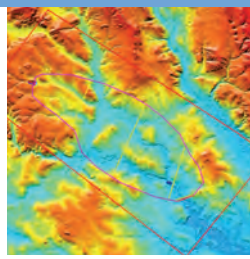
MSc Environmental Consultancy



Research Project Summaries
Volume 1

edited by ***Duncan Bayliss***

UWE BRISTOL
University of the West of England

bettertogether

MSc Environmental Consultancy Research Project Summaries Volume 1

Introduction

This is one of a linked pair of publications which show case the excellent work done by MSc Environmental Consultancy students in placements and on research projects:

MSc Environmental Consultancy Placement case studies Volume 1

MSc Environmental Consultancy Research project summaries Volume 1

Students undertaking the MSc Environmental Consultancy come from a wide range of backgrounds, some straight from a first degree, others after a period of work in another field. During the course they undertake a 3 month work placement and also a research project. Over a number of years it has become apparent that these are especially valuable parts of the course for the students. The quality of placement opportunities has been very high with students undertaking placements in an interesting range of public and private sector organisations. Students and the Department of Geography and Environmental Management, which hosts the Masters programme, are grateful for opportunities those organisations have provided and students are grateful for what they have been able to gain from their experience of working with them. Former students have frequently said that the placement was the most valuable part of the course and it has often been an invaluable part in securing relevant employment after their study. They have also commented on how the intensely practical study undertaken in UWE prepared them effectively for those placements. Of course the learning curve on a placement is often very steep. Students typically find themselves joining in with projects and work for clients that is in progress. Often they are part of a team working on a related set of projects, but still have clearly identifiable projects or tasks for which they are responsible. However, a recurring theme is that capable committed students are rapidly given a lot of responsibility and rise to the challenge.

Similarly students on the MSc Environmental Consultancy have undertaken an interesting and diverse range of research projects. Sometimes they have used the research project as an opportunity to explore in greater depth an issue that is relevant to consultancy practice and for some it has also helped secure employment after the course. Others have pursued interests that they have enjoyed following for their own sake and for some this has led on to signing up for a research degree (e.g. a PhD).

These two publications, MSc Environmental Consultancy Placement case studies Volume 1 and MSc Environmental Consultancy Research project summaries Volume 1 are intended to open a window on the really interesting range of placements and research projects recent students have completed. It is intended both as a record of what our students have achieved and also as a helpful insight for prospective students thinking of enrolling in the MSc Environmental Consultancy and for prospective placement providers to see what previous students have done.

Above all it is worth emphasising that the title of a degree can only capture part of what it is about, whereas spending some time finding out what students have actually done and how they have then used that study and placement work to find employment and further their careers allows a much richer understanding of the opportunities that the MSc provides. Since the MSc Environmental Consultancy started we have been pleasantly surprised at the variety of placements students have found and the diversity of work they have gone on to and we are delighted that this course has acted very effectively as a bridge between previous study (and work experience) and a rewarding range of careers. Often when applying for jobs students find that employers want some previous experience in the field and a placement can provide that vital element. Many employers also want to know that students they take on are able to tackle complex problems in a defined timescale with a high degree of autonomy and many research project projects demonstrate exactly those skills.

Career destinations of former students have included, for example, the following roles:

- EIA co-ordinator. Environmental impact assessments are complex processes involving many technical experts and often many sub-contractors. An EIA co-ordinator plays a vital role in commissioning, coordinating contributions and then compiling the Environmental Statement for submission to the relevant planning authority
- Technical roles in environmental consultancies, in specialisms such as contaminated land surveys, ecological surveys, bat surveys
- Energy manager in the public sector. e.g. Undertaking energy surveys and behavioural change work across an NHS trust to improve energy efficiency.
- Environmental business advisor to SMEs in the South West
- Renewable energy projects community liaison officer, working with planned wind farm projects
- BREEAM assessor and Code for Sustainable home assessor, assessing the environmental performance of proposed buildings and assisting with improving their performance
- Waste manager for a packaging company
- Environmental transport logistics officer for a major international deliveries business, seeking to reduce the environmental impact of their operations
- Implementing Environmental management Systems for SMEs

Duncan H. Bayliss July 2015

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Enquiries

Enquiries about the MSc Environmental Consultancy should be directed to the Admissions Office.

The Admissions Office deals with enquiries and applications for all full-time postgraduate programmes.

Telephone: +44 (0)117 32 83333
Fax: +44 (0)117 32 82810
E-mail: admissions@uwe.ac.uk

Contact address:
Admissions Office
University of the West of England
Frenchay Campus
Bristol, BS16 1QY
UK

MSc Environmental Consultancy Research Project summaries Volume 1

Contents

Patricia Allen

***Project title*:** 'Carbon reduction scenarios for 2050: are there public preferences?'

http://www.sciencedirect.com/science/article/pii/S0301421513008835

Current role: Head of South West Local Growth Delivery Team
Department for Communities and Local Government
uk.linkedin.com/pub/tricia-allen/8b/407/974

Abstract

In 2008, the United Kingdom government adopted an ambitious and legally binding target to reduce greenhouse gas emissions by 80% by 2050 (HM Government, 2008). This project aimed to identify public preferences for long-term carbon reduction scenarios by analysing data from a digital simulation on the Department of Energy and Climate Change (DECC) website entitled 'My2050' (DECC, 2011a). Participants consistently selected greater demand-side options over supply, including extensive energy efficiency improvements. Participants also preferred more extensive implementation of renewable energy options (wind, solar, marine and hydro power) to other low carbon supply options (nuclear power, carbon capture and storage).

Summary

Public participation in the development of carbon reduction scenarios is an emerging research field with relevance to policy decision-making. After adoption of the Climate Change Act in 2008, exploring how the UK could achieve the 2050 carbon reduction target, Professor MacKay from Cambridge University published several possible scenarios with associated emissions reduction calculations (MacKay, 2009). DECC subsequently published six 'pathways' outlining possible whole energy system change scenarios, alongside a Call for Evidence (HM Government, 2010). DECC has encouraged public engagement in creating new scenarios, facilitated by an online and offline calculator (DECC, 2010), a simplified web-based simulation called 'My2050' (DECC, 2011a; see Figure 1[1]), an online debate initiated by a panel of experts, and a toolkit to enable local community participation. This emerging body of evidence addressing a significant long-term policy challenge, combined with a recognised need for public engagement and support in policy decisions, created a timely opportunity for this research project, building on my combined interests in policies to achieve carbon reduction goals and public participation in policy decision-making.

[1] The supply and demand options for the online simulation become visible alternately when the player scrolls over each section, preventing a screenshot from showing both supply and demand options at the same time.

Figure 1 – 'My2050' online simulation

Research aims

This project aimed to identify public preferences for how the UK can achieve an 80% reduction in carbon emissions by 2050, by analysing data from 10,983 self-selected respondents who played DECC's 'My2050' simulation, and evaluating the representativeness of respondents to establish whether findings could be generalised. Preferences were compared with DECC's three preferred scenarios to establish the degree of alignment between government proposals and respondents' preferences. Reflections on early findings and improvement recommendations for the 'My2050' simulation were sought from topic experts, to triangulate results and to identify opportunities to strengthen future public engagement for climate change policy decision-making.

Research design and methodology

The research design involved a quasi-experimental mixed methods evaluation with quantitative and qualitative research strategies. Four methodologies were employed - quantitative statistical analysis; qualitative analysis, involving semi-structured interviews; a critical research review; and the creation of a simple pathways comparison method. The overall methodology was developed as a result of an extensive literature review. Considering methodological limitations was a defined a part of the project.

Results

Clear patterns in preferences for long-term carbon reduction scenarios were identified through statistical interrogation (including cluster analysis), since over 85% of responses were unique. Using mode data, the most popular setting choice for each slider created the pathway in Figure 2.

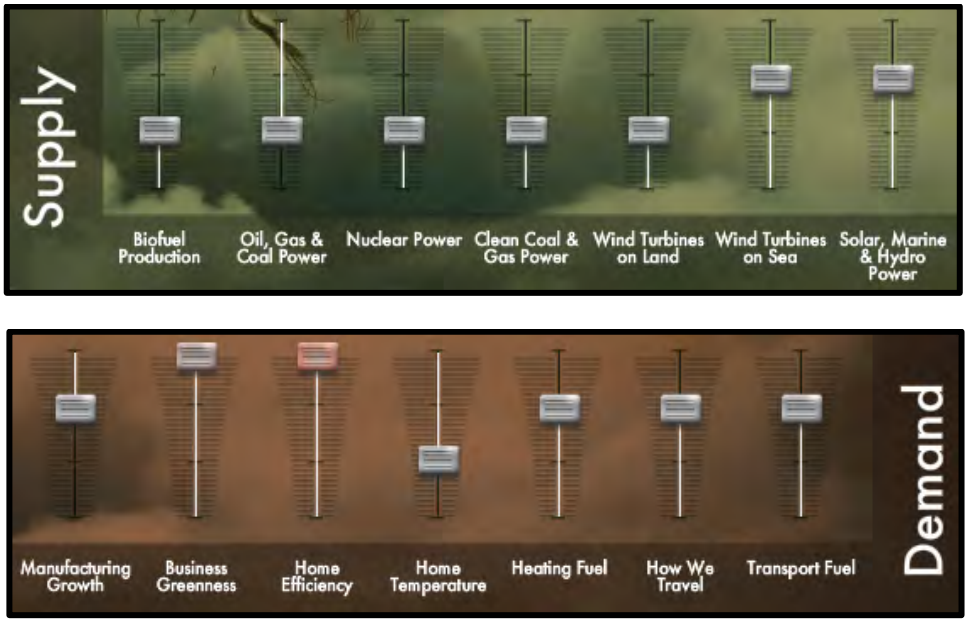

Figure 2 – Most popular slider settings selected

The preference ranking for effort across all sliders is illustrated in Figure 3, where the settings selected by all respondents for each slider have been summed. This shows the overall preference for demand-side options, in particular for extensive energy efficiency improvements, and home and transport electrification.

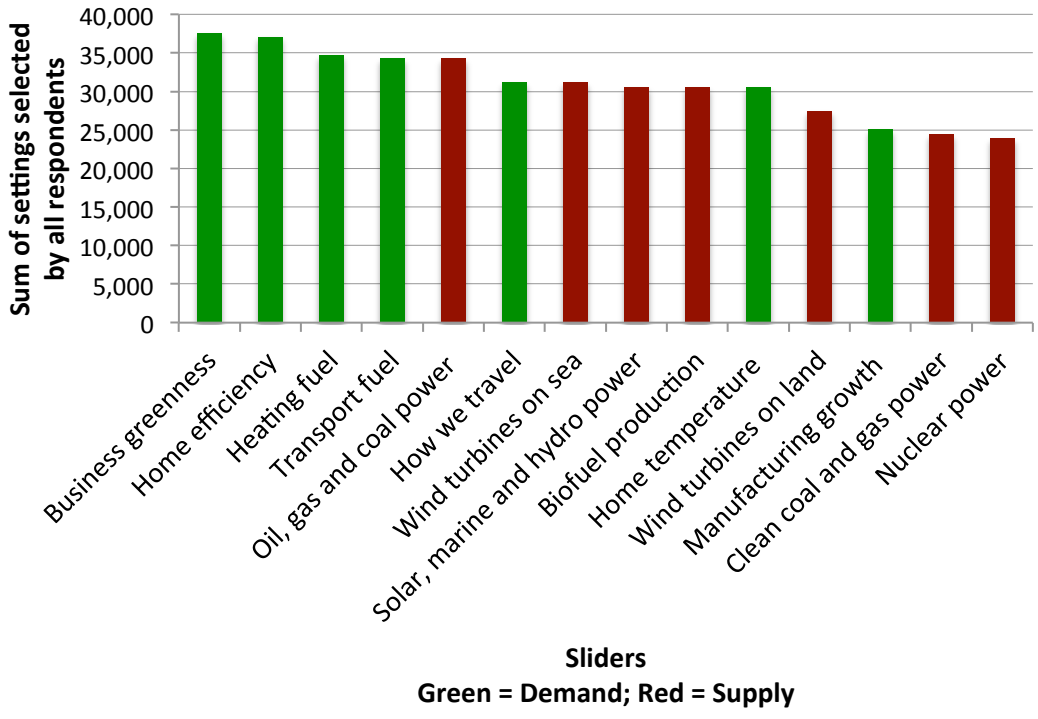

Figure 3 – Preference ranking for effort: all sliders

There were patterns in the preferences selected for carbon reduction scenarios in this sample, although there was no one clear preference. Different patterns emerged when comparing mode data with the results of cluster analysis, and also when comparing responses from different sub-groups. Nearly all patterns demonstrated a preference for higher effort for demand-side options compared to supply.

Demographic and attitudinal analysis demonstrated that participants were younger than the UK population and also more concerned about climate change. To what extent preferences expressed in this data can be generalised is questionable, since 'My2050' respondents were not a representative population sample. Respondents were also more concerned about climate change than the general public.

Acceptability of the government's three proposed 2050 carbon reduction scenarios was tested by comparing these scenarios with research findings. Greatest support was demonstrated for the DECC scenario named *'Higher CCS, more bioenergy'*, with weakest alignment demonstrated by *'Higher nuclear, less energy efficiency'* (see Figure 6).

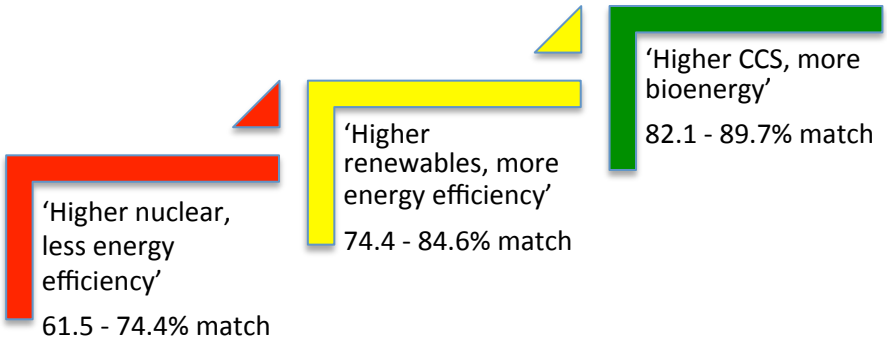

Figure 6 - Relative popularity of DECC's scenarios

Topic experts offered several recommendations concerning how 'My2050' could be improved during semi-structured interviews, offering opportunities to strengthen future public engagement for climate change policy decision-making.

Conclusions

This research project demonstrated that preference patterns for long-term carbon reduction scenarios can be identified, although there is huge diversity in the choices selected. The extent to which these findings can be generalised to public opinion is limited, due to the largely unrepresentative nature of the sample. Further research with a demographically representative sample is required to test the reliability of these findings. As the government explores the acceptability of different carbon reduction scenarios with stakeholders and the public, this research suggests that the DECC scenario currently labelled *'Higher CCS, more bioenergy'* is the most popular. There are risks attached to regarding this as a 'public

preference' however, partly due to the self-selecting nature of this sample, and also due to simulation design features that may have influenced choices.

The 'My2050' simulation is an innovative public engagement tool, conveying the complexity and trade-offs required in mapping long-term carbon reduction scenarios in an accessible way. Qualitative interviews with topic experts identified a number of improvement recommendations.

Without significant input from the public in shaping policy in the near future, strategies to achieve a low carbon economy in the long-term may be notably hampered by possible opposition and backlash towards major changes to energy supply, and a lack of participation for demand-side options, thereby preventing the achievement of essential climate change targets.

Personal reflections

Completing this research project was a major undertaking, involving learning how to apply new statistical analysis skills and software, developing a critical thinking approach, achieving competence in synthesising micro and macro policy analysis, and conducting robust semi-structured interviews with leading experts in a professional way. Subsequent publication of this research in the journal Energy Policy (Allen and Chatterton, 2013) where a fuller discussion of the research can be found, provided me with an opportunity to engage with a peer review process, and exposed me to the challenges and rewards of academic publishing. The skills and competencies developed as a result of this research project assisted me to secure two promotions (in October 2012 and June 2014), and my abilities to conduct a publishable research project were recognised as contributing factors in both recruitment processes.

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JENNA BROWN

Project title: UK Shale Gas: Is it all it's 'fracked' up to be?

An assessment of the potential contribution to security of supply

Current role: Extended work placement at a Bristol-based carbon reduction consultancy, contributed to a DECC funded research project and presently studying for a PhD at UWE

Contact: Twitter and Linkedin jenna2brown

Abstract

Summary

PROJECT CONTEXT

Climate change presents the unprecedented challenge of meeting growing energy demands whilst reducing our carbon emissions. In the UK, the energy sector produces around 30% of GHG emissions; consequently reducing the carbon intensity of energy is integral to meeting carbon reduction commitments. The Climate Change Act (2008) requires an 80% emission reduction from 1990 levels with the Statutory Committee on Climate Change advising a carbon emission factor of 50g CO_2 per kWh generated to decarbonise the energy sector by 2050 with the Energy Bill 2012 controversially amending the target from 100g to 200gCO_2/kWh.

Natural gas is purported to be half the carbon intensity of coal and is therefore considered to be a 'transition fuel' to a low carbon economy, supplementing renewables and nuclear in the energy portfolio. In the Spring 2012 budget George Osborne announced: "Gas is cheap, has much less carbon than coal and will be the largest single source of our electricity in the coming years." In the 2012 predicted energy mix, natural gas was to provide 30% of UK electricity, totalling over 100tWh (fig. 1). There was however a problem, the UK imports more than half of all consumed natural gas and has done since 2011 as our security of supply status declines.

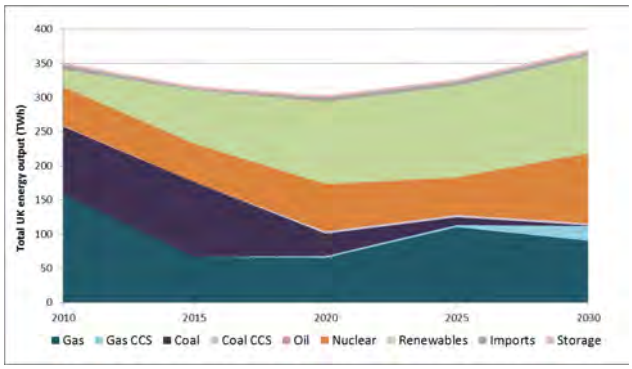


Figure 1. UK predicted energy mix (DECC, 2013)

As a result of increased wholesale prices and technological advancements, shale gas an 'unconventional' source became economically viable and saw large-scale development across the US. The environmental credentials associated with it however continue to be debated by environmental advocates, policy makers and politicians alike.

DISSERTATION AIM AND METHODOLOGY

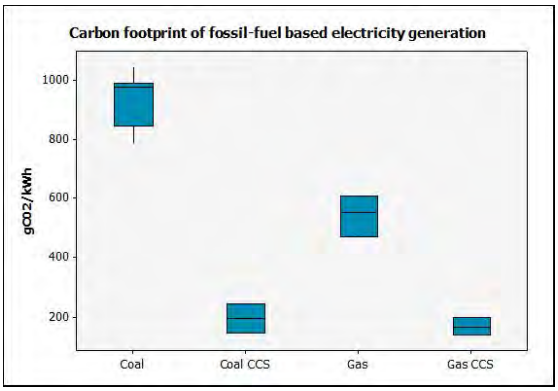
To assess the viability of supporting a policy for continued and expanded use of natural gas and in a status review, evaluate the potential cumulative impact upon natural gas security of supply.

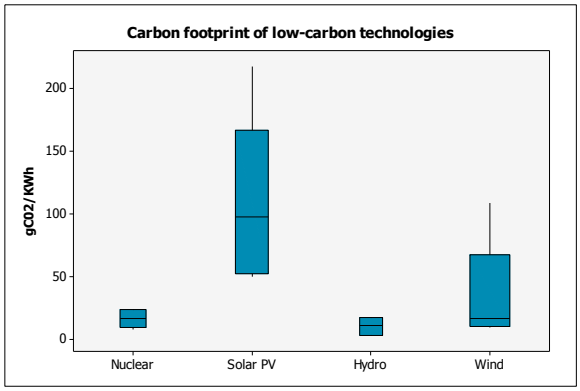
The aim was split into two research questions: Has natural gas the potential to assist the UK in meeting carbon reduction commitments and to what extent has shale gas the potential to provide natural gas security of supply in the UK? The former required the carbon intensity of shale gas to be assessed and contextualised against existing primary energy sources including natural gas before the carbon emission factor of the projected energy mix was calculated at varying contributions of shale gas. The latter, reviewed published resource estimates to predict the annual contribution shale gas could make to our natural gas supply.

RESULTS

Carbon emission factor

A literature review of the carbon intensity of primary energy sources found that coal has the highest carbon intensity with a median value of 975.3gCO_2eq/kWh, natural gas produced 549gCO2/kWh (a 56% reduction) compared to wind and hydro generation at 16.5gCO_2/kWh and 11.3gCO_2/kWh respectively as shown below (fig. 2 and 3).





Figures 2. Carbon footprint of fossil-fuel based electricity generation
Figure 3. Carbon footprint of low-carbon technologies in electricity generation

A much-cited, but also contested paper by Howarth et al (2011) of Cornell University, argues that "compared to coal, the [greenhouse gas] footprint of shale gas is at least 20% greater and perhaps more than twice as great on the 20-year horizon and is comparable when compared over 100 years" (Howarth et al. 2011). The authors attribute this greater carbon footprint predominantly to the fugitive methane released from wells during drilling for shale gas transport pipelines. Based on a natural gas footprint of 549.3gC02eq/kWh, a 20% increase would equate to **659.2gC02eq/kWh** and with the addition of CCS technology: 200.4gC02eq/kWh.

Median figures of primary energy sources were combined with the 2012 predicted energy mix for the period until 2030 (fig. 4). In delivering 45% of UK energy supply in 2010, natural gas generated 47% of the energy sector's GHG emissions. As the proportion of low carbon power generation displaces fossil fuels, the carbon emission factor decreases. Figure 4 reveals that in 2012 the energy mix produced a CEF of 532gCO_2eq/kwh. Based on the present DECC energy mix projections in 2030 the CEF will stand at **162gCO_2eq/kWh** meeting the target of 200gCO_2eq/kWh by 38gCO_2eq/kWh. However,

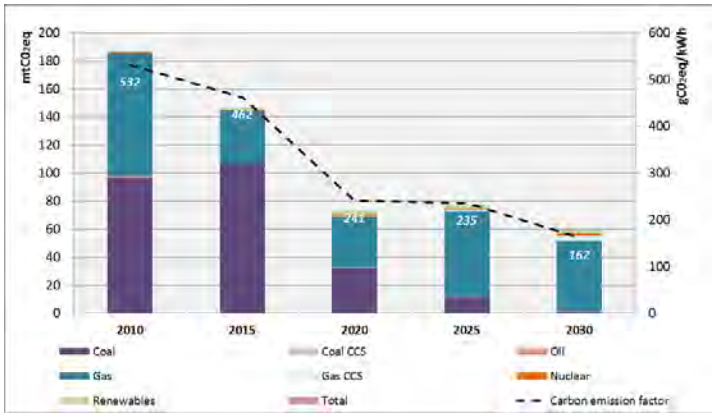


Figure 4. UK carbon emission factor 2010 -2030 with only conventional gas

this is three times the CEF recommended by the Committee on Climate Change (2012) of 50gC02eq/kWh in order to decarbonise the power sector by2050.

The impact of 50% natural gas supplies originating from shale gas for the years 2025 and 2030 is shown in fig. 5. In 2025 the carbon emission factor increases to 341gC02eq/kwh before decreasing due to an increased proportion of renewables to **239gC02eq/kWh** in 2030. Nonetheless, this **exceeds the recommended CEF of 200gC02/kWh by nearly 20%.** Therefore, without an increase in CCS technology it can be deduced that the UK would not meet carbon reduction targets in 2030 if natural gas supplies contain 50% shale gas.

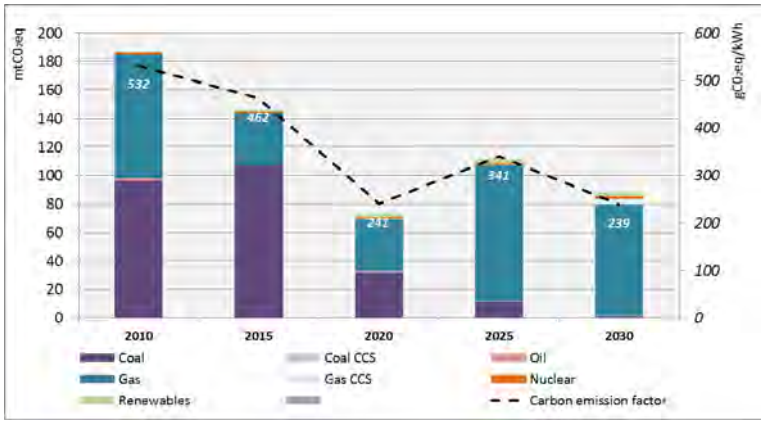


Figure 5. UK carbon emission factor 2010 -2030 with 50% of natural gas supplies originating from shale

Security of supply

The contribution shale gas can make to domestic production varies subject to reserve estimate and thus annual output: DECC's (Department of Energy and Climate Change) reported UK reserves of 150bcm could provide 0.5bcm of gas extraction by 2020; In comparison, EIA's estimate of 566bcm could provide 2.2bcm of gas and Cuadrilla's total estimate of 1132bcm could provide 3.1bcm of gas in 2020. By 2030 this increases to an estimated contribution of 4bcm, 15.5bcm or 28bcm respectively (fig. 6).

Consequently, shale gas has the ability to enhance energy security providing a contribution between 8 and 48% of UK natural gas production by 2030 based on well production rates and shale gas development rates. It is however thought that contribution would be 'modest' to natural gas supplies until 2030.

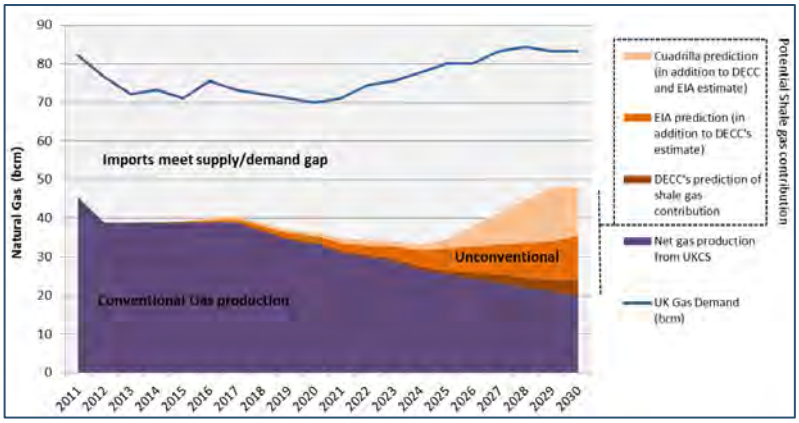


Figure 6. Impact of shale gas scenarios on natural gas security of supply

Conclusion

Ultimately, the expansion of shale gas extraction in the UK in order to secure domestic supplies will be subject to technological, economic, social and political factors, whilst the degree of public acceptance is likely to be a greater and more powerful constraint to extraction expansion rather than quantity of shale gas basins present. The ability of gas to act as a transition fuel relies upon the development of carbon capture and storage and the presumption that its carbon footprint is smaller than its predecessor coal, which remains contested.

References

Howarth et al (2011)

Stephanie Jones

Current role: Graduate Flood Risk Officer at Devon County Council

Project title: The Impact of Climate Change on Augmentation Flow at Roadford Reservoir Supply System.

Abstract:

Climate change is a significant issue with global temperatures projected to rise by between 0.3°C to 0.7°C by 2035. The implications resulting from this level of climate change will have an impact on hydrological systems. Understanding the potential impacts is imperative when implementing a successful water resource management strategy. This project aimed to provide an assessment of the potential impact climate change will have on augmentation flow at Roadford Reservoir supply system. Augmentation flow is when water is additionally added from a storage facility, such as a reservoir, into a river system in order to supplement low river flows. This was done using an eleven member climate change ensemble of future river flows and comparing against the calculated operation flow sequence at Roadford Reservoir, looking at the frequency, duration, seasonality and volume of augmentation flows.

During my course the opportunity arose to undertake my dissertation focusing on water management which would be supported by the Environment Agency. I am particularly interested in the water management sector within environmental consultancy so applied and was successful. The project involved comparing climate change data from the UK Climate Change Projections project for 11 scenarios and Environment Agency data from a river gauge downstream from Roadford Reservoir in the southwest of the UK. The comparisons across the different sets of data highlighted potential changes for the future and key issues to focus on for the future water resource management of the area.

The project started out as a number of teleconferences with the Environment Agency to provide the foundation for the project and the aims and objectives. Once I had received the first lot of data I started to do the preliminary analysis with the help of my supervisor. The Environment Agency provided me with the necessary figures to manipulate the raw data. However, at the beginning the time taken to obtain data meant that working towards the set deadlines was a bit of a challenge.

Once I had a better understanding of all of the data, I was able to undertake more complicated analyses and use new analysis techniques. For example, one of the new techniques I learned was how to construct a flow duration curve. A flow duration curve is a way to illustrate the relationship between the magnitude and frequency of a stream flow for a particular river basin. The analysis highlighted the impact of the catchment characteristics on the river flow and focused on the periods of low flow. Figure 1 shows one of the flow duration curves I produced during my project.

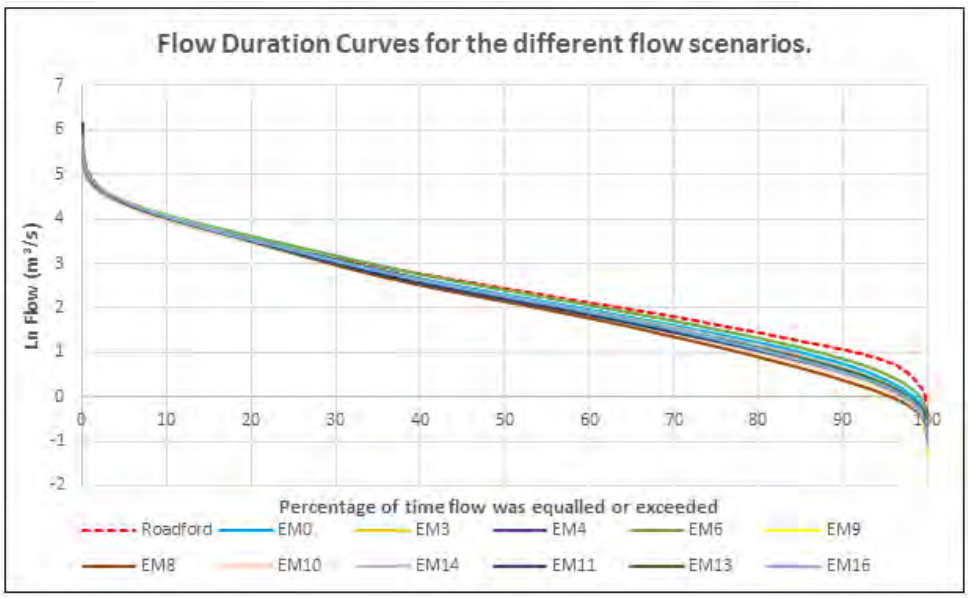


Figure 1. A flow duration curve for all of the data sets analysed.

I also calculated and compared the frequency, duration and seasonality of augmentation flow between the all of the data sets. When the flow is recorded below the figure of 2.85m³/s, augmentation flow is released from Roadford Reservoir in order to be able to maintain the volume of abstractions from the system. I calculated the total number of days the flow went below this figure and the number of days during each period of augmentation, using a variety of techniques in Microsoft Excel, including the use of macros which was a new and complex method to me. For the seasonality analysis, patterns and trends in the dates of the first and last time augmentation were required in each year and were indentified.

For a more in depth and specific analysis of the augmentation flows, I concentrated on the volume of augmentation. To calculate this I learnt how to use the pivot table function in Microsoft Excel, providing a new and useful skill for the future. In order to make comparisons between Roadford Reservoir historical data, and the eleven member climate change ensemble data, two series of graphs were generated for both the monthly volumes and the yearly volumes of augmentation flow. Figure 2 shows an example of a 'box and whisker' plot created to examine the monthly volumes of augmentation.

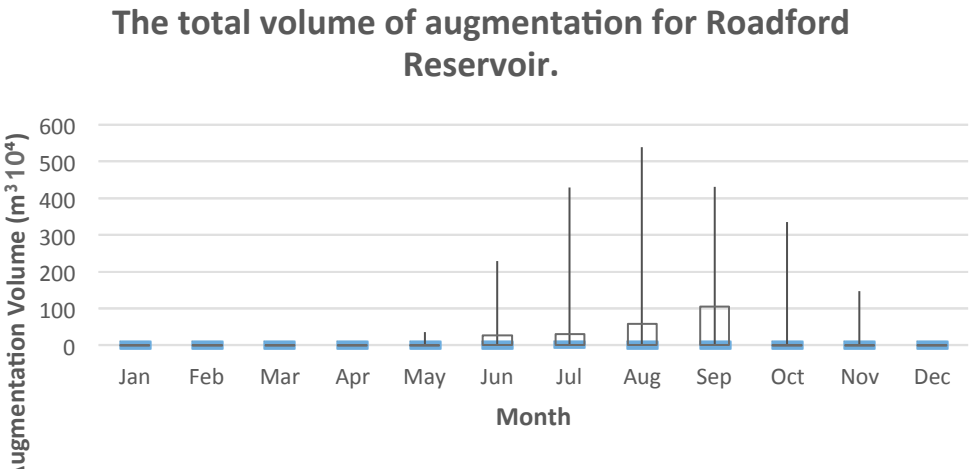


Figure 2. A box and whisker plot showing the monthly volumes of augmentation flow.

The results highlighted a degree of variability within the climate change ensemble and the Roadford Reservoir operational flows. In order to build a more comprehensive picture of the potential impacts climate change will have on augmentation flow at Roadford Reservoir, further research into alternative SRES emission scenarios trends will need to be undertaken in the future. One of the main findings from my results was that future management decisions and implementation of new policies and guidelines will need to prepare for a wide range of possible impacts on the characteristics of augmentation flow.

The main results indicated that climate change is likely to have an impact on augmentation flow in the Roadford Reservoir supply system. The frequency and duration will increase but there is a degree of variability concerning the magnitude of change. The potential changes in the volumes of augmentation flow will occur during the summer months and on a yearly scale. As a result I found that the critical management decisions should be concerned with the summer months when preparing for the future. The potential changes in precipitation patterns mean summer is likely to see a fall, with a possible increase in the volume of augmentation flow required contrast one. As a result there is a chance the demand and supply ratio will become critical.

Although my dissertation presented a number of challenges, overall it provided the opportunity to complete research in a topical and relevant area and gain new skills. My new experience and knowledge of using Microsoft Excel has helped with projects I am currently working on in my role as a graduate flood risk officer. Also, a significant part of my new role is working with partner organisations such as the Environment Agency. My dissertation provided a great opportunity to learn and gain experience of how to effectively work with other people through the numerous teleconferences and meetings and significantly developed my knowledge of some aspects of hydrology.

Ian Brooks

Current role: Business Support Manager, Environmental iNet

LinkedIn: http://uk.linkedin.com/in/ianmbrooks/

Research Project: Comparison of a multi-model approach with a single model approach for developing behaviour change interventions to reduce energy consumption

Abstract

Two existing behaviour models were used to develop interventions to reduce energy consumption in four schools. One model, the 'Triandis Theory of Interpersonal Behaviour' is an individualist, psychological model, looking at the behaviour of people. The other model is the 'Three Elements' model which is a sociological model, looking at elements which constitute a practice or action. Using the Triandis model and the Three Elements model together, this multi-model approach resulted in just over 50% more interventions which were considered implementable than the Triandis model alone. The interventions also covered a wider range of themes than the single model.

Summary

Among the range of actions to avoid dangerous levels of global warming, behaviour change is seen as a key lever to improve energy efficiency (DECC, 2012) and reduce Greenhouse Gas (GHG) emissions. If we are to develop the most effective behaviour change interventions then we need good tools to understand behaviour in the first place. I was interested in testing an emergent model of behaviour change against an established model to compare their usefulness in designing behaviour change interventions and if there was a benefit from using both models in the same project.

The Triandis model of interpersonal behaviour (Triandis, 1977) was published in the 1970's and is a well understood and frequently cited approach. It comes from an individualist view of behaviour and is widely used to assess energy consuming behaviours in order to design initiatives for change.

The Three Elements model (Pantzar and Shove, 2011) is much more recent and still emergent. It comes from a sociological background and focuses on the nature of energy-consuming practices rather than on individuals.

The research looked at four schools in South Gloucestershire, identifying ways to reduce energy consumption and associated GHG emissions in those schools.

In many schools in England there have already been extensive ecological awareness and behaviour change programmes aimed at pupils, such as the Eco-Schools award (Eco-Schools, 2012) . It is important for future energy usage patterns that pupils learn about sustainability and energy

efficiency in school. However pupils do not necessarily have a high degree of influence over energy consumption and GHG emissions in the schools they attend at the time. If behaviour change is going to have an impact in reducing school energy consumption, we must identify who has real influence on the energy use and design the most effective behaviour change interventions suitable for them.

The method for the project was designed to include problem diagnosis through structured interviews and extensive analysis supported by the Nvivo 9 tool (QSR International Pty Ltd, 2010) as shown in Figure 1.

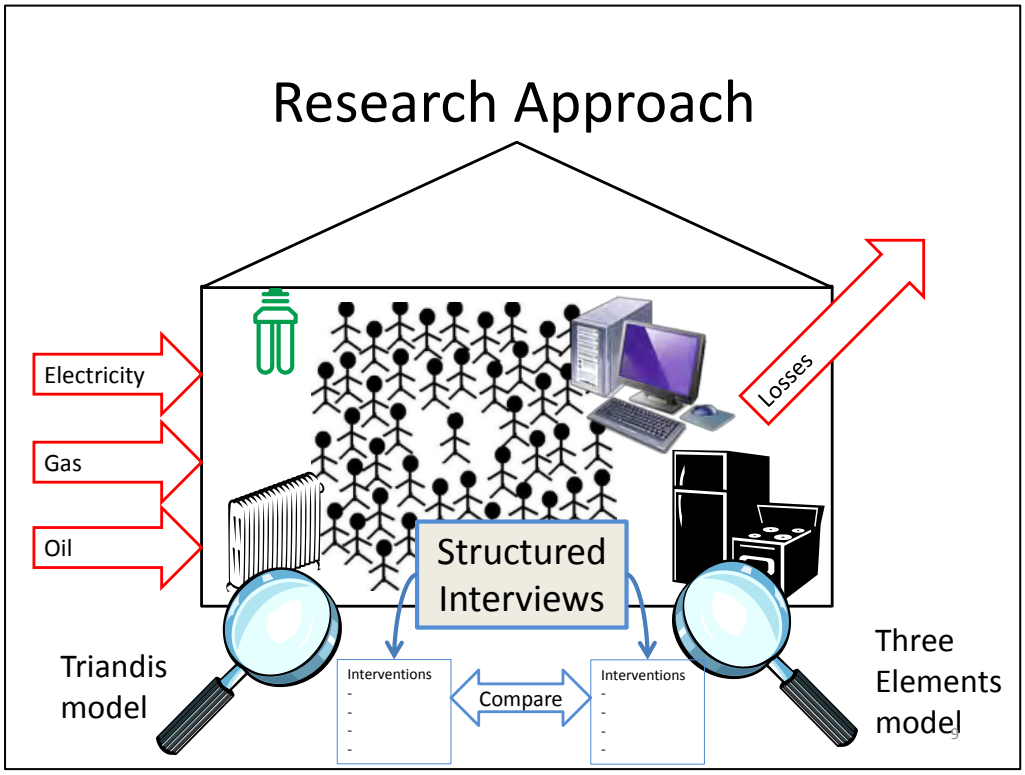


Figure 1 Overview of Research Approach

Recognising that the strengths of the Triandis model lie in understanding individuals and their rational choices, the interviewees selected were administrators, caretakers, facilities management, ICT managers and teachers. The Triandis model appeared to lend itself to identifying issues within the day to day experience of the interviewees.

The scope for the Three Elements investigation had to be rather more constrained in order to avoid constructing models of many different practices. The scope was restricted to reducing the electricity consumption of the ICT used to support learning. Three practices were identified which shared the physical materials – desktop PCs and the ICT suite, as shown in Figure 2. These practices each had an influence on the future electricity consumption. A group of questions were added to the structured interview to elicit information about these practices in these schools.

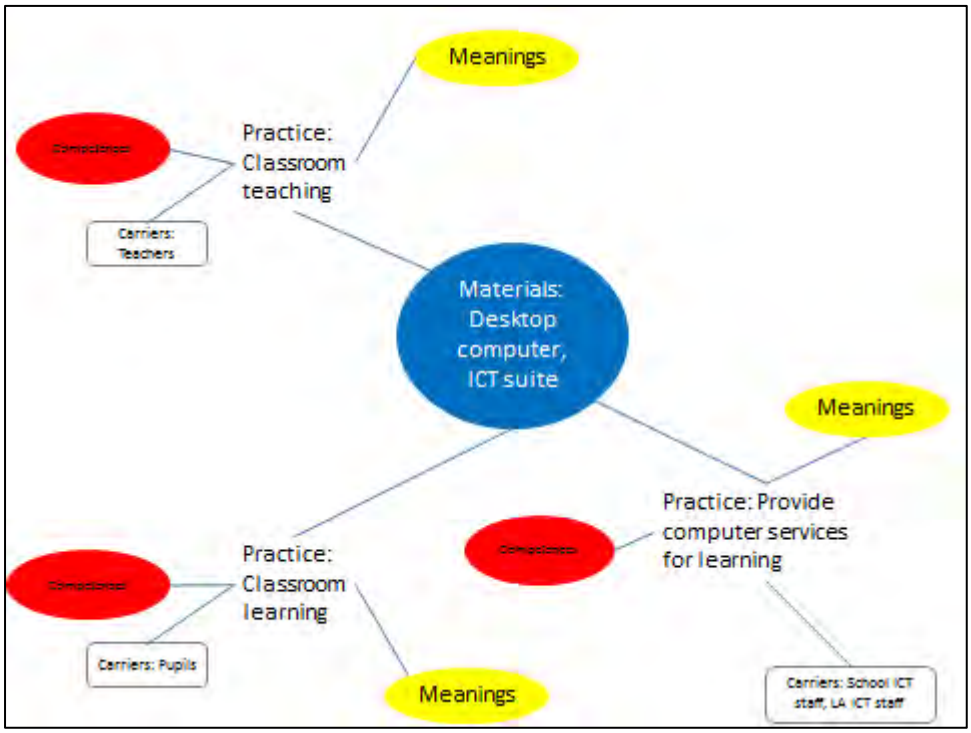


Figure 2 Scope for Three Elements investigation

The notes from each interview were loaded into NVivo 9 qualitative data analysis software (QSR International Pty Ltd, 2010) and reviewed to identify energy consumption issues raised. Each issue was then reviewed to design potential behaviour change interventions to address the issue. An overview of the process is shown in Figure 3.

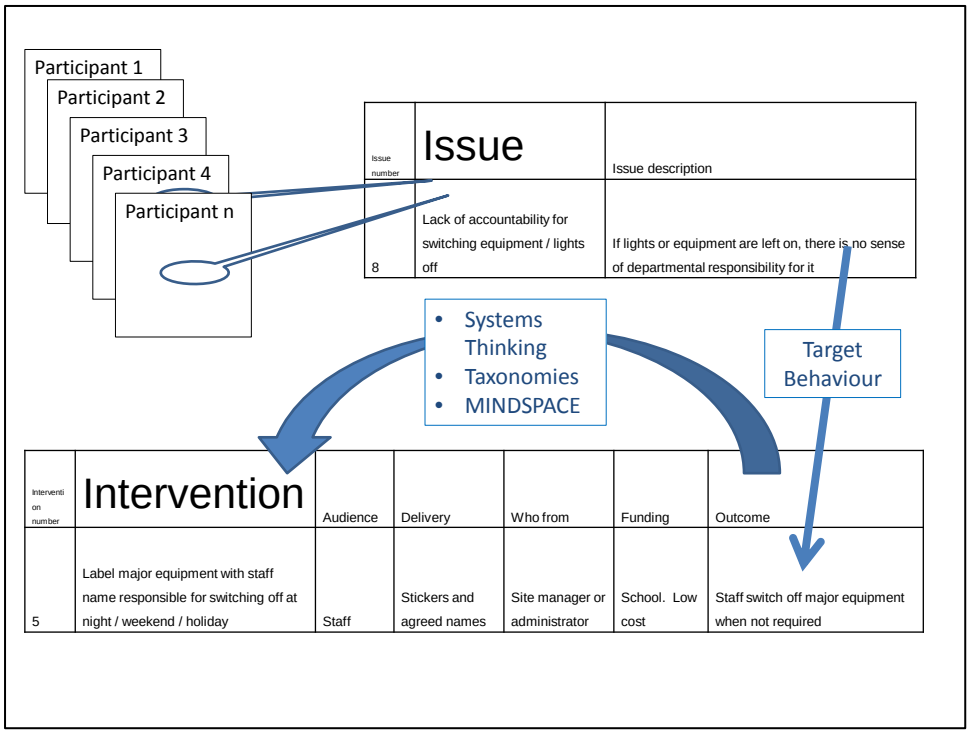


Figure 3 Intervention design process

The Head Teachers of each of the four schools evaluated each of the potential behaviour change interventions. They scored each intervention against the statement "This intervention would work well in my school".

Of the 25 interventions designed, 22 were scored as potentially suitable for implementation. Interventions arising from the Triandis model had higher scores than those arising from Three Elements model or from both models.

Interventions from the Triandis model analysis which fell into the themes of accountability and information scored highest. The highest scores were for interventions which are relatively straightforward and clearly within the scope of the school.

Example interventions included:

- Label major equipment with staff name responsible for switching off at night / weekend / holiday
- Add energy efficiency as a specific responsibility in the caretaker job role description
- Include comparison of lifetime energy costs when making equipment purchasing decisions

The advantages of the Triandis model were that it readily highlighted specific energy-related behaviour issues and opportunities. The interventions designed using the Triandis model were also scored more highly by the Head Teachers as being implementable in their schools.

An apparent disadvantage of the Triandis approach was its weak insight into energy consumption when it was part of an overall service delivery. This was exemplified by the view that the smooth operation of the school would always override the search for energy efficiency.

The interventions from the Three Elements model analysis which scored most highly were those which emphasized how tablet computers, with their lower electricity consumption, could be an enabler of the teaching model and make school logistics easier.

Example interventions included:

- Integrate personal tablet computers into curriculum to support independent learning
- Use personal tablet computers in classroom setting to release space in school facilities for other uses by reducing number of ICT suites
- Encourage teachers across SGC who are early adopters of teaching software apps to share their experience by blogging

The advantages of the Three Elements model were in identifying issues and developing interventions for systemic change where the energy usage reduction was a co-benefit of the change rather than the primary motivation for the actors to change. It was effective at providing insight into energy consumption embedded into the delivery of other services.

The potential disadvantage was that many of the interventions were more strategic in nature and were viewed in the evaluation as being less in the direct control of the schools.

In terms of the evaluation approach used in this research, it is clear that using multiple models did result in better behaviour change interventions. The multi-model approach, compared to the single

Triandis model, resulted in just over 50% more interventions which were viewed as implementable and offered additional insights into more structural change. Despite the greater effort required to use the Three Elements model, it enables powerful insights and should certainly be added to the behaviour change consultant's toolkit and a community of practice should be built up around its use in the field.

I benefited from the project by developing a working expertise in two key behaviour change models. Behaviour change is a pervasive requirement in sustainability projects and I have made frequent use of these insights in the context of my subsequent work with the Environmental iNet since graduating, supporting SMEs in environmental management.

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Adam Withers

Current role: Associate Project Planner for AEE Renewables

Placement Employer: Carbon Leapfrog

Project Title: Analysis of The Green Deal in conjunction with the solar pv market

Abstract

The aim of the report was to establish what effect The Green Deal will have on the solar photovoltaic market, with a deductive hypothesis asking whether the increase in demand through The Green Deal, will reflect the demand achieved by the peak Feed-in-Tariff of 2012. The methodology for the investigation was achieved through market data comparison with a questionnaire response from 100 participants. The results of the questionnaire indicated the likely uptake of solar pv in the future will increase 4-fold with The Green Deal. A 10-16 fold increase was needed to meet the hypothesis. The results indicated that The Green Deal's financial structure would not appeal to the consumer as much as the peak Feed-in-Tariff financial structure, in late 2011 and early 2012.

Summary

My bachelor degree in Mechanical Engineering ignited my interest in the renewables sector. With the ever-prevalent issues of climate change and finite energy resources, the sector caught my interest. Following my bachelor degree, the MSc Environmental Consultancy course offered me the chance to explore the more political, legal and social challenges renewable energy faces globally. It became clear to me whilst studying on the MSc, that the real challenges in developing a large renewable resource within the UK lie with those political, legal and social challenges. This is due to a number of factors, in particular the need for public acceptance. Having this highlighted to me, I was keen to look at new carbon reduction schemes by the UK Government, and try to predict whether this would be successful. At the time of my course, the most prominent scheme coming into place was The Green Deal.

The Green Deal is an initiative developed by the coalition Government and founded under the Energy Act 2011 to encourage householders to install more energy saving technologies. At the time of its unveiling, the scheme was described by the then Secretary of State for Energy and Climate Change, Chris Huhne MP, as the biggest home improvement programme since World War II. The premise behind the Green Deal was to "enable private firms to offer consumers energy efficiency improvements to their homes, community spaces and businesses at no upfront cost, and recoup payments through a charge in instalments on the energy bill." – Department of Energy and Climate Change (DECC). The scheme follows the 'Golden Rule', which states customers will only pay a monthly fee, equivalent to the average energy saved each month through the energy bill. With over 87% of the UK's housing stock to remain by 2050, the Government had

highlighted the importance of a significant retrofit programme to people's homes. Coupled with the ambitious (but essential) targets of the Climate Change Act 2008, which proposed large carbon reduction targets for 2050, the scheme became a flagship energy reduction plan for the coalition Government.

I decided to analyse the impact The Green Deal would have on the solar pv market in the UK, in comparison to the achievements of the industry reached during 2012 with the peak Feed-in-Tariff. There were a few reasons behind the decision. Firstly, the project is primarily seeking to predict the market trends for the solar pv technology. This is an essential skill for any business, not just environmental consultancies. It is important to know where the market is heading, and particularly in such a volatile market as renewable energy. Another reason for undertaking the project was to gain a better understanding of people's attitudes to not just renewables, but financing renewables. The survey, which I undertook, gave me the opportunity to gain a good understanding of what appeals to the average consumer in terms of financing a domestic system. It also highlighted the pitfalls of the current opportunities in the marketplace and where the problems could arise in The Green Deal's success. Finally, I felt the thesis would be of interest to potential employers. With grand statements by the Government about the future success of The Green Deal, I predicted that the research could prove useful discussion in an interview or future projects. I was keen to ensure the project gave me the opportunity to try different techniques in research and analysis, thereby enabling me to apply them within my future consultancy career.

The project aimed to incorporate quantitative and qualitative data to reach a final conclusion on whether The Green Deal would be successful. A deductive hypothesis was devised at the start of the project:

'The Green Deal will increase the uptake of domestic solar pv technologies to the levels reached during the peak feed in tariff, due to the improved financial support from the Government'

In order to achieve this I modeled the financial outcomes for three different scenarios, comparing the payback period a retrofitted scheme would provide under the old Feed-in-Tariff system, the present day loan schemes, and new Green Deal finance scheme for a 3kW roof-mounted solar pv system. This was modeled for a small, medium and large house. Once the data is collated, it was presented in a clear format to the 100 participants to rank their preferred choice of finance scheme for having solar pv installed at their home. This information was compared with the market trends of the peak FiT to determine whether it could be as successful as the earlier scheme.

The results clearly identified a preference for the old FiT system, and demonstrated The Green Deal to be very unpopular from the survey results. Only 15% of participants preferred The Green Deal to the old system, with most people commenting the payback period was too long (due to the large repayment interest rate of 7.5%). The opinions of the participants indicated that the payback periods for loans and capital are the driving factor for people's choice of solar pv finance package. The results were only strengthened when the results were filtered down to homeowners who would consider buying the technology. It was clear from the data set that The Green Deal financial package was the least favourite financial scheme for many of the participants. In order for the hypothesis to be true, the results would needed to have demonstrated a popularity for The Green Deal financial package close to the Peak Feed-in-Tariff Financial Package popularity, and show 10-16 times more support than the Present Day Financial Package, which would indicate sales would return to the levels shown for March 2012.

I felt the project has given me significant experiences, which have benefitted my career to date. It enabled me to explore a number of different aspects surrounding the domestic renewable energy market, including the financial issues faced by consumers to accessing carbon reduction technology. One of the most useful parts of the process was the chance to talk to so many people about their perceptions of The Green Deal, and from that delve into more opinions on energy policy, renewable energy and climate change. In essence, the survey aspect of the study gave me a glimpse of what a career as an environmental consultant can be. Working with the public is something I wanted to focus on within my research project and the placement, and the course has certainly given me the opportunity to do so. Being a consultant has required good communication skills, not just verbally, but also in the materials I produce for the public to read, and I can see the direct benefit this report has given me for recent projects in my workplace. The report still has relevance in today's market, and I am proudly able to demonstrate the report to potential employers with the knowledge my conclusions closely match the actual outcome of The Green Deal's success. A willingness to analyze the present day market and come up with a recommendation for a potential employer has certainly proved a useful attribute in looking for a job.

Duncan White

Current role: Consultant with RSK

Title of research project : The effect of demographics on household recycling rates in North Somerset

Abstract

In this summary I explain the context of the research project within the syllabus of the course. I wanted to do research on a subject that provided some real value to somebody, so I contacted North Somerset Council's recycling team. In discussion with them it was decided that I should look at the relationship between demographics and recycling. The nature of the research undertaken including the findings and recommendations is discussed. The undertaking of the project helped to develop many transferable skills.

Summary

When I first embarked on the MSc in environmental consultancy, the part of the course that I was least confident with was the research project. This probably stemmed from a previous experience as an undergraduate, having to abort a previous idea at the eleventh hour and scrabble around trying to come up with something new to research. The key issue for me was trying to settle on a subject on which I had more than just a basic understanding, but which had sufficient knowledge gaps to be able to explore with new research. I finally chose to research the relationship between demographics and recycling.

I was undertaking the course as a mature student, having worked for a private business for many years. As such I was aware of the great value that research information could add to an organisation, and so I was keen, if I had to undertake a research project that would require many hours of my time, to try and do something that could be really useful for somebody.

I had recently moved from Bristol to an area administered by North Somerset Council and the reduction in the number of waste streams that could be recycled in my new home was very noticeable. So, I wrote to Colin Russell the head of recycling at North Somerset Council to offer my services to see if there were any areas of research that would be beneficial to him and his team. We arranged a meeting and he suggested that a greater knowledge of how the demographic splits were affecting the recycling rates within North Somerset would be helpful as it could be a benefit when planning waste strategies to increase recycling performance. The title of the project that emerged following this meeting was 'The effect of demographics on household recycling rates in North Somerset.'

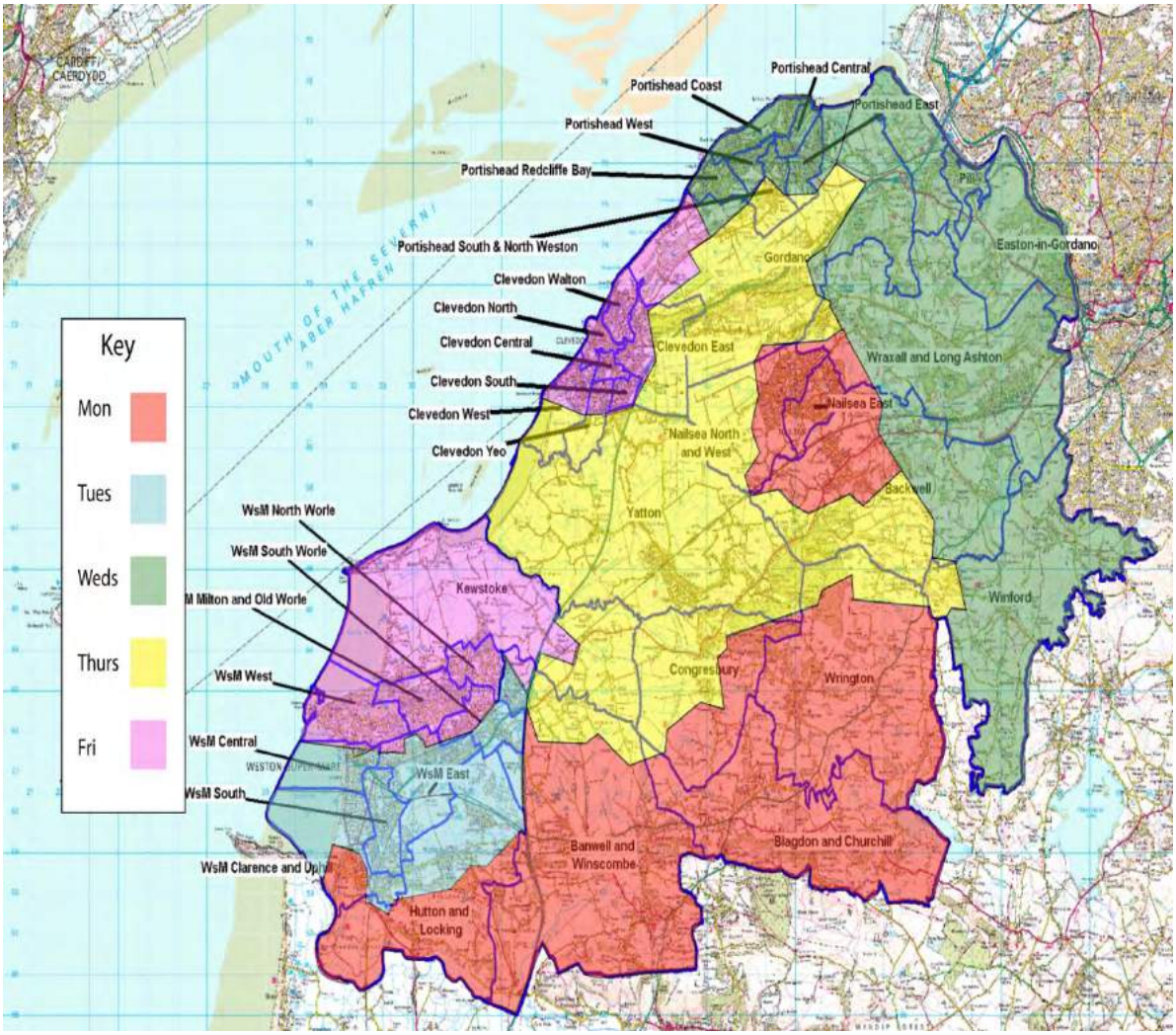
Getting from an idea to a completed research document seemed like a mammoth task, but I received some excellent guidance from the lecturers. I understand that one of the purposes of

setting students the task of a completing a research project is to evaluate their ability to work independently. However, a comprehensive introduction to research processes was given as part of the taught syllabus and once I had settled on a topic, I was assigned a tutor to give further guidance, which was invaluable.

As well as for the final document, marks for the module were given for a research proposal and a presentation. The preparation of these pieces of work was a good way to break up the work load, to make it more manageable and help to develop the ideas and refine them before the final document. Personally I found giving the presentation was something that I was comfortable with, having some previous experience, but preparing the proposal was a new skill to learn, especially the literature review. At first I found the amount of journals and articles that could potentially be relevant to my subject was daunting, but after a short time I had established for narrowing my search for articles. I was reassured, after undertaking the literature review, that it became clear that my specific research question hadn't been covered before and there was indeed a need for more research in this area.

The research itself was designed to explore the extent that various different demographic variables affected or had a significant relationship with the recycling rates in the various wards in North Somerset. This was done in two stages. The first by comparing data from all of North Somerset's 36 wards and the second by selecting 3 wards and conducting a household survey.

For the first stage it was a major undertaking to manipulate all the data, requiring a much higher level of skill in Microsoft Excel that I previously possessed. The waste collection data, provided by the council's contractor, May Gurney was recorded by truck round, and the census data by geographic ward. Once the data was compatible, a statistics package was used to determine relationships between the waste data and demographics.

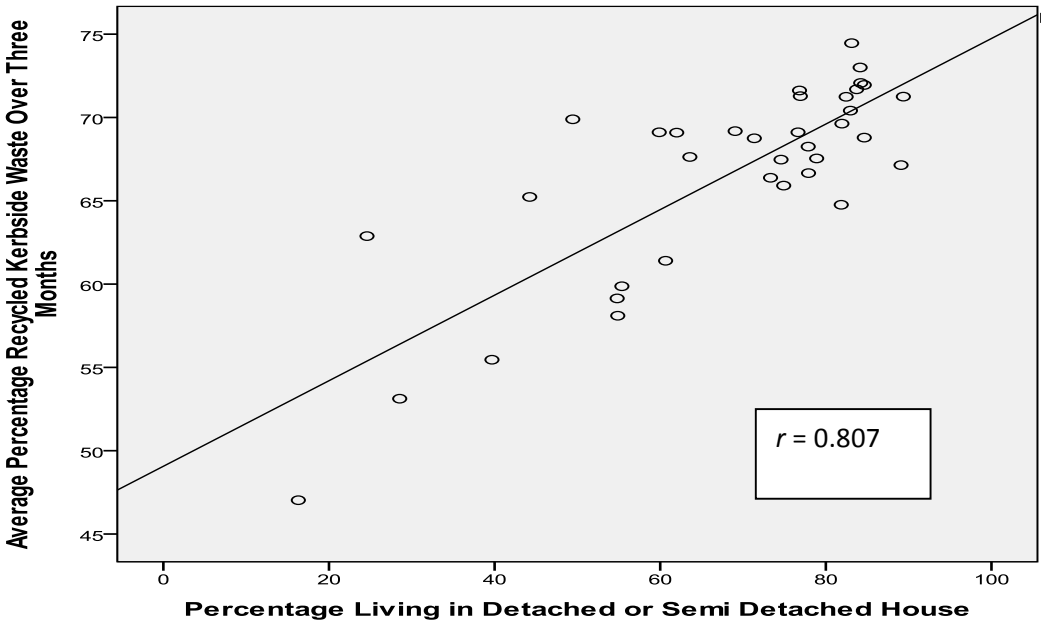


Based on Ordnance Survey mapping, an Edina supplied service.

Recycling collections across North Somerset

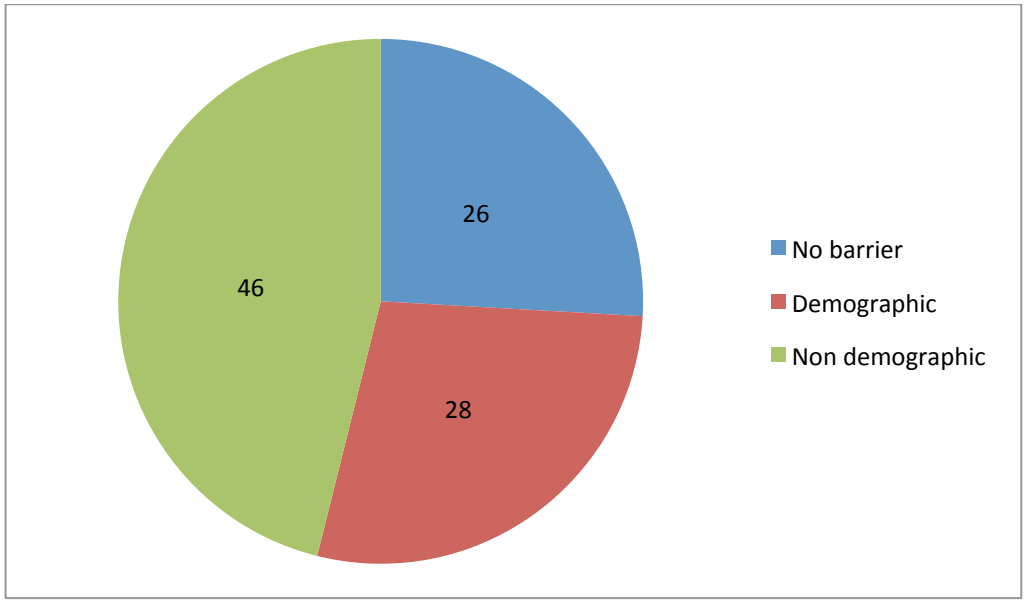
The analysis on the data found that 11 out of the 13 demographic factors had statistically significant relationships with the recycling percentages at a ward level, as shown for one of the demographic factors in the figure below.

Scatter plot showing linear relationship between percentage living in a detached or semi detached house and recycling percentages



The household survey which targeted samples within three wards found that between one quarter and one third of the respondents believed that demographic factors were the main barrier to an increased rate of recycling (as shown in the figure below). This showed that demographics had a strong influence, but the mechanics of the recycling scheme were at least as important and other factors and also had an influence.

Perceived main barriers to recycling in all three wards by percentage of response



The demographic barriers given as responses were all situational. Cultural or attitudinal demographic issues were difficult to identify at household level. I concluded by recommending more

research to identify the links between the cultural or sociological demographics that were identified at district/ward level and the situational demographics that were identified at a household level.

Once my project had been finalised, bound and handed in, it was something that I was immensely proud of. It represented the culmination of not only many hours work, but a vast improvement in my knowledge and skills, not just in producing an academic document, but more crucially in widely desirable skills in the environmental consultancy profession such as improved computer literacy and statistical analysis.

Sarah Whereat

Placement organisation: Johns Associates, Bath

With thanks to Mathew Johns at John Associates, Simon Lohrey at South East Water and Huw Taylor at Brighton University for their support and raw data for this project.

Research Project: How Catchment Management in the Sussex Ouse could address the declining water quality from intensive agriculture.

Abstract

This study examined existing research related to agricultural intensification and declining water quality in associated river catchments that provide domestic water supply resources. The legislation relating to water quality was then used to explore the need for land-based management strategies by water companies to stop declining water quality and to help meet the targets set by the government under the Water Framework Directive.

The background of nutrient and sediment loadings of river catchments was investigated including sources, cycles, interactions, transportation, and delivery into river catchments and then applied to the South East Water case study of the River Ouse Catchment in Sussex.

The relationship between agricultural intensification and decline in water quality was analysed using turbidity data obtained from South East Water and the Aquamanche project (Aquatic Management of Catchments for Health and Environment) a cross-border initiative from the University of Brighton for rivers such as the Ouse.

Present UK catchment management strategies were reviewed and the mitigation methods to reduce agricultural pollution discussed in terms of improving farming practice whilst examining the cost/benefit analysis for uptake. Finally the best practice for water companies such as South East Water to conserve their resources was investigated.

The research found there is a need to protect water quality in the Sussex Ouse by addressing the pollution problems posed by increasing agriculture; however it has also highlighted the financial implications of mitigation and the need for incentives and subsidies to drive improvements which could be facilitated by South East Water.

The project has allowed me to carry out research in water quality monitoring which is a relevant topic to environmental consultancy and an interest of mine. It has given me the opportunity to integrate material from the Advanced Specialist Topic Module (such as water management) and has also brought in the elements of my placement which concentrated on the water sector.

Summary

In Europe, the importance of assessing nutrient and sediment loads and their impact on water bodies has leapt up the agenda in the past few decades with emphasis on water quality monitoring research. This research has been concentrated mainly on estimating nutrient fluxes, primarily nitrogen and phosphorous, and assessing their inputs/outputs. However, research has largely focused on industrial and effluent pollution sources rather than agricultural sources.

Agricultural land often lies within water catchments that are important for their supply of drinking water. The intensification of agriculture therefore creates a new challenge in managing nutrient loads and requires control to maintain acceptable water quality as well as ensuring the protection of valuable ecosystems.

This research aimed to investigate the relationship between agricultural intensification and declining water quality in these particular water catchments. This could then be applied to water companies managing agriculturally affected domestic water supply resources, reviewing the current status and future of land based catchment management initiatives for the reduction of nutrients and sediment into watercourses in the United Kingdom to meet legislative standards.

Investigation:

A number of land–based nutrient management initiatives have been completed or are underway in the UK for river catchments. This has occurred in response to observations of decline in the water quality of resources used by water companies for domestic supply. In the water industry, companies that deal with sewage and provide domestic water supply, are increasingly becoming concerned about improving the quality of their water resources.

The water quality of the River Ouse, managed by South East Water for domestic supply has been monitored by consistent turbidity measurements over 2 years. These measurements can indicate water quality deterioration for example from soil erosion or pollution.

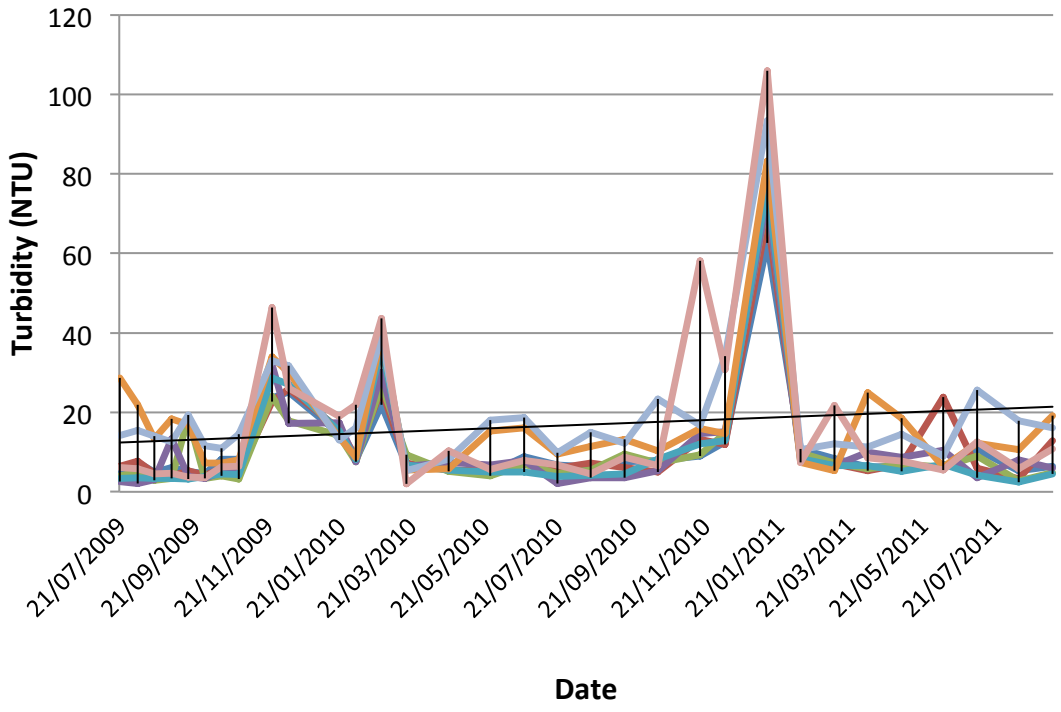


Figure 1: Mean turbidity data in the whole catchment of the Sussex Ouse

Monitoring of turbidity has shown an annual mean increase on the River Ouse (including its tributaries).

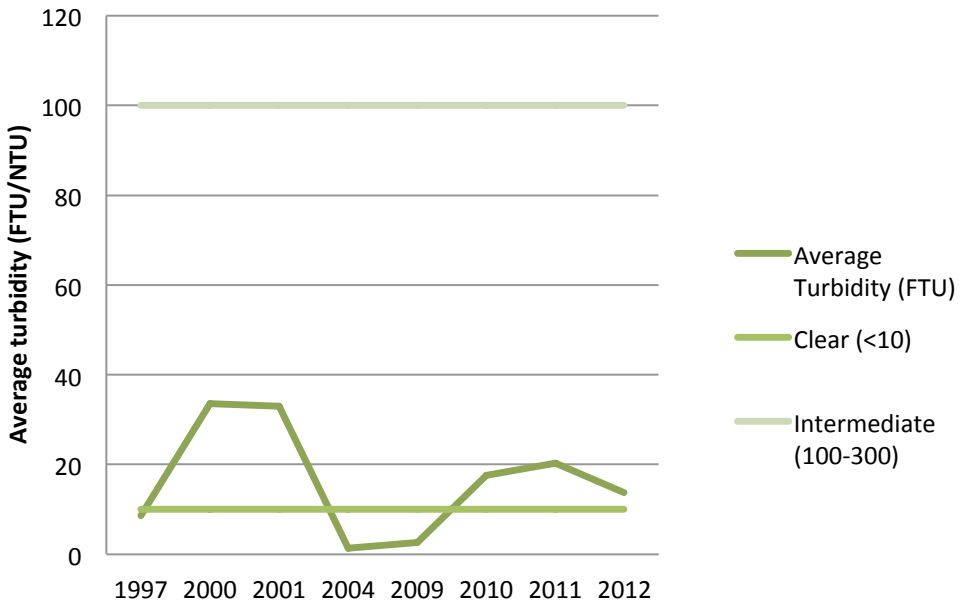


Figure 2: Average turbidity at Barcombe Mills compared to Water Framework Directive standards.

Barcombe Mills is the location of a water treatment plant by South East Water. Figure 2 shows evidence of higher turbidity (with a value above clear water) compared to standards set by the Water Framework Directive.

The high turbidity level in the river use means higher water treatment costs for South East Water in order to supply the public with acceptable quality water. This reason is behind many water companies initiatives for improving the water quality in sources from which they abstract water for supply, as well as being important in meeting targets set by the government. Catchment management is an important step in improving the water quality, particularly reducing diffuse pollution and thus reducing the extra costs for water treatment and improving the water environment.

Many farmers are unaware of their contribution to declining water quality; therefore water companies are making the effort to raise awareness of the problem to them. It was found that South East Water could assist in the development of catchment management techniques and systems to reduce the negative impact of agriculture on the water environment by landowners.

This includes a mixture of methods such as:

1) Incentives and voluntary approaches to protect receptors and control pathways such as agri-environment schemes which reward farmers for doing more than the minimum required by regulations.
2) Advice (win-win) and baseline regulations to control mobilisation and sources via soil and nutrient management such as

i) Catchment Sensitive Farming provides advice and funding for farmers
ii) Code of Good Agricultural Practice
iii) Pollution prevention regulations

Research indicates that there are financial implications to incorporating mitigating measures into farming practices around the River Ouse. The cost and benefit analysis of measures will encourage or discourage mitigation. Voluntary measures are a cost to farmers; hence the predicted uptakes are low unless incentives are provided.

It is evident that there needs to be emphasis on what best course of action could be carried out and how it can be completed, and what measures can be agreed to ease the cost burden of mitigation. South West Water could reap benefits from assisting farmers through advice and infrastructure to reduce their pollution and farm more sustainably by assisting them financially to achieve these improvements, rather than investing in building more treatment plants.

James Bumphrey

Title of Research Project: An Assessment of Existing Green Space and the Potential for Further Greening in Bristol City Centre

Current Role: Ecological Consultant

Current Employer: Greengage Environmental LLP

Abstract

Due to increasing urban populations and development pressure, urban ecosystems are being subjected to greater levels of degradation and fragmentation. Despite this these ecosystems can provide numerous important services such as water management, air quality improvement and cooling. However, for populations to benefit from these ecosystem services, the reinstatement and maintenance of healthy functioning ecosystems is vital. Many towns and cities across the globe are increasingly recognising the importance of strengthening their green space networks and embracing the concept of 'Green Infrastructure' (GI). One such city is Bristol which has introduced a number of policies that promote GI in new developments. The study looked at the quality of publically accessible green space, the potential to enhance this and the area of roof available to provide further greening, in an area of central Bristol. The results indicated that there is significant scope for the ecological enhancement of Bristol's existing green space. Additionally, it was also shown that there are considerable opportunities for further greening through the retrofitting of green roofs

Summary

As an ecologist working in London I have a keen interest in urban ecology, a discipline that is becoming more and more important as populations become increasingly urbanised. This trend has major implications for ecology with urban habitats subject to degradation, fragmentation and alterations to species composition and richness. Despite these stresses urban ecosystems can provide numerous important services such as water management, air quality improvement and cooling. The reinstatement and maintenance of healthy functioning ecosystems is vital, if urban populations are to benefit from these ecosystem services. It was my interest in this particular area of ecology, in addition to the benefits that these ecosystems offer, that in part lead me to undertaking this research project.

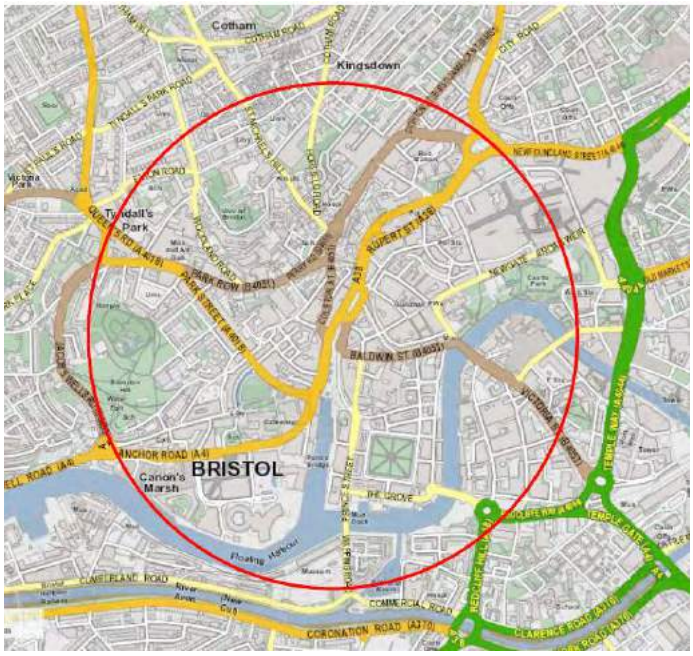
The significance of urban ecosystems is being increasingly recognised with many towns and cities across the globe strengthening their green space networks and embracing the concept of 'Green Infrastructure' (hereafter GI). GI is the multifunctional, interdependent network of open and green spaces and green features. It comes in many forms including parks, open spaces, green walls, green roofs, rain gardens, swales, planted landscaping, private gardens and allotments. Furthermore, many of these features are being increasingly seen as important methods of adapting to and mitigating climate change.

The value that policymakers are now placing on GI is particularly evident in London with frameworks like the All London Green Grid (ALGG) and an increasing trend for the completion of GI audits. A GI audit assesses the extent and quality of existing GI and indentifies opportunities to improve and create GI assets. Greengage, the consultancy at which I completed my placement and am now employed, were looking to undertake GI audits and I therefore saw this research project as a potential opportunity to produce something that had a practical application within my placement and future career. However, producing a full GI audit is a considerable undertaking and one that was considered too large to be meaningfully covered in a project such as this. It was decided that only certain elements of the audit methodology would be utilised in this study.

The first element that was chosen to be included in the study was to assess the quality and distribution of publically accessible green spaces such as public parks and churchyards. The primary reason for this was that it was felt these spaces would be most easily surveyed (as they were publically accessible) and would also offer the most scope for enhancement. The second part of the study was to undertake a survey of flat roofs to identify the potential for the retrofit of green roofs. Green roofs are a much heralded piece of GI that are used to provide greening in urban environments. The central Bristol study area was chosen because it appeared that a study of this nature had not been completed within this location whereas numerous GI audits had been undertaken in London. In addition to this, from a review of aerial photography, it was noted that very few green roofs existed within Bristol city centre.

The exact 750m radius study area was chosen primarily because it was reasoned that green spaces towards the urban centre would be subject to the greatest level of degradation and therefore benefit most from enhancement (see Figure 1). In addition, this area also incorporated predominately commercial buildings which, according to previous research, were more likely to offer potential for greening. Green spaces were assessed through a variety of categories including function, management and habitat cover. Plant species richness in each site was also calculated using a simple plant species richness equation. The potential for retrofitting green roofs was identified through an assessment of roof pitch, location, orientation, finish and presence of plant material.

Figure 1 Study area



Study area (image from Bristol City council pinpoint mapping service) http://maps.bristol.gov.uk/pinpoint/?service=localinfo&layer=wards)

An initial review of aerial photography revealed 51 green spaces in the study area with the 19 that fell in the publically accessible category then assessed on foot (see Figure 2). The majority of these green spaces were managed for informal recreation and were therefore subject to a good level of management with only two appearing to have any focus on wildlife benefit. The most common habitat across the green spaces was amenity grassland making up 53% of total coverage. Perhaps not surprisingly the plant species richness tended to be greater in the spaces subject to less formal level of management and those specifically managed for wildlife.

Figure 2 Roofs with potential for green roofs to be retrofitted

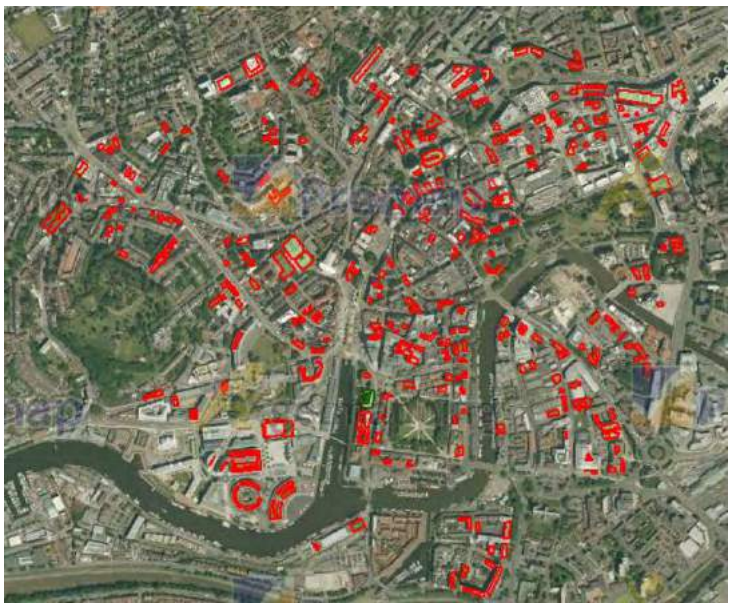


Image taken from Promap (http://www.promap.co.uk/) showing roofs with potential for green roof retrofit

Significant scope for ecological enhancement was noted across all of spaces surveyed. It was recommended that any measures to enhance these spaces should be aimed at the priority species identified within the Bristol BAP (Biodiversity Action Plan), with particular attention paid to the house sparrow (*Passer domesticus*). Suggested enhancements included alteration of mowing regimes to increase grassland diversity, converting some of the amenity grassland to wildflower meadow, incorporation of nest boxes and native shrub planting. Additional enhancements included creating a greater diversity of physical invertebrate habitats through log piles, rocks and patches of sand, in addition to the creation of invertebrate habitat wall. An increase in invertebrate habitat such as this would provide additional prey for BAP species such as the aforementioned *Passer domesticus* and all bat species.

Figure 3 Invertebrate wall enhancement feature

Example invertebrate habitat wall (photo taken by James Bumphrey at London Wetland Centre)

The potential for green roofs to be retrofitted was assessed from both aerial photograph and on the ground. 12.30% of all the roofs in the study area had greening potential, this represented a total potential coverage of 101250m^2 (4.5% of the of the study area). Only 33% of flat roofs surveyed had potential for greening with the presence of building plant and building age being the most common reason for roofs being unsuitable. The roofs with largest area with potential for greening were generally commercial including offices, shopping centre and car parks. Based on an assertion made in a previous study, that retrofitting green roofs cost £150 per square metre, to install the 101250m^2 of potential green roof it would cost around £15,187,500.

The study indicated that there is significant scope for the ecological enhancement of Bristol's existing green space. Additionally, there are considerable opportunities for further greening through the retrofitting of green roofs. The main benefit I gained from the study was a greater understanding of GI audit process. This is something that has been beneficial to my placement and current job role. Indeed I have now undertaken two GI audits in my role as an Ecological Consultant. Furthermore, elements of the research I undertook into enhancing the enhancement of the greenspace I now incorporated into the reports I write.

Faculty of Environment and Technology

UWE, Bristol
Frenchay Campus
Coldharbour Lane
Bristol BS16 1QY

Telephone 0117 965 6261