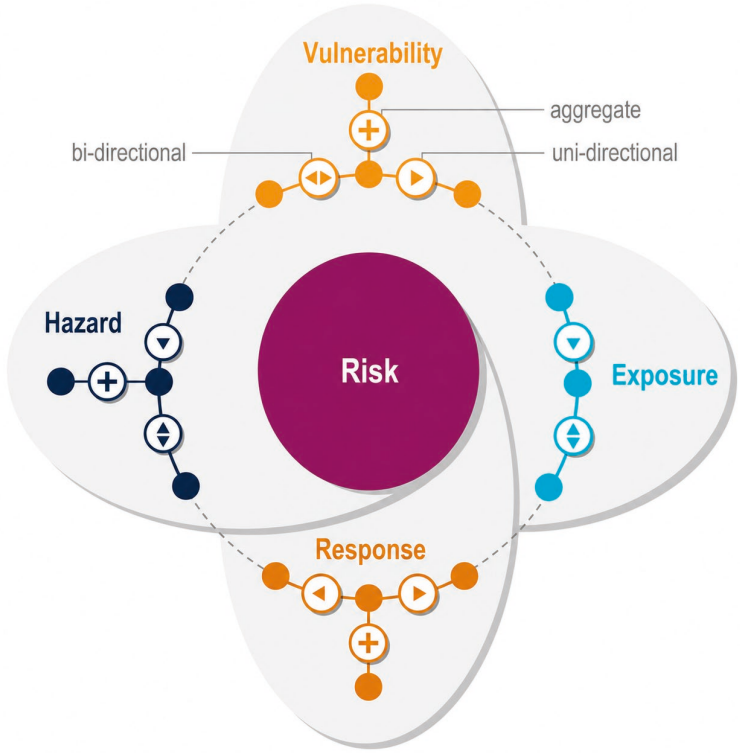

Figure 3: Risk is a result of the interaction of climate-related hazards with the vulnerability, exposure of human and natural systems, and response.
Source: IPCC, AR6 Working Group II (2022)

A climate risk (e.g. drought damage in agriculture) results from interactions between climate-related hazards (e.g. the frequency and intensity of droughts) with exposure (e.g. agriculture land) and vulnerability (e.g. drought resistance of crops, presence or absence of irrigation) of natural and human systems , and can be reduced or managed by a relevant response (e.g. irrigation or introduction of more drought resistant crop species). The Intergovernmental Panel on Climate Change (IPCC) sets out this relationship in Figure 3. Consideration of cross-cutting issues and interactions across systems from a risk perspective to illustrate the relationship between systems, sub-systems, and elements at risk (See Figure 4 below). The National Climate Change Risk Assessment (NCCRA) adopts a systems-based approach to support the identification and assessment of risks and crosscutting risks (EPA, 2025). Systems are a group of interacting or interrelated elements that can provide nationally important functions. Each system, e.g., Energy, is comprised of sub-systems, e.g., Energy Transportation and Distribution Grid, which are comprised of elements at risk, e.g., Electricity Network. Elements at risk are objects, persons, animals, plants, activities, and processes of value to Ireland that may be exposed to climate change and potentially impacted, negatively or positively, directly, or indirectly. To align with the NCCRA Methodology (EPA, 2024a), it is recommended that sectors use the systems and sub-systems approach (and classification of systems and subsystems contained within the NCCRA where relevant) to broadly determine the sectoral relevant systems, sub-systems, and elements (Section 2.1.2 of the NCCRA Methodology).

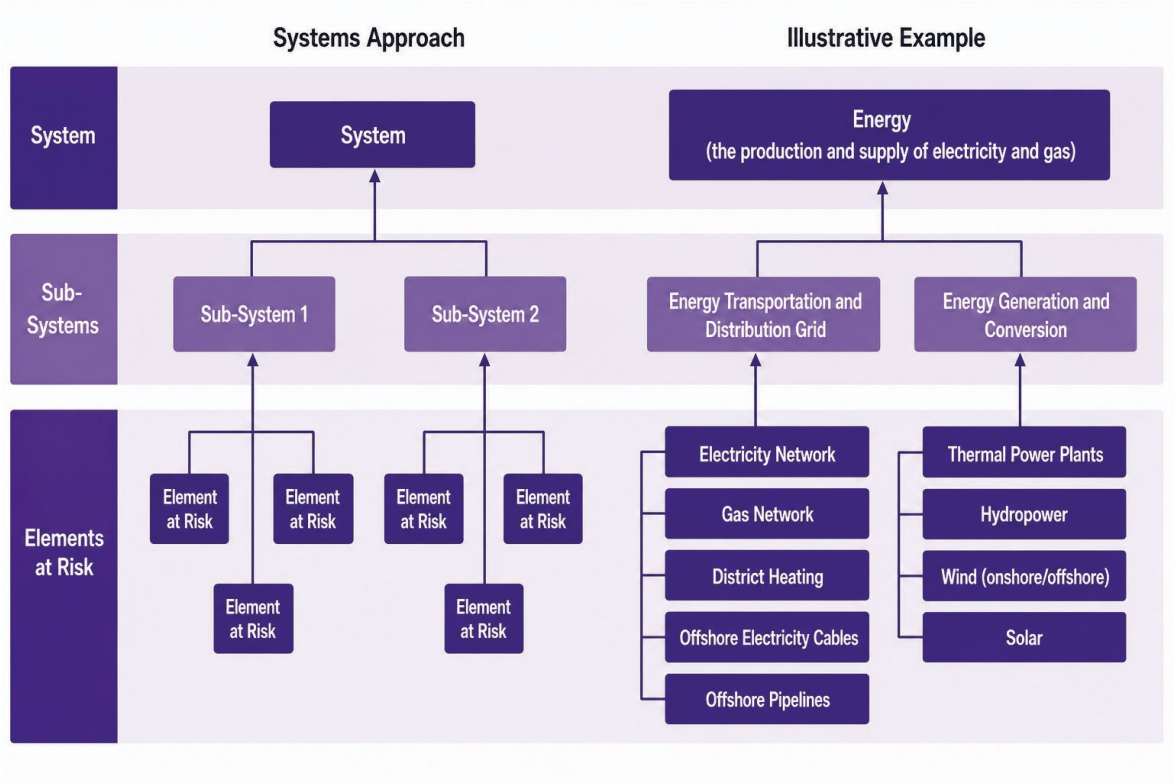

Figure 4: NCCRA Methodology EPA, 2024a.

Source: Environmental Protection Agency, NCCRA Methodology (2024a)

4. Human indicators

What constitutes as a human indicator in this report was largely informed through the CIAN Working Group 4 ToC and first workshop. Here, human indicators refer to measures describing human exposure to environmental and climate hazards, indicators of vulnerability, morbidity, mortality, broader dimensions of human development (i.e., Human Development index) such as health, education, living standards and demographics (UNDP, 2025).

According to the CSO statistical release on 16 July 2024, Ireland's population is projected to grow significantly under the high net migration scenario (M1), reaching approximately seven million by 2057. This growth, however, masks underlying demographic challenges. Although births are increasing, Ireland's fertility rate is just 1.5, well below the 2.1 replacement level, signalling an aging population and a shrinking pool of younger workers. Inward migration, often comprising younger cohorts, may partially offset this trend. However, its scale and stability are less predictable and typically reinforce urban concentration. These trends have profound implications for resilience planning. Regional variations in population density, occupational profiles, and livelihoods mean that rural areas, urban centres, and coastal communities will face distinct vulnerabilities. A declining working-age population could reduce Ireland's capacity to implement adaptation measures, maintain infrastructure, and support vulnerable groups, while increasing demand for health and social care services. International evidence, such as findings by Long and Yoshida (2023), highlights how demographic transitions can influence energy consumption and adaptation effectiveness dynamics that may similarly affect Ireland's housing, energy use, and community-level strategies. Therefore, human indicators of resilience must incorporate demographic realities, including population distribution, age structure, dependency ratios, and sector-specific vulnerabilities, to ensure robust climate risk assessments and adaptive capacity over the coming decades.

5. Environmental indicators

Environmental indicators are measures used to track the condition of the environment and related pressures/responses across domains such as air, water, biodiversity nature, soil, land use, etc., (EPA, 2024b). For example, EPA monitoring uses hydrological measurements such as river level and flow to assess water conditions, and it also tracks changes in habitats and species (EPA, 2024c).

There is an urgent need to track and monitor environmental and Nature-based Solutions (NbS) projects already underway, as proper tracking could significantly enhance their impact. Achieving this requires adequate capacity, technical expertise, and community buy-in, all of which should be reflected in the indicators used. Under the NAF, efforts are being made to promote NbS, but current measurement and inclusion practices remain limited; even visibility at the county level would represent progress. A two-tier situation exists, where large-scale coastal, marine, forestry, and peatland projects such as Bord na Móna's notable 30,000-hectare restoration effort are advancing, often led by landowners who benefit from land ownership advantages. While carbon credits are gaining traction, biodiversity credits remain underdeveloped, and financial benefits currently favour landowners in woodland and peatland areas. Ambitions for NbS should be clearly articulated but tempered with realism to ensure feasibility.

Defining and measuring NbS in Ireland requires careful consideration of whether existing metrics adequately capture their contribution to climate resilience. This includes assessing whether we measure how NbS make the environment resilient to climate change, or how we use the environment to make society resilient and whether both perspectives should be integrated. Frameworks such as natural capital accounting offer useful insights, but broader approaches like Planetary Health may provide more inclusive ways to evaluate outcomes. Performance-based monitoring should be prioritised, and concepts such as Biodiversity Net Gain (BNG) could strengthen ecological results. Developing higher-level biodiversity indicators beyond project-specific metrics is essential to assess the overall health of Ireland's ecosystems under climate pressures. Geohazard data from bodies like Geological Survey Ireland (GSI) and Office of Public Works (OPW), including landslide and coastal vulnerability indices, should support NbS planning and risk assessment, alongside mapping of heritage and cultural assets at risk from extreme weather by initiatives such as National Inventory of Architectural Heritage (NIAH) and INTERREG. Finally, accessible, locality-based indicators and dashboard-style tools could empower communities to track NbS performance, while collaboration with universities and Horizon Europe research partners will be key to developing standardised, scalable metrics across sectors.

6. Capacity and resource needs

Ireland faces significant gaps in climate resilience competencies, particularly in areas such as climate risk analysis, coastal engineering, emergency response, and health and social care (UNDP, 2025). In many private-sector organisations, sustainability or environmental functions often managed by Environment, Health, and Safety (EHS) teams are primarily compliance-driven rather than focused on adaptation planning and delivery, leaving resilience efforts fragmented and under-resourced (IDA Ireland, 2024). Many firms lack dedicated sustainability roles, and smaller projects often struggle to secure financing due to scale and perceived risk. These sustainability professionals should work closely with other functions, as climate adaptation projects need to be transversal rather than siloed; for example, involving operational and finance teams is important for mapping the impacts and costs of historical extreme weather events. Overall, while dedicated professionals are essential to lead the climate adaptation roadmap, the work should also be embedded across existing business areas. Adaptation projects are typically small, distributed, and yield public-good benefits, making them difficult to finance, while climate finance literacy remains low.

Best practices are not consistently shared, and training materials rarely persist beyond initial programs, highlighting the need for open, reusable content and communities of practice (UNDP, 2025). Capacity and resource planning are further hindered by fragmented, insufficient, and hard-to-access data, and there is no centralised guidance on how organisations should build resilience.

To measure indicators effectively, expert input will be important to achieve the necessary level of detail and guide indicator selection. The Belém Adaptation Indicators were created as part of a United Nations Framework Convention on Climate Change (UNFCCC) process leading up to COP30 in Belém in 2025; a list was drafted with around 100 indicators, with 59 being finalised and 30–40 not currently being measurable (UNFCCC, 2025). There is a growing push for business-related indicators driven by frameworks such as the Corporate Sustainability Reporting Directive (CSRD), which should be incorporated, and avoiding duplication must remain a core principle so indicators are developed in the least burdensome way possible.

International guidance highlights the importance of centralised, accessible climate resilience information systems to support equitable adaptation planning (UNDP, 2025). Addressing related gaps will require a national, centralised climate resilience data portal to catalogue adaptation-relevant roles, provide hazard and vulnerability layers, host guidance and toolkits, offer standardized risk screening tools, maintain a calendar of EU and domestic programs, and drive targeted outreach through industry bodies and local authorities to ensure programs reach firms and communities (UNDP, 2025).

7. Private sector adaptation indicators

Companies are increasingly expected by investors to plan for climate risks because events like flooding, heatwaves, and storms create real financial impacts. Investors want businesses to show that their leadership understands these risks, that they have assessed how climate impacts could affect them over time, and that they have set clear goals and timelines to improve resilience. They also expect companies to report openly on progress, make sure investment decisions support long-term resilience, and consider how climate actions affect workers, communities, and vulnerable groups. To do this effectively, companies need simple, measurable indicators that show whether they are reducing vulnerability and strengthening resilience. Clear indicators help companies improve planning, communicate progress, and demonstrate to investors that they are taking climate risks seriously.

A robust framework for private sector development of climate adaptation monitoring and implementation must be anchored to, in part at least, international standards for reporting and focus on measuring and tracking resilience across sectors as they are one of the key drivers for climate resilience indicators both within Ireland and by large corporations based in Ireland. Therefore, by leveraging the Revised ESRS (EFRAG), IFRS S2, CDP, and ISO standards, and the KPI's that are most addressed within them, it should provide an understanding of what databases, useability, interoperability and comparability issues are needed to underpin EPA indicator development. All of this must be underpinned by equity of access for SME's, along with other sectors of Irish society. A key to success is to acknowledge a lack of technical expertise in interpretation in the private sector, without diluting the quality of technical expertise being developed by the EPA.

Recent research by the Central Bank of Ireland highlights major obstacles businesses face in collecting climate adaptation and risk data (Disch & McElligott, 2025). High financial costs discourage investment in data systems, particularly for smaller firms, while limited technical expertise makes it difficult to identify, collect, and analyse relevant information. Reliable, standardised data, especially from suppliers and across value chains, remains scarce, and adaptation often competes with more immediate business priorities. Complex and fragmented regulations add compliance burdens, and poor cross-sector coordination restricts data sharing. Supplier engagement is also challenging due to limited capacity and misaligned priorities, while many organisations perceive adaptation risks as outside their planning horizons, weakening the business case. Finally, sector-specific local climate impact data suitable for non-technical reporting is lacking. Addressing these issues will require long-term solutions such as capacity building, sectoral collaboration, improved digital tools, and clearer regulatory guidance. Long-term solutions require capacity building, sectoral collaboration, improved digital tools, and clearer regulatory guidance (e.g. Climate Policy Info Hub, 2015).

To achieve "just" resilience in private sector indicator development, adaptation strategies must be inclusive and equitable, recognising that many businesses will lack the time, skills, or technical capacity to report on climate adaptation and may be overwhelmed by complex data requirements (Boltz et al., 2022). Indicators should reflect equity and accessibility by capturing the proportion of adaptation measures that protect disadvantaged groups, the extent of stakeholder engagement and training including SMEs and community involvement and the integration of outreach and awareness into business reporting practices. Addressing barriers will require harmonising standardised KPI definitions and methodologies using ESRS, IFRS, and ISO baselines; centralising data repositories and facilitating national and regional data collection; building capacity through partnerships with representative bodies such as Irish Business and Employers Confederation (IBEC) and Irish Small and Medium Enterprises Association (ISME); and incorporating climate scenario modeling tools with regular updates to hazard estimates, asset vulnerabilities, and adaptation progress. Private sector actors can implement indicators by integrating climate-related Key Performance indicators (KPIs) into existing corporate reporting systems, aligning with international frameworks such as ESRS, IFRS, CDP, and ISO. Businesses should prioritise internal capacity building, develop supplier engagement strategies, and use centralised or shared data platforms to improve interoperability and comparability. Leveraging scenario modeling tools and sector-specific guidance can help firms track adaptation progress and demonstrate resilience without relying solely on state agencies. For businesses to effectively integrate climate adaptation into planning, data must be accessible, actionable, and tailored to different levels of technical expertise. Practical solutions include interactive map-based tools that allow users to visualise hazards such as flooding, heat stress, and water scarcity, with simple legends and site-level exposure scores that can be easily exported. Open APIs and standardised tile services (e.g., OGC/WMS/WFS) enable integration of climate projections into existing GIS platforms and dashboards, supporting advanced users who build internal tools. Ready-made locality reports summarising key metrics by time horizon and scenario, presented in clear language for non-specialists, can help bridge technical gaps. Additionally, curated case study libraries showcasing real-world applications from data to decision to provide templates and KPIs that businesses can adapt to their own contexts. Global exemplars such as Climate-ADAPT (European Environment Agency, 2018), UK Met Office UKCP18 (Met Office, 2018), and Copernicus Climate Data Store (Copernicus, 2018),

8. Cross-cutting issues

The working group discussed that Ireland's climate resilience strategy must address interconnected challenges in governance, equity, data, capacity, and systems thinking. A consistent indicator framework is essential to track climate risks, impacts, implementation, and outcomes across sectors. Indicators should capture hazard, exposure, vulnerability, and response while reflecting demographic realities such as aging populations, regional job patterns, and digital skills. Environmental indicators, particularly those for NbS, need better visibility, standardisation, and community involvement. Persistent gaps in data quality, resolution, and compatibility hinder effective planning, making investment in centralised data systems and collaboration with agencies like CSO and Tailte Éireann critical. Indicators must also account for interdependencies between systems such as energy, health, and environment to support integrated risk management. It is essential to initiate the development of outcome indicators early, as these processes are complex and time-intensive, yet critical for tracking progress and ensuring long-term resilience. Common climate resilience KPI's with suggested data and delivery methods can be seen in Appendix A.

Capacity limitations remain a major barrier, especially for local authorities and small organisations that lack technical expertise and resources, leading to uneven implementation and reliance on external consultants. Policy must prioritise capacity building, streamlined approaches, and inclusive outreach to ensure indicators are scalable and aligned with national and EU frameworks. Private sector adaptation adds complexity, requiring alignment with international standards (ESRS, IFRS, CDP, ISO) while remaining accessible for SMEs and vulnerable businesses. Equity must be embedded in all indicator frameworks through clear justice metrics and fair access to data, ensuring vulnerable populations are identified and supported.

9. Conclusions and future considerations

The working group concluded that Ireland's climate resilience strategy must address interconnected issues of governance, equity, data, capacity, and systems thinking through a clear, inclusive, and future-ready framework. A national indicator hierarchy is essential to track adaptation progress across sectors, covering climate hazards, impacts, implementation, and outcomes. Indicators should capture interactions between hazard, exposure, vulnerability, and response, while incorporating demographic factors such as aging populations, regional job patterns, and digital skills, alongside environmental metrics that strengthen Nature-based Solutions (NbS). However, persistent gaps in data quality, accessibility, and compatibility hinder effective planning, making investment in centralised data systems and capacity building a priority.

The working group recommended that policy action should focus on creating standardised resilience indicators aligned with national and EU frameworks, supported by cross-sector collaboration and technical training for local authorities to reduce reliance on external consultants. Equity must be embedded in all indicator frameworks through clear justice metrics and inclusive stakeholder engagement. Private sector adaptation should be facilitated by harmonizing international standards (ESRS, IFRS, CDP, ISO) with accessible guidance for SMEs and vulnerable businesses. Investment planning must consider both economic and non-economic benefits such as health, biodiversity, and social cohesion while addressing financial barriers through reforms in insurance and risk-sharing. Finally, resilience planning should integrate foresight tools, scenario-based approaches, and transparent communication strategies to ensure decisions are actionable, measurable, inclusive, and responsive to evolving climate risks.

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Appendix A

Common climate resilience KPI's with suggested data and delivery methods compiled by authors during the report writing process

Common Climate Resilience KPI's	Proposed Data and Delivery (with best-practice examples)
Climate Scenario Analysis Required for risk/opportunity	Publish an open Scenario Hub offering pre-computed national downscaled projections (temperature, precipitation, sea-level, drought indices) under multiple SSPs/RCPs(Shared Socioeconomic Pathways)/RCPs (Representative Concentration Pathways) including ready-made PDFs by county and an API (Application Programming Interface) for programmatic pulls; mirror the UK Met Office Local Authority Climate Service model with simple narrative reports plus geospatial exploration maps for SMEs and planners; integrate a "use-case library" like EEA Climate-ADAPT showcasing sector examples to guide selection of scenarios and time horizons
Physical & Transition Risk Assessment	Provide a national Risk Atlas with harmonised hazard layers (coastal/ inland flood, heat, wildfire, landslide, drought/water stress) and standard consequence/vulnerability scoring templates downloadable as spreadsheets; curate EU case studies from Climate-ADAPT and Member State platforms to show how firms translate hazards into business risks and controls; include Copernicus Climate Data Store (CDS) pointers for advanced users and sector exemplars (agriculture, water, transport)
GHG Emissions/ Reduction Targets	Host a consolidated emissions-factors catalogue with electricity location-based factors, heat/fuel factors, and sector activity proxies, plus APIs; link to Copernicus climate datasets for weather-normalisation; reference EU best-practice portals that bundle mitigation and adaptation data for businesses (e.g., Climate-ADAPT services and case libraries)
Adaptation Measures Implemented	Publish an Adaptation Action Catalogue with standardised tags, example business measures, indicative costs/benefits, co-benefits, and monitoring indicators; model after Climate-ADAPT case study explorer with filters by sector, hazard, and company size, plus downloadable "measure fiches" and dashboards
Asset Vulnerability/ Exposure	Deliver web heat maps and tiled services for: flood probability/depth, heat exposure indices, water stress/drought (e.g., SPEI/SSI), coastal erosion susceptibility, etc. Include address/postcode lookup and batch upload CSV for asset lists to obtain per-site exposure scores; follow Met Office/ESRI geospatial delivery patterns and Copernicus tiling performance principles

Common Climate Resilience KPI's	Proposed Data and Delivery (with best-practice examples)
Reduction in Climate-related Damage	Maintain an Event Impact Register with harmonised per-event hazard footprints (e.g., storm, flood, heatwave) and return-period overlays that firms can intersect with assets; provide template calculators aligning loss categories to hazards used in European case studies for tourism, infrastructure, and agriculture to benchmark reductions after measures
Stakeholder/ Community Resilience	Provide downloadable Social Vulnerability Layer pack combining deprivation, health sensitivity, and critical-services proximity metrics at small-area level with guidance drawn from EU adaptation platform methodologies; add case studies from Spain's AdapteCCa/Climate-ADAPT on co-design and monitoring community outcomes to inform private-sector engagement KPIs
Climate Adaptation Budgeting	Publish a Prioritisation Toolkit with standard cost-benefit analysis (CBA) templates, discounting guidance under uncertainty, and multi-criteria scoring consistent with EU mission adaptation guidance; include a catalogue of funding sources and example business investment roadmaps from EU cases to normalise unit-costs and timing
Training & Capacity Building	Create a national Training Hub offering short e-courses and "how-to" notebooks on scenario use, hazard data interpretation, and ISO 14091-aligned workflows; mirror UK and EU practice by bundling curated case studies and templated reports that SMEs can adapt rapidly

An Ghníomhaireacht um Chaomhnú Comhshaoil

Tá an GCC freagrach as an gcomhshaol a chosaint agus a fheabhsú, mar shócmhainn luachmhar do mhuintir na hÉireann. Táimid tiomanta do dhaoine agus don chomhshaol a chosaint ar thionchar díobhálach na radaíochta agus an truaillithe.

Is féidir obair na Gníomhaireachta a roinnt ina trí phríomhréimse:

- Rialáil: Rialáil agus córais chomhlíonta comhshaoil éifeachtacha a chur i bhfeidhm, chun dea-thorthaí comhshaoil a bhaint amach agus díriú orthu siúd nach mbíonn ag cloí leo.
- Eolas: Sonraí, eolas agus measúnú ardchaighdeáin, spriocdhírithe agus tráthúil a chur ar fáil i leith an chomhshaoil chun bonn eolais a chur faoin gcinnteoireacht.
- Abhcóideacht: Ag obair le daoine eile ar son timpeallachta glaine, táirgiúla agus dea-chosanta agus ar son cleachtas inbhuanaithe i dtaobh an chomhshaoil.

I measc ár gcuid freagrachtaí tá:

CEADÚNÚ

- Gníomhaíochtaí tionscail, dramhaíola agus stórála peitril ar scála mór;
- Sceitheadh fuíolluisce uirbigh;
- Úsáid shrianta agus scaoileadh rialaithe Orgánach Géinmhodhnaithe;
- Foinsí radaíochta ianúcháin;
- Astaíochtaí gás ceaptha teasa ó thionscal agus ón eitlíocht trí Scéim an AE um Thrádáil Astaíochtaí.

FORFHEIDHMIÚ NÁISIÚNTA I LEITH CÚRSAÍ COMHSHAOIL

- Iniúchadh agus cigireacht ar shaoráidí a bhfuil ceadúnas acu ón GCC;
- Cur i bhfeidhm an dea-chleachtais a stiúradh i ngníomhaíochtaí agus i saoráidí rialáilte;
- Maoirseacht a dhéanamh ar fhreagrachtaí an údaráis áitiúil as cosaint an chomhshaoil;
- Caighdeán an uisce óil phoiblí a rialáil agus údaruithe um sceitheadh fuíolluisce uirbigh a fhorfheidhmiú
- Caighdeán an uisce óil phoiblí agus phríobháidigh a mheasúnú agus tuairisciú air;
- Comhordú a dhéanamh ar líonra d'eagraíochtaí seirbhíse poiblí chun tacú le gníomhú i gcoinne coireachta comhshaoil;
- An dlí a chur orthu siúd a bhriseann dlí an chomhshaoil agus a dhéanann dochar don chomhshaol.

BAINISTÍOCHT DRAMHAÍOLA AGUS CEIMICEÁIN SA CHOMHSHAOL

- Rialacháin dramhaíola a chur i bhfeidhm agus a fhorfheidhmiú lena n-áirítear saincheisteanna forfheidhmithe náisiúnta;
- Staitisticí dramhaíola náisiúnta a ullmhú agus a fhoilsiú chomh maith leis an bPlean Náisiúnta um Bainistíocht Dramhaíola Guaisí;
- An Clár Náisiúnta um Chosc Dramhaíola a fhorbairt agus a chur i bhfeidhm;
- Reachtaíocht ar rialú ceimiceán sa timpeallacht a chur i bhfeidhm agus tuairisciú ar an reachtaíocht sin.

BAINISTÍOCHT UISCE

- Plé le struchtúir náisiúnta agus réigiúnacha rialachais agus oibriúcháin chun an Chreat-treoir Uisce a chur i bhfeidhm;
- Monatóireacht, measúnú agus tuairisciú a dhéanamh ar chaighdeán aibhneacha, lochanna, uiscí idirchreasa agus cósta, uiscí snámha agus screamhuisce chomh maith le tomhas ar leibhéil uisce agus sreabhadh abhann.

EOLAÍOCHT AERÁIDE & ATHRÚ AERÁIDE

- Fardail agus réamh-mheastacháin a fhoilsiú um astaíochtaí gás ceaptha teasa na hÉireann;
- Rúnaíocht a chur ar fáil don Chomhairle Chomhairleach ar Athrú Aeráide agus tacaíocht a thabhairt don Idirphlé Náisiúnta ar Ghníomhú ar son na hAeráide;
- Tacú le gníomhaíochtaí forbartha Náisiúnta, AE agus NA um Eolaíocht agus Beartas Aeráide.

MONATÓIREACHT AGUS MEASÚNÚ AR AN GCOMHSHAOL

- Córais náisiúnta um monatóireacht an chomhshaoil a cheapadh agus a chur i bhfeidhm: teicneolaíocht, bainistíocht sonraí, anailís agus réamhaisnéisiú;
- Tuairiscí ar Staid Thimpeallacht na hÉireann agus ar Tháscairí a chur ar fáil;
- Monatóireacht a dhéanamh ar chaighdeán an aeir agus Treoir an AE i leith Aeir Ghlain don Eoraip a chur i bhfeidhm chomh maith leis an gCoinbhinsiún ar Aerthruailliú Fadraoin Trasteorann, agus an Treoir i leith na Teorann Náisiúnta Astaíochtaí;
- Maoirseacht a dhéanamh ar chur i bhfeidhm na Treorach i leith Torainn Timpeallachta;
- Measúnú a dhéanamh ar thionchar pleananna agus clár beartaithe ar chomhshaol na hÉireann.

TAIGHDE AGUS FORBAIRT COMHSHAOIL

- Comhordú a dhéanamh ar ghníomhaíochtaí taighde comhshaoil agus iad a mhaoiniú chun brú a aithint, bonn eolais a chur faoin mbeartas agus réitigh a chur ar fáil;
- Comhoibriú le gníomhaíocht náisiúnta agus AE um thaighde comhshaoil.

COSAINT RAIDEOLAÍOCH

- Monatóireacht a dhéanamh ar leibhéil radaíochta agus nochtadh an phobail do radaíocht ianúcháin agus do réimsí leictreamaighnéadacha a mheas;
- Cabhrú le pleananna náisiúnta a fhorbairt le haghaidh éigeandálaí ag eascairt as taismí núicléacha;
- Monatóireacht a dhéanamh ar fhorbairtí thar lear a bhaineann le saoráidí núicléacha agus leis an tsábháilteacht raideolaíochta;
- Sainseirbhísí um chosaint ar an radaíocht a sholáthar, nó maoirsiú a dhéanamh ar sholáthar na seirbhísí sin.

TREOIR, ARDÚ FEASACHTA AGUS FAISNÉIS INROCHTANA

- Tuairisciú, comhairle agus treoir neamhspleách, fianaise-bhunaithe a chur ar fáil don Rialtas, don tionscal agus don phobal ar ábhair maidir le cosaint comhshaoil agus raideolaíoch;
- An nasc idir sláinte agus folláine, an geilleagar agus timpeallacht ghlan a chur chun cinn;
- Feasacht comhshaoil a chur chun cinn lena n-áirítear tacú le hiompraíocht um éifeachtúlacht acmhainní agus aistriú aeráide;
- Tástáil radóin a chur chun cinn i dtithe agus in ionaid oibre agus feabhsúchán a mholadh áit is gá.

COMHPHÁIRTÍOCHT AGUS LÍONRÚ

Oibriú le gníomhaireachtaí idirnáisiúnta agus náisiúnta, údaráis réigiúnacha agus áitiúla, eagraíochtaí neamhrialtais, comhlachtaí ionadaíocha agus ranna rialtais chun cosaint chomhshaoil agus raideolaíoch a chur ar fáil, chomh maith le taighde, comhordú agus cinnteoireacht bunaithe ar an eolaíocht.

BAINISTÍOCHT AGUS STRUCHTÚR NA GNÍOMHAIREACHTA UM CHAOMHNÚ COMHSHAOIL

Tá an GCC á bainistiú ag Bord lánaimseartha, ar a bhfuil Ard-Stiúrthóir agus cúigear Stiúrthóir. Déantar an obair ar fud cúig cinn d'Oifigí:

- An Oifig um Inbhunaitheacht i leith Cúrsaí Comhshaoil
- An Oifig Forfheidhmithe i leith Cúrsaí Comhshaoil
- An Oifig um Fhianaise agus Measúnú
- An Oifig um Chosaint ar Radaíocht agus Monatóireacht Comhshaoil
- An Oifig Cumarsáide agus Seirbhísí Corparáideacha

Tugann coistí comhairleacha cabhair don Ghníomhaireacht agus tagann siad le chéile go rialta le plé a dhéanamh ar ábhair imní agus le comhairle a chur ar an mBord.

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