Natural flood management in Wales

From promise to practice: a pathway to a more resilient flood future

Rheoli llifogydd naturiol yng Nghymru

O addewid i weithredu: llwybr at ddyfodol mwy cydnerth yn wyneb llifogydd

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Please note there is a Welsh version of the Executive summary on pp. vii-x.

Am fersiwn Gymraeg o'r Crynodeb Gweithredol gweler tt.vii-x.

EXECUTIVE SUMMARY

Flood risk in Wales is already significant. Wales has experienced multiple major flood events over recent years, with Natural Resources Wales recording ~94 flood events since the year 2000. Storm Ciara and Storm Dennis caused over £81 million in damage to over 3,000 properties in Wales in February 2020 (NRW, 2020). Communities from Pontypridd to Holyhead were hit by flooding, landslides, and severe wind in 2024 as Storm Bert and Storm Darragh hit Wales, with major impacts on people's lives. In late 2025, flooding was once again widespread, when Storm Claudia led to severe flooding across much of South Wales, with over £9 million in damage in Monmouthshire alone (NRW, 2025). Such events are set to increase as climate change continues to lead to more intense rainfall and higher river flows, as well as sea level rise.

At the same time, the limits of conventional flood defences are becoming clear. In some locations, authorities are finding it increasingly difficult to justify investment in flood defences. Difficult choices to relocate some homes have already been taken (as in the case of Clydach Terrace, Rhondda Cynon Taf) and elsewhere the future remains uncertain (as in the coastal town of Fairbourne, where maintaining existing sea defences is deemed untenable and the prospect of future abandonment is real). Flood risk is growing and conventional approaches alone, including built defences, cannot meet this challenge. Although conventional infrastructure still has a role to play, in some locations built defences are likely to be unaffordable, and in others unnecessarily degrade ecosystems, or impact communities.

The analysis presented in this report highlights both the scale of the flood risk challenge in Wales, the opportunity to reduce flood risk through Natural Flood Management (NFM - an approach that works with natural processes, rather than against them), and the policy, planning, and practice needed to realise these opportunities. NFM includes methods such as restoring functional floodplains, tree planting, leaky dams, shelter belts, local attenuation ponds, enhancing soil infiltration, and modifying surface vegetation to increase roughness. Key findings from this report are summarised below.

Scale of the flood risk challenge in Wales

- **Around one in seven homes are exposed to flooding:** Natural Resources Wales (NRW) estimate around 275,000 properties in Wales are exposed to either coastal, fluvial or surface water flood hazards.
- **Flood risk is significant today and set to increase unless we act:** The most recent report published by the Climate Change Committee (Sayers *et al.,* 2026a) suggests around ~4,200 residential and non-residential properties are expected to flood each year (across all sources of flooding), with an estimated Expected Annual Damage across Wales of ~£93 million (including £41m residential, and £52m non-residential property damage). As the climate changes, these risks are set to increase markedly unless appropriate action is taken to adapt, increasing by a factor of 1.8 by the 2050s (given 2^{o}C rise in global warming levels), and by a factor of 4.3 by the 2080s (given a 4^{o}C rise).
- **Many households have little or no flood insurance:** Analysis for this report suggests ~25-40,000 households living in high-risk areas in Wales do not have adequate flood insurance. This suggests ~£15m of annual average flood losses are uninsured or under-insured. This compounds issues of social flood disadvantage, with those on low income and in rented accommodation most likely to have inadequate flood insurance.
- **Flooding depresses property asset value:** Evidence from England suggests properties exposed to flooding are sold at a discount compared to others. Translating this evidence to Wales suggests flood exposure acts to reduce the value of the housing asset base in Wales by ~£4.7 billion.

The opportunity Natural Flood Management provides

Flood risk is best managed through a whole system portfolio of measures that address the sources and pathways of the flood hazards, and reduce the impact on communities should a flood occur (*e.g.,* Sayers *et al.,* 2013). Within this portfolio, each measure has strengths and weaknesses. Good strategic planning brings these together in a way that enables flood risk to be reduced effectively, efficiently, and in a way that provides multiple benefits for people and nature.

Within the literature, policy, and guidance, NFM is increasingly recognised as central to this portfolio and the evidence base for NFM strong to support action at scale. This is reflected in the findings of the analysis presented here:

- **NFM has the potential to deliver significant flood risk reduction benefits across Wales**: NFM works by restoring and enhancing natural processes across catchments to reduce run-off, increase storage, reduce peak flood flows, manage morphological dynamics, and reduce soil loss. NFM measures, if given space, are inherently adaptable. Their performance evolves over time, responding to changing conditions and can deliver multiple benefits beyond flood risk reduction (as noted below). These attributes contrast with built flood defences that are often mono-functional with a performance that decays over time (committing future generations to continued investment). The NFM opportunity mapping produced by NRW shows that physical conditions conducive to NFM are widespread across Wales. These include opportunities to *'slow the flow'* through woodland and peatland (blanket bog and upland peat) restoration, floodplain and riparian reconnection, and changes in agricultural management (to reduce run-off and loss of surface soils). National-scale modelling undertaken for the Climate Change Committee (Sayers *et al*., 2026a) and the Natural Environment Research Council's OpenCLIM programme (Sayers *et al*., 2025) suggests that NFM can make a substantial contribution to managing future fluvial flood risk. The analysis indicates that, when implemented as part of a portfolio of interventions across Wales, NFM could deliver around 12% of the overall fluvial risk reduction. This is equivalent to a risk saving of ~£9.7m per year (given 2^{o}C rise in global warming levels). Given a more extreme (but plausible) climate future of 4^{o}C, by the 2080s the contribution of NFM remains robust, increasing to ~15% of the portfolio benefits (contributing up to ~£16.3m per year risk reduction by the 2080s). These values reflect a nationally averaged contribution. At a local scale, the flood risk reduction benefit achieved by NFM will vary across Wales. In many catchments the contribution will be significantly higher, and in some NFM will be the dominant contributor to flood alleviation. This flood focused assessment, although a central lens, systematically underestimates the value of NFM, as many substantial co-benefits for people and nature are simply missed. Guidance on how to value the full benefits of NFM at multiple scales is emerging, but there remains a tendency to overstate the uncertainties in NFM and understate the full range of benefits.
- **The NFM story extends beyond its ability to reduce flood risk, to its ability to simultaneously address multiple environmental and societal challenges.** NFM provides a scalable solution that delivers multiple co-benefits, and a pathway to long-term resilience. NFM contributes to multiple other benefits, for example, water resources (by encouraging infiltration and groundwater recharge), reducing pollution in rivers, food security (by reducing surface soil erosion and improving soil health), well-being benefits and carbon sequestration. These are not assessed in this report, but all act to reinforce the case for NFM. Decision processes tend to ignore the more subtle advantages of NFM. NFM interventions may require longer to establish and deliver than a built solution, but their contribution will improve as they mature. Conversely, built infrastructure may deteriorate over time, and cost more to maintain. These wider benefits and inherent adaptability mean NFM supports intergenerational justice in a way built solutions may not. NFM is not a silver bullet but valuing its cumulative contribution to multiple benefits

across **a** catchment and through time, is a prerequisite to rebalancing the decision process and the choices we make.

- **Practical experience reinforces the multiple benefit case for NFM at scale:** The longstanding *Pontbren project* in mid-Wales demonstrates how farmer-led land management, including shelter belts and reduced grazing pressure, can improve soil structure, increase infiltration and reduce rapid surface run-off at field and hillslope scales. The *Resilient Rivers* project is showing how partners, including businesses, the public sector and farming communities, can be brought together to coordinate action across entire landscapes to reduce flood risk, protect water supplies, benefit nature, and restore rivers. Central to this collaborative endeavour are nature-based catchment solutions hosted and managed by farmers. The *Cwm Ivy realignment* on the Gower shows how making space for natural coastal processes can rapidly create valuable habitat while reducing reliance on hard defences. Urban examples, such as *Greener Grangetown*, show how nature-based drainage can reduce pressure on conventional systems while creating greener, more attractive places. Taken together, these examples underline NFM as a practical and effective flood management response, not a speculative concept: when planned in the right places, and delivered with land managers, communities and infrastructure providers, it can provide credible flood risk benefits alongside wider resilience gains.

Realising the opportunities through policy, planning, and practice

- **Leverage existing momentum:** Wales is well placed to lead on NFM. Wales has the evidence, political mandate and policy framework to support long-term and catchment scale decision-making, promote the link between ecosystem health and well-being and scale up nature-based solutions. Wales has already laid the foundations and set the direction. The challenge is to deliver at pace and scale and ensure commitments across flooding, farming, cleaner rivers, woodland creation, and river restoration are joined together into a coherent national programme for catchment resilience.
- **Establish strategic oversight and leadership of all water issues:** Strategic oversight and leadership across the water domain is needed if plans and actions are to be aligned without unnecessary complexity and in a practical way. The ongoing process of water reform in Wales provides an opportunity to establish this oversight and move towards system-scale planning and to strengthen the contribution of NFM (and other NbS) to a resilient water future for Wales. The Welsh Government's Green Paper consultation suggested the need for a National Systems Planner which speaks directly to this need. A strategic National Systems Planner would have oversight of all water-related issues in Wales (flooding, water resources, the water environment) and appropriate powers to act. It would provide visibility of trade-offs and co-benefits across water-related activities, providing opportunities for co-funding (such as private sector investment) and aligned actions. In doing so, this would provide a means to bring together Welsh Government commitments across flooding, farming, cleaner rivers, woodland creation and river restoration into a coherent national programme for catchment resilience.
- **Promote strategic landscape and catchment planning**: Adopting a strategic landscape scale perspective shifts the focus towards delivering multiple outcomes from NFM measures such as reducing downstream flooding, soil health, food security, water security and multiple livelihood and well-being outcomes**.** There is a need to continue to strengthen policy to promote a strategic landscape and catchment scale perspective. Developing catchment plans that deliver multiple outcomes through NFM provides opportunities to blend multiple public and private funding sources. Catchment plans need to involve and align all sectors including government (national and local), landowners, regulators, businesses (including Dŵr Cymru), communities, environmental organisations and other stakeholders to actively seek opportunities to align actions and deliver coordinated schemes that reduce flood risk and wider outcomes.
- **Enable opportunities for collaboration and alignment of actions:** The Sustainable Farming Scheme (SFS) collaborative layer provides an excellent opportunity to align farm-scale actions

that support NFM at a catchment scale. The extensive nature of the NRW *'opportunity maps'* provide strong supporting evidence for the underlying case to scale-up investment in NFM and provide an important resource to inform spatial prioritisation of SFS funding.

- **Scale investment in NFM through a change in planning and design perspective:** In recent years investment in flood risk management in Wales has increased substantially. This is a positive step. However, only a small proportion has been directed toward NFM (less than 2% of the total flood risk management funding in 2022-26). Without rebalancing investment, NFM will not be delivered at the scale and the pace required. There is an opportunity to reset how flood risk management is approached, avoiding a *'false'* binary choice between natural flood management or built defences, and reframing NFM away from a supporting role (to help offset the shortcoming of built defences) to **a leading role** (with support where needed). This change in perspective provides the planning and design space to explore the full value of the NFM opportunities, and investment to scale to realise these opportunities.

If Wales is to become more resilient in the future, working with nature must become part of the mainstream, not the exception. This is a direction the Welsh Government has set out in principle; the challenge now is to turn this into good plans and successful action.

CRYNODEB GWEITHREDOL

Mae Cymru eisoes yn wynebu risg llifogydd sylweddol ac wedi profi nifer o lifogydd mawr dros y blynyddoedd diwethaf, gyda Chyfoeth Naturiol Cymru (NRW) yn cofnodi ~94 o ddigwyddiadau ers y flwyddyn 2000. Achosodd Storm Ciara a Storm Dennis dros £81 miliwn o ddifrod i dros 3,000 eiddo yng Nghymru ym mis Chwefror 2020 (NRW, 2020). Cafodd cymunedau o Bontypridd i Gaergybi eu heffeithio gan lifogydd, tirlithriadau a gwyntoedd difrifol yn 2024 wrth i Storm Bert a Storm Darragh daro Cymru, ac effeithio'n sylweddol ar fywydau pobl. Ar ddiwedd 2025, arweiniodd Storm Claudia at lifogydd difrifol ar draws rhan helaeth o dde Cymru, gan achosi dros £9 miliwn mewn difrod yn Sir Fynwy yn unig (NRW, 2025). Mae disgwyl y bydd digwyddiadau o'r fath yn cynyddu wrth i newid hinsawdd barhau i arwain at lawiad mwy dwys a llif afonydd uwch, yn ogystal â chynnydd yn lefel y môr.

Ar yr un pryd, mae diffygion amddiffynfeydd confensiynol yn dod i'r amlwg. Mewn rhai lleoliadau, mae awdurdodau yn ei chael hi'n fwyfwy anodd cyfiawnhau buddsoddiad mewn amddiffynfeydd rhag llifogydd. Mae'r dewis anodd i adleoli rhai cartrefi eisoes wedi'u gwneud (er enghraifft, Teras Clydach, Rhondda Cynon Taf) ac mae'r dyfodol yn ansicr mewn mannau eraill (fel yn nhref arfordirol Fairbourne, lle mae amddiffynfeydd môr presennol yn anghynaliadwy ac mae posibilrwydd go iawn o orfod ymadael yn y dyfodol). Mae risg llifogydd yn cynyddu. Ni all dulliau confensiynol ar eu pennau eu hunain, gan gynnwys amddiffynfeydd adeiledig, gwrdd â'r her hon. Er bod gan seilwaith confensiynol rôl i'w chwarae o hyd, mewn rhai lleoliadau mae amddiffynfeydd wedi'u hadeiladu yn debygol o fod yn anfforddiadwy. Ac mewn mannau eraill maen nhw'n diraddio ecosystemau yn ddiangen, neu'n effeithio ar gymunedau.

Mae'r adroddiad hwn yn tynnu sylw at raddfa her risg llifogydd yng Nghymru, y cyfle i leihau'r risg drwy Reoli Llifogydd Naturiol (NFM – Natural Flood Management - dull sy'n gweithio gyda phrosesau naturiol, yn hytrach nag yn eu herbyn), a'r polisi, y cynllunio a'r arfer sydd eu hangen i wireddu'r cyfleoedd hyn. Mae NFM yn cynnwys dulliau fel adfer gorlifdiroedd swyddogaethol, plannu coed, argaeau sy'n gollwng, gwregysau cysgod, pyllau gwanhau lleol, gwella ymdreiddio pridd, ac addasu llystyfiant arwyneb i gynyddu garwedd. Mae canfyddiadau allweddol yr adroddiad hwn wedi'u crynhoi isod.

Graddfa'r her perygl llifogydd yng Nghymru

- **Mae tua un o bob saith cartref yn agored i lifogydd:** Mae NRW yn amcangyfrif bod tua 275,000 eiddo yng Nghymru yn agored i beryglon llifogydd arfordirol, afonol neu ddŵr wyneb.

- **Mae perygl llifogydd yn sylweddol heddiw ac mae disgwyl iddo gynyddu oni bai ein bod yn gweithredu:** Mae'r adroddiad diweddaraf a gyhoeddwyd gan y Pwyllgor Newid Hinsawdd (Sayers *et al*., 2026a) yn awgrymu bod disgwyl i tua ~4,200 eiddo preswyl ac eiddo amhreswyl lifogi bob blwyddyn (ar draws pob ffynhonnell llifogydd), gydag amcangyfrif o ~£93 miliwn o Ddifrod Blynyddol Disgwyliedig ledled Cymru (gan gynnwys £41m preswyl, a difrod eiddo amhreswyl o £52m). Gyda newid hinsawdd, mae disgwyl y bydd y risgiau hyn yn cynyddu'n sylweddol oni bai bod camau priodol yn cael eu cymryd i addasu, gan gynyddu ffactor o 1.8 erbyn y 2050au (o ystyried cynnydd 2°C mewn lefelau cynhesu byd-eang), a ffactor o 4.3 erbyn y 2080au (o ystyried cynnydd o 4 °C).

- **Mae gan lawer o aelwydydd ychydig neu ddim yswiriant llifogydd:** Mae dadansoddiad yr adroddiad hwn yn awgrymu nad oes gan ~25-40,000 o aelwydydd sy'n byw mewn ardaloedd risg uchel yng Nghymru yswiriant llifogydd digonol. Mae hyn yn awgrymu bod ~£15m o golledion llifogydd cyfartalog blynyddol heb yswiriant neu heb yswiriant digonol. Mae hyn yn gwaethygu anfantais llifogydd cymdeithasol, gyda'r rhai ar incwm isel ac sy'n rhentu ymhlith y mwyaf tebygol o fod heb yswiriant llifogydd digonol.

- **Mae llifogydd yn lleihau gwerth asedau eiddo:** Mae tystiolaeth o Loegr yn awgrymu bod eiddo sy'n agored i niwed llifogydd yn cael eu gwerthu ar ddisgownt o'i gymharu ag eraill. Mae trosi'r dystiolaeth hon i gyd-destun Cymru yn awgrymu bod llifogydd yn costio ~£4.7 biliwn mewn gwerth asedau tai yng Nghymru.

Y cyfle y mae Rheoli Llifogydd Naturiol yn ei roi

Mae risg llifogydd yn cael ei reoli orau trwy bortffolio system gyfan o fesurau sy'n mynd i'r afael â ffynhonnell neu lwybr y risg. Ac yn cyfyngu canlyniadau unrhyw lifogydd ar ein cymunedau (er enghraifft, Sayers *et al.,* 2013). O fewn y portffolio hwn, mae gan bob mesur gryfderau a gwendidau. Mae cynllunio strategol da yn dod â'r rhain at ei gilydd mewn ffordd sy'n galluogi lleihau risg llifogydd yn effeithiol, yn effeithlon, ac mewn ffordd sy'n cynnig nifer o fanteision i bobl a natur.

O fewn y llenyddiaeth, y polisi a'r canllawiau, mae NFM yn cael ei gydnabod yn fwyfwy canolog i'r portffolio hwn. Ac mae sylfaen dystiolaeth gref yn cefnogi gallu NFM i weithredu ar raddfa. Mae hyn yn cael ei adlewyrchu yn y canfyddiadau sy'n cael eu cyflwyno yma:

- **Mae gan NFM botensial i ddarparu manteision sylweddol i leihau risg llifogydd ledled Cymru**: Mae NFM yn gweithio drwy adfer a gwella prosesau naturiol ar draws dalgylchoedd i leihau dŵr ffo, cynyddu storio, lleihau llif llifogydd brig, rheoli deinameg morffolegol, a lleihau colli pridd. Mae mesurau NFM, gyda'r amodau cywir, yn gynhenid addasadwy. Mae eu perfformiad yn esblygu dros amser, gan ymateb i amodau sy'n newid ac maen nhw'n darparu manteision lluosog y tu hwnt i leihau risg llifogydd (fel y nodir isod). Mae'r nodweddion hyn yn cyferbynnu ag amddiffynfeydd llifogydd adeiledig sy'n aml yn mono-swyddogaethol gyda pherfformiad sy'n dirywio dros amser (gan ymrwymo cenedlaethau'r dyfodol i fuddsoddiad parhaus). Mae mapio cyfleoedd NFM gan NRW yn dangos bod amodau ffisegol sy'n ffafriol i NFM yn gyffredin ledled Cymru.

  Mae'r rhain yn cynnwys cyfleoedd i 'arafu'r llif' trwy goetir a mawndiroedd (gorgorsydd a gweundir), adfer, ailgysylltu gorlifdir a glannau môr, a newid rheolaeth amaethyddol (i leihau dŵr ffo a cholled pridd wyneb). Mae modelu ar raddfa genedlaethol ar gyfer y Pwyllgor Newid Hinsawdd (Sayers *et al*., 2026a) a rhaglen OpenCLIM Cyngor Ymchwil yr Amgylchedd Naturiol (*Sayers et al*., 2025) yn awgrymu y gall NFM wneud cyfraniad sylweddol at reoli risg llifogydd afonol yn y dyfodol. Mae'r dadansoddiad yn nodi, pan gaiff ei weithredu fel rhan o bortffolio o ymyriadau ledled Cymru, y gallai NFM gyflawni tua 12% o'r gostyngiad risg cyffredinol. Mae hyn yn cyfateb i arbediad risg o ~£9.7m y flwyddyn (o ystyried cynnydd o 2°C yn lefelau cynhesu byd-eang). Gan ystyried dyfodol hinsawdd mwy eithafol (ond credadwy) o 4 °C, erbyn y 2080au mae cyfraniad NFM yn parhau i fod yn gadarn, gan gynyddu i ~15% o fanteision y portffolio (gan gyfrannu at lleihau risg o hyd at ~£16.3m y flwyddyn erbyn y 2080au). Mae'r gwerthoedd hyn yn adlewyrchu cyfraniad cyfartalog cenedlaethol. Ar raddfa leol, mae buddion NFM i leihau risg llifogydd yn amrywio ledled Cymru. Mewn sawl dalgylch bydd y cyfraniad yn sylweddol uwch, ac mewn rhai eraill NFM fydd y prif ymateb i liniaru llifogydd. Mae'r asesiad hwn, sy'n canolbwyntio ar lifogydd, yn tanbrisio gwerth NFM o ran y buddion ychwanegol sylweddol i bobl a natur. Mae canllawiau yn dechrau ymddangos ar sut i fanteisio'n llawn ar NFM (ar raddfeydd gwahanol), ond mae tueddiad o hyd i orbwysleisio ansicrwydd NFM a thanseilio'r ystod lawn o fanteision.

- **Mae stori NFM yn fwy na'r gallu i leihau risg llifogydd, gall fynd i'r afael â heriau amgylcheddol a chymdeithasol niferus ar yr un pryd.** Mae NFM yn darparu datrysiad graddadwy sy'n darparu cyd-fanteision lluosog, a llwybr i wydnwch tymor hir. Mae NFM yn cyfrannu at nifer o fanteision

eraill, er enghraifft, adnoddau dŵr (trwy annog ymdreiddio ac ail-lenwi dŵr daear), lleihau llygredd mewn afonydd, diogelwch bwyd (trwy leihau erydiad pridd wyneb a gwella iechyd pridd), buddion o ran llesiant ac atafaelu carbon. Nid yw'r rhain yn cael eu hasesu yn yr adroddiad hwn, ond mae pob un yn atgyfnerthu'r achos dros NFM. Mae prosesau penderfynu yn tueddu i anwybyddu manteision mwy cynnil NFM. Efallai y bydd angen mwy o amser ar ymyriadau NFM i sefydlu a chyflawni na datrysiad adeiledig, ond bydd eu cyfraniad yn gwella wrth iddynt aeddfedu. I'r gwrthwyneb, gall seilwaith adeiledig ddirywio dros amser, a chostio mwy i'w gynnal. Mae'r manteision ehangach hyn a'r gallu cynhenid i addasu yn golygu bod NFM yn cefnogi cyfiawnder rhwng cenedlaethau sydd y tu hwnt i ddatrysiadau adeiledig. Nid ateb i bob anhawster mohono, ond mae gwerthfawrogi cyfraniad NFM i fuddion ar hyd a lled dalgylch dros amser yn hanfodol er mwyn ail-gydbwyso ein proses gwneud penderfyniadau a dewisiadau.

- **Mae profiad ymarferol yn atgyfnerthu buddion lluosog defnyddio NFM ar raddfa:** Mae prosiect hirsefydlog Pontbren yng nghanolbarth Cymru yn dangos sut y gall rheoli tir dan arweiniad ffermwyr - gan gynnwys gwregysau cysgod a llai o bwysau pori - wella strwythur pridd, cynyddu ymdreiddio a lleihau dŵr ffo arwyneb cyflym ar raddfa cae a llethr. Mae'r prosiect *Afonydd Gwydn* yn dangos sut i ddod â phartneriaid, gan gynnwys busnesau, y sector cyhoeddus a chymunedau ffermio, at ei gilydd i gydlynu gweithredu ar draws tirweddau cyfan i leihau risg llifogydd, diogelu cyflenwadau dŵr, budd natur, ac adfer afonydd. Yn ganolog i'r ymdrech gydweithredol hon mae datrysiadau dalgylch sy'n seiliedig ar natur sy'n cael eu cynnal a'u rheoli gan ffermwyr. Mae prosiect adlinio *Cwm Ivy* ar Afon Gŵyr yn dangos sut y gall gwneud lle ar gyfer prosesau arfordirol naturiol greu cynefin gwerthfawr yn gyflym tra'n lleihau'r ddibyniaeth ar amddiffynfeydd caled. Mae enghreifftiau trefol, fel *Greener Grangetown*, yn dangos sut y gall draenio sy'n seiliedig ar natur leihau'r pwysau ar systemau confensiynol wrth greu lleoedd gwyrddach, mwy deniadol. Gyda'i gilydd, mae'r enghreifftiau hyn yn tanlinellu NFM fel ymateb ymarferol ac effeithiol i reoli llifogydd, yn hytrach na chysyniad heb sail. Pan gaiff ei gynllunio yn y mannau cywir, a'i gyflwyno gyda rheolwyr tir, cymunedau a darparwyr seilwaith, gall ddarparu manteision credadwy i leihau risg llifogydd ochr yn ochr â manteision gwytnwch ehangach.

Gwireddu'r cyfleoedd trwy bolisi, cynllunio ac ymarfer

- **Adeiladu ar y momentwm presennol:** Mae Cymru mewn sefyllfa dda i arwain ar NFM. Mae gan Gymru'r dystiolaeth, y mandad gwleidyddol a'r fframwaith polisi i gefnogi gwneud penderfyniadau ar raddfa hirdymor a dalgylch, hyrwyddo'r cysylltiad rhwng iechyd a lles ecosystemau a chynyddu atebion sy'n seiliedig ar natur. Mae Cymru eisoes wedi gosod sylfaen a chyfeiriad. Yr her nawr yw cyflawni gyda chyflymder a graddfa. A sicrhau bod ymrwymiadau ar draws llifogydd, ffermio, afonydd glanach, creu coetiroedd ac adfer afonydd yn cael eu cyfuno fel rhan o raglen genedlaethol gydlynol ar gyfer gwytnwch dalgylchoedd.

- **Sefydlu goruchwyliaeth ac arweinyddiaeth strategol o holl faterion dŵr:** Mae angen goruchwyliaeth ac arweinyddiaeth strategol ar draws y maes dŵr os yw cynlluniau a chamau gweithredu i gael eu halinio heb gymhlethdod diangen ac mewn ffordd ymarferol. Mae'r broses barhaus o ddiwygio dŵr yng Nghymru yn rhoi cyfle i sefydlu'r oruchwyliaeth hon a symud tuag at gynllunio ar raddfa system ac i gryfhau cyfraniad NFM (ac atebion sy'n seiliedig ar natur eraill) at ddyfodol dŵr gwydn i Gymru. Awgrymodd ymgynghoriad Papur Gwyrdd Llywodraeth Cymru yr angen am Gynllunydd Systemau Cenedlaethol sy'n ymateb yn uniongyrchol i'r angen hwn.

Byddai gan Gynllunydd Systemau Cenedlaethol strategol oruchwyliaeth o'r holl faterion sy'n gysylltiedig â dŵr yng Nghymru (llifogydd, adnoddau dŵr, yr amgylchedd dŵr) a phwerau priodol i weithredu. Byddai'n darparu, mewn ffordd gweledol, gyfaddawdau a chyd-fanteision ar draws gweithgareddau sy'n gysylltiedig â dŵr, gan ddarparu cyfleoedd ar gyfer cyd-ariannu (megis buddsoddiad yn y sector preifat) a chamau gweithredu wedi'u halinio. A thrwy hynny, cyfuno ymrwymiadau Llywodraeth Cymru ar draws llifogydd, ffermio, afonydd glanach, creu coetiroedd ac adfer afonydd fel rhan o raglen genedlaethol gydlynol ar gyfer gwytnwch dalgylchoedd.

- **Hyrwyddo cynllunio tirwedd a dalgylch strategol**: Mae mabwysiadu persbectif strategol ar raddfa tirwedd yn symud y ffocws tuag at gyflawni nifer o ganlyniadau NFM megis lleihau llifogydd i lawr yr afon, iechyd pridd, diogelwch bwyd, diogelwch dŵr a chanlyniadau bywoliaeth a lles lluosog**.** Mae angen parhau i gryfhau polisi i hyrwyddo persbectif strategol ar raddfa tirwedd a dalgylch. Mae datblygu cynlluniau dalgylch sy'n cyflawni canlyniadau lluosog trwy NFM yn darparu cyfleoedd i gyfuno ffynonellau cyllido cyhoeddus a phreifat lluosog. Mae angen i gynlluniau dalgylch gynnwys ac alinio pob sector gan gynnwys llywodraeth (cenedlaethol a lleol), tirfeddianwyr, rheoleiddwyr, busnesau (gan gynnwys Dŵr Cymru), cymunedau, sefydliadau amgylcheddol a rhanddeiliaid eraill i chwilio am gyfleoedd i alinio camau gweithredu a chyflawni cynlluniau cydgysylltiedig sy'n lleihau risg llifogydd a chanlyniadau ehangach.
- **Galluogi cyfleoedd ar gyfer cydweithio ac alinio camau gweithredu:** Mae haen gydweithredol y Cynllun Ffermio Cynaliadwy (SFS) yn darparu cyfle gwych i alinio camau gweithredu ar raddfa fferm sy'n cefnogi NFM ar raddfa dalgylch. Mae natur helaeth 'mapiau cyfle' NRW yn darparu tystiolaeth ategol gref o blaid cynyddu buddsoddiad mewn NFM ac yn darparu adnodd pwysig i lywio blaenoriaethu gofodol o fewn cyllid SFS.
- **Buddsoddiad graddfa mewn NFM drwy newid persbectif cynllunio a dylunio:** Yn ystod y blynyddoedd diwethaf mae buddsoddiad mewn rheoli risg llifogydd yng Nghymru wedi cynyddu'n sylweddol. Mae hwn yn gam cadarnhaol. Fodd bynnag, dim ond cyfran fach sydd wedi'i chyfeirio tuag at NFM (llai na 2% o gyfanswm y cyllid rheoli perygl llifogydd yn 2022-26). Heb ailgydbwyso buddsoddiad, ni fydd NFM yn cael ei gyflawni ar y raddfa a'r cyflymder sydd ei angen. Mae cyfle i ailosod sut mae rheoli risg llifogydd yn cael ei weithredu, gan osgoi dewis deuaidd 'ffug' rhwng rheoli llifogydd naturiol neu amddiffynfeydd adeiledig. Ac ail-fframio NFM, gan symud o rôl gefnogol (fel ymateb i ddiffygion amddiffynfeydd adeiledig) i **rôl flaenllaw** (gyda chefnogaeth lle bo angen). Mae'r newid hwn mewn persbectif yn darparu'r cyfle o ran cynllunio a dylunio i archwilio gwerth llawn y cyfleoedd NFM, a buddsoddiad i raddfa i wireddu'r cyfleoedd hyn.

Os yw Cymru am dyfu'n fwy gwydn yn y dyfodol, rhaid gwneud gweithio gyda natur yn flaenoriaeth, yn hytrach nag yn eithriad. Mae Llywodraeth Cymru wedi nodi ei fod yn symud i'r cyfeiriad hwn mewn egwyddor; Yr her nawr yw troi hyn yn gynlluniau da a gweithredu llwyddiannus.

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LIST OF ABBREVIATIONS

Acronym	Meaning
AEP	Annual Exceedance Probability
CARR / CaRR	Communities at Risk Register
CCC	Climate Change Committee
CIWEM	Chartered Institution of Water and Environmental Management
CCRA4	UK Climate Change Risk Assessment 4
CRMP	Coastal Risk Management Programme
Defra	Department for Environment, Food and Rural Affairs
EAD	Expected Annual Damage
EAE	Expected Annual Exposure
FCERM	Flood and Coastal Erosion Risk Management
FFE	Future Flood Explorer
FRM	Flood Risk Management
GMST	Global Mean Surface Temperature
ICE	Institution of Civil Engineers
JRF	Joseph Rowntree Foundation
LLFA	Lead Local Flood Authority
LSOA	Lower Super Output Area
NbS	Nature-based Solutions
NERC	Natural Environment Research Council
NFM	Natural Flood Management
NFVI	Neighbourhood Flood Vulnerability Index
NICW	National Infrastructure Commission for Wales
NRW	Natural Resources Wales
OMReg	Online Marine Registry
REP	Relative Economic Pain
rSLR	Relative Sea Level Rise
SCCAN	System Cynorthwyo Cunllunio Adnoddau Naturiol
SFS	Sustainable Farming Scheme
SPL	Sayers and Partners LLP
SuDS	Sustainable Drainage Systems
UKCP18	UK Climate Projections 2018
WINS	Welsh Information for Nature-based Solutions
WwNP	Working with Natural Processes

1.0 INTRODUCTION

Flood risk is a present and growing constraint on the prosperity of Wales and the well-being of the Welsh people. Successfully managing future flood events and their associated risks will rely upon the implementation of a portfolio of measures (to reduce the flood hazard, exposure to those hazards, and the vulnerability of those that are exposed). Nature-based Solutions (NbS, specifically Natural Flood Management, NFM) are increasingly seen as legitimate and important contributors to this portfolio but remain underused in practice.

1.1 Aims and Objectives

This report has two objectives:

- **To better understand the scale of flood risk in Wales**: including the number of households at risk, and how climate change may increase these risks.
- **To assess the opportunity for Natural Flood Management (NFM) to reduce flood risk in Wales:** exploring why NFM continues to be under-represented in efforts to reduce flood risk and the scale of the opportunity it offers if implemented at scale.

1.2 Target audience

This report has been written for WWF Cymru and targets those involved in the management of flood risk in Wales. No attempt is made to design local flood risk management schemes, but rather the focus is on supporting national policy choices.

1.3 Report Structure

The report is structured as follows:

- **Chapter 2: Wales: The flood challenge in context**: Presents selected recent floods, estimates present-day flood risk, how these may change in the future, and some of the 'live issues' which underlie these risks (including insurance, relocation and property blight).
- **Chapter 3: Wales: Flood risk policy and investment:** Discusses the existing policy context, including policy support for NFM and just transition, and the scale of recent public investment in flood risk management.
- **Chapter 4: Realising the contribution of natural flood management:** Explores the opportunity, and the contribution NFM provides, as well as how to overcome some of the barriers to implementation at scale.
- **Chapter 5: Conclusions:** Provides a summary of key findings and suggested areas for further research and development.
- **Chapter 6: References.**

Shaded boxes are used throughout the report to provide supporting information (green boxes) and to highlight assumptions and known limitations within the data and analysis (blue boxes).

2.0 WALES: THE FLOOD CHALLENGE IN CONTEXT

Across Wales, most people live in the more urbanised southern and northern coastal fringes, particularly around cities such as Cardiff, Swansea, Newport and along the North Wales coast. The central and western valleys are characterised by low overall population densities, punctuated by densely populated settlements associated with the industrial legacy of the former coalfields, together with a dispersed network of villages and market towns (*left and centre*, Figure 2-1). The flood drivers within these settings vary. Urban settings are often subject to multiple flood sources, including coastal, fluvial (by a river or stream) and surface water flood hazards, with a combination of conventional flood defences and drainage measures used to manage these risks, particularly against coastal flooding. Inland rural towns and villages often lie in the fluvial valleys with few conventional built defences. These areas are often subject to both flash floods (with a rapid onset of flooding and quickly rising flood waters in response to rainfall) and fluvial floods (often in response to rainfall over more prolonged periods) - *right*, Figure 2-1.

Recent floods, the scale of present-day flood risk, how these may change in the future if we fail to adapt to climate change, and the 'live issues' that are emerging across Wales are discussed in turn below.

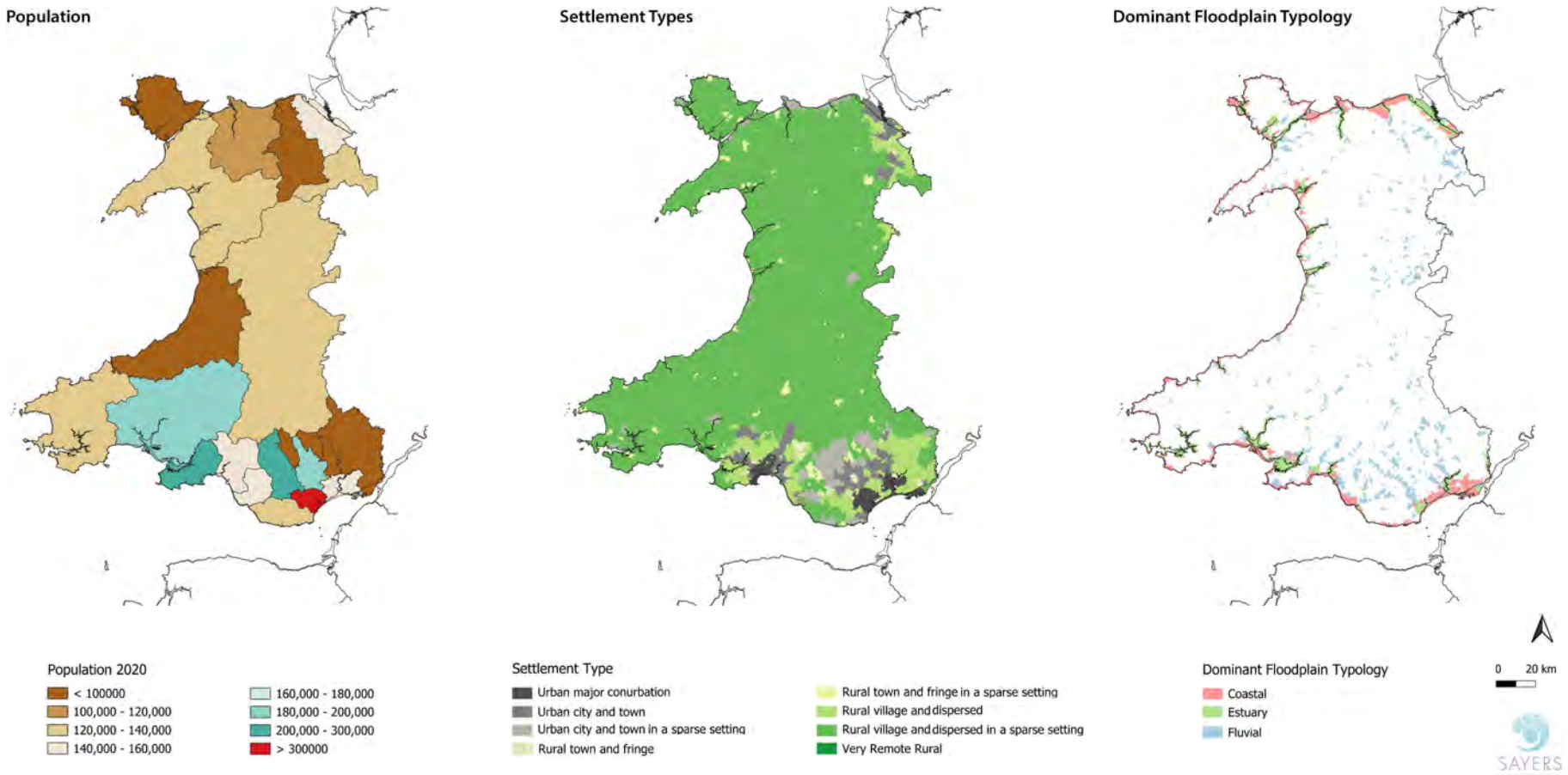


Figure 2-1 Wales – Population distribution by local authority, settlement type, and floodplain typology

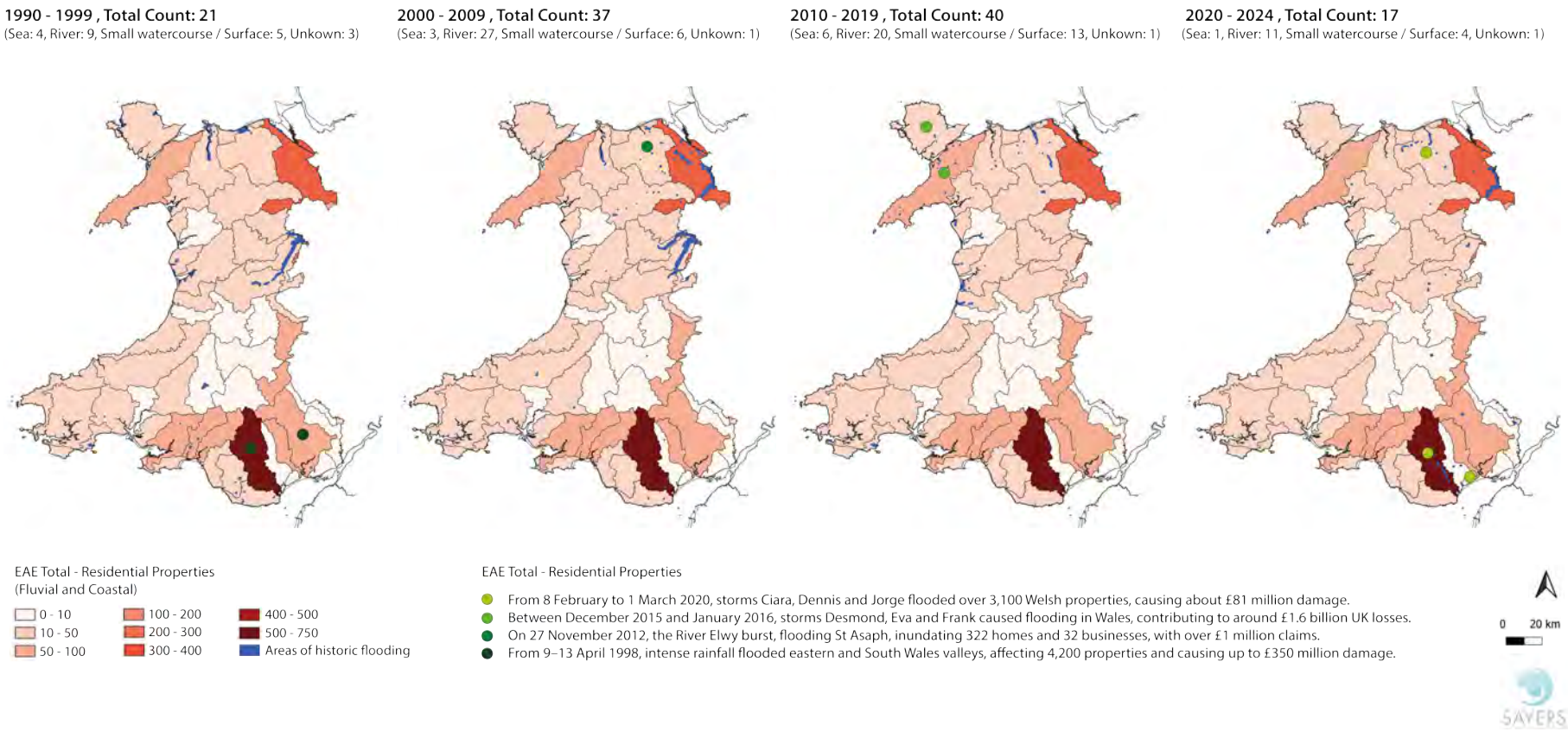
2.1 Recent floods

Wales has experienced multiple major flood events over recent years, with Natural Resources Wales (NRW) recording ~94 flood events since the turn of the century (Figure 2-2). Some of these events relate to localised flooding from small watercourses and surface water, but others have caused widespread disruption and damage. In February 2020, for example, Storms Ciara, Dennis and Jorge caused over £81 million in damage and impacted over 3,100 properties across Wales (NRW, 2020). In November 2025, Storm Claudia, the third named storm of the 2025/2026 season, brought extensive heavy rainfall across Wales causing over £9 million in damage in Monmouthshire alone (NRW, 2025).

2.2 Present-day flood risk

2.2.1 National scale

NRW estimate around 275,000 properties are exposed to either coastal, fluvial or surface water flood hazards (Table 2-1). This is around one in seven homes. Recent analysis for the Climate Change Committee (CCC, Sayers *et al.,* 2026a) suggests around ~4,200 properties are expected to flood each year (on average) with an associated Expected Annual Damage of ~£93 million (including £41m residential, and £52m non-residential property damage). Coastal flooding accounts for around half of this risk, with fluvial and surface water flooding contributing the rest (Figure 2-3). These damage estimates exclude indirect impacts, including physical and mental health impacts. Such damages can be significant, particularly for the most socially vulnerable and those without access to adequate insurance (see section 2.4.2). The highest flood risks are concentrated in the local authorities on the southern and northern coasts, although across Wales flood risk is a significant challenge (Figure 2-4).



Source: See [Recorded Flood Extents | DataMapWales]

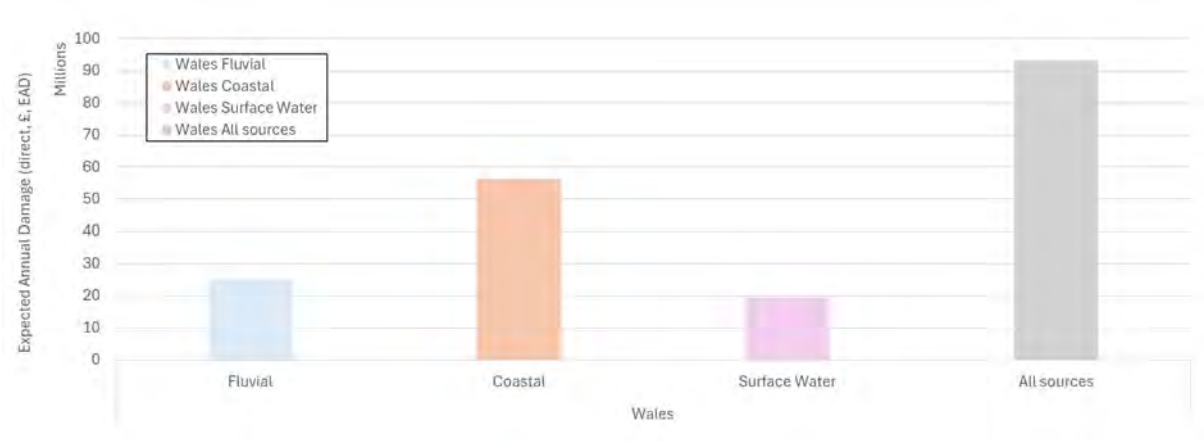
Figure 2-2 Wales – Recorded flood events since 1990

Table 2-1 Present-day flood exposure in Wales

No. residential properties, non-residential properties, and services exposed to flooding in Wales				
Flood risk description	Residential properties at risk of flooding	Non-Residential properties at risk of flooding	Key Services* at risk of flooding	Total at risk of flooding
Fluvial flooding				
High	25,126	3,074	787	28,897
Medium	17,172	2,528	486	20,186
Low	48,409	6,988	1,361	56,758
Total	**91,102**	**12,630**	**2,745**	**106,477**
Coastal flooding				
High	56,759	5,913	1,194	63,866
Medium	13,638	2,097	458	16,193
Low	9,884	1,429	335	11,648
Total	**80,281**	**9,439**	**1,987**	**91,707**
Surface water and small watercourse flooding				
High	34,977	3,877	1,015	39,869
Medium	18,057	2,188	533	20,778
Low	74,042	7,562	2,001	83,605
Total	**127,076**	**13,627**	**3,549**	**144,252**

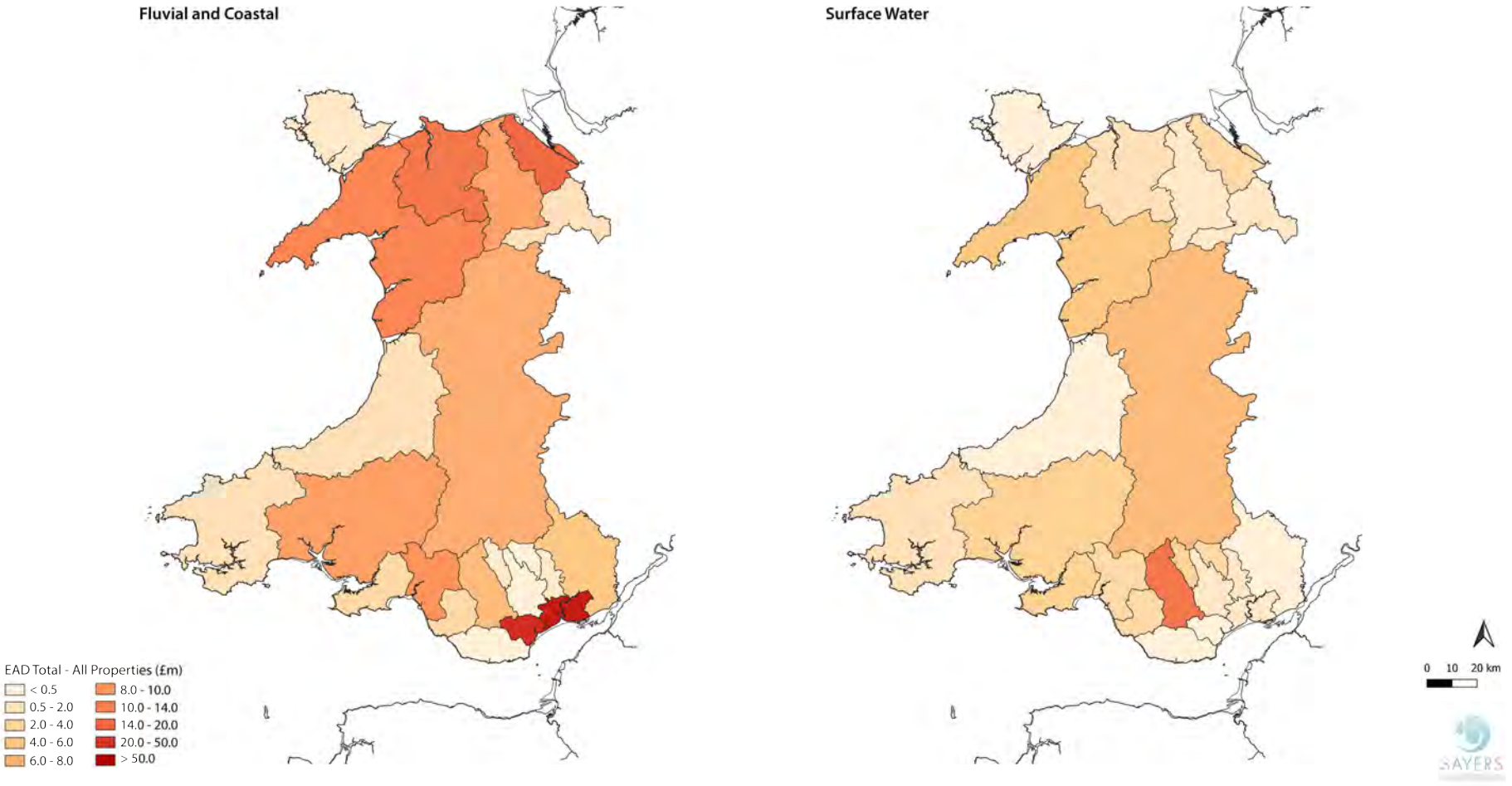
Note: *High* refers to "More than a 1 in 30 chance every year on average", *Medium* 'Between 1 in 30 and 1 in 100 chance per year on average', and *Low* 'Between 1 in 100 and 1 in 1000 chance per year on average'. Some properties may be subject to more than one source of flooding; hence some properties may be double counted in the table above. Small watercourse is used to refer to minor drainage channels with an upstream catchment area of less than ~3km^2.

Source: Natural Resources Wales / Flood risk management annual report 2024 to 2025



Source: Based on Sayers *et al.,* 2026a. Note: Groundwater and other sources, such as reservoir failure, excluded

Figure 2-3 Wales – Present-day: Expected Annual Damage (residential and non-residential properties, £)



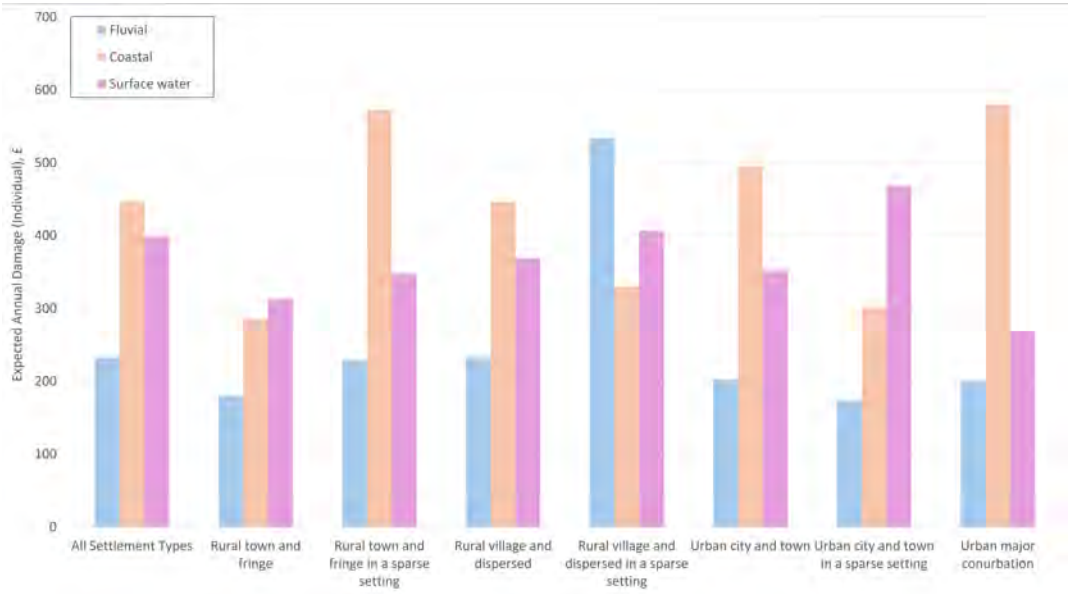
Expected Annual Damage (property) from flooding across Wales as estimated within the UK CCRA4 (based on Sayers *et al.,* 2026)

Figure 2-4 Wales – Present day: Expected Annual Damage (residential and non-residential properties)

2.2.2 Flood risk across rural and urban settings

Across all sources of flooding, the majority of the flood risk in Wales lies in urban areas (accounting for ~72% of the national flood risk). When considered from the perspective of coastal (including tidal) flooding, ~81% of today's risk is in urban areas (reflecting the concentration of urban settlements along the coastal and estuary fringes of Wales). The urban bias is less distinct (but still evident) in the case of surface water flooding (with ~64% of the risk in urban areas), and less still in the context of fluvial flooding (with ~61% of the risk in urban areas).

These headlines mask the uneven distribution of risk between rural and urban areas. When considered from the perspective of an average household, those living in rural settlements tend to be at higher risk from fluvial flooding than those in urban settings. For those living in *rural villages in dispersed and sparse settings*, for example, the average annual fluvial flood risk per household today is ~£533, this compares to an average of between £175-203 per household per year in urban settings - Figure 2-5. From the perspective of coastal flooding, both *rural towns* and *major urban conurbations* experience the highest risk (~£570 per household per year). Surface water flooding shows less variation between settlement types; a finding consistent with previous studies (Sayers *et al.,* 2022a, Sayers *et al.,* 2026a).



Source: Present day risk - based on Sayers *et al.,* 2026

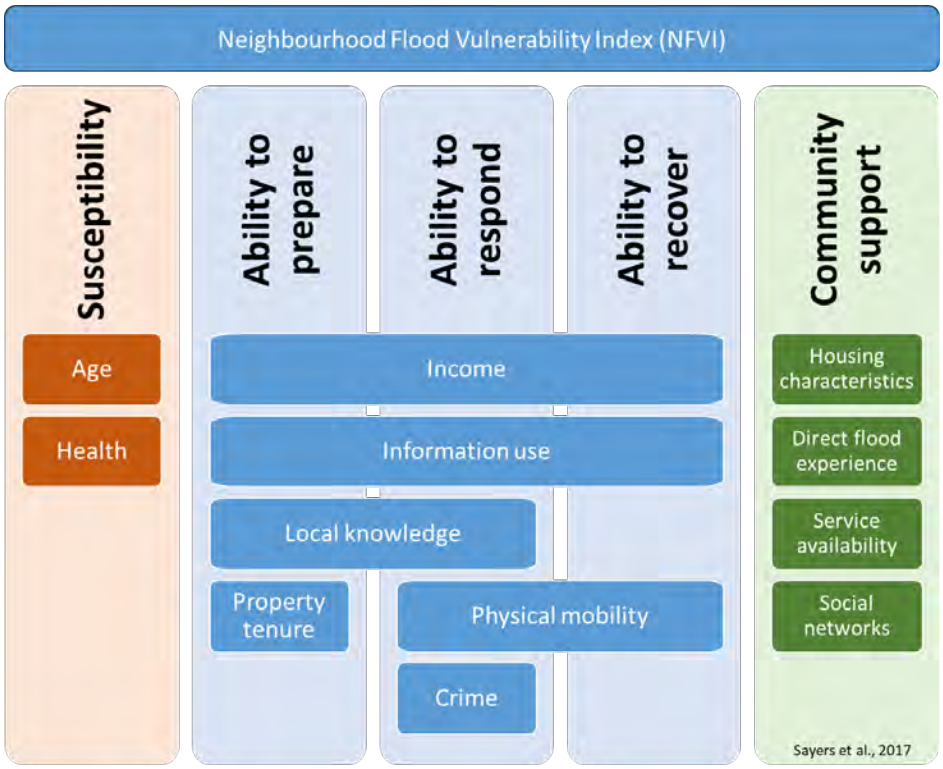
Figure 2-5 Expected Annual Damage – for an 'average' exposed household across settlement types

2.2.3 Social flood disadvantage

Flood risk is often falsely considered simply as an exposure to a hazard. Whilst important, hazard and exposure are only part of the story if we are to understand where the most significant harm may be felt. For example, not everyone is affected by a flood in the same way. Some people may be more susceptible to harm due to their age or underlying physical or mental health challenges. Social factors (such as housing tenure and income), as well as these biophysical ones, are also often important in determining the impact, as they can influence a person's ability to prepare for, respond to, and recover from a flood. In combination these factors determine a person's vulnerability and the degree of harm (loss of well-being) a person may experience when exposed to a hazard.

It is however difficult to express vulnerability in 'absolute' terms. Instead, vulnerability is typically expressed as a 'relative' rather than 'absolute' distributive measure. The Neighbourhood Flood Vulnerability Index (NFVI, Sayers *et al.,* 2017, as updated by Sayers *et al.,* 2025) is used here to provide a spatial differentiation of the likely impacts of a flood on well-being. The NFVI considers

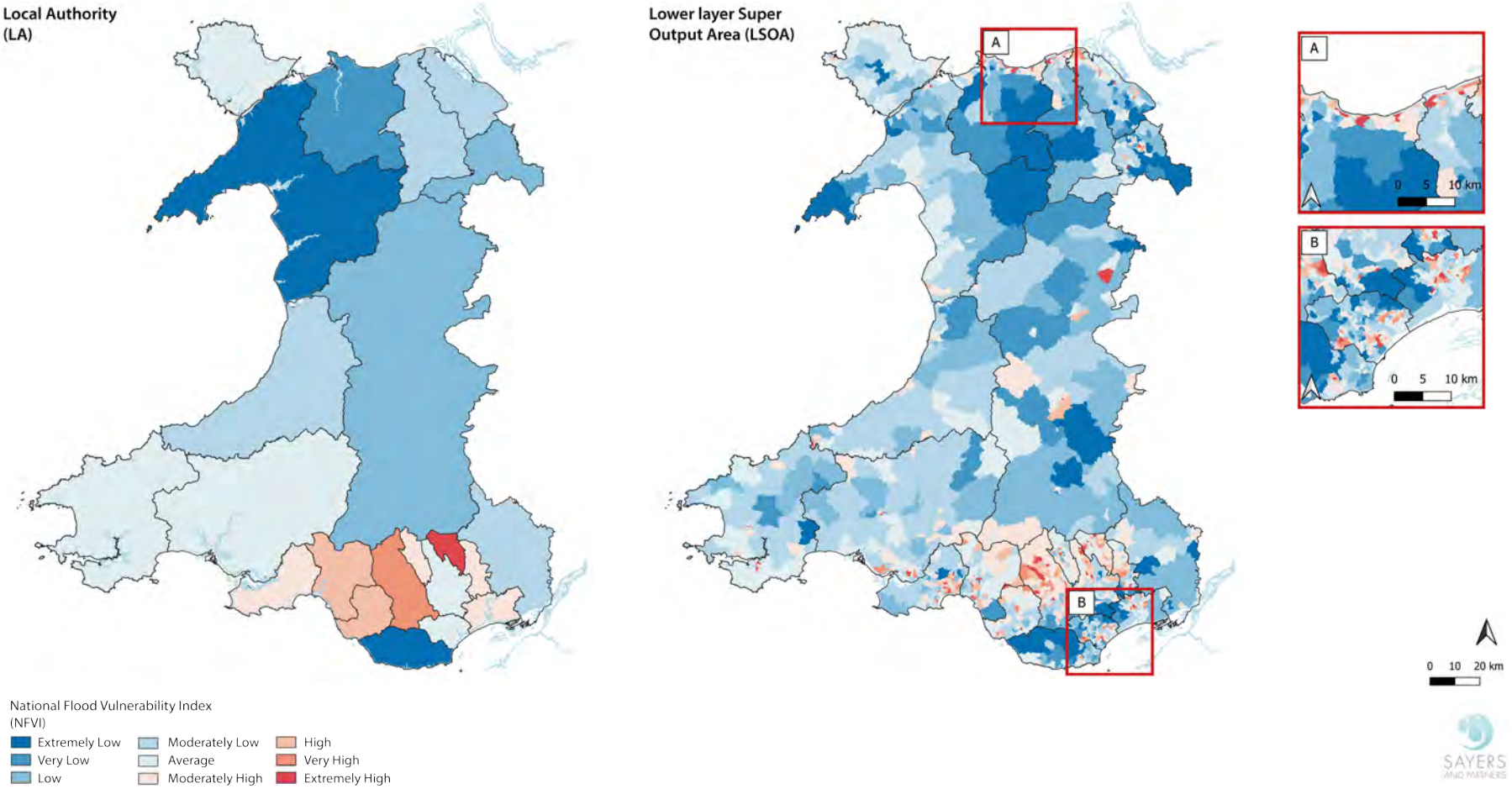
various aspects of social vulnerability, and accounts for a range of interwoven individual, social, economic, and environmental factors that affect social vulnerability (Figure 2-6). For example, people who are socially isolated may have fewer people checking on their well-being in the aftermath of a flood. Those that live in rented accommodation, or are on a low income, may be less able to adapt their homes (for example to install property level flood measures) compared to others, even if they wish to. If community services are flooded, accessing alternative services may be difficult or impossible for those with limited mobility. These factors vary spatially and combine to make the potential for harm greater in some neighbourhoods compared to others.



Source: Sayers *et al.,* 2017

Figure 2-6 Factors that influence the Neighbourhood Flood Vulnerability Index

The NFVI is assessed at a 'neighbourhood' scale (as defined by Census Lower Super Output Area, LSOA, geographies). Comparing the NFVI at neighbourhood scale provides an insight into the relative vulnerability across Wales and highlights concentrations of social vulnerability along the North Wales coast, but also inland in the valleys of South Wales (*right*, Figure 2-7). When aggregated to the scale of local authorities the social and economic challenges faced by many people within the Welsh valleys are reflected in the social flood disadvantage experience across the southern valley authorities (*left*, Figure 2-7).



Left: Based on the mean of the NFVI within each local authority. *Right:* The NFVI assessed at Lower Super Output Area scale.
Source: Neighbourhood Flood Vulnerability Index (NFVI, Sayers *et al.,* 2017 updated 2025)

Figure 2-7 Spatial variation in social flood vulnerability across Wales (based on the NFVI)

2.3 Future risk

2.3.1 Climate change

Global warming – GMST scenarios and associated rate of rise

The two climate scenarios used in support of the UK Government's Fourth Climate Change Risk Assessment (CCRA4) are re-used here. These are defined by an increase of either 3C or 4C by 2100 from pre-industrial times. To place these in context, recent assessments indicate the GMST is approximately **1.24 °C** above pre-industrial levels for 2015–2024 (Forster *et al.,* 2025).

Coastal flooding - Changes in sea level rise

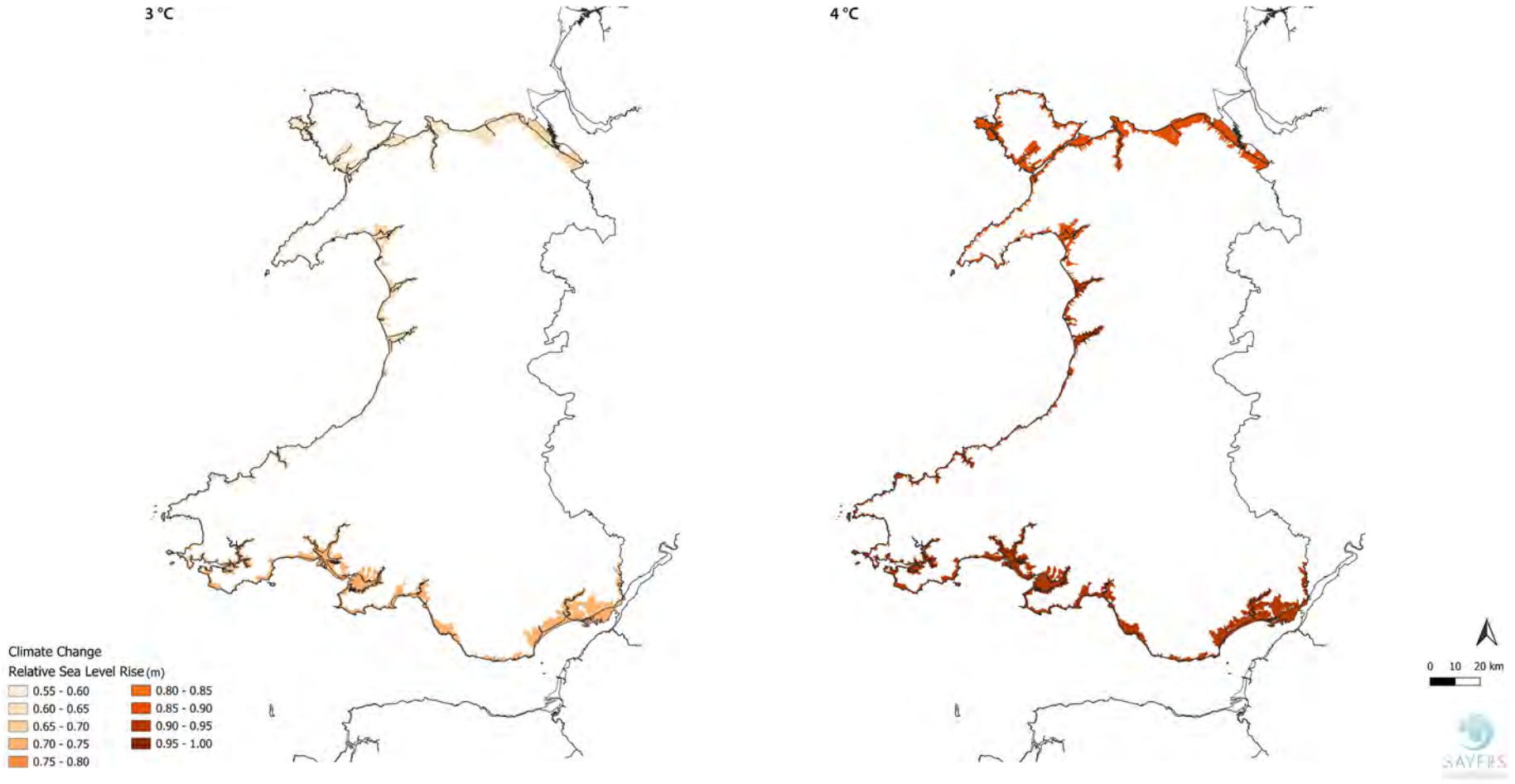
Wave conditions around much of the Welsh coast are depth-limited. This means the primary control on wave conditions at the shoreline is the local water depth and hence the dominant climate change driver is sea level rise. By increasing the local water depth, relative Sea Level Rise (rSLR) enables larger waves to reach the shoreline and hence increases wave-driven overtopping even in the absence of a change in the offshore wave conditions. In turn, larger incident wave conditions and overtopping increase the chance of a breach. The relative sea level rise projections for Wales are reused from the CCRA4 (Sayers *et al.,* 2026a) and are based on the UK Climate Projections 2018 (UKCP18) Marine Report (Palmer *et al.,* 2018) - Figure 2-8. These projections include the influence of changing oceanographic processes as well as gravitational and other adjustments due to ice melt and changes to terrestrial water storage, and the isostatic response of the land to the last de-glaciation.

Fluvial flooding - Changes in peak river flow

Climate change influences fluvial flood risk through changes in flood flows that in turn change in-river levels and the chance of flooding. The projections of the change in river levels from CCRA4 (Sayers *et al.,* 2026a, which in turn are based on earlier analysis of the UKCP18 Probabilistic Projections set out in Kay *et al.,* 2021), are reused here to provide an assessment of changes in return period peak flood flows on a 1 km grid across Wales (Figure 2-9).

Surface water flooding – Changes in short duration rainfall

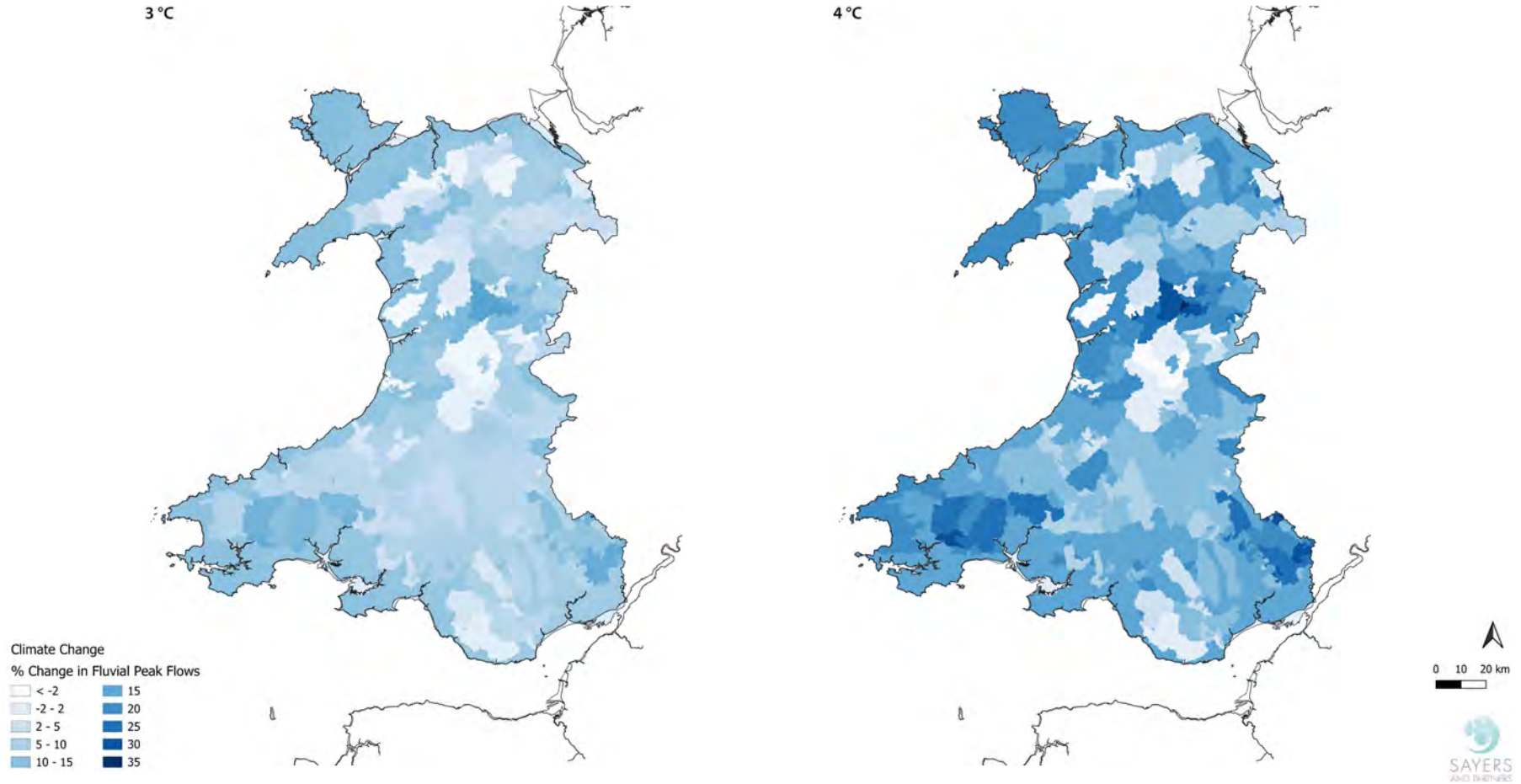
Surface water flooding primarily reflects the intensity of short duration rainfall and the capacity of the surface and sub-surface drainage system. Chan *et al.* (2021, 2023) set out the influence of climate change on short duration rainfall intensity for a range of return periods and critical durations (1, 3, 6, 12 and 24 hours) on a 5km grid linked to a rise in GMST values (including 3 and 4^{o}C). These are used in CCRA4 (Sayers *et al.,* 2026) and reused here (Figure 2-10).



Climate Change – Influencing coastal flooding (relative sea level rise). *Left:* Assuming a 3°C rise in GMST by 2100; *Right:* Assuming a 4°C rise in GMST by 2100. In both futures the largest rise in sea levels occurs along the south coast. The figures also illustrate the much larger rise in sea levels under the 4°C future when compared to the 3°C future, highlighting the importance of action to mitigate climate change as well as to adapt to it.

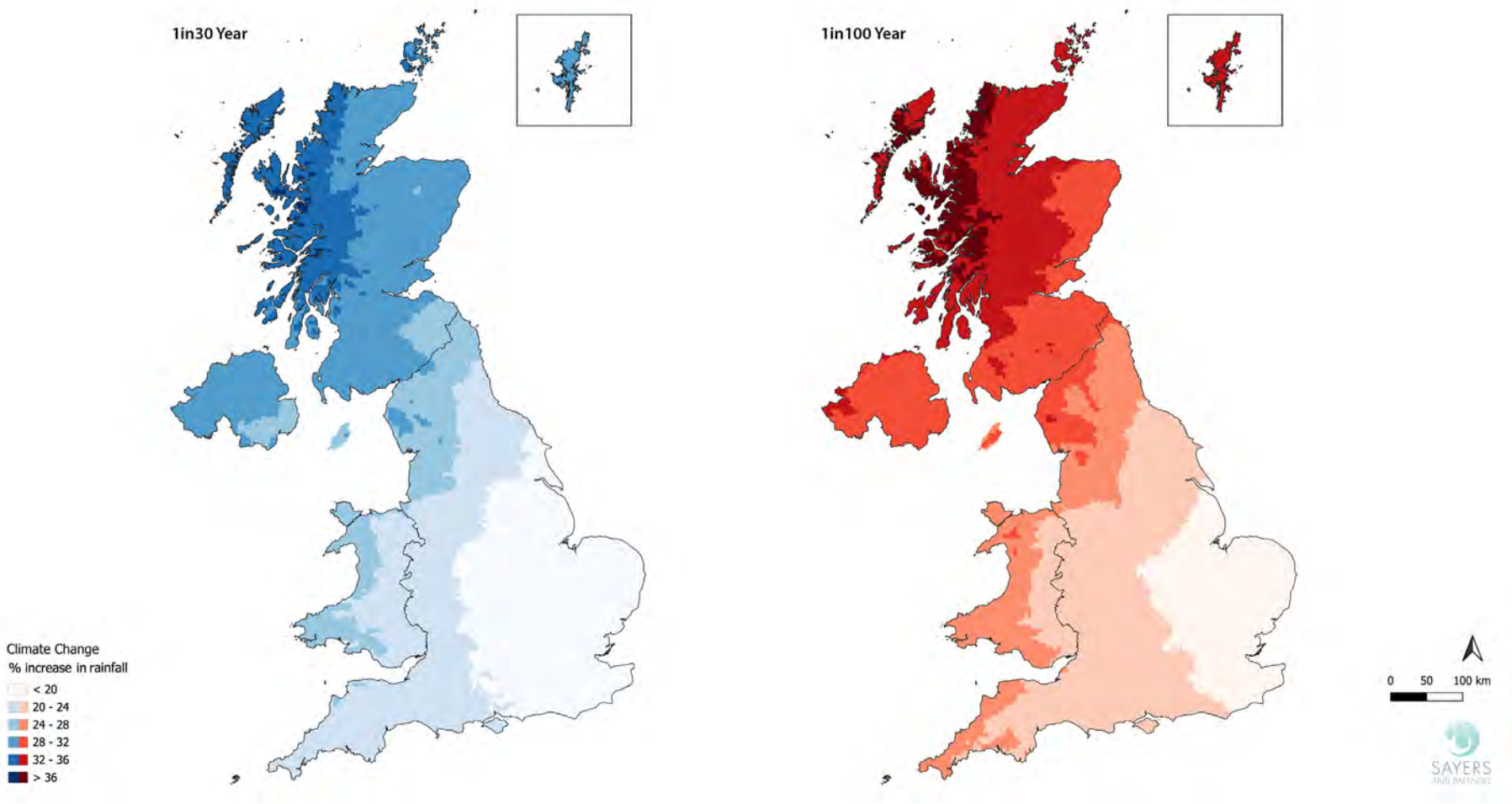
Source: Adapted from Sayers *et al.,* 2026 and Palmer *et al.,* 2018

Figure 2-8 Projections of relative sea level rise around the Welsh coast - 2018 to 2100



Climate Change – Influencing peak river flows. 3 *Left:* Assuming a 3°C rise in GMST by 2100; *Right:* Assuming a 4°C rise in GMST by 2100. In both futures the increase in peak flows is complex, but much greater given a 4°C future when compared to the 3°C future, highlighting the importance of action to mitigate climate change as well as to adapt to it.
Source: Adapted from Sayers *et al.,* 2026 and Kay *et al.,* 2021

Figure 2-9 Projected changes in peak river flows across the Welsh catchments - 2018 to 2100



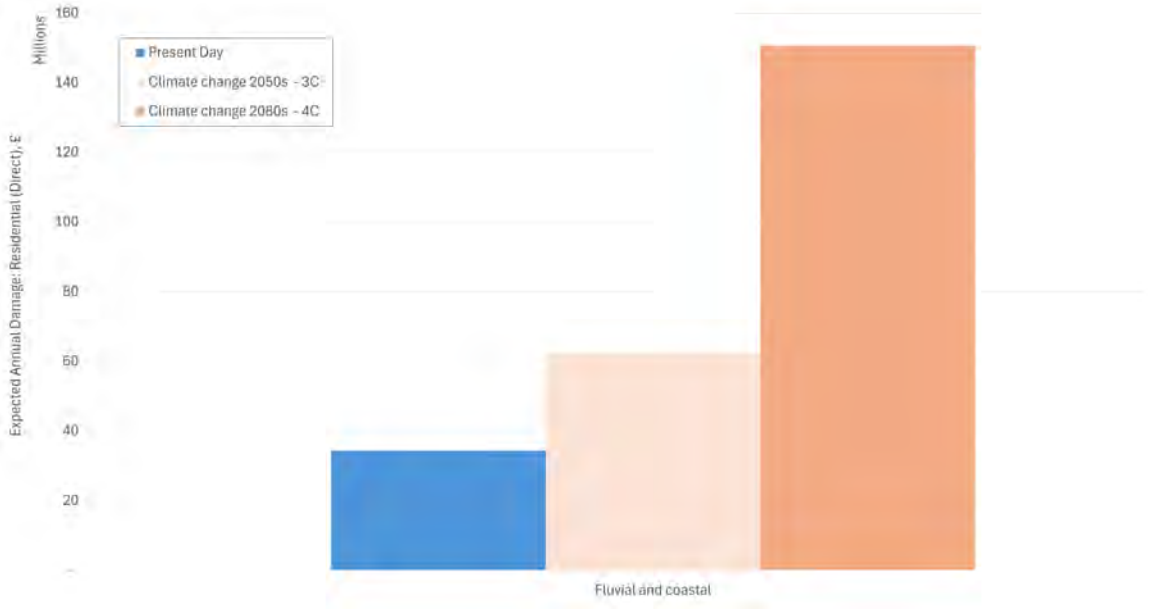
Climate Change – Influencing short duration intense rainfall. *Left:* Uplift in the 1in30 year return period rainfall (mm/hr) by the 2080s from baseline period (1981-2000) assuming a 4°C GMST rise by 2100 (from pre-industrial times). The uplifts are based on an average of the <3 and <6-hour critical storm duration. *Right:* The equivalent plot showing the increase in the 1in100 year return period rainfall (mm/hr) by 2080s. The maps highlight the significant increase in intense rainfall across Wales, but particularly along the coastal fringe, with the greatest percentage increases associated with the more extreme events.
Source: Based on Chan *et al.,* 2021 and 2023

Figure 2-10 Projected change in the 1in30 and 1in100 year return period intense rainfall by the 2080s assuming a 4°C climate future (increase from baseline 1981-2000)

2.3.2 Changes in flood risks

Increases in Expected Annual Damage

As the climate changes, flood risk is set to increase. Assuming existing defences continue to be maintained but are not raised, residential direct damages are projected to increase, from ~£34m today (fluvial and coastal sources only), to ~£63m by 2050s (given a climate projection of a 3°C rise in global warming levels by 2100), and ~£151m by 2080s (given a climate projection of a 4°C rise in global warming levels by 2100) - Figure 2-11.



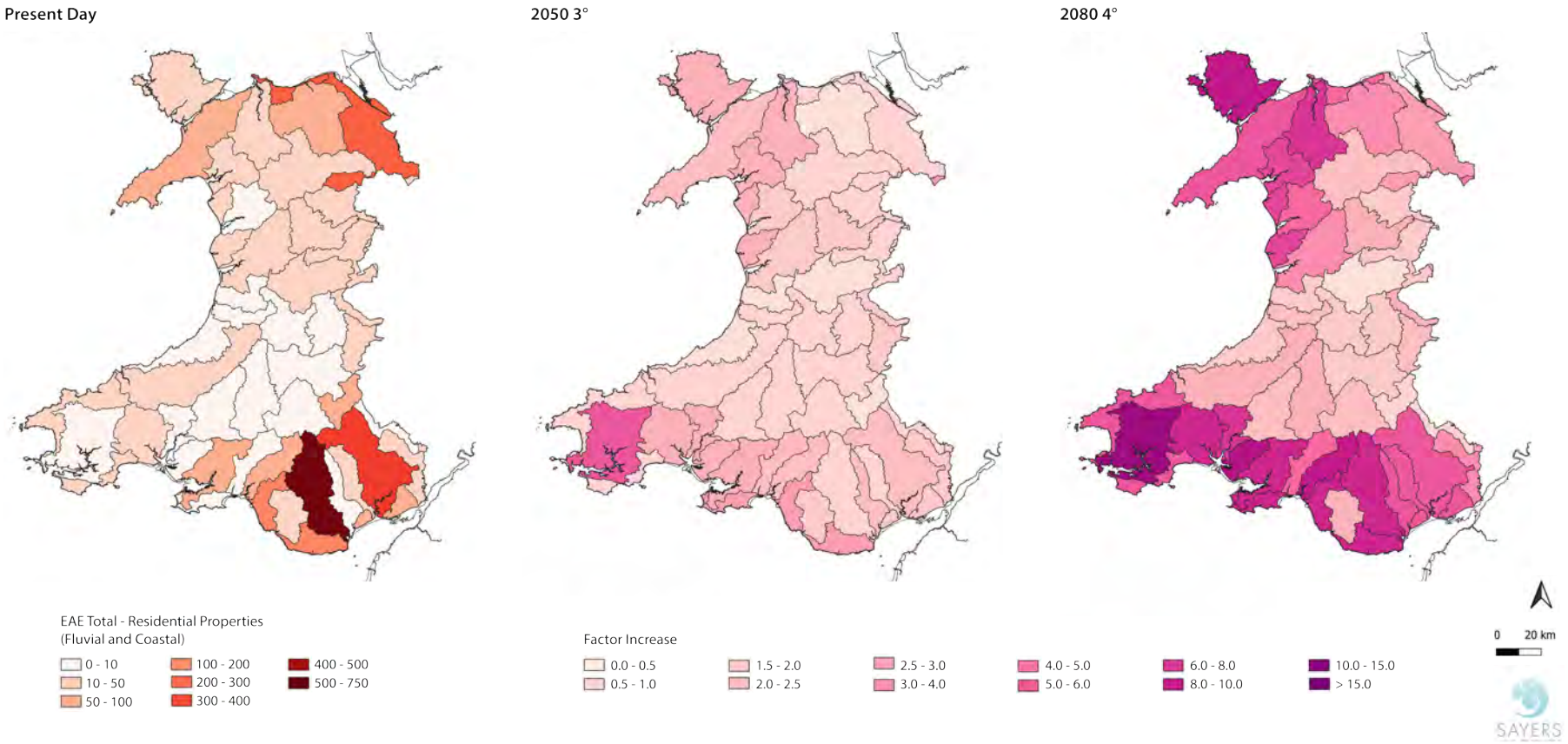
Expected Annual Damage, direct residential property damage from fluvial and coastal flood sources.
Source: Based on Sayers *et al.,* 2026a

Figure 2-11 Present and future Expected Annual Damage (direct, residential): Fluvial and coastal

Increases in the Expected Annual number of properties flooded

The spatial distribution of present-day flood risk, and the future increase in risk is not equal across Wales. When viewed from the perspective of the annual number of households that may be expected to flood (assuming existing defences continue to be maintained but are not raised), this number is set to increase from ~2,100 today, to ~4,600 by 2050s (given a 3°C future), and 14,000 by 2080s (given a 4°C future) - Figure 2-12.

The largest increase (as a factor of the present-day risk) is expected to occur in areas exposed to coastal flooding (rising by a factor of ~2.0 by 2050, and 5.3 by 2080s). Fluvial risks are also set to increase (rising by a factor of ~1.2 by 2050, and ~1.5 by 2080s). There is a marked acceleration in risk between a 2050s 3°C and a 2080s 4°C, which highlights the sensitivity of sea level rise in relation to this risk. The acceleration is however not limited to coastal areas and is evident across fluvial sources too (to a lesser extent). This reinforces the importance of continued climate change mitigation efforts alongside adaptation; a dual objective that is supported by natural flood management (as returned to later).

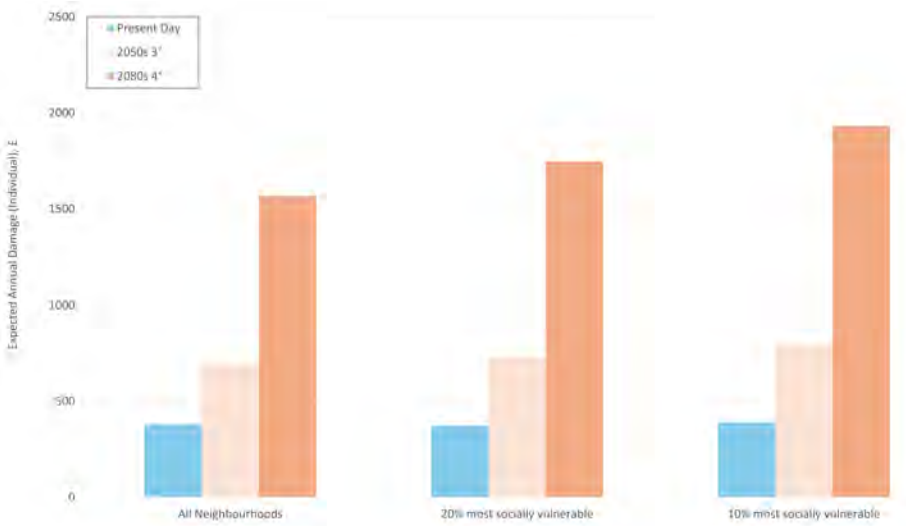


Left: Expected Annual Exposure (EAE) of residential properties today; *Middle*: Projected increase in EAE by 2050s given a climate future of a 3°C rise by 2100, and assuming no further adaptation. *Right:* Further change assuming a 4°C rise in GMST by 2100. The figures illustrate the concentration in flood risk around the southern and northern coastal areas of Wales, but also the marked acceleration in flood risk between 3°C /2050s and 4 °C /2080s.
Source: Based on UK Climate Change Risk Assessment 4 – Future flood projections – Sayers *et al.,* 2026

Figure 2-12 Present and future change in risk – Expected Annual Exposure (Residential Properties) – Fluvial and coastal

Flood disadvantage: Comparing flood risk across neighbourhoods

When viewed at the national scale, the present-day household risk is similar across more and less socially vulnerable neighbourhoods. However, as the climate continues to change, and in the absence of further adaptation, the most socially vulnerable are projected to see a disproportionate increase in flood risk compared to others (Figure 2-13). Previous studies have found the same issue of systematic flood disadvantage and have suggested exposure to flood hazards acts as a brake on economic development, leading to persistent disadvantage in the most deprived areas (Sayers *et al.,* 2017, Ellmore, 2025). This reinforces the need to direct resources to managing risk in the most socially vulnerable neighbourhoods if flood risk is to be managed fairly and social-economic growth is to be enabled as the climate changes.



The average 'Expected Annual Damage' experienced by a residential household within the fluvial and coastal floodplain within Wales, today and given 3°C and 4°C rise in GMST by 2100, and an assumption of no further adaptation to raise defence standards in the face of climate change. *'All neighbourhoods'* refers to all residential properties. *'20% most socially vulnerable'* and *'10% most socially vulnerable'* refers to households within 20% and 10% most socially vulnerable neighbourhoods as defined by the NFVI Sayers *et al.,* 2025.
Source: Based on UK Climate Change Risk Assessment 4 – Future flood projections – Sayers *et al.,* 2026 and the NFVI-CCRA4 (Sayers *et al.,* 2025)

Figure 2-13 Systemic disadvantages: Expected Annual Damage - Individual Households: Fluvial and coastal flooding

Note: The comparison of Expected Annual Damage between more and less socially vulnerable neighbourhoods assumes losses incurred are experienced equally by all. This of course is not the case, not least because of differences between households in their capacity to recover from a flood event. The more socially vulnerable, for example, are more likely to be uninsured; an issue returned to later in Section 2.2.3.

2.4 Live issues

2.4.1 Relocation: Conventional protection is increasingly unaffordable

For many larger towns and cities located in flood prone areas, the economic impacts of flooding, together with the scale of sunk investment in infrastructure, commerce, and housing, will continue to justify investment in flood protection as the climate changes. Equally, in undeveloped floodplains where opportunities exist to remove redundant infrastructure (reducing long term management costs), realign the defence line (to make space for coastal dynamics), restore natural processes (to slow the flow or attenuate wave conditions), or create habitats, the case for managed realignment is gathering pace and often presents a (relatively) straightforward option (Box 2-1).

Box 2-1 Cwm Ivy, Salt Marsh Creation: Realising opportunities through realignment without relocation

National Trust: Cwm Ivy marsh is a small parcel of land on the coast of North Gower. It was claimed from the sea to be used as farmland in the 17th century and was protected by a sea defence which over the years increased in size and strength. In 2014 the sea wall breached, and the sea reclaimed the land, transforming Cwm Ivy freshwater marsh to salt marsh.

The site has become a diverse transitional marine to freshwater habitat, and an excellent example of how these realigned sites rapidly evolve. This evolution has been captured by monitoring work and in a series of videos by the National Trust.

Sources:

National trust: Cwm Ivy on North Gower coast|Wales | National Trust

Monitoring and scheme details: Cwm Ivy unmanaged realignment – OMReg

Image: National Trust

The relocation of people is a more difficult challenge in response to climate change, but is a necessary option to consider, with planned relocation increasingly seen as a decision for today, not for the future. Protection from flooding in Wales (as elsewhere in the UK) is not a right or entitlement but authorities act through permissive powers. As communities face increasing flood risk, there will be instances where continued investment to maintain existing defences or invest in new defences is unlikely to be justified (under current funding regimes, Sayers *et al.,* 2022b). This is already the case in Wales, in both coastal and inland settings (Box 2-2). However, relocation raises many difficult issues around loss of place and community, and property value collapse (for properties directly or indirectly impacted, which we'll return to in the next section). There is also the issue of fairness and support provided, given that there is no statutory pathway for compulsory purchase for flood risk, no guaranteed rehousing funding, and no consistent compensation rules for those impacted.

Box 2-2 Clydach Terrace, Ynysybwl and Fairbourne: Relocation an increasing challenge

Inland relocation – The example of Clydach Terrace, Ynysybwl (Rhondda Cynon Taf)

The Welsh Government recently funded the buy-out of properties at Clydach Terrace (Rhondda Cynon Taf, 2026) due to an unacceptable risk to life from repeated river flooding. The relocation of residents represents a landmark case of managed inland retreat in Wales, following repeated life-threatening flooding and the absence of viable engineered defences. Triggered by extreme events including Storm Dennis in February 2020—when internal flood depths reached nearly 2 metres—Natural Resources Wales concluded that structural measures such as flood walls were not economically viable under Welsh Government appraisal rules. In response, Rhondda Cynon Taf Council, supported by Welsh Government funding, approved the acquisition and demolition of 16 properties at a cost of approximately £2.5 million, including rehousing. This intervention, driven by an assessed "danger to life" risk, is widely regarded as the first large-scale inland residential relocation scheme implemented by a Welsh local authority and establishes an important precedent, albeit not yet a formal shift in national policy. The first large-scale inland flood relocation by a Welsh local authority (and possibly the first multiple property relocation in the UK, although not the first internationally).

Coastal relocation – The continued discussion of Fairbourne, Gwynedd

Fairbourne in Gwynedd represents a long-term coastal managed retreat case driven by sea-level rise and coastal erosion rather than fluvial flooding. Under the West of Wales Shoreline Management Plan (adopted by Gwynedd Council), the village has been designated for "no active intervention" in the longer term, meaning that maintaining or upgrading sea defences is not considered sustainable. Instead, a strategy of managed realignment and eventual decommissioning has been established, with projections indicating the settlement may become unsafe or effectively uninhabitable by around 2050. Unlike inland flood relocation schemes, there

is no immediate buy-out or clearance; instead, the policy framework supports gradual adaptation, continued short-term defence maintenance, and long-term relocation as risks from rising sea levels increase.

Sources:

Rhondda Cynon Taf, 2026 Proposal agreed for homes at severe risk of flooding in Ynysybwl

Hilson, C., and Arnall, A. (2025) Sea level rise, claims-making and managed retreat in Fairbourne, North Wales, Climate Policy, 25:6, 852-865, DOI: 10.1080/14693062.2024.242073

Gwynedd Council (updated) Frequently Asked Questions. Access May 2026

2.4.2 Insurance: A safety net for some, not all

Flood insurance is made available in Wales (as across the UK) to domestic properties and businesses through private insurance companies. This has been the situation since the 1960s and in response to increasing premium costs, Flood Re has been in operation since April 2016 to help pool the risks and reduce costs to individual households (Box 2-3). Despite Flood Re access, flood insurance remains incomplete, with insurance penetration known to vary according to (Sayers *et al.,* 2017):

- **Income** (those on lower incomes are much less likely to have insurance)
- **Tenure** (those living in rented accommodation – particularly social housing – are much less likely to have insurance)
- **Experience of flooding** (there is some limited evidence that direct experience of a flood increases the take-up of insurance).

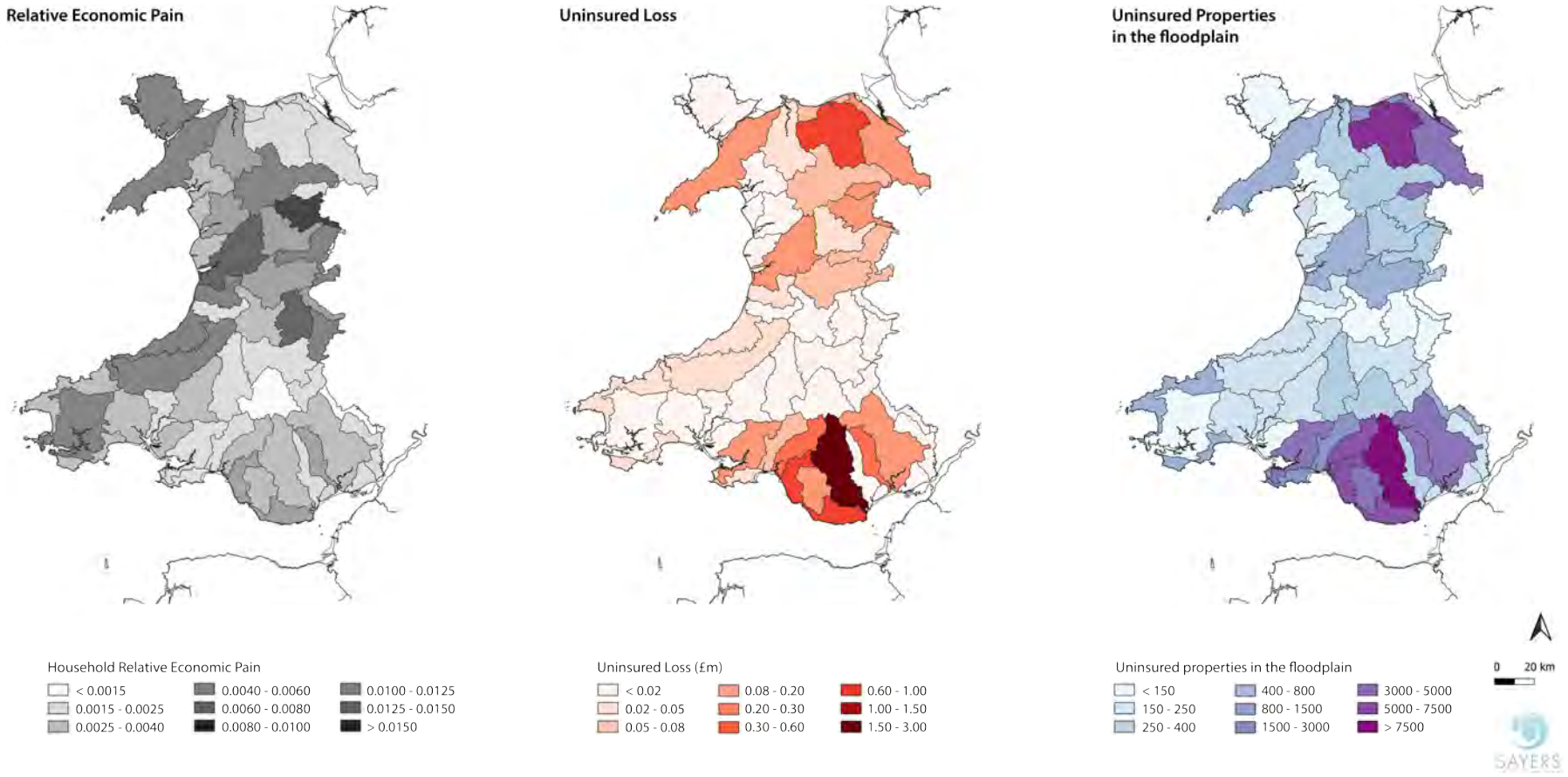
Methods developed for the Joseph Rowntree Foundation (JRF, Sayers *et al.,* 2017), latest Census data (2021) on tenure and income (Sayers *et al.,* 2025), and latest flood hazard data (Sayers *et al.,* 2026a) are used here to provide a high-level estimate of the number of households in Wales living in the fluvial and coastal floodplain without adequate flood insurance. The assessment suggests ~25-40,000 residential properties do not have adequate flood insurance, with an Expected Annual Damage equivalent to ~£15m per year. Department for Environment, Food and Rural Affairs (Defra, 2018) reinforces the limited access to flood insurance amongst low-income households, suggesting 34% of low-income households do not have contents insurance. This difficulty in accessing adequate flood insurance compounds the flood disadvantage and heightens the Relative Economic Pain (REP) for those on low income (defined as ratio of uninsured loss to income, Sayers *et al.,* 2017). There is a strong spatial variation in the REP (Figure 2-14), reflecting the underlying social vulnerability, housing tenure, and the flood hazards.

Box 2-3 Flood Re – Transition to risk-reflective pricing by 2039

Flood Re provides a financial resource pool into which all insurers contribute. This pool enables individual insurers to pass a sub-set of their insured properties to Flood Re where they deem the flood risk too high to retain on their own books (subject to certain eligibility criteria, including the property having been built before 1 January 2009). Passing a property to Flood Re incurs an additional fee but reduces the insurer's exposure to flood risk. Householders purchasing insurance will not know whether their property has been ceded to Flood Re, as they continue to deal solely with their retail insurance provider. The scheme is explicitly time-limited and is intended to support a transition to fully risk-reflective pricing by 2039. Its long-term success therefore depends on sustained reductions in flood risk, improved resilience of properties, and more effective flood risk management—particularly in areas of high and increasing risk.

Source: www.floodre.co.uk including eligibility criteria /homeowner/eligibility/

Note: Flood Re have recent announced changes to the scheme to encourage insurance take up by those in rented accommodation and lower income households. These changes may help reduce the uninsured losses present here.



Left: average Relative Economic Pain (as defined by Sayers *et al.,*2017 and reassessed here); *Middle:* Estimate of the total Expected Annual Damages that are uninsured. *Right:* Estimate of the total number of the uninsured properties exposed to flooding. Estimates are for today, taking account of defences where they exist, drawing upon UK Climate Change Risk Assessment 4 – Future flood projections – Sayers *et al.,* 2026a. Spatial units shown are based on catchments.

Figure 2-14 Present-day – Relative Economic Pain and uninsured flood risk – Fluvial and coastal

2.4.3 Blight: Flood risk impacts property value

Evidence for the impact on property price

Recent years have seen increasing evidence presented that properties exposed to flood hazards typically sell for less than comparable properties not exposed to flooding. Estimates of the scale of the impact vary between studies and tend to focus on England, nonetheless there is increasingly strong evidence that the impact is real and significant. In a study of property price and flood hazard datasets for England, Skouralis *et al.,* (2024) suggest properties exposed to flooding are typically sold at an 8.14% discount compared to non-exposed properties, and for some properties exposed to a high chance of flooding the discount can reach 32.2%; concluding that a 1% increase in flood hazard is linked to a property price decline of 0.07%−0.11%.

The Bank of England (2024) explored the effect of subsidised flood insurance on housing markets. Although not a direct assessment of property values, it suggests that without access to subsided insurance (i.e. before the introduction of Flood Re), property values in flood prone areas were typically 1.6% lower than elsewhere. By inference the report suggests that access to affordable insurance can reduce the negative effect of flood risk on property prices, but also suggests the offset is highest in high-income areas, with much weaker impact in lower income and more deprived areas.

Scale of the loss in property value across Wales

Given the complex and uncertain relationship between flood risk and property value, it is difficult to provide a single robust estimate of the loss in the property asset value across Wales. It is clear however that even modest reductions in property values associated with flood risk translate into significant losses in asset value. For example, in Wales, NRW estimate 275,000 properties are exposed to flood hazards. Assuming an average house price in Wales of £210,000 (ONS, April 2026) and using the assumption of 8.14% (from Skouralis *et al.,* 2024), this suggests a notional loss in house value of: 210,000 * 275,000 * 8.14% = **£4.7 billion**. Adopting the lower value of 1.6% implied by the Bank of England, and assuming no change in exposure or impact when Flood Re ends and insurance transitions to fully risk-reflective pricing in 2039, the notional loss in house value due to flooding remains substantial: 210,000 * 275,000 * 1.6% = **£924 million**.

Note: The estimates here provide a first pass indication. Further research to incorporate data from Wales, and the distribution of property prices, the variation in flood exposure, and the sensitivities of house prices in different settings would need to be incorporated. Although possible, this is beyond the scope of this report.

3.0 WALES: FLOOD RISK POLICY AND INVESTMENT

3.1 Overview of FRM Roles and Responsibilities in Wales

Flood Risk Management (FRM) in Wales involves organisations working across national, regional and local levels to reduce the risk of flooding to people and property. Key responsibilities are shared between Welsh Government, Natural Resources Wales (NRW), Lead Local Flood Authorities (LLFAs), water and sewerage companies, and other risk management authorities (Figure 3-1). Together, these bodies set the policy framework, develop strategies, plan projects, and fund and deliver actions. The governance framework emphasises collaboration, sustainable management of natural resources, and a risk-based approach to prioritising investment and interventions.

Source: Welsh Government (2020) National Strategy for Flood and Coastal Erosion Risk Management in Wales (English).

Figure 3-1 Governance Framework - Flood Risk Management in Wales

3.2 Policy support for 'good' flood risk management

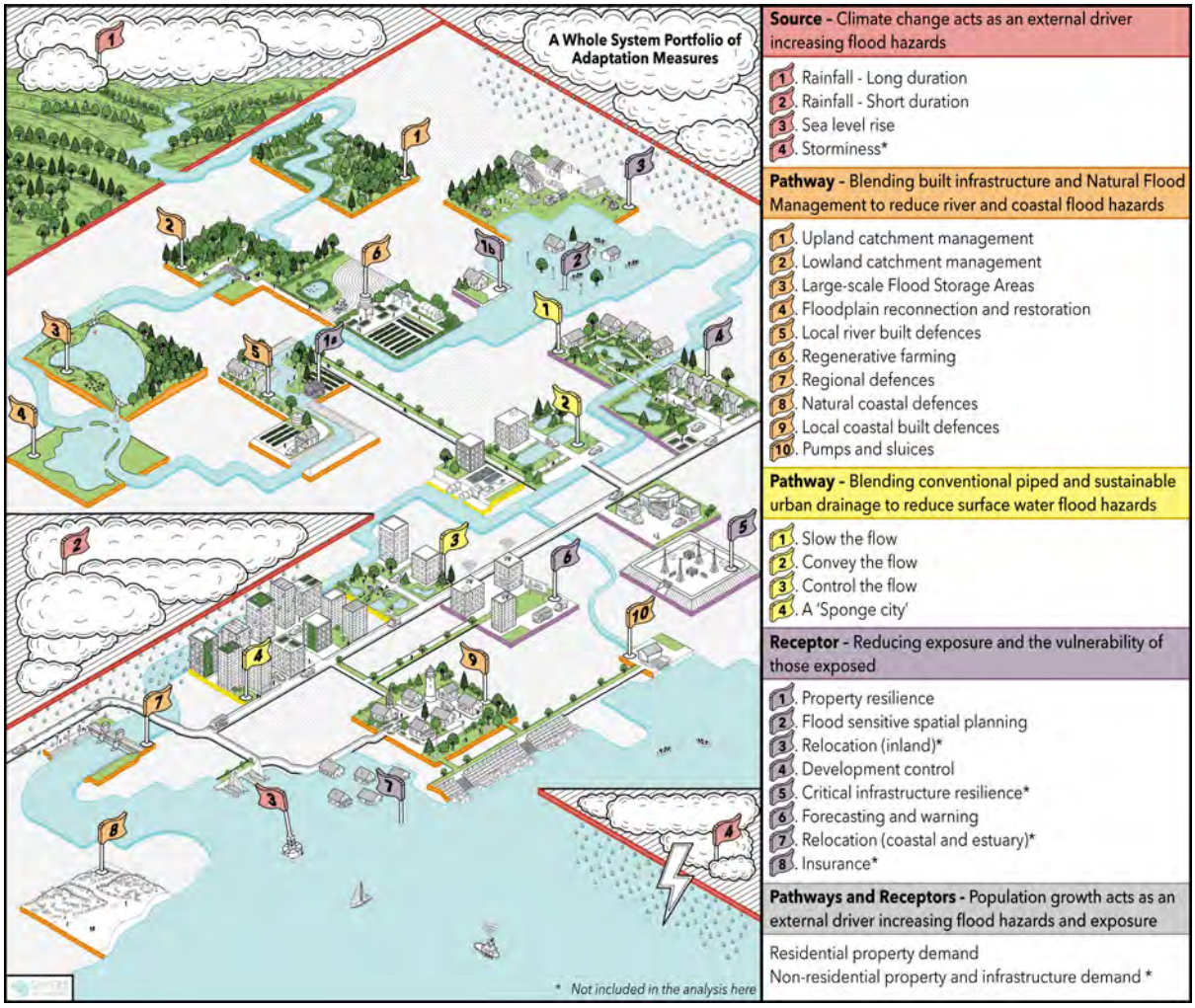
3.2.1 Support strategic planning that aligns plans and actions

It has long been understood that FRM does not stand alone but contributes to broader Sustainable Development Goals. In Wales, this principle is embedded in policy through the Well-being of Future Generations (Wales) Act 2015 and River Basin Management Plans, which promote integrated, cross-sector planning and a catchment-based approach to water resource management. A strategic approach to FRM recognises this and proactively seeks to align with spatial planning, nature recovery, water security, food security, and other demands and processes across government (Sayers *et al.,* 2014; Pegram *et al.,* 2013). Delivering this in practice remains challenging, as FRM is often perceived as a passive response to evolving risks and as a planning constraint, rather than a collaborative opportunity to deliver multiple benefits in line with wider policy objectives.

3.2.2 Support for Natural Flood Management as central to a portfolio of measures

It is widely accepted that flood risk is best managed through a portfolio of measures (*e.g.,* Sayers *et al.,* 2013). These measures should be planned and implemented inclusively and managed through a process of monitoring, periodic adjustment (incremental adaptation) and strategic change when

necessary. Such a portfolio underpins strategic management of flood risk (Figure 3-2). Within this portfolio, each measure has strengths and weaknesses. Good strategic planning brings these together in a way that enables flood risk to be reduced effectively, efficiently, and in a way that provides multiple benefits for people and nature. Within the literature, policy and guidance, NFM is increasingly recognised as central to this portfolio.



Source: Sayers *et al.,* 2026a – CCRA4 A well-adapted UK – Exploring future flood risk

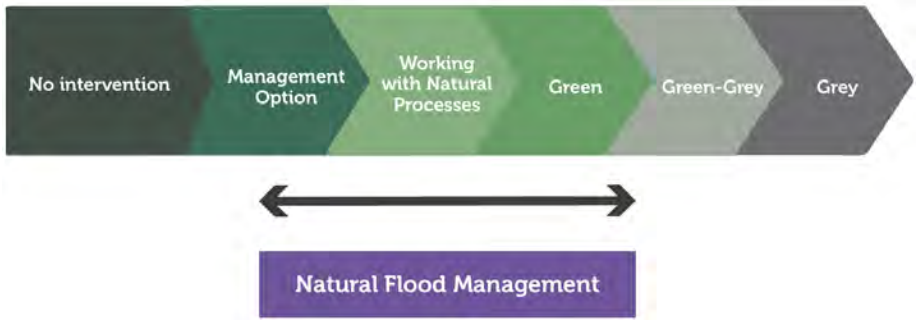
Figure 3-2 Good flood risk management relies upon a whole-system portfolio-based approach

In many ways, Wales leads the way in promoting NFM. Various Welsh policies are supportive of NFM and encourage the full value of NFM to emerge, including:

- **Well-being of Future Generations (Wales) Act 2015**[1] embeds a long-term perspective and the need for actions that deliver multiple benefits and adaptation duties.
- **Environment (Wales) Act (2016)**[2] places a duty on National Resources Wales (NRW, the lead for flood and coastal erosion risk management in Wales) to maintain and enhance biodiversity and ecosystem resilience while undertaking its functions.

[1] Well-being of Future Generations (Wales) Act 2015: guidance | GOV.WALES
[2] Environment (Wales) Act 2016

- **Natural Resources Policy (2017)**[3] puts an emphasis on taking a place-based approach to delivering nature-based solutions.
- **National FCERM Strategy for Wales (2020)** translates this to focus on Flood and Coastal Erosion Risk Management and gives NFM priority in the appraisal process, encouraging consideration of NFM ('green' interventions) ahead of other built solutions ('grey' interventions) - Figure 3-3. This echoes international best practice across the water sector, which highlights natural infrastructure as a legitimate flood risk management asset, and the change in emphasis to focus on the role built infrastructure can play in supporting natural infrastructure, and not vice versa, to deliver desired outcomes (Sayers *et al.,* 2026b).



Source: National Strategy for Flood and Coastal Erosion Risk Management in Wales

Figure 3-3 Option appraisal continuum promoted in the National Strategy for FCERM

- **National Infrastructure Commission for Wales (2024)** highlights integrating nature and community as crucial for creating sustainable and resilient solutions to flood risk management and that nature and community have been *'insufficiently considered within flooding policy and practice'*.
- **Flood Risk Management Annual Reports** (most recently 2024–2025) produced by NRW emphasises whole system, catchment wide actions.
- **Schedule 3 of the Flood and Water Management Act 2010,** Wales leads the way in policy backing to implement Sustainable Urban Drainage Systems (SuDS). SuDS act to slow the production of runoff by increasing infiltration, storage, or both (e.g., Woods Ballard *et al.*, 2015). Measures include ponds and swales to help maintain a greenfield runoff signature for new developments, as well as measures to retrofit increased infiltration and storage into the existing urban fabric (at property, street, and area scales; Figure 3-2). Take-up of well-designed SuDS that provide multifunctional benefits in new developments continues to vary in practice and policy across the UK, but Wales leads the way. Implementation of Schedule 3 of the Flood and Water Management Act 2010 has commenced, requiring SuDS Approval Bodies to approve SuDS and secure long-term maintenance arrangements for most new developments (Welsh Government, 2018; Welsh Government, 2026). This is positive for new developments but for existing towns and cities, although retrofit SuDS is encouraged, it is not mandated (as it is for new developments) and take-up is less clear (although some leading examples do exist, such as the Dŵr Cymru (Welsh Water) RainScape programme - Box 3-1).

[3] Natural resources policy | GOV.WALES

Box 3-1 RainScape Programme - Greener Grangetown SuDS project

Dŵr Cymru (Welsh Water) working together with NRW and Cardiff Council is implementing a SuDS project at Grangetown as part of their RainScape programme. The project was initiated to decrease the volume of rainwater entering the overloaded sewage system and provide attractive green space for residents and commuters. To achieve this, over 100 raingardens featuring a diverse mix of native trees, shrubs and grasses were created on the streets of Grangetown to catch and filter rainwater, before entering the River Taff. This is interesting in that it was one of the first to use these techniques at this scale, covering an area of 12 hectares that included 500 properties in 12 streets with approximately 1,150 residents. Prior to implementation, run-off that entered the sewage system was pumped 8 miles for treatment in the Vale of Glamorgan before being discharged into the sea. The SuDS scheme not only provides nature and people benefits, but it also saves energy and water treatment costs for Welsh Water. The project was initiated in November 2016 and completed in 2018.

Source: Greener Grangetown SuDS project: NbS Knowledge Hub Accessed May 2026

3.2.3 Support for a just transition

Social vulnerability factors are integrated into how NRW plans and prioritises investments through the ranking of *'communities at risk'* (set out in the *'Communities at Risk Register, CaRR'*).[4] The CaRR calculates a *'danger score'* for each community that is then ranked from highest to lowest (Figure 3-4). In doing so, two scenarios are considered:

- an 'undefended' scenario, that assumes any defences that are present are removed and any flood warning service that may be in place is not functioning
- a 'managed' scenario, where existing flood defences and flood warnings are in place.

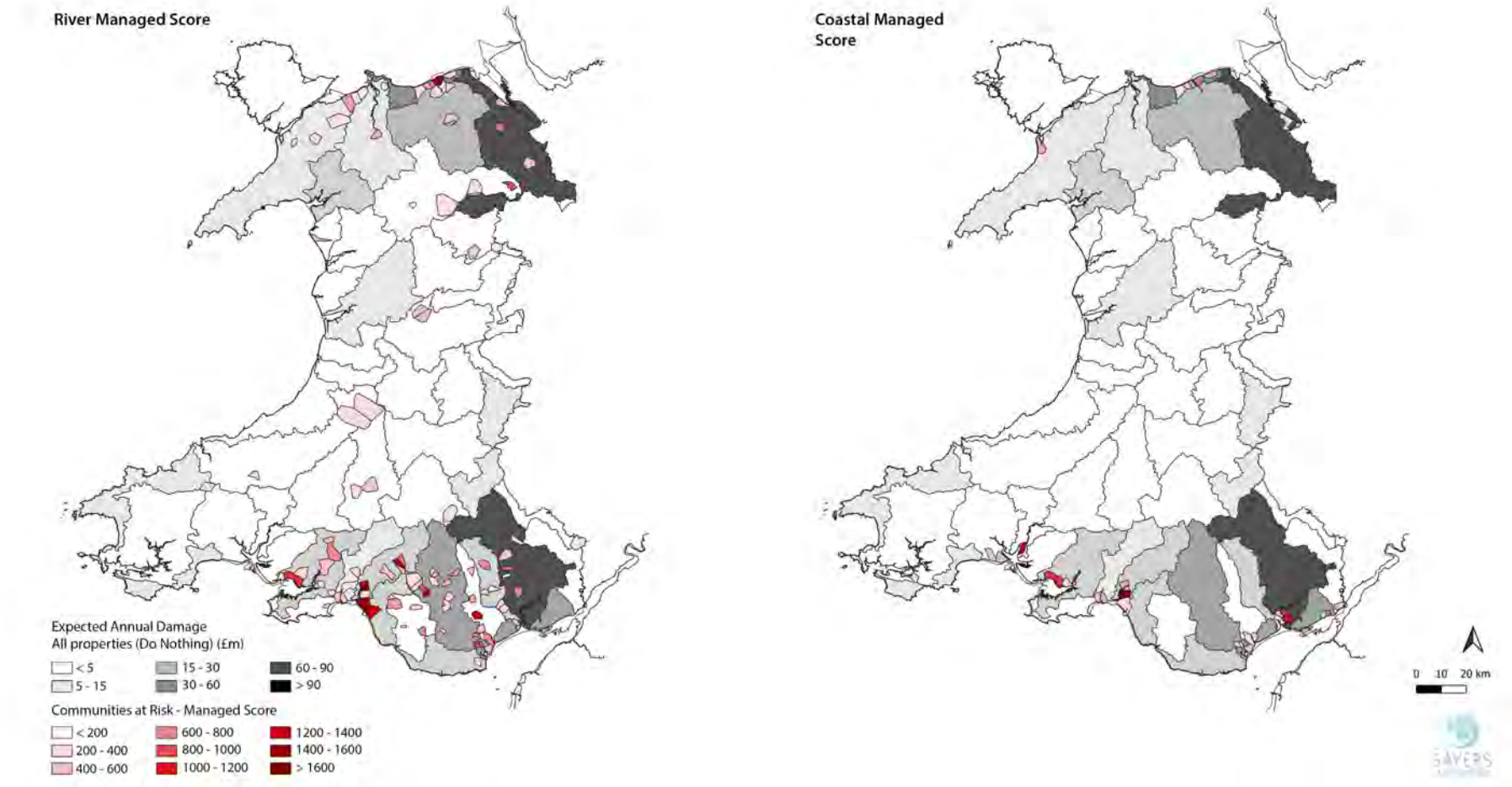
The CaRR is then assessed using information on:

- flood hazard – frequency, extent, depth and velocity as well as the speed of onset
- exposure of the people and property to those hazards
- social vulnerability of those exposed (using the simplified descriptors set out in Defra, 2006)
- flood risk management actions, including the presence or absence of defences and the availability of flood warnings.

NRW use the CaRR to inform the Welsh Government funding allocations through the Flood and Coastal Erosion Risk Management Programme and shares the data to support Lead Local Flood Authorities (LLFAs) in their flood risk management decision making.

The National Infrastructure Commission for Wales (NICW, 2024) emphasises the importance of developing solutions that work for the most vulnerable, including those in private and social rented accommodation.

[4] Natural Resources Wales / How we plan and prioritise our flood risk management work Accessed May 2026



Left: Base map of the Expected Annual Damage (residential and non-residential properties) by 2050s given a 3°C climate future and no further adaptation, is overlain with the NRW Communities at Risk Register score for the managed case, river flooding; *Right:* The same base map overlain with the NRW Communities at Risk Register score for the managed case, river flooding. The Expected Annual Damage mapping is based on CCRA4 Sayers *et al.,* 2026a. Spatial units shown are based catchments.

Figure 3-4 Present-day – NRW Communities at Risk Register – River and Coastal Managed Risk scores

3.3 Investment in reducing flood risk management

Flood and Coastal Erosion Risk Management investment has increased in recent years in Wales. Before 2021, the annual investment was typically less than ~£50m (2011-2020). During financial years 2022/23 to 2025/26, the Welsh Government invested over £377 million in the development and construction of FCERM schemes in Wales, with a projected record investment of £85m proposed for 2026/27. The majority of this spend has been delivered through the Coastal Risk Management Programme (CRMP). Funding is also directed towards reactive emergency actions, with ~£7 million of capital emergency funding allocated to local authorities in response to recent storms including Storms Bert, Darragh and Claudia. Flood warnings are also an important aspect of flood risk management and NRW recently launched a new Flood Warning Service, backed by £5 million in capital funding.

Funding for Natural Flood Management (NFM) is a small proportion of this overall expenditure, with investment in NFM initiatives over this period ~£6 million (less than 2% of the total). This total includes funding provided through the *Natural Flood Management Accelerator Programme* (£4.6 million over 2 years, 2023–2025). This pilot NFM programme has now ended but Welsh Government has developed new funding mechanisms to support the take-up of NFM via the *Natural Flood Management Fund 2026 to 2027.* The NFM fund seeks to support linking NFM with wider landscape activities and seeks to link to the *Sustainable Farming Scheme* (SFS) and encourage farmers to meet SFS requirements (e.g. habitat management) through NFM activity. This recognition of a landscape scale perspective is a positive and welcome step. However, to be successful it will require sufficient funding to be mobilised. Integrated management plans will need to be developed and delivered (with a focus on natural flood management measures at farm and catchment levels to increase storage capacity, reduce run-off - of rainfall, soil and pollutants - from agricultural land and encourage groundwater recharge).

The multiple benefits provided by NFM are also increasingly attractive to private investors, and blended public and private financing is increasingly seen as an important mechanism to scale NFM. Tangible examples are emerging across Wales, including initiatives such as Resilient Rivers (Box 3-2).

Box 3-2 Leveraging multiple benefits to increase NFM funding in the Wye and Usk

The Wye and Usk Foundation promotes strategic tree planting as part of its Natural Flood Management (NFM) work across the Wye and Usk catchments. The strategy focuses on upper catchments to increase rainfall interception, improve soil infiltration, and slow run-off. The wider programme combines woodland creation with NFM measures like wetlands, ponds, scrapes, and leaky woody debris dams—such as those piloted in the Lugg, Frome, Monnow, and Yazor Brook catchments—to reduce downstream flood peaks, curb soil erosion, capture carbon, and restore aquatic habitats.

To accelerate these landscape-scale objectives, the Foundation introduced its 100,000-tree initiative, a targeted milestone integrated into broader partnerships like the Resilient Rivers project. This ambitious push recognises that effective flood risk management requires coordinated action across entire landscapes rather than relying solely on hard-engineered defences. By collaborating with farmers and landowners, the programme builds landscape resilience to store water during storms and release it slowly. Beyond flood mitigation, increased woodland cover actively tackles severe soil loss, offsets nutrients, and addresses rising water temperatures, reflecting the Foundation's view that nature-based solutions deliver vital, multi-benefit ecological returns across the river catchments.

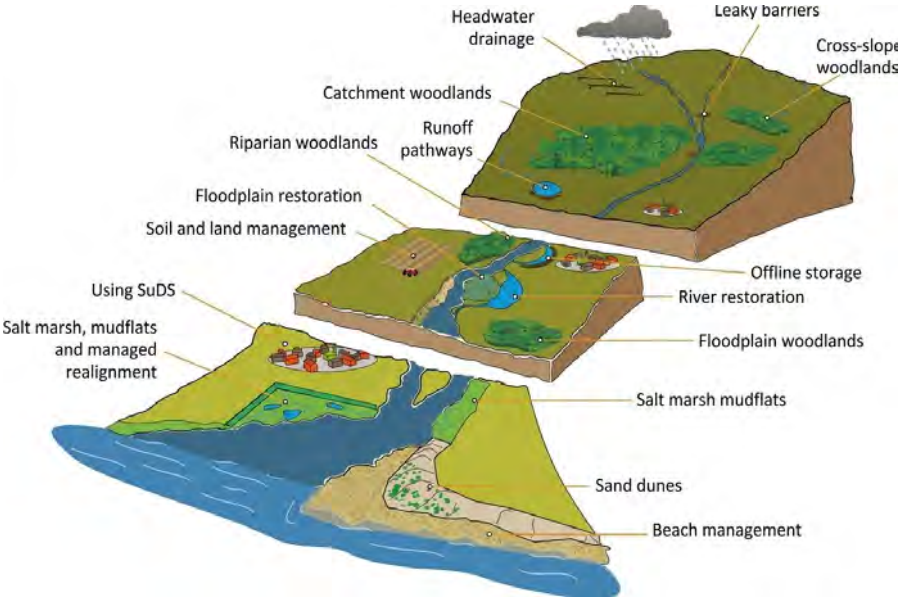
To financially sustain these goals, the initiative relies on blended finance models that stack public grants with private capital. Government funding from Defra schemes like the England Woodland Creation Offer (EWCO) covers upfront planting costs and standard stewardship. Simultaneously, private funding—secured through corporate supply chain investments via partnerships like the Wye Agri Food Partnership and voluntary carbon or biodiversity credit trading de-risks the transition for farmers, providing the long-term commercial incentives needed to convert productive land into environmental buffers

Source: https://wyeuskfoundation.org/

4.0 REALISING THE CONTRIBUTION OF NATURAL FLOOD MANAGEMENT

4.1 Natural Flood Management: Opportunity Maps

Natural Flood Management (NFM) works by restoring and enhancing natural processes across catchments to reduce run-off, increase storage, reduce peak flood flows, manage morphological dynamics, and reduce soil loss (Figure 4-1). NFM forms a legitimate part of a portfolio response to flood risk management (as introduced earlier, Figure 3-2) and works in combination with other measures to reduce flood risk whilst providing a wide range of co-benefits (such as improved water quality, increased biodiversity, amenity and livelihood support, carbon sequestration, and many others). NFM measures, if given space, are also inherently adaptable, with measures able to evolve over time in response to changing conditions.



Source: Redrawn from Environment Agency, 2017 and updated evidence directory 2024.

Figure 4-1 Types of NFM interventions

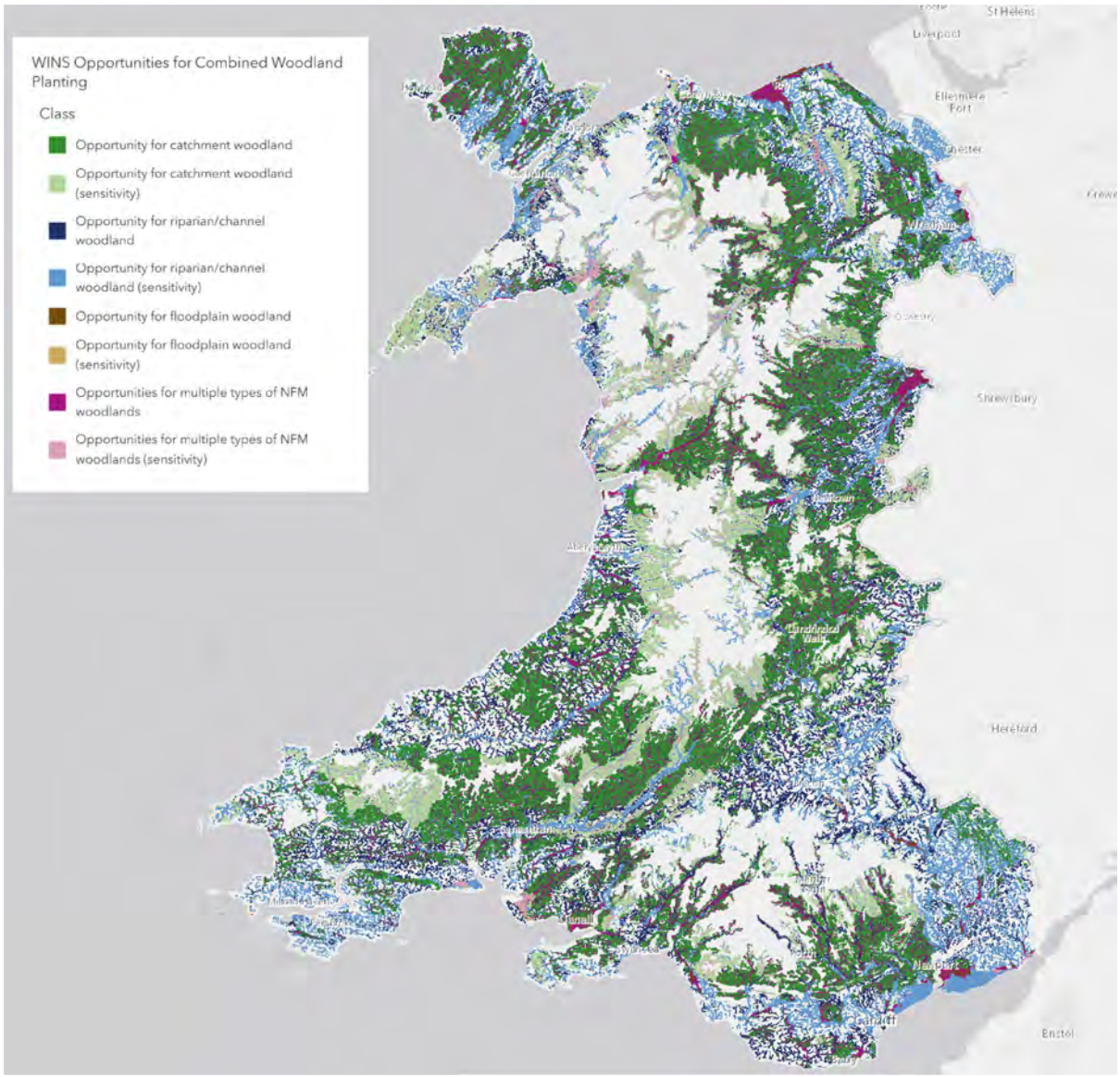
To support the uptake of NFM, NRW have produced a series of 'opportunity maps' (based on Working with Natural Processes, WwNP Environment Agency, 2017) and *System Cynorthwyo Cunllunio Adnoddau Naturiol* (SCCAN) developed by NRW (see Welsh Information for Nature-based Solutions, WINS portal). The WINS maps help identify spatial (area) opportunities for land management interventions that relate to priorities set out in the Welsh Government Natural Resources Policy (2017), including the four main policy themes:

- Marine and freshwater quality
- Natural flood management
- Woodland planting
- Urban and peri-urban green infrastructure

Within the theme of Natural Flood Management, spatial opportunities are mapped for a range of NFM-related measures, including:

- Woodland planting - catchment woodland
- Woodland planting - floodplain woodland
- Woodland planting - riparian woodland
- Bog restoration
- Surface roughness
- Agricultural management

The opportunity maps do not differentiate the locations by likely contribution to flood risk reduction, but use an understanding of the topography, hydrological processes, and geology to assess areas where the alternative NFM measures are likely to be feasible. Importantly, the 'opportunity maps' do not attempt to show where a scheme will work but rather identify where the physical conditions are conducive to NFM. Nonetheless, this is a useful guide to motivate action, and where the greatest opportunities are likely to lie across Wales (Figure 4-2) and by catchment (Table 4-1). Although indicative, the extensive nature of the mapped opportunity provides strong support for the case to scale-up investment in NFM and provides an important resource to inform spatial prioritisation of SFS funding.

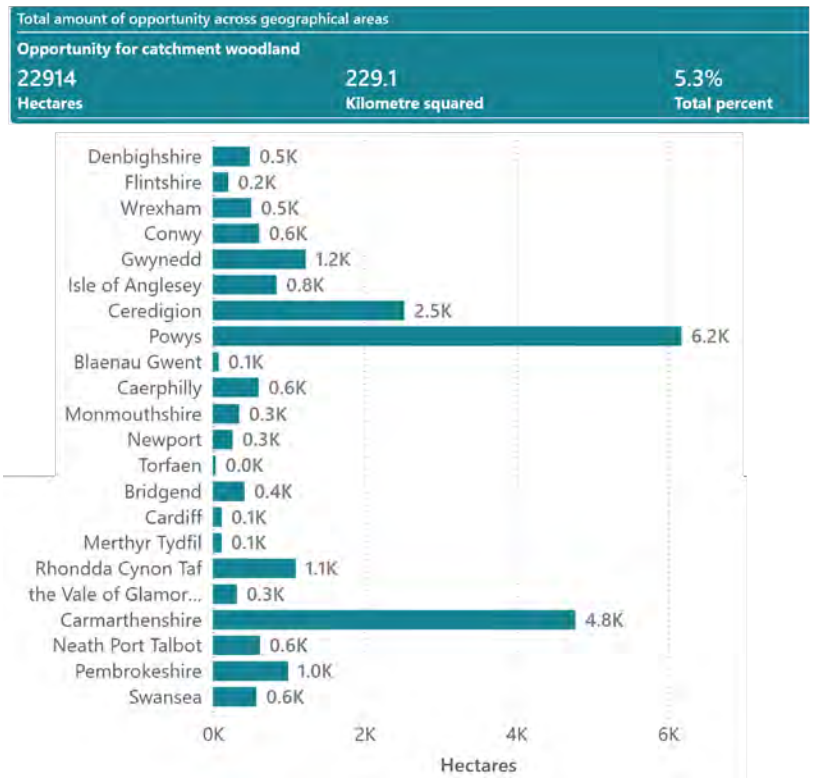


The WINS portal provides access to the 'opportunity maps', which provide spatial (area) mapping of the suitability of different types of Natural Flood Management measures. The maps represent the physical suitability rather than feasibility but provide a useful starting point to scale-up NFM in practice. The figure shows different types of woodland opportunities to illustrate the type of mapping that is available via the portal.
Source: Portal - Welsh Information for Nature-based Solutions (WINS)

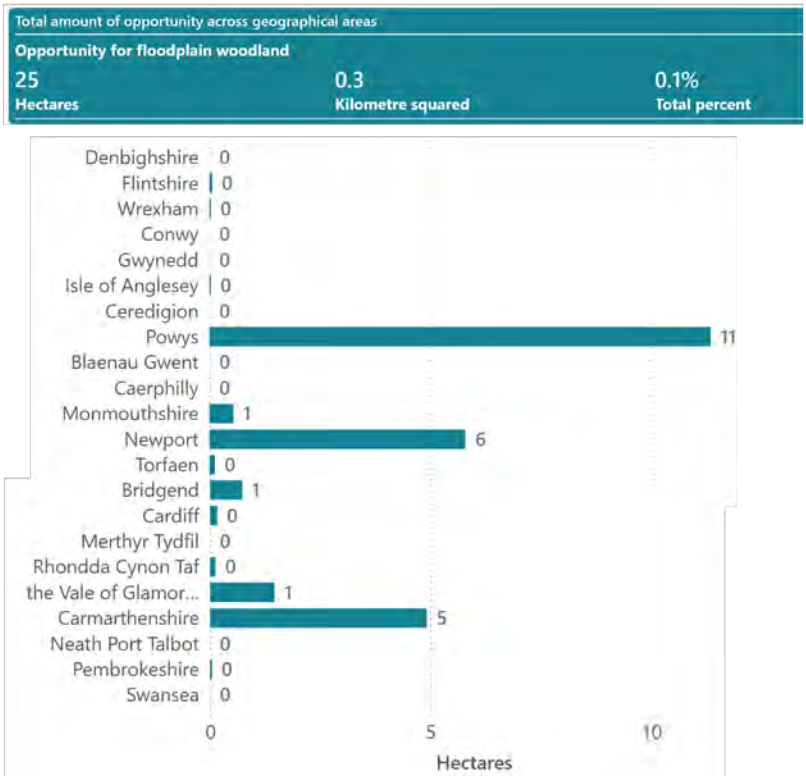
Figure 4-2 NFM opportunity mapping – Spatial opportunities across Wales

Table 4-1 Scale of the opportunity for catchment and floodplain woodland

Opportunity for catchment woodland to contribute to NFM



Opportunity for floodplain woodland to contribute to NFM



The WINS portal enables the scale of the 'opportunity map' to be compared across NRW operational Areas (lefthand column above) or across local authorities (righthand column above) for any selected Natural Flood Management Measures. The areas quoted are based on physical suitability rather than feasibility but provide a useful guide to where the opportunities are greatest.
Source: Examples from the WINS portal (accessed May 2026).

4.2 Natural Flood Management: Contribution to reducing flood risk

4.2.1 Potential for NFM to contribute to flood risk reduction across Wales

The *opportunity maps* stop short of quantifying the flood risk reduction NFM may achieve. This is difficult to do and is highly dependent on local context. Nonetheless, this has been explored at the UK scale through the NERC funded OpenCLIM research (Sayers *et al.,* 2025) by bringing together the spatial *opportunity maps*, process-based hydrological modelling (including HBV-TYN, He *et al*., 2022), and the Future Flood Explorer (FFE). It quantifies the flood risk reduction benefits of NFM across Great Britain under conditions of future climate and socio-economic change. An optimisation of these benefits is presented considering alternative NFM policy ambitions that range from a more limited uptake to an 'NFM Max' scenario that assumes all opportunities (as set out in the opportunity maps) are implemented.

Quantifying the scale of the potential contribution of NFM to national flood risk reduction

As introduced earlier, NFM will seldom be a complete solution in response to the risks but instead form part of a broader portfolio of measures that in combination seek to manage flood risk. The analysis considers NFM in that context. The benefit of NFM therefore depends on how other measures have been prioritised; but prioritising NFM and seeing built defences as supportive of NFM (and not vice versa) enables the full opportunity for NFM to reduce flood risk to be attributed to the NFM (if built defences are prioritised the contribution from NFM may be understated).

With current levels of adaptation and given a 3C climate future, it is estimated that NFM will contribute an estimated 12% of the overall fluvial risk reduction within the portfolio of measures by the 2050s. This is equivalent to a risk saving of ~£9.7m per year (reduction in direct and indirect Expected Annual Damage to residential and non-residential properties). Given a more extreme (but plausible) climate future of 4^{o}C, by the 2080s the contribution of NFM remains robust, increasing to ~15% of the portfolio benefits (equivalent to a risk saving of ~£14.5m per year as reduction in Expected Annual Damage). Given further priority directed to NFM, the potential contribution to fluvial flood risk reduction also increases. Assuming a bias towards implementing NFM at scale, with other measures acting to supplement the NFM performance to manage risk where needed, the assessment suggests the NFM contribution by the 2080s has the potential to increase to ~15% (contributing ~£16.3m per year risk reduction by the 2080s). These values broadly align (although slightly exceed) with the UK wide findings set out in Sayers *et al.,* 2025.

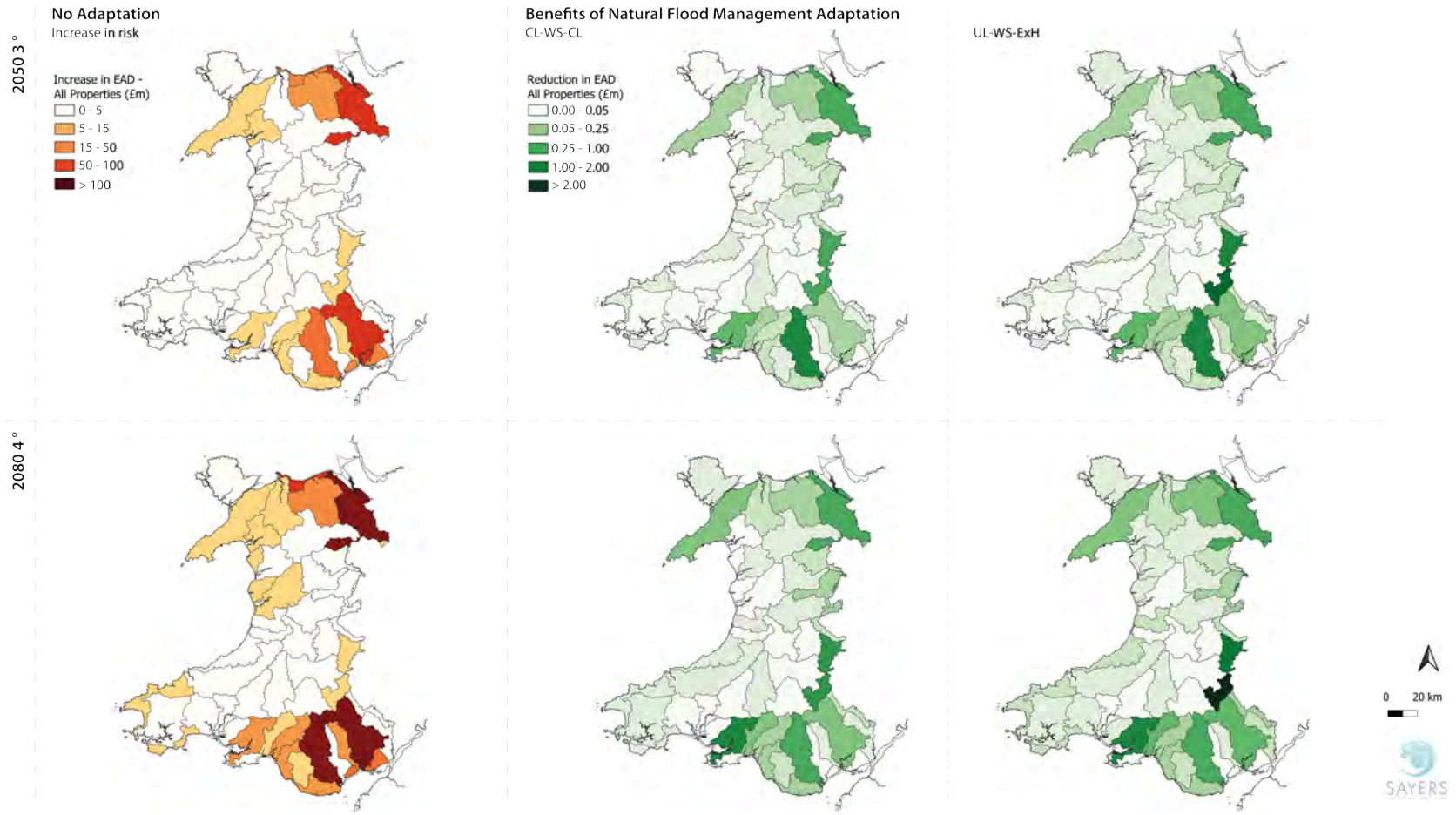
Note:

Assessed benefits are incomplete: The assessment here focuses solely on flood risk reduction benefits to properties (direct and indirect). Wider benefits are excluded.

Local and downstream benefits: Sayers *et al.,* 2025 and 2026a assess the benefit of an NFM measure based on its ability influence flow, the subsequent influence of any change on the downstream hazard (including the performance of downstream flood defences, where they exist), and change in exposure in response to that change (taking account of the spatial distribution of residential properties). The analysis also captures the accumulation of downstream benefits in a way that reflects connectivity. This enables the benefits of single and multiple local interventions to be captured and reinforces the principle that benefits of NFM emerge most strongly when it is delivered 'at-scale'.

Exploring the spatial variation in the scale of the opportunity

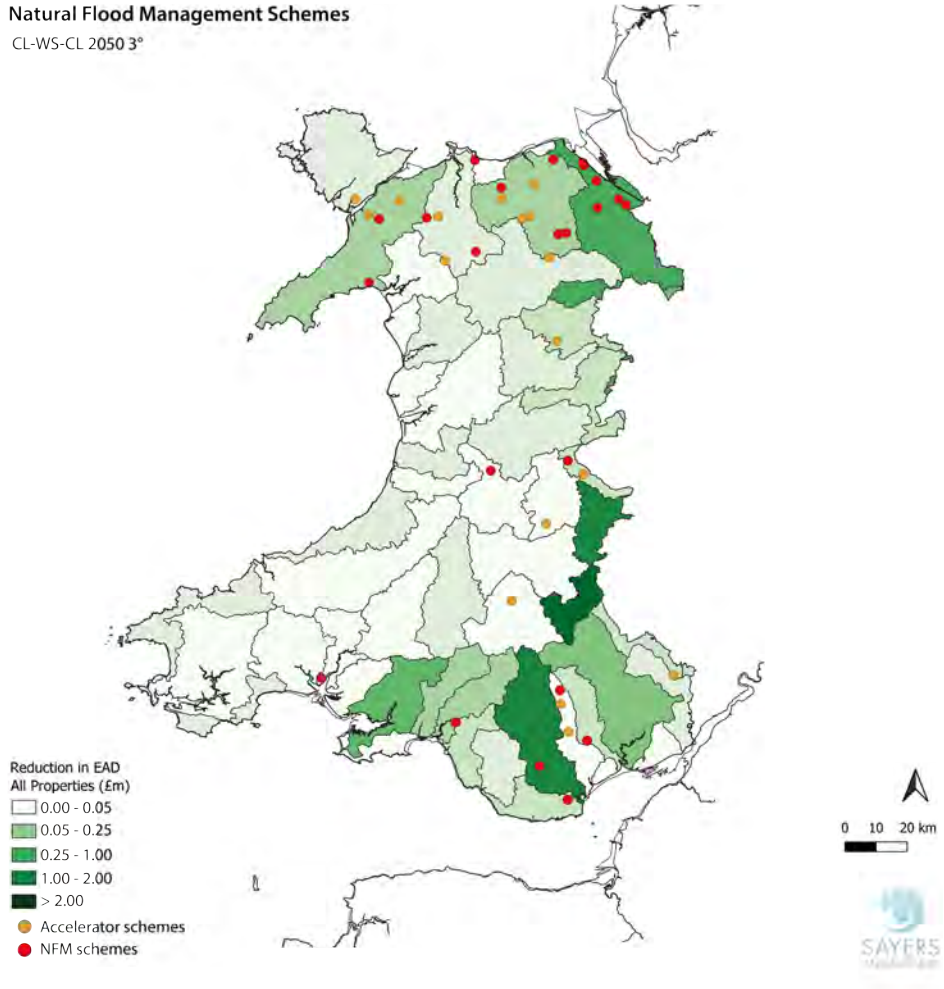
The benefits achieved vary spatially, reflecting the interaction between the opportunity, the river flows, and the associated downstream conventional defences and exposure. These results highlight the significant contribution NFM can make to reducing Expected Annual Damage in catchments across Great Britain, but also specifically in south, north and central Wales (Figure 4-3). The results also suggest that although the focus of NFM schemes in recent years links closely to areas where the greatest benefits may accrue, significant opportunities remain to extend the NFM investments across Wales (Figure 4-4).



Left: Increase in present Expected Annual Damage (direct) given no further adaptation, top row by 2050s given a 3°C rise in GSMT by 2100, bottom row, by 2050s given a 4°C rise in GSMT by 2100. Central: The potential benefit of NFM, expressed in terms of reduction in Expected Annual Damage when implemented as part of portfolio of measures that reflect a continuation of a similar level of investment in NFM, in flood defences, forecasting and warning, and other measures as in the recent past. *Right:* The NFM benefit when a higher ambition approach to NFM is adopted and lower ambition approach is adopted on other measures.

Source: Based on CCRA4 future flood projections (Sayers *et al.,* 2026a)

Figure 4-3 NFM – Exploring risk reduction benefits by catchment



Source: Opportunities here. Programme of NFM investments from NRW

Figure 4-4 NFM – Recent investment compared to spatial opportunities across Wales

4.2.2 Linking NFM opportunities to Communities at Risk

NRW identified the NFM opportunities that link closely to communities most at risk from fluvial flooding using their *Communities at Risk Register (CaRR*). The results have been created to target two different catchment scales, small watercourse and larger catchment (Figure 4-5). The mapping prioritises those catchments above communities at risk where the Natural Flood Management (NFM) opportunities are greatest and may be a suitable means of reducing flood risk (building upon the NERC funded NFM programme).

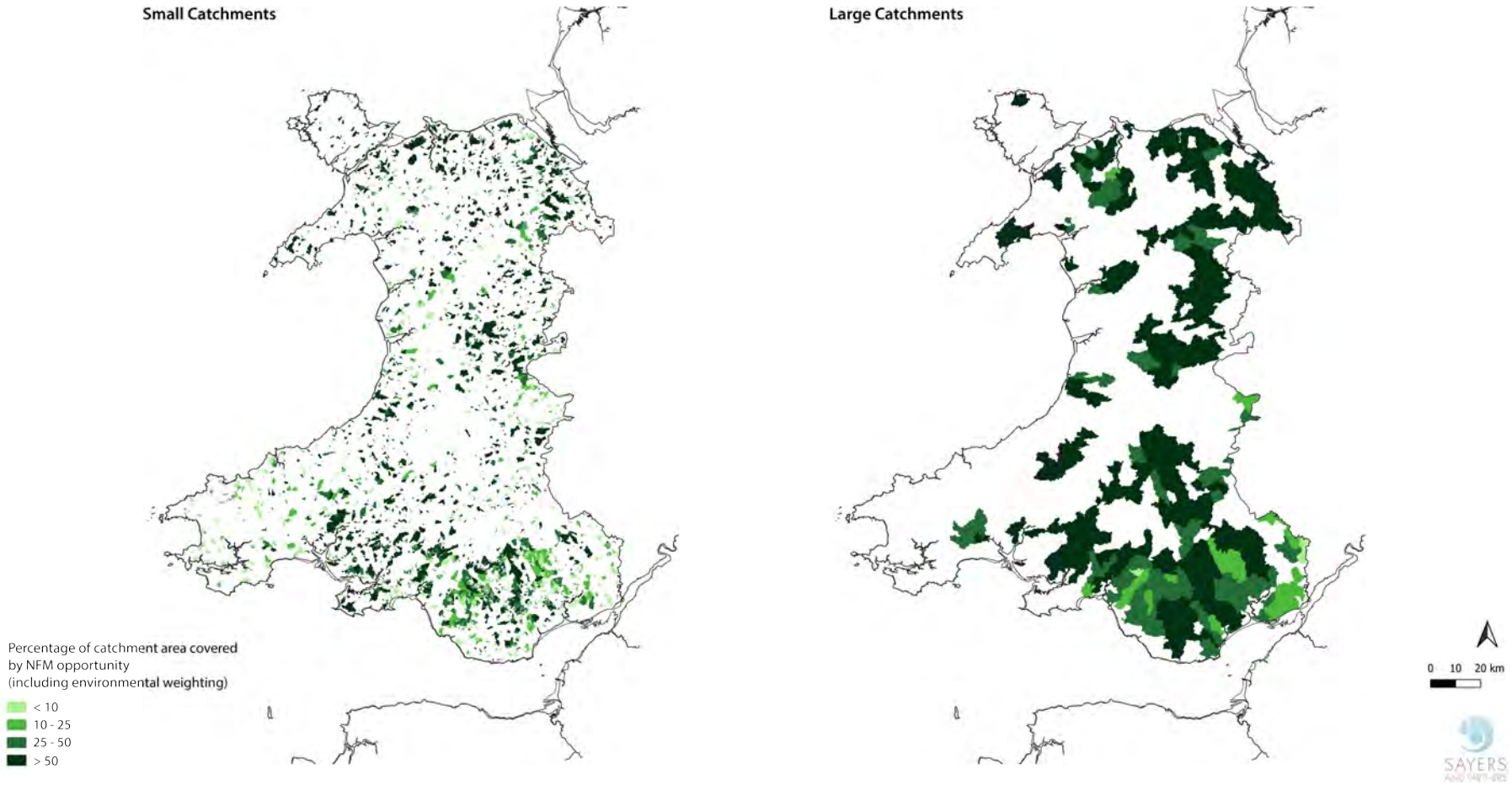
This data also provides a useful insight to guide strategic NFM funding as part of the SFS, particularly where high flood risk is matched with considerable NFM opportunity in local catchments. The NRW opportunity maps for example show considerable local catchment potential for NFM areas such as Pontypridd and communities across Monmouthshire that have all suffered severe flooding in recent years. Targeting NFM delivery where risk and opportunity intersect helps maximise the efficiency of public spending on flood risk management whilst generating wider benefits (Box 4-1). Understanding this intersection also provides an opportunity to align investment vehicles, such as the Sustainable Farming Scheme (SFS) strategic NFM funding framework. By prioritising agricultural grants and woodland creation incentives within high-opportunity catchments upstream of flood risk areas, the SFS can proactively drive landscape restoration that delivers the greatest combined returns for flood risk reduction alongside wider benefits (such as soil management, water quality, and biodiversity).

Box 4-1 Aligning flood risk with NFM opportunity

The 2025–26 Welsh Natural Flood Management (NFM) programme demonstrates a scalable investment spectrum, showcasing how interventions range from localized protections to landscape-wide schemes. For instance, the Pwllglas scheme (Clwyd West management catchment) illustrates targeted investment in NFM within north-east Wales. Led by Denbighshire County Council, this project was in the design and construction phase during 2025–26 and received £200,000 of programme funding. Located within the upper Clwyd catchment, the project forms part of wider efforts to use catchment-based approaches to manage runoff and reduce downstream flood risk to four properties. Although details of the specific interventions are not available within the dataset, the scheme demonstrates continued investment in NFM as a complementary component of flood risk management in rural Welsh catchments.

In contrast, Wye SOIL (Upper Wye catchment, Powys) is one of the larger NFM projects identified in the programme database. Led by Powys County Council, this scheme was also in the design and construction phase during 2025–26 and received approximately £296,000 (£295,556) of funding. Located within the Mid and West Wales river basin district, the project is estimated to benefit 151 properties, making it one of the higher-impact schemes within the dataset. While specific details of the individual interventions are not provided, the reference to "SOIL" strongly implies a focus on land management, soil condition, and infiltration. Ultimately, the scheme illustrates the potential for catchment-scale NFM approaches to contribute to flood risk reduction across larger rural river systems rather than relying on isolated, site-specific interventions.

Source: Welsh Government Natural Flood Management (NFM) Programme Dataset (2025–26)



The maps show the priority given to NFM for *Left:* Small catchments *Right:* Large catchment opportunities. The map was developed to give a strategic overview of the priority areas for NFM. Priority is based on a combination of considerations including the relative location of the Communities at Risk (based on the CARR) and scale of the NFM opportunity (across all relevant measures) to provide an overall priority. It is this priority that is mapped here.

Source: WINS portal, by NRW – data accessed May 2026. DataMapWales NFM Catchments Layer

Figure 4-5 Opportunities for NFM – Large and small catchments

4.3 Natural Flood Management: Role in reducing soil erosion and managing soil health

Soil health and flood management are closely linked. Many NFM measures act to reduce flood flows through mechanisms that also reduce soil erosion and improve soil health by restoring natural hydrological processes within catchments. Measures such as woodland creation, riparian buffers, leaky barriers, and changes to grazing management increase vegetation cover and root density, which enhance soil structure, porosity, and organic matter content. This improves infiltration and water storage within soils, reducing the generation of rapid surface runoff during rainfall events. In turn, slower flow pathways decrease the mobilisation and transport of sediment, limiting both on-site soil loss and downstream sedimentation. Evidence from field-based studies, including the Pontbren project in Wales (Box 4-2), highlights this link and how land-use changes (such as tree shelterbelts and reduced grazing pressure) can significantly increase infiltration rates and reduce overland flow. The strongest evidence relates to field and hillslope scales. These processes are fundamental to catchment functioning, which means NFM provides a practical, nature-based approach to simultaneously enhance soil resilience, reduce erosion risk, as well as contributing to wider risk management.

Box 4-2 Pontbren – Improving soil health

The Pontbren Catchment Project in Powys, mid-Wales, is a long running farmer-led case study exploring the efficacy of Natural Flood Management (NFM). Originating in 1997, it explores a co-operative approach to improving upland farming efficiency, and how land-use management directly restores soil health and reduces downstream flooding.

Heavy livestock grazing historically had caused severe near-surface soil compaction, resulting in low permeability and high volumes of rapid surface run-off during heavy rainfall. As part of the case study, various NFM interventions were implemented, including strategically located belts of trees (shelter belts) across headwater catchments and excluding sheep grazing.

Linked monitoring and multiscale experimental modelling led by Imperial College (Wheater *et al.,* 2008 as part of the Flood Risk Management Research Consortium) highlighted that excluding sheep and establishing broadleaved tree strip shelter belts improved soil health, enabling the soil to naturally decompress. The reduction in soil compaction improved soil structure and permeability, and consequently reduced surface sheet flows and surface soil erosion. Although the results relate mainly to field / hillslope scale, and scaling to full catchments remains more uncertain, the Pontbren project demonstrates strong local-scale evidence; a scale that is particularly important in the context of soil health findings.

Although no longer an active experimental research programme, the farms and land management practices promoted continue to be developed through the farmer group and land management practices are still in place.

Sources:
Wheater et al., 2008. Impacts of upland land management on flood risk: multi-scale modelling methodology and results from the Pontbren experiment.
Woodland Trust (2013): Pontbren Project: Sustainable Uplands Management - Woodland Trust
Welsh Government (2013): The Pontbren project: the farmers' experiences & lessons learnt

4.4 Barriers to scaling NFM in practice

Bridging the gap between the policy ambition that supports NFM, funding, and action will be the next step needed to realise the potential of NFM at scale. In part, this will require overcoming several perceived and real barriers to NFM. Many of these barriers, and the actions needed to overcome them, have been well rehearsed through international experience (Sayers *et al.,* 2026b) and directly in the Welsh context (Afonydd Cymru, 2026, JBA, 2025). Central actions include:

Rebalance investment, setting out an expectation for NFM investment to become mainstream: A well-adapted Wales will rely on both natural and engineered solutions, alongside planning non-structural measures to deliver multiple outcomes. Investment in NFM has been only a small fraction of the overall expenditure on FRM despite the significant benefits it has the potential to provide,

both to flood risk reduction and wider catchment health. The concept of nature-based solutions is not new in Wales, and Wales leads the UK in sustainable urban drainage systems (SuDS), but if Wales is to lead on NFM, such measures must become part of the mainstream, not the exception.

Continue to strengthen policy to promote a strategic landscape scale perspective: Flood risk management does not stand alone. Adopting a strategic landscape scale perspective shifts the focus towards delivering multiple outcomes and helps avoid a 'bias to build' and the presentation of a simple (and false) binary choice between natural flood management or built defences to manage flood risk (Sayers *et al.,* 2026b). NFM is implicitly a multi-benefit response and inherently adaptive; these attributes can be hidden when planning is small-scale, short-term, or single-objective driven, but are made visible when a strategic, longer-term, landscape planning lens is adopted. The ambition to scale up nature-based solutions across Wales is evident across policy. To transition to action at scale a coherent national programme for catchment resilience that prioritises well-functioning natural infrastructure (including NFM) is now needed. Doing so would both signal the ambition to scale up nature-based solutions and provide the enabling framework to deliver on this ambition through aligned action on flooding, farming, river health, and well-being.

Simplify delivery through catchment scale plans not piecemeal projects: Strengthening the role of catchment planning provides an opportunity to develop the aligned actions across the catchment to successfully manage flood risk, align wider opportunities, and balance trade-offs. This does not imply a detailed master-planning process, but appropriately strategic plans that set out catchment-scale programmes of aligned projects that deliver multiple outcomes. Doing so opens opportunities to share costs (modelling and design), create a shared vision for the catchment, and shared ownership for delivery, with space to explore ambitious NFM options. Many of the building blocks to support this are already in place in Wales but require a combination of simplification and clear responsibilities for strategic oversight of catchment resilience. For example, the collaborative layer of the Sustainable Farming Scheme in Wales provides a UK leading mechanism that links farm scale choices with NFM, but many find it difficult to access and use.

A note from England. At the local level where these schemes are implemented, Russell *et al.* (2024) have shown only 10 of the 152 Local Flood Risk Management (FRM) Strategies in England include more than passing references (or no references) to NFM (or similar). This limited progress highlights the significant work to be done at the national and local levels (in England at least) to integrate NFM as a central component of FRM. To be successful, landowners will need to be supported and encouraged to implement NFM on their land. This will continue to require co-design and financial support but also reinforces the importance of the evidence gap this paper responds to.

Simplify processes to promote collaborative and coordinated funding: Multi-benefit projects attract multi-funders. Developing catchment plans that deliver multiple outcomes through NFM provides opportunities to blend multiple public and private funding sources. There is an increasing array of private funding mechanisms that align with NFM (e.g., Green Bonds, Carbon Credits). Welsh Government funding mechanisms also encourage sustainable outcomes (such as the SFS). Mechanisms that proactively encourage alignment of Welsh Government funds (across local authorities, Natural Resources Wales, farmers and other public and private stakeholders), and encourage access to innovative private finance, have the potential to be an important driver of scaling NFM at pace.

Rebalance the knowledge asymmetry: There is often an asymmetry in data and knowledge between the narrowly defined engineering performance of built infrastructure and perceived uncertain performance of NFM. This is countered by acknowledging the multiple benefits NFM provides (including reducing soil loss, encouraging groundwater recharge, amenity, pollination) in addition to flood risk benefits. This more complete view enables the case of a portfolio of measures where the advantages of one compensate for the disadvantages of another in a way that enables flood risk to be managed and wider benefits to be delivered. Although we have much to learn about NFM, and continued research is required, we already know enough to move robustly to action.

Develop professional training that reflects the multidisciplinary nature of NFM: Flood risk management is evolving. Ensuring that training and professional development keep pace with the increasingly multidisciplinary nature of flood and coastal erosion risk management (FCERM) will be important to mainstreaming NFM. River and coastal engineering have always drawn on a broad range of disciplines and perspectives, but NFM often requires even closer integration of expertise in hydrology, geomorphology, ecology, land management, environmental economics and stakeholder engagement alongside more conventional engineering skills. As a result, practitioners involved in planning and delivering flood risk management interventions may benefit from broader training opportunities that build confidence in working across these areas of expertise and applying them in an integrated way. Professional bodies such as the Institution of Civil Engineers (ICE) and the Chartered Institution of Water and Environmental Management (CIWEM) could play an important role in supporting this transition through accreditation, competency frameworks and continuing professional development programmes that reflect the full range of knowledge needed to design and implement NFM as part of a wider portfolio of flood risk management measures.

Rebalance the decision asymmetry: Decisions inevitably rely on an understanding of benefits and costs of one course of action compared to another. In such processes, the full value of NFM is often underestimated, and some benefits are simply missed. Guidance on how to value the full benefits of NFM at multiple scales is emerging, but processes tend to overstate the uncertainties in NFM and understate the benefits. Beyond flood risk benefits, both directly through reducing downstream flooding and indirectly through reducing costs for downstream defences, NFM supports soil health and pollinators with long term food security outcomes, encourages groundwater recharge improving water security, and provides multiple livelihood and well-being outcomes. Decision processes also tend to ignore more subtle advantages of NFM. Ecosystem restoration, for example, may require longer to establish and deliver than a localised built solution, but its contribution will improve as it matures. Conversely, built infrastructure may deteriorate through time, and demand increased costs to maintain. Rebalancing the decision process to explicitly prioritise fairness is part of the wider resilience focus (recognising that across Wales climate change is projected to impact the most socially vulnerable more than others). NFM is not a silver bullet but valuing its cumulative contribution to multiple benefits across the catchment and through time, is a prerequisite to rebalancing the decision process.

5.0 CONCLUSIONS

5.1 Momentum continues to grow

In recent years, Nature-based Solutions (NbS) have emerged as central to sustainable development. Recognising that NbS provide simultaneous benefits for both people and nature, Natural Flood Management (NFM) aligns with this objective and echoes similar international approaches. NFM includes methods such as restoring functional floodplains, tree planting, leaky dams, enhancing soil infiltration, and modifying surface vegetation to increase roughness. In all its forms, NFM strives to work with natural processes to 'slow the flow' (WWF, 2007) and maintain the dynamic stability of landscapes essential for healthy ecosystems while providing wider benefits (for soil health, water resources, recreation and well-being) (e.g. Sayers *et al.,* 2026b).

The notion of resilience is increasingly positioned at the heart of flood risk management (FRM), recognising that 'resilience' is not the same as 'protection'. This reinforces the sentiment that to succeed as a society, we need to *'learn to manage risk and not simply seek to avoid it'* (Walport and Craig, 2014). This context is crucial in promoting NFM, given that NFM does not directly equate to conventional 'flood protection' but contributes to the management of flood risk and simultaneously other societal goals.

5.2 Action is needed to realise the NFM opportunity in Wales

Today, flood risk in Wales is significant and set to increase with climate change and population growth. Conventional approaches alone, including built defences, cannot meet this challenge. Although conventional infrastructure still has a role to play, in some locations built defences are likely to be unaffordable, and in others unnecessarily degrade ecosystems, or impact livelihoods. NFM provides a scalable solution that delivers multiple co-benefits, and a pathway to long-term resilience.

Wales is well placed to lead on NFM. Wales has the evidence, political mandate and policy framework to support long-term and catchment scale decision-making, promote the link between ecosystem health and well-being and scale up nature-based solutions. Wales has already set the direction, and the foundations are already there - the challenge is to deliver at pace and scale and ensure commitments across flooding, farming, cleaner rivers, woodland creation, and river restoration are joined together into a coherent national programme for catchment resilience. To deliver NFM at scale, however, persistent governance and planning challenges will need to be overcome.

5.3 Acting upon the opportunity in Wales

Recent investment in flood risk management in Wales has increased substantially. This is a positive step. However, only a small proportion has been directed toward NFM. Without rebalancing investment, NFM will not be delivered at the scale and pace required.

Doing so will require proactive promotion of NFM within landscape-scale plans that enable NRW, local authorities, landowners, communities and businesses (including Dŵr Cymru Welsh Water) to actively seek opportunities to align actions and deliver coordinated schemes that reduce flood risk and deliver wider outcomes (for water resources, river health, soil health, and biodiversity).

The Sustainable Farming Scheme (SFS) collaborative layer provides an excellent bottom-up opportunity to align farm-scale actions that support NFM. The process however requires simplification and streamlining to realise this potential. At a national scale, the ongoing process of water reform in Wales provides an opportunity to move towards system-scale planning, and in particular strengthening the role of catchment planning to strengthen the contribution of NFM (and other NbS) to resilient water systems. Strategic oversight and leadership across the water domain will be needed if plans and actions are to be aligned without unnecessary complexity and in a practical way. The Welsh Government's Green Paper consultation suggested the need for a National

Systems Planner and speaks directly to this need. A strategic National Systems Planner would have oversight over all water-related resilience (flooding, water resources, the water environment) and appropriate powers to act. It would provide visibility of trade-offs and co-benefits across water-related activities, providing opportunities for co-funding (such as private sector investment) and aligned actions.

5.4 Bridge the investment gap

The desire to promote NFM has not yet been matched by implementation. The evidence around multiple and long-term benefits of the argument for NFM are well established. These arguments are increasingly supported by evidence, including evidence from pilots and research. Private sector initiatives are also increasing (such as those being taken forward by Wye and Usk Rivers Trust). Nonetheless, public investment for NFM remains a small proportion of the overall expenditure. Evidence on the costs and benefits of NFM is of course important in making policy decisions and quantified evidence on the national and local scale opportunity for NFM remains limited. However, much is known. NRW have published '*opportunity maps'* and projects such as OpenCLIM have explored the scale of the opportunity NFM provides to reduce flood risk (see earlier in Section 4.2.3). These are not definitive assessments, but they are a robust basis for action. These building blocks (provided by NRW and others) provide the foundation to be ambitious for NFM and move forward at pace.

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