Rural-Urban Outlooks: Unlocking Synergies (ROBUST)
*ROBUST receives funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 727988.**

September 2018
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Snapshot: Expressions of Urban – Peri-Urban – Rural Relationships

Flood risk management

Gloucestershire, UK

1. Brief Description

Gloucestershire is a rural county in south-west England (population 605,000; land area c.2,700 km^2 excluding the Severn Estuary[i]). Figure 1 shows it location, marked in red.

Figure 1 – Location Gloucestershire

Flooding is a key expression of urban – peri-urban – rural relationships in the county because:

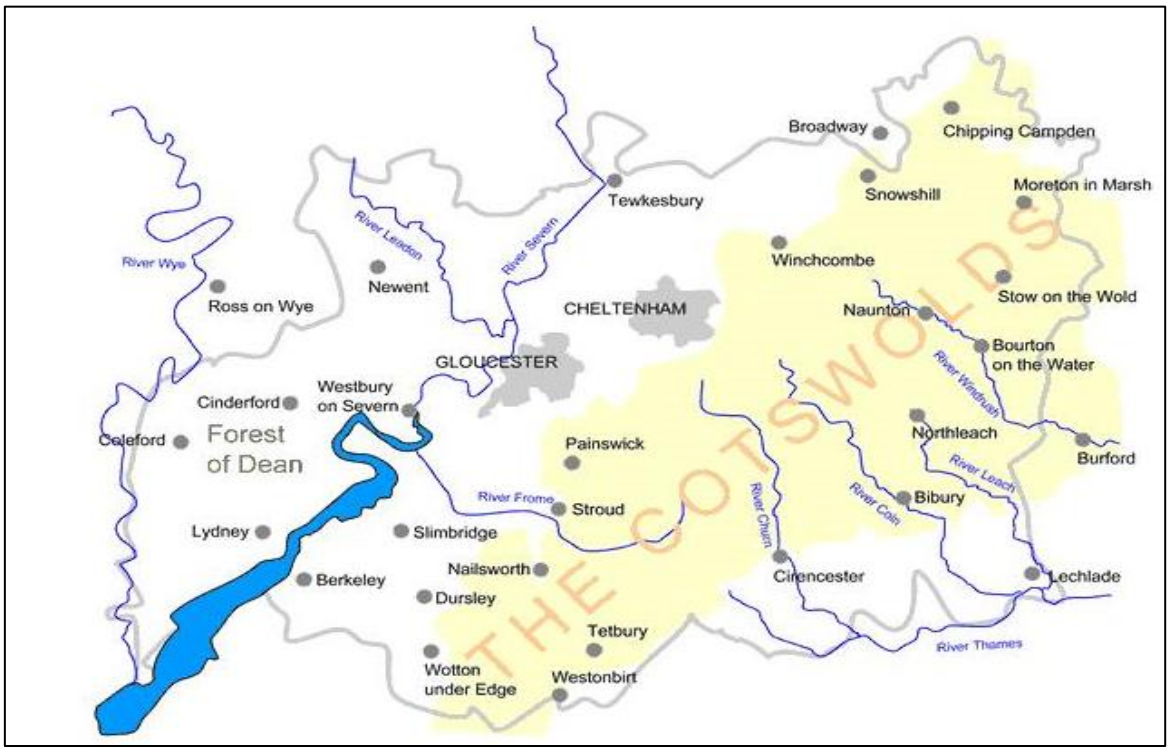
(i) major flooding has been experienced twice in the last decade, affecting large parts of the county and substantial sea level rises are predicted (20cm by 2050);
(ii) large areas of low-lying land are being identified for substantial urban expansion; and
(iii) agricultural water management has a significant impact, in Gloucestershire and beyond, both on surface water flooding in urban areas and on the quality of designated rural and wildlife landscapes.

Flooding has come acutely into focus in the last decade or so, due to *'devastating effects of flooding … following the unprecedented flooding in Gloucestershire in 2007, and … in 2012 and 2013. (GCC 2014:ii)'*[ii]

The county's water courses include the Severn, Britain's longest river, its basin area covering over 11,000 km^2 extending from North Wales to south east England; and the Thames, which rises in Gloucestershire, and connects the densest urban settlements in England (Thames Water company has 15 million customers[iii], almost a quarter of the population of the UK). The River Wye forms part of the border between England and Wales and flows into the Severn Estuary. The upper part of the Severn Estuary is situated next to the land area of the county and has one of the highest tidal ranges in the world

Other local wetlands include the Cotswold Water Park, an area of flooded sand/gravel pits; and the Cotswold River Valleys, which drain the Cotswold plateau and flow into the Water Park and Thames. In the Cotswolds, flood risk is connected with run-off as a consequence of agricultural and rural development, rather than concerns linked to bursting banks or ground saturation.

Figure 2: Gloucestershire's principal watercourses[iv]



2. Questions and/or Challenges

A range of questions emerge, including how planning restrictions in designated areas can improve agricultural water management or how improvements in green infrastructure can be realized in the light of urban expansion. In the context of ROBUST, there are two major questions/challenges:

Question / Challenge 1

> How can the complexities of watercourse and water quality management be optimised, given the need to unite the objectives of multiple organisations and individuals responsible for the county's major rivers, the Severn Estuary and areas of standing water?

The importance of challenge 1 is that (as further described in section 3) there are a substantial number of actors, institutions, policies, indicators and instruments which have a role to play in flood risk management. These cross private, public and third sectors. Some arrangements overlap, some are statutory, others are advisory. Some interests, such as biodiversity policy and urbanisation seem to be in conflict, while others, such as rural

watercourse management and environmental protection are complementary and exhibit a record of success.

Question / Challenge 2

> What mechanisms are available/needed to ensure that natural flood management (such as woodland planting and wetland restoration) can be incentivised and that the subsequent/existing habitats are managed towards maturity and beyond?

Gloucestershire has a record of success in piloting natural flood management (NFM) in rural areas as a way to substantially impede water dynamics in times of flood. The work so far has been incentivised by policy pilot schemes and, while successful, remains marginal. NFM has potential to be scaled up and planning instruments could be adapted to ensure NFM commitments/actions cover much longer periods of time.

3. Main Insights

3.1. Indications of the application of the new concept of 'New Localities'

3.1.1 The Joint Core Strategy – Tri-partite development?

Since 2015 the responsibility for generating and implementing development plans has rested with district councils. In Gloucestershire, a combination of the shared flood risk and the plans/opportunities for new development (see section 3a above) has led to the production of a collaborative Joint Core Strategy (JCS[v]), by the three districts of Cheltenham, Gloucester and Tewkesbury. Shared flood risk management policies in the JCS represent an important collaborative area for the three districts, and a third-party website has been established[vi] to offer details on current projects, documents and news. The JCS strategy commits authorities to avoiding development in flood risk areas (see section 4, below), requiring flood risk assessments and drainage proposals in development plans (JCS 2017:100).

3.1.2 The Severn – Vale, Estuary, Catchment

The influence of the Severn is prominent in the different locality concepts. For example, the Severn Vale (i.e., valley) habitat priority map and associated habitat description[vii] presents the Vale as a major wetland habitat for birds and outlines a target area of 11,000 ha representing the county's future wetland habitats[viii]. Secondly, while there are several priority landscapes in Gloucestershire, the identification of the Vale complements local perceptions that the county is divided three ways, west-to-east, into the Forest of Dean, the central Vale and the Cotswolds. Thirdly, the Severn Estuary itself is a designated RAMSAR site of 4680 ha[ix], a global designation, and is designated as a Special Conservation Area (SCA) and a Special Protection Area by the EU. Fourthly, the Environment Agency's map of the Severn catchment covers most of the county.

Figure 3: Severn Catchment (Source: Environment Agency/Severn Estuary Partnership 2011[x])

3.1.3 Water catchment governance

The complexities of water catchment governance exert a locational identity on the county, comprising (i) the River Thames catchment and including the mineral extraction lakes in the south, around Stroud; (ii) the Severn catchment around Tewksbury; (iii) the distinct identity of the Severn Estuary which also includes the Welsh coast and Bristol; (iv) the Wye; and (v) the Cotswolds plateau.

Following the severe floods of 2007 and the subsequent national review of flood risk management, GCC became a 'Lead Local Flood Authority' (LLFA) in its area. This required GCC to develop, implement and monitor a Flood Risk Strategy for the county focusing especially on flooding from 'surface run-off, groundwater and ordinary watercourses' (GCC 2014:1), working in partnership with other agencies that have some influence over flood risk. Key partners include:

> six district (sub-county) municipalities (which have delegated emergence response authority from GCC and support the development and implementation of planning and land use policies)

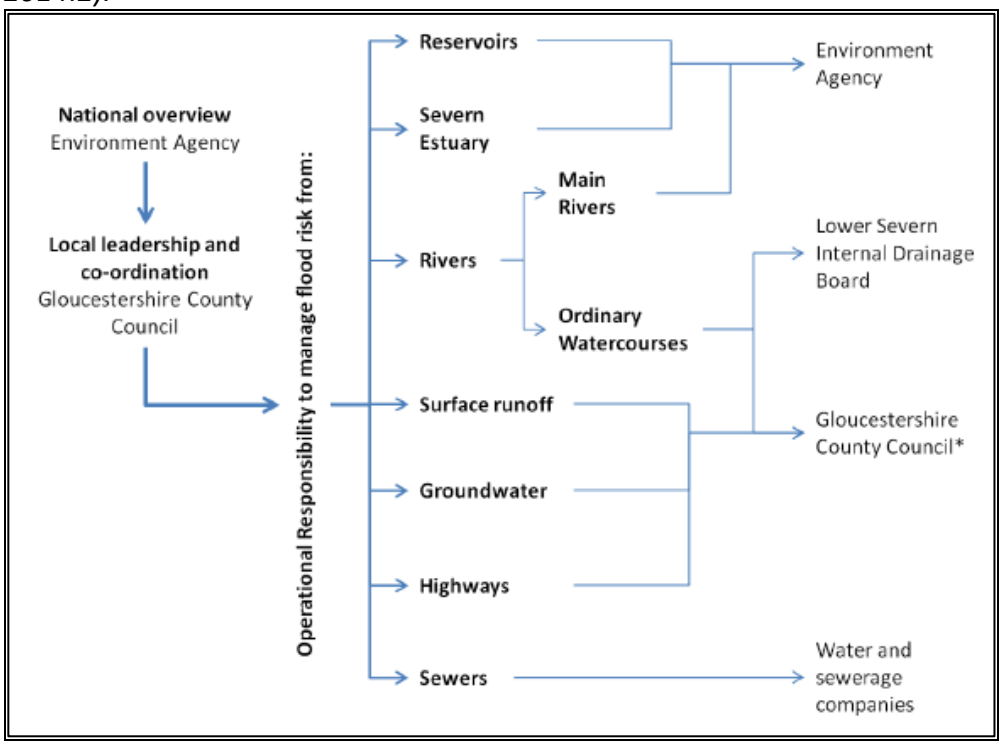
> the national (ie. English) Environment Agency (an independent but publicly funded body responsible for environmental protection)

> the Lower Severn Drainage Board (drainage boards are also publicly funded bodies with elected local representation and their duty is to manage and maintain sea and flood defences and drainage in low-lying and flood sensitive areas).

> two privatised regional water companies (which provide sewerage and drinking water services), Thames Water and Severn Trent Water. These are the principal water companies covering Gloucestershire but two more, Wessex Water and Dŵr Cymru (Welsh Water) supplies water in the south and west of the county. This makes water governance a complex issue in Gloucestershire.

Watercourse governance arrangements are illustrated below, in figure 4:

Figure 4: Overview of connected watercourse management Gloucestershire (Source: GCC 2014:2).



3.1.4 Looking outside, looking for the good life

Gloucestershire lacks a discreet internal identity. The south of the county takes its cultural inspiration from Bristol. The Forest of Dean, while well-connected to Gloucester, also looks towards Newport and Cardiff (this is expected to deepen as the toll charges on the Severn Bridge are removed, by the end of 2018). Tewkesbury residents may look towards the midland cities of Worcester or Birmingham for leisure, shopping or work[xi]. London, around 90 minutes by train from Cirencester and Stroud, exerts a pull on these towns, but also attracts visitors to these rural Cotswold areas. Data from the 2011 census[xii] for Stroud, Tewkesbury and the Forest of Dean reveal that almost 10,000 people own second homes in these districts. Greater London represents the largest regional origin (17%) of visitors to the Cotswolds and this trend is rising[xiii].

3.2.Insights related to the broad area of 'Smart Development'

Familiar from the H2020 project *Pegasus*[xiv], WILD may represent the best ESS valorisation opportunity, because of its clear links with market mechanisms captured by the concept of PES – Payment for Ecosystems Services (DEFRA 2013[xv]). Several challenges have been identified within the Upper Thames Catchment in Gloucestershire in relation to its conformation with targets set out in the European Water Framework Directive. These include river sedimentation, run-off pollution from agriculture and adverse biodiversity impacts as a result of building developments. Tackling these challenges is difficult because there are over 20,000 individual landowners in the catchment area.

The Thames is an important and iconic river and Thames Water is legally responsible for the water quality of many millions of people in London and the South East of England. A 3-year project brought the water company and local farm advisory groups and parish councils together to coordinate and incentivise farmers and local people to work together to keep water courses in good shape and to reduce pollution. This integrated and locally embedded approach helped farmers avoid 'red tape' regulation and helped give local people a voice and a practical role in water course maintenance. Financial incentives for farmers paid for by the water company through a Payment for Ecosystems Services (PES) scheme were a 'soft' and more cost effective way to control and reduce upstream pollution, compared to the alternative requirement for 'hard' water treatment technology further down the catchment to remove pollutants such as metaldehyde, used in agricultural pesticide applications. The project has also resulted in the planting and management of greater pollinator plant biodiversity and improved soil conditions.

3.3.Other insights that could be relevant for further work

3.3.1 Green infrastructure

An innovation with interesting rural-urban synergy potential is the reintroduction of beavers (*Castor fiber*) on the Lydbrook, specifically as a flood risk measure[xvi]. This action is designed to help slow river flows in times of flood and attract wildlife visitors to the Forest of Dean.

The county's transport plan[xvii] outlines the need to ensure that the highways network is resilient to flooding, not least because:

> *Gloucestershire is a rural county which depends on its highway network for the movement of people and goods. … National and Primary Links therefore must be resilient to abnormal events, such as flooding, road closures or accidents, to maintain journey reliability which in turns supports confidence in the network and inward investment in the region.* (GCC 2017: 4.1.1)

The county and district councils and the national Environment Agency have invested in a series of technical works to ensure that highways, culverts and gullies are clear to drain flood water away in the experience of having *'continued to be hit by adverse weather*

conditions since 2007' (GCC 2017, 4.1.2). Winter rainfall is expected to increase by 14%, while summer rain decreases by 16%, and sea levels may rise by 20cm around the Welsh coast by 2050 (Wye Valley AONB 2015[xviii]). There is, however, a conviction that technical interventions have a limit in the light of ongoing challenges and that *'it is not economically viable to eliminate flooding altogether'* (GCC 2017, 4.3.2). In this respect, green infrastructure is regarded as a key tool in flood alleviation which promises economic savings in the long-term. The inclusion of green infrastructure, such as tree planting as a form of Natural Flood Management (NFM)[xix], enhancing and connecting woodlands and wetlands, and including new open spaces is foreseen in both localised and landscape-scale development, including through opportunities within the European Water Framework Directive (GLNP 2015)[xx] (cf. WILD project). The enhancement of water quality and the maintenance of water course flows are similarly regarded as an essential part of flood risk management.

Two district councils – Tewkesbury and Stroud (within the county), working with South Gloucestershire Council (ie. adjacent to GCC) and the University of the West of England, piloted a green infrastructure benchmark against which local authorities can assess development proposals. This benchmark has been launched as a developers' accreditation scheme by the Gloucestershire Wildlife Trust under the name 'Building With Nature'[xxi].

Some interesting land management projects have emerged in the county which may hold some interest for flood management. For example, any new developments within 3 miles (4.8km) of Minchinhampton and Roborough Common (designated sites for nature conservation including SAC in the Cotswolds compel developers to contribute to a Community Infrastructure Levy used to enhance the commons and which is managed locally by the National Trust, the UK's largest environmental organisation. A similar scheme is being developed within Stroud District for new development near the Severn Estuary European Marine Site, which is internationally important for wintering wetland birds.

3.3.2 New technologies/ICT

New technologies affect the ability and accuracy of flood risk management predictions. For example, GIS and other meteorological modelling have informed estimations of rainfall increases, Severn Estuary storm surge level rises and the location of subsequent hard and soft (green/natural) flood management infrastructures. LIDAR (Light Detection and Ranging) is an airborne laser topography system which can be used with historical rainfall data to model future long-term flooding susceptibility[xxii]. In addition, the Environment Agency uses telemetrics to gauge rainfall and river flows, which also supports future modelling and early warning alerts[xxiii, xxiv]. Citizens can register to receive early warning alerts if they live in flood vulnerable areas.

Finally, the satellite guidance of agricultural machinery has become routine and helps to enhance specific targeting of pesticide and herbicide application, minimising the risk of water contamination linked to run-off.

4. Data Sources and Indicators

4.1. Flood defence funding

The decision about whether or not to fund a Flood Alleviation Scheme from public finances (in this case, the Flood Defence Grant in Aid which is awarded to the Environment Agency by DEFRA) is based upon a number of criteria, among the most important of which is the number of homes a scheme will protect. This immediately creates a bias towards urban flood defence schemes because urban areas are more densely settled. Further weighting might be linked to deprived areas which are often also urban neighbourhoods. Other measures are linked to considerations including how many kilometers of Water Famework Directive water bodies and related habitats have been protected.

4.2. Groundwater flooding

The (national) Environment Agency has produced a map of Areas Susceptible to Groundwater Flooding, which identifies flooding vulnerability on a $1km^2$ grid according to the level of flood risk (GCC 2014:§66) in three orders of severity: high (flooding once in 100 years – flood risk level 3), medium (once in 1000 years, level 2) and low (less than once in 1000 years, level 1). To complement these maps, Gloucestershire County Council, the Lead Local Flood Authority (LLFA), prepared a Strategic Flood Risk Assessment (SFRA) in September 2008 which examined 'fluvial (rivers), tidal (sea), surface water, groundwater, sewers and impounded water bodies (reservoirs and canals), in the context of the situation at the time and taking into account the likely impacts of climate change in the future' (JCS 2017: §3.5.5). More detailed SFRA reports were commissioned by the three JCS authorities. These reviewed flood probability, flood depth, flood velocity, rate of onset of flooding. The definitions for flood risk in the SRFAs have been taken from the 2010 Flood and Water Management Act [of Parliament][xxv].

Figure 5 below shows levels of higher risk in red shading and medium risk appears as orange.

Figure 5: Flood risk areas in Gloucestershire (Source: GCC 2015:21[xxvi])

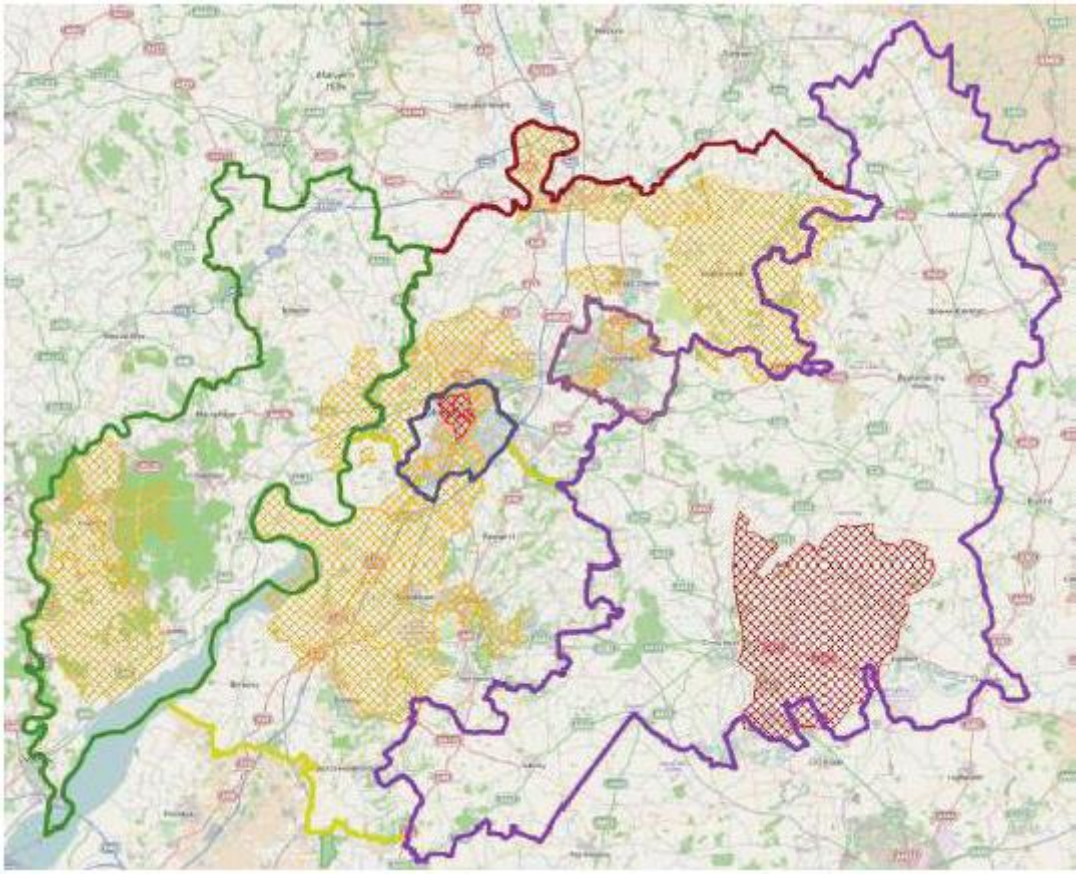


Table 1 Data / Indicators

Data / Indicator	Source
Name of data source / indicator	Citation, website link, organization
Regional Flood and Coastal Committee Outcome Definition Measures April 2017 / Number of houses protected by flood defence schemes (OM2 a-c) and waterbody/habitat protection (OM4 d-h).	English Severn and Wye Regional Flood and Coastal Committee.

5. Critical Appraisal of Data Use

The rapid appraisal outlines a picture of impending urbanization, population mobility and increased climate uncertainty in Gloucestershire, a rural county with a high proportion of landscape and biodiversity designation. Data revealed a complex picture of public sector governance in relation to flood risk management. An increasingly diffused range of actors seem likely to be able to enhance FRM in the county, both in terms of which sectoral interests they represent, and in respect of the influence of water management in areas beyond the county.

Specific data availability has been, unsurprisingly, primarily local and this is reflected in GCC's role as the lead FRM authority, but the importance of the EC Water Framework Directive is

clear in terms of how public and funds are directed towards FRM projects. It seems likely that the private sector will need to be further incentivized to help establish resilient and long-term green infrastructure, without which, urban development and economic growth plans will increase impermeable surfaces and reduce water quality.

6. References

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2015
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