the ecological
sequestration trust

PATHWAY TO A RESILIENT FUTURE FOR DORSET

A feasibility Study

April – June 2014

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Cover photo: Corfe Castle, Richard Jefferey, 2013.

This research was supported by:

Dorset Local Enterprise Partnership

Local Nature Partnership

mouchel building great relationships

Bournemouth University

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Glossary

BU	Bournemouth University
CDE	Construction, Demolition and Excavation (waste)
C&I	Commercial and Industrial (waste)
CIC	Community Interest Companies
DEFRA	Department for Environment, Food and Rural Affairs
DCC	Dorset County Council
DFID	Department for International Development
DLEP	Dorset Local Enterprise Partnership
DWT	Dorset Wildlife Trust
EA	Environment Agency
ESE	Economic-Social-Ecological (value)
GVA	Gross Value Added
IC	Imperial College, London
IPCC	Intergovernmental Panel on Climate Change
JRC	Joint Research Council
LLFA	Lead Local Flood Authority
MOOC	Massive Open Online Course
MSW	Municipal Solid Waste
NE	Natural England
NFU	National Farmers Union
SAB	Sustainable Drainage Systems Approving Body
TEST	The Ecological Sequestration Trust
TPA	Tonnes Per Annum
WRAP	Waste and Resources Action Programme

Executive Summary

This feasibility study set out to uncover whether The Ecological Sequestration Trust resilience.io integrated regional model is a suitable choice for Dorset, to help the DLEP to achieve its objectives to build a competitive business environment with clean, highly developed industries, and support an outcome of an educated and healthy population. This is not a business case but summarizes the work carried out over three months against four objectives to uncover whether the resilience.io model can:

1. Increase Dorset's collaborative planning and investment decision making capacity, the contribution made by people and businesses, and their linkages with academic and/or training institutions.
2. Support new business growth and demonstrate how data can improve decision making.
3. Reduce risk to Dorset's business growth and innovation.
4. Broaden Dorset's sources of financial support for economic growth.

Through a series of investigative meetings, an interactive cross-sector workshop, two desk-based locally relevant case studies based on flood water management and commercial and industrial waste plus the development of an EU funding structure, the results show is that the resilience.io platform satisfies all four of these objectives.

During the study a project steering group was formed, which evolved into a core cross-sector Collaboratory group, enthusiastic to take forwards the governance and management of the resilience.io platform. Drawing on local expertise and using large regional and local data sets donated for the study by EA and Wessex Water, local case studies focused on commercial and industrial waste management and flooding in Christchurch were processed visualized using The Ecological Sequestration Trust partners GEODAN, GeoDesign/Geoplaza methodologies, illustrating both potential risks and commercial opportunities for Dorset. The offer by GEODAN to provide Dutch water management expertise was immediately taken up by Dorset. The ability of resilience.io to attract new British technologies to Dorset for scale up and implementation was also proven during the study through the Technology Strategy Board 'Innovation and Knowledge Centre' programme SPECIFIC, who are now in discussion with Mouchel regarding turning their buildings into power stations.

As aired at the accompanying workshop, Dorset decision-makers, business and third sector leaders recognise the need to gather data, develop regional knowledge, embed integrated planning and build cross-sector confidence in the evidence base and decisions taken. By uniting economic-social-ecological (ESE) perspectives, a robust regional systems approach would allow interventions to be shaped with common and credible economic analyses. Dorset needs to "up its game" to really increase ESE value in Dorset. The integrated resilience.io regional model would provide the metrics on the flow of products, goods, materials and waste and model the manufacture and distribution of goods and resources to enable this transformational change. Businesses or individuals would be able to research and develop new products and business models that can support community benefits of a circular economy.

Overall the region could become an open-innovation platform to create new businesses, which could have significant opportunity in Europe as a whole and help build local jobs.

The establishment of resilience.io as the EU Demonstrator in Dorset would be funded through EU and UK channels and a Regional Accelerator Scale-up Fund established to draw in investment. It is estimated that 1-2% regional GDP could be generated by the deployment of the resilience.io platform.

1. Introduction

This report was prepared as an account of work sponsored by the Dorset Local Enterprise Partnership (DLEP), Local Nature Partnership (LNP), Mouchel and Bournemouth University.

Dorset is a diverse county with a mix of rural and urban areas. Economic sectors range from marine engineering and financial services through to tourism and agriculture. Ensuring that future policy and development decisions take full account of the combined economic, environmental and social factors will be crucial to ensuring that the growth and balance of the county is sustainable. As set out in the project Terms of Reference, the achievement of the DLEP vision to 'deliver growth through business enterprise whilst safeguarding the environment', depends heavily on the availability of reliable and comprehensive information on key issues such as local resource availability, the impact of proposed growth, environmental value, demographics and future skill needs and limiting factors such as water availability and site related conflicts of interest.

However, much of this information is not readily available to stakeholders in a usable form. One solution would be a data 'platform' that integrates established and newly-developed sources of information into a systems model, that is designed to test and enable decisions to be taken with a full appreciation of the value of human-ecological-economics systems. This would include the best use of local resources, the inward flow of resources to the region, such as fuel, water, food and raw materials, and the outward flow of manufactured goods, wastes and pollution. Such an evidence base can be used to attract inward investment into the overall integrated strategic approach being planned and minimise risk.

Drawing on the results and analysis of the work conducted over the three-month period April – June 2014, with quotes from Dorset stakeholders shown in italics throughout, this report sets out to answer whether The Ecological Sequestration Trust, open-source city-region collaborative, low-carbon, planning and investment platform resilience.io, that integrates established and newly-developed sources of information, allowing decisions to be taken with an appreciation of the value of economic-human-ecological (ESE) systems, is a suitable solution for Dorset.

If adopted, Dorset would join the resilience.io global demonstration network including China, Mongolia, Brazil and Africa and supported by The Ecological Sequestration Trust network of experts. A key advantage of being an early adopter of resilience.io for local businesses would be to have the ability to test new products and business models at home, share learnings across peer and new networks and publicise via an App on the global open source platform enabling sales across Europe and around the world.

In short, this report will outline whether the resilience.io platform is achievable, if it will bring clear benefits to the region and whether it is the right choice for Dorset.

Terms of Reference

The resilience.io Project Steering Board or "Collaboratory"[1] , set up to oversee the delivery of the contracted 3-month £20,000 research project (see Annex 1), decided upon four objectives, including two case studies, to demonstrate the capacity of the resilience.io platform as:

- a regional platform for data and systems modelling
- a shared platform for integrated planning, procurement and learning
- a vehicle for scenario testing for future investment
- an investment vehicle for public private partnership projects on the basis of attracting environmental industries to Dorset

Objective	Focus	To illustrate how resilience.io might be used:	Status
Objective 1	Collaboration	To increase Dorset's collaborative planning and investment decision making capacity, the contribution made by people and businesses, and their linkages with academic and/or training institutions; to assist DLEP to make a decision on whether the resilience.io model is one of the correct decision-making tools to support Dorset's sustainable development.	Achieved
Objective 2	Flood risk	To reduce risk to Dorset's business growth and innovation, resilience.io will demonstrate flooding scenarios using the proxy GeoDesign capability working with DLEP, LNP, DCC's Flood Risk Management Team and the EA.	Achieved
Objective 3	Waste	To support new business growth, resilience.io will demonstrate how data can be used to improve decision making for e.g. waste.	Achieved
Objective 4	Economic resilience	To broaden Dorset's sources of financial support for economic growth resilience.io will investigate the potential to create a Regional Investment Fund for 'good projects'[2].	Achieved

Table 1 RAG status of objectives set by the resilience.io Project Steering Group

For details of the actions, criteria for success against these objectives please refer to Annex 1.

The full budget is accounted for in Annex 2.

[1] The Ecological Sequestration Trust has coined the word "Collaboratory", a collaboration laboratory, to describe the convening and facilitation space governing the resilience.io model.

[2] "Good" projects are a portfolio of PPPs that meet the social, environmental and economic objectives for the region set by the DLEP & government whilst meeting the revenue and asset value increases required by the private sector to achieve return on capital.

2. Strategic links

The DLEP strategy for 2014 is entitled “Transforming Dorset” and to deliver this, a transformational change is specified through “integration of cross cutting themes and a sustainable approach to development”. The way regional data and information is accessed, evaluated and employed across all sectors has strong links with the “focus on enhancing access to, and use and quality of, information and communications technologies”. The more information the more value can be created.

The overall DLEP aim to “deliver growth through business enterprise whilst safeguarding the environment“, stems from the question of whether Dorset has maximised the advantages it possesses and reflects the UK’s need to address its long-term structural issue of under-investment in both infrastructure and innovation. The Ecological Sequestration Trust showed in the workshop on the 19th June, that they can bring new British technologies from the Technology Strategy Board 'Innovation and Knowledge Centre' programme (such as the Buildings as Power-stations SPECIFIC IKC) to Dorset for scale up and implementation. This can create new jobs and enable training and skill development to focus on emerging opportunities across Europe as the resilience.io platform is rolled out. Such innovation needs inward investment, based on robust economic business cases, which in turn will be enabled by reliable and comprehensive information on local demand, the material needs of the economy and the physical assets of all natural resources in the region and how they can play a positive role in supporting human well-being and productivity.

However costs are high if investment is carried in small-scale local contracts. Taking a regional approach will create a scale of investment that reduces cost from bulk purchasing and more efficient installation processes. Growth programs that improve energy, water and waste efficiency reduce long-term community and family costs and also lower carbon intensity. It is from these savings that returns for investors come and SMEs will gain access to capital for growth. The integrated resilience.io regional model will provide metrics of the flow of products, goods, materials and waste. It will model the manufacture and distribution of individual private sector company goods. Companies will therefore be able to research and develop new products and business models that can support community benefits of a circular economy and make the link between the two. Symbiotic systems of resource sharing can be easily investigated. Social entrepreneurs will also have the information to investigate new ideas and business opportunities. Overall the region can become an open-innovation platform to create new businesses, which could have significant opportunity in Europe and help build local knowledge, skills and jobs, whilst safeguarding the environment. It will attain a higher ESE Value.

Business decisions are less robust with uncertainty. Deploying the collaborative resilience.io platform makes economic sense to businesses because it will help to reduce uncertainty by providing greater clarity over resources, policy and planning decisions. This in turn will de-risk investment decisions that businesses make and therefore encourage greater investment. In addition, having a single open-access data model that everyone uses will ensure consistency.

The achievement of economic goals goes hand in hand with improving human well-being; the enrichment of human life is vital to the conditions for growth and thus, being able to make this integral to society and the economy is critical to future success. The March 2014 LNP strategy to enhance “natural

value" in Dorset, to "champion its interests and better integrate environmental objectives with social and economic goals" makes this link clear. New tools are needed to achieve this which is why excitement was expressed at the workshop for the resilience.io approach.

The DLEP 2014 Strategic Economic Plan outlines an application for inward investment from the Local Growth Fund of £596 million from 2015 to 2021, leveraging £1,342 million in private investment to improve the economy through:

- Creating 7,239 new homes
- Attracting 2,910,000 new visitors to the region, including 410,245 new international visitors to the UK
- Attracting £200 million in new inward direct investment
- Creating 1,000 new business start-ups and 22,000 new direct jobs

The integrated planning and prioritisation for delivery of these ambitious goals will benefit from a greater understanding of complex system interactions within the county. At present, strategic decision-making in Dorset is critically constrained by access to good reliable data in public and private sectors and in the ability to integrate activities between sectors; for example energy and resource management, water management and agriculture, housing and flood risk. Accessing robust data on primary production, marketing, trade and skills requirements presents a major challenge in developing and monitoring appropriate policy interventions in Dorset. Thus, Dorset decision-makers, business leaders and investors recognise the need to gather data, develop regional knowledge, embed integrated planning and build cross-sector confidence in the evidence base and decisions taken. By uniting economic, societal and environmental perspectives, a robust regional systems approach[3] would allow interventions to be shaped with common and credible economic analyses. This requires numerous new systems approaches, which need to be developed and tested before implementation. The tools and approaches must provide insights into the trade-offs of many combinations of new technology and policy options, and their impact on economic, environmental, and social circumstance.

A regional systems approach such as resilience.io was recognised at the 19th June workshop as fundamental to developing inward investment and community participation, not only in delivering annual strategic plans but to meet the combined challenges in Dorset of: (i) climate variability and extremes[4], (ii) below average productivity cost impact and escalation and, (iii) societal stresses including joblessness and poverty.

There is… *"no single view of the impact of a development or policy"*

The opportunity to be an EU Demonstrator test-bed will enable Dorset to attract new technologies from across the UK and EU for scale-up in support of the DLEP 2020 plan for low carbon, resilient, inclusive development. The reason for this attraction will be the ability for new technology businesses to test the beneficial impact of their technologies and new business models to be rolled out at scale using the resilience.io platform, and to form partnerships with local businesses for delivery with access to a regional investment fund.

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[3] A systems approach is the process of understanding how systems behave, interact with their environment and influence each other. 'Systems thinking' has been applied to problem solving, by viewing 'problems' as parts of an overall system, rather than reacting to specific parts, outcomes or events.

[4] The IPCC Working Group I's report on physical scientific evidence was based on 9,200 peer-reviewed studies.

Resource efficiency is another strategic opportunity to create jobs and reduce costs. Through regional private sector partnerships transformation can be achieved by a move to a 'circular economy'. If businesses collaborate within a region and develop symbiotic resource sharing using a collaborative resource flow platform, this can spark creative new solutions, boosting innovation rates. This approach also links into diverting waste materials from expensive landfill towards recycling and refurbishment. Also businesses are discovering that moving from selling products to selling services to communities, often with other companies, can be a source of greater profit but for this to be successful community needs must be factored in. This approach can yield the following benefits:

How economy will improve - from substantial net savings on material and energy costs, improved mitigation of volatility and supply risks (e.g. renewables), higher multipliers due to sectoral shifts and reduced externalities.
How companies will win - by creating new profit pools and competitive advantage, building resilience against some of today's most strategic challenges, and the opportunity for growth.
How consumers and users will win - by gaining more choice, experiencing fewer hassles from premature obsolescence, and enjoying improved service quality.

3. The resilience.io platform explained

3.1 A regional platform for data, systems modelling and scenario analysis

resilience.io is an open-source city-region platform[5] for planning, decision making & investment

- It is collaborative by design and is intended for use in city-region planning processes.

- It is a GIS[6] and agent-based[7] data collection and analysis system which calculates the resource flows from human and ecological activity through a region. Resources might be energy, infrastructure, water, population skill set, phosphorus or appealing natural environments like the Jurassic coast.

- It is the first computer-based model to integrate human-ecological-economic systems.

- It enables economically beneficial urban-rural initiatives to be funded and implemented through 'good' projects[8], together with insurance against extreme risks with an integrated focus on energy, water and food security.

Economic benefits	Social benefits	Ecological benefits
• data and information resource centre • evidence base for attracting inward investment • process for refining appropriate fiscal and economic policies • enabler of performance-based procurement • integrated land use and resource planning tool	• creation of jobs from new data and information source • skills mapping • training and skills development (with a dedicated education interface) • involvement of the community in data collection and decision making • accessing and growing cultural history • connecting environmental and social outcomes in e.g. the health community	• resource use management • improving agricultural performance • pollution and waste reduction • holistic carbon management • forestry management • measurement of key mineral and nutrients through the region e.g. phosphorous

Feedback from many stakeholders we spoke to during the three months in Dorset suggested that despite addressing complex issues by function of its design and capabilities, a simplified explanation of resilience.io was needed as a starting point. Stakeholders also suggested the name of TEST was readdressed - the platform is now known as resilience.io

In layman's terms resilience.io might be described as *"an integrated resource use planning tool"* or expanded, "*a new way of creating a future and informing decisions that considers holistically the interactions between economic, environmental and human criteria to promote Dorset as a place for*

[5] The resilience.io platform is currently being developed in the UK by Imperial College, London with support of the Department for International Development (DFID).

[6] GIS = Geographical Information System

[7] An agent-based model simulates the actions and interactions of autonomous agents with a view to assessing their effects on the system as a whole

[8] 'Good' projects are a portfolio of PPPs that meet the social, environmental and economic objectives for the region set by the DLEP & government whilst meeting the revenue and asset value increases required by the private sector to achieve return on capital.

innovation and investment". However for a person working in the health sector this description would have little traction, so it might be rephrased as *"a tool which can relate the health of the population to demographics, mobility and the availability of and access to green spaces".*

Illustrating the use of resilience.io at its most simple level and taking education as an example, data from a wide variety of reputable providers[9] is assembled in a Cloud-based platform[10]. The regions resource flows and human and ecological activity are visualized and processed through user-interfaces in "sector specific cockpits":

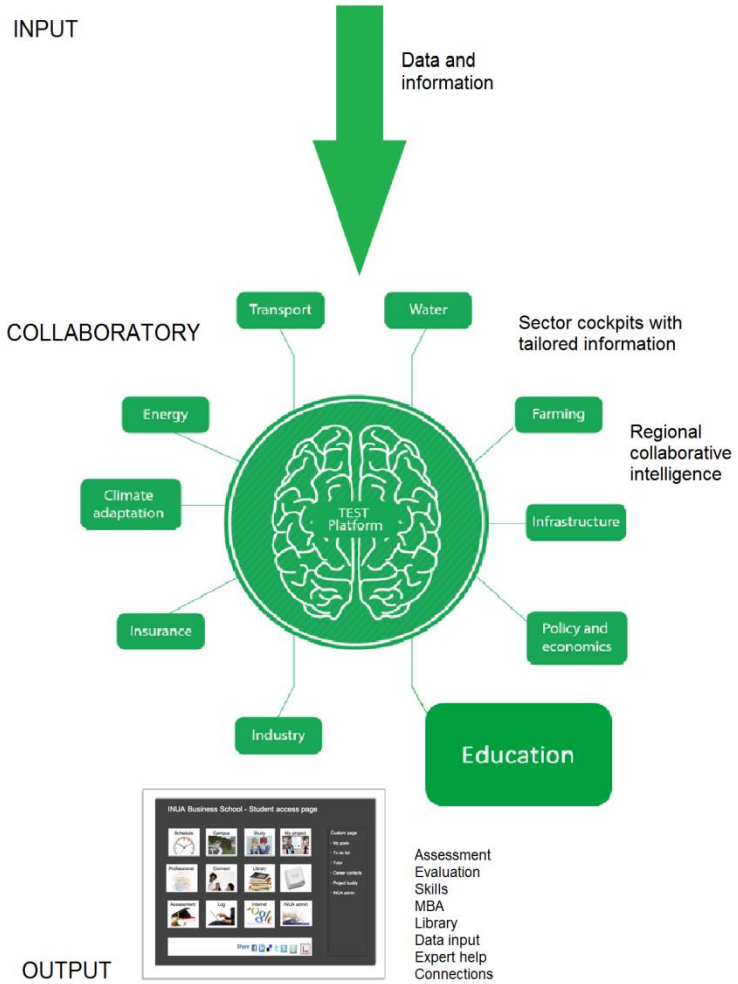

Figure 1 Simplified schematic of the resilience.io Collaboratory and an education cockpit

Users are able to select data, change parameters, change land use and agriculture-forestry practice, add new infrastructure and buildings, test new policies, add more data, conduct impact assessments, learn new skills, ask experts for assistance, build networks and collaborate with others using the tool. The tool becomes a competitive procurement framework for projects in which performance based competition winners have access to funding from a new Regional Investment Fund. Further, services can be shared and sold through Apps on the platform interfaces.

[9] Such as European Space Agency, Environment Agency, Dorset County Council and EC INSPIRE database

[10] "The Cloud" is a shared computer network which includes computing hardware or servers connected through a communication network such as the internet. Any individual user who has permission to access the server can use the server's processing power to run an application, store data, or perform any other computing task.

Delivering health and wellbeing benefits alongside projects that are earmarked as income and job generators can increase competitiveness and lower costs. Improving the quality of air, fresh and sea-water and soils and having daily access to biodiversity is known to impact positively on health and long term economics, and this is how the platform can be used to justify protection and enhancement of the local environment. The integrated analyses and design-led systems approach, coupled to regional capacity building, offers the chance to provide a stronger evidence base for linking physical and policy interventions with health and wellbeing outcomes and to enable access to funding for this change.

For those who require a deeper understanding of the technical detail of the platform's capabilities please refer to Annex 3.

3.2 Service value chain and interactions among customers, users & service providers

One of the ambitions listed in the DLEP 2014 strategy is to transform Dorset by leveraging its unique natural advantages. However, none of the ten points and principles for progressing and evaluating projects makes reference to social or ecological measures. The DLEP partners are "committed to ensuring that Dorset can deliver the local growth potential suggested by economic forecasts" and in order to deliver on this affirmation, significant measurement of resource investment will be necessary to meet the requirements of the 2003 Green Book for all development appraisal and evaluation (HM Treasury 2003). This methodology relies upon traditional monetary cost-benefit analysis and includes items for which the market does not provide a satisfactory measure of economic value. Sections added to the Green Book in 2011 [p57], outline the preferred market-based measure of social-cost-benefit, is the "willingness to pay to receive a good or service or the amount of compensation required to give up a good or service".

Without considering the relative merits and failings of these approaches, there is significant requirement for "plausible estimates" to be made by the DLEP in the valuation of time, health, environmental impact, green-house-gasses, climate vulnerability, air quality, water, biodiversity, noise, recreational and amenities and so on, vital for human wellbeing and all of which must be presented in multi-criteria business cases. Underpinning this evidence-based requirement is the assessment of risk – from natural and human induced causes. The resilience.io model might be one of several solutions the DLEP is considering in order to fulfil this commitment.

As suggested above, in order to deliver a Connected, Talented, Responsive and Competitive Dorset strategy requires a systems approach - the capability to link global, regional and local geographic data and information to agent-based (people) and process models and examine different scenarios. Through the case study work, The Ecological Sequestration Trust found that a vast quantity of geographical data and information is available from many different government agencies, public, private and other sources within Dorset, all found in a multitude of web portals and viewers. Ten organisations and thirty data sets were accessed to build the flooding case study discussed in Section 5 below exemplifying the arduous nature of building necessarily integrated cases. Often this means that it is difficult to use the data quickly and effectively, and because many people do not have the expertise and resources to access and process it in a meaningful way, it may take considerable time to develop projects and navigate them through planning. However, utilising an open-source Cloud-based setting

will enable geospatial information[11] and supporting technologies such as 'plug & play'[12] Apps, to be integrated with resilience.io to analyse data and information from multiple sources for multiple uses on any linked device (laptop, mobile phone, tablet), for the benefit of regional spatial planning, economic development.

This conveniently also negates the need to pay for expensive data servers, their maintenance, housing or upgrade. There will be many opportunities for local entrepreneurs to develop new communications and technology applications, as the first users of the tool in Europe.

3.3 Why resilience.io as opposed to other models?

A number of stakeholders in Dorset were keen to understand why Dorset should invest in this model over and above others. The 2013 review of current Advanced Agent-based Integrated Resource and Economics Models for City-Regions for the Technology Strategy Board's (TSB) Future Cities Catapult, found traditional city development simulations are now being augmented with, for instance, emissions-related information and the capability to model building energy use.

Most models have been developed in the corporate domain and are only available under service contracts for a given region, where the capabilities but not the model are delivered to the client, such as the T21 model which has already been suggested for deployment in Dorset. Most are still operating on open-ended material and wider energy supply chains, omitting the simulation of material and energy conversions within and across sectors[13] and ignoring economic systems by assuming exogenous growth factors or labour availability scenarios. Moreover, event driven (e.g. flood), long term (e.g. temperature), or seasonal behavioural aspects (e.g. tourism) find no or limited recognition. The economic modelling capabilities of these models were analysed by TSB with specific scrutiny, because the ability to provide insight into the economic consequences of scenarios relevant to city planning is a fundamental and growing requirement.

Globally and at time of writing, resilience.io is the only IP-free open-source model under development which includes ecological, social and economic city-region systems modelling capability, in a sector-specific accessible visual way, and which also provides the unique opportunity to 'bolt on' existing models as exemplified in the Christchurch flooding case study in Section 5 below. A summary of reviewed models is found in Annex 4. In addition, partnerships with organisations such as the European Space Agency ensure quality and longevity of data access and the Regional Accelerator funding solution explained in Section 7 guarantees resilience.io can be scaled up and financed in perpetuity out of the value it creates.

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[11] Conforming with Open Geospatial Consortium standards - an international industry consortium of 479 companies, government agencies and universities participating in a consensus process to develop publicly available interface standards http://www.opengeospatial.org/ogc/vision

[12] Examples of plug and play apps are e.g. The Train Line or Visit Dorset though these would not necessarily be integrated with resilience.io.

[13] The inputs and outputs of these conversions are necessary to understand technological choices and their impact on the transport system, environment, employment, and many other aspects related to the ecosystem of the city and its hinterland.

4. Objective 1 - Collaborative decision-making

A key part of the study was to assess whether building of a 'Collaboratory' for the governance, management and implementation of resilience.io would be feasible in Dorset. It was decided to take a three-pronged approach to this challenge, by approaching professional organizations and enrolling them in data sharing and building technical capacity, engaging and enrolling individuals and businesses by convening a cross-sector workshop, and forging links with a number of academic institutions.

4.1 Approaching professional organizations

The Ecological Sequestration Trust has engaged and enrolled EA, Wessex Water and DCC (among many others) in this project in the use of their valuable local expertise and significant amounts of data[14], which was modelled and layered to illustrate resilience.io capability using the Christchurch lower catchment.

4.2 Engaging and enrolling individuals and businesses

Acting on the advice of and leads from the resilience.io Project Steering Group/Collaboratory and key Dorset contacts, 141 carefully selected cross-sector individuals or entities from across the county were contacted, interviewed and engaged in the project proposal in the period April – June by The Ecological Sequestration Trust.

Target cross-sector mix for Dorset resilience.io feasibility study			
Government	**Academic sector**	**Private sector**	**Third sector**
Dorset County Council	Bournemouth	Balance between local, regional, international	Experience in delivering community projects
West Dorset	Kingston Mauward College	Sectoral relevance	Credible
North Dorset	Weymouth College	· Arts and culture	Competent
East Dorset	Avonbourne Academy	· Technology (IT or other)	
Christchurch	Southampton	· Infrastructure	
Purbeck	Exeter	· Leisure and tourism	
Weymouth	Surrey	· Finance and insurance	
Poole	Bristol	· Water & waste	
Bournemouth	Other	· Transport	
		· Retail	

Table 2 Target cross-sector mix for Dorset

Individuals were then scored against an impact and influence scale[15] asking "*who are the people or groups with an interest in this project and who will be affected by it and/or can influence whether it is taken forwards either positively or negatively?*" and rating low/medium/high and positive/negative/unknown by the resilience.io project team. Whilst not an entirely impartial system, the resilience.io team remained the same throughout the engagement process and thus the deviation from the objective scale used, was uniform across subjects. Evaluation was conducted via telephone or Skype calls, 121 or small group meetings with emphasis placed on building collaborative connections. Transparency was maintained throughout with all those engaged. The schematic in Annex 6 shows the breadth of cross-sector engagement achieved in the short timeframe.

[14] Please see Annex 5 for a full list of data made available and used in this study.
[15] This scale is employed by the UK's Foreign Office to assist in stakeholder selection processes.

From this scored group and under the advice of the resilience.io Project Steering Board, approximately 75-80 people were invited to attend the Pathway to a resilient future for Dorset workshop on the 19th June.

As exemplified above, compiling and combining data from multiple sources, using and employing a complete systems approach leads to greater depth of understanding of a situation and its possible scenarios or solutions. The same applies to people in a collaborative framework. The "Pathway to a resilient future for Dorset" workshop gave a unique cross-sector opportunity for learning and debate on whether resilience.io is appropriate for Dorset.

Invited speakers:

1. Tony Williams, Bournemouth Borough Council – Opening scene setting
2. Peter Head – The Ecological Sequestration Trust
3. David Buckland, Cape Farewell – Dorset farming community project
4. Martin Peersmann, Geodan – Visualization of flooding
5. Bob Lisney – Waste as a resource
6. Kevin Bygate, Specific – Buildings as power stations
7. Peter Matthews, Castlepoint – Because it makes economic sense!

The day closed with a short pause for reflection, a performance by local guitarist, Stephen Kenyon.

Plate 1 Pathway to a resilient future for Dorset workshop brochure

Held on the 19th June at the RNLI College, Poole, a location kindly donated for free due to the nature and content of the day, the workshop attracted 51 attendees across all sectors (Fig 9 below) and comprised of 33.3% from local government (Dorset County Council, Poole and Bournemouth Borough Councils, North Dorset, Christchurch and East Dorset Council local councils); private sector (infrastructure, retail, transport, finance); third sector (human rights, ecology, wildlife, communities);

academic sector (Bournemouth University and University of Southampton). The workshop also attracted attendance by national organisations such as Natural England, the EA and the National Farmers Union.

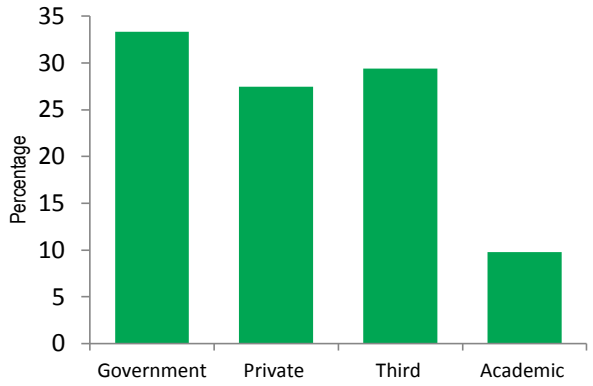


Figure 2 Workshop attendees as a percentage of total by sector

To ensure that all views were represented in depth, INUA Business School provided INUA provided an independent platform for people to share priorities and concerns about the resilience.io proposition leading two audience sessions, morning and afternoon entitled *Mapping Complexity*, a profiling tool to enable like-minded people – regardless of discipline – to group together for their initial discussions (See Annex 7 for explanation).

Mapping Complexity represents 5 fields of complexity:

I. *Managing Organisation* - a focus on data and evidence
II. *Managing Relationships* - engaging stakeholders
III. *Mapping Culture* - issues of culture, purpose and identity for a region or organization
IV. *Managing Context* - the big picture, strategic approach
V. *Implementing Change* – attention to detail and reliability and security of process

The discussion sessions at the workshop elicited deep and broad feedback from the many diverse interest groups represented as shown in the bars in Figure 10 below sorted by profile type.

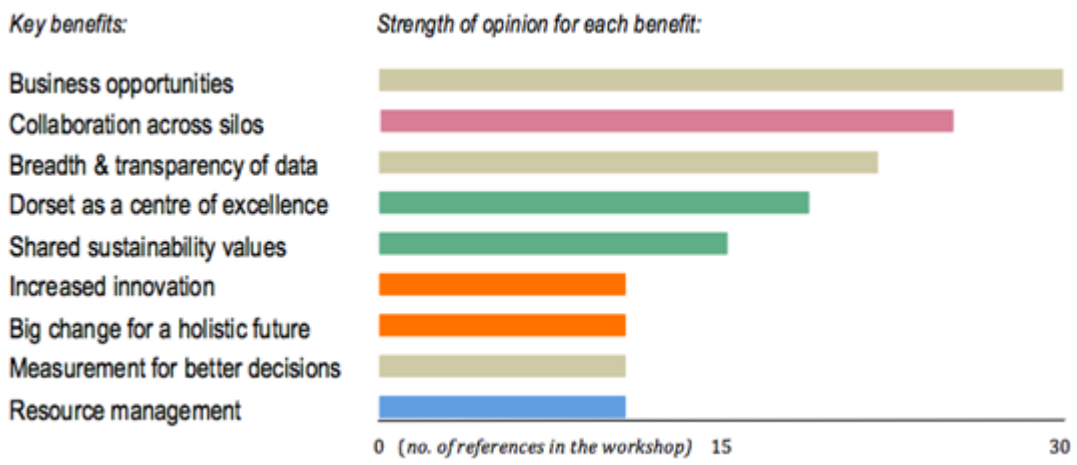


Figure 3 Key benefits of resilience.io platform based on audience feedback interpreted by INUA

The Mapping Complexity profiling tool shows that 'big picture thinkers' (orange) see the resilience.io platform as affording a holistic innovative approach; organised managers immediately see how the breadth and transparency of data will bring advantages to business and decisions; and it is worth noting how purpose and identity, a centre of excellence with shared values for the region was picked up in more than 50% of references made. To expand on INUA's evaluation of workshop feedback:

I. Managing Context – the big picture

"Dorset needs to innovate and take risks with investing in projects like resilience.io."

Dorset has a number of strengths - environmental quality of life, high-quality educational institutions, technology; these allow it to take its place in the global knowledge economy. With the resilience.io model these translate into great business opportunities, ensuring clear benefits for the environment and for ecological sustainability.

As time goes by there will be significantly more data available to support decision-making, and businesses and regional institutions will benefit from becoming involved at this early stage. For the future, bringing together the LNP and DLEP on projects locally, but always looking globally, is the way forward. resilience.io would allow for scenario building of projects prior to implementation, offering real benefit to the region.

II. Managing Organisation – evidence, data

"The amount of data which resilience.io would supply is massive…social, environmental and ecological, all in one place."

resilience.io offers breadth of data accessible from just one place, making a truly holistic picture possible, and giving it strong commercial viability. Its ability to highlight the commercial value of initiatives and projects, to inform decision-making, and ensure infrastructure is constantly improving, will give new strength to communities. Moreover, with transparent and measurable information, it will generate the evidence people need to be positive about sustainability. Open data of this nature leads to new ideas, and new levels of innovation.

Wealth generation comes from employers and businesses. With high quality information both in and out of the model, perhaps supported by technical teams in local universities, they can continue to generate wealth whilst protecting the environment.

III. Implementing Change – reliability of process

resilience.io offers an important tool for public sector planning, with useful practical information for project managers. Its 'knowhow' information would allow for many and varied commercial applications of big data.

How the tool is implemented - the interface with resilience.io, interrogation of the data, how the system responds as information changes – all will be important in its success. But it is its neutrality that makes it relevant in a political environment that is increasingly dependent on collaboration for future success.

IV. Managing Relationships – engagement and collaboration

"This open source data model is the driver we need to get together to collaborate and pool resources."

resilience.io is a systemic tool that will make collaborative working much more possible. With high-quality information all in one place, this open source data model provides evidence for better decisions, and, adding in the environmental perspective, is the driver needed to collaborate and pool resources. It develops a critical mass that can demonstrate wider social and environmental benefits.

Dorset needs to attract people from diverse backgrounds and age ranges, and this offers a real opportunity to engage both young people and the silver surfer generation. They will need the sense of empowerment that comes from easy access to data and information, and it will be important to engage openly with people, and to encourage them.

resilience.io allows people to see "the greater good", to find early adopters to cascade to others, to take action differently, to retain skills to support growth sectors and to make change happen with more intelligent, meaningful discussions.

V. Mapping Culture – identity and values

"resilience.io will help work with communities, manage concerns, address limitations, raise expectations…"

What does Dorset want to be known for? resilience.io offers neutral ground to be the catalyst to change mind sets about sustainability and the circular economy. By using the model, learning will spread from early adopters and new values and understanding will come from change.

resilience.io is a holistic way to approach the future. It is not just pounds, shillings and pence; it will generate consensus of opinion and big picture change across the region.

What makes Dorset special?
It's because we live here and we're committed to its future.

The workshop clearly signalled a considerable interest and intent from a broad range of individuals from government, private, third and academic sectors in adopting this kind of collaborative integrative solution that balances and embeds social, environmental and economic impacts. The commitment and support of the existing Project Steering Group/Collaboratory members has been exemplary throughout the period and six delegates (from private, government and third sector) applied to join the now expanding resilience.io Project Steering Group/Collaboratory to progress the project within a week of the workshop. The conclusion drawn from this study suggests there is sufficiently strong will and buy-in across sectors for the set-up and implementation of resilience.io to be a success.

4.3 Forging links with a number of academic institutions

During the study period The Ecological Sequestration Trust worked to introduce the platform to and forge links with a number of academic institutions, required to fully support the local development, implementation and testing of the resilience.io platform as the EU Demonstrator. It is hoped that Bournemouth University would become the home of resilience.io and benefit from the potential knowledge and skills enhancement made possible through its maintenance and associated research programmes. Under the leadership of the senior university staff, researchers at Bournemouth University have stated their interest in taking the platform forwards.

Peter Head (CEO) was invited by both Exeter and Southampton Universities to present the resilience.io project to staff (and did so at Exeter), and both have expressed strong interest in collaborating with Bournemouth University, building on existing relationships and significantly on new technology capacities in the fields of GIS, systems computing, geography and social science.

5. Objective 2 - Christchurch flooding case study

"Enhance the skills of our current and future workforce" and offset skills gaps, remove blockages to employment and enable adaptation and innovation in the region's present and future workforce.

Dorset's nine local authorities cover an area of 1,024 square miles and 745,300 citizens. Over 75% of the population are located in the south east of the county in the conurbations of Poole, Bournemouth and Christchurch, although the county is predominantly rural in character with the World Heritage Jurassic coast to the south and two Area of Outstanding Natural Beauty designations covering 53% of the county. Flood risk in Dorset relates to flooding from (i) the main river catchments of the River Brit, the Frome, Stour and Hampshire Avon which all drain into the English Channel. Coastal and tidal flood risk is apparent at the main communities of Lyme Regis, Seatown, West Bay, Chiswell, Portland, Weymouth, Swanage, Poole, Bournemouth and Christchurch. Areas of Dorset are also susceptible to significant flood risk from surface water and groundwater flooding. Flood risk in Christchurch is related to flooding from the River Stour, which along with the Avon, flow out though Christchurch Harbour. Christchurch also is at risk from surface water flooding.

The Comprehensive Climate Change Risk Assessment (2010) supported by the IPCC WGII report (IPCC AR5 WGII 2013), states moderate risk of increasing temperatures, changing rainfall patterns, rising sea levels and more extreme weather events in the period up to 2050 for Dorset; predominately intense rainfall and flooding with higher temperatures exacerbating exposure of persons and property in flood risk areas, plus problems with crop growth, pests and diseases, risk from food poisoning and thermal discomfort across the region. Some areas are within the high or Flood Zone 3 risk category[16] (EA 2014). When economic growth is included, economic flood losses in Europe could increase 17-fold under the A1B climate scenario (Rojas et al. 2013 in IPCC 2014).

5.1 Technical capacity building to reduce flood risk and improve decision-making

Geo-information tools are available but underutilized and rarely used for typical planning tasks, such as sketching, forecasting, analysis and evaluation of policy alternatives (Vonk et al., 2005). The resilience.io partner Geodan digital Cloud-based environment allows for collection, visualization and analysis of potential spatial development according to certain policy objectives (Koomen, 2011), for example water quality, flood risk and/or economic development.

Devastating floods, droughts and contamination can be prevented or ameliorated. A solid understanding of hydrological behaviour should therefore be integrated in any urban systems design and planning effort that aspires to be sustainable.

In the following pages, we will illustrate how potential future flood area or land-use configurations can be modelled according to different scenarios. By up-skilling and using spatial models in this manner, land-use patterns can be optimized according to specific constraints or policy objectives and solutions developed for a variety of spatial (in this case flooding) problems and evaluated by a variety of stakeholders.

[16] National Planning Policy Guidance Flood Zone 3 - land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.

To illustrate the power of integrating data for decision-making, just a few combinations of the 21 generated layers have been selected for display in this report.

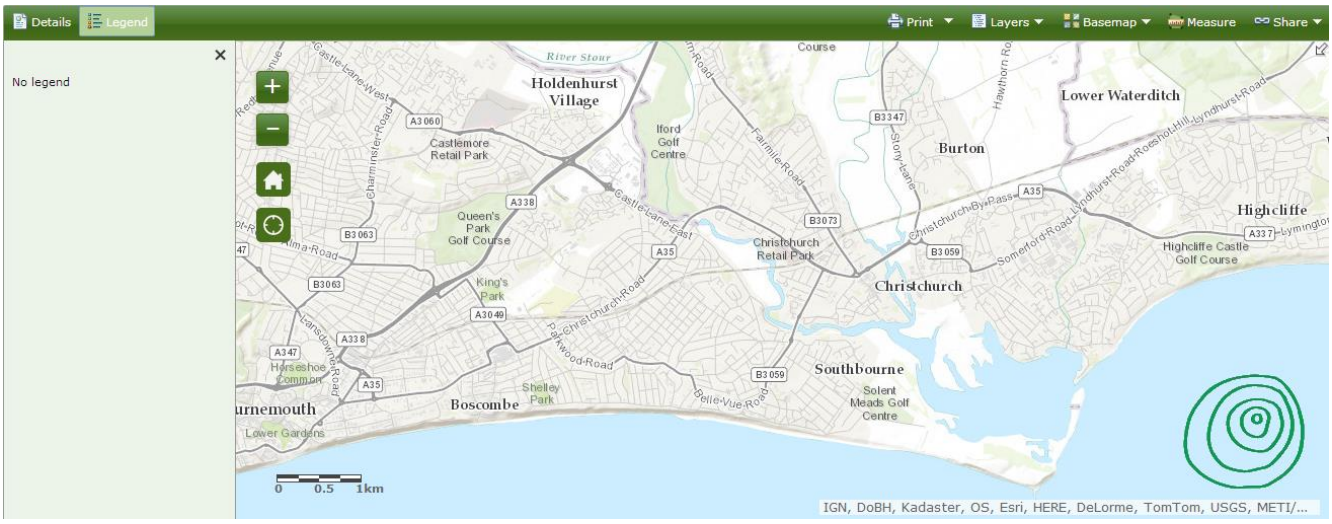


Figure 4 Base map of Christchurch and surrounding area

Flooding from rivers is a problem in many of the urban areas in Dorset, including Christchurch (CBC, 2009 & EA, 2012) and problems with coastal inundation are significant. In fact, the most significant floods experienced in Christchurch[17] have been from main river and tidal events. However, Christchurch is also susceptible to local flooding when the surface water system cannot discharge due to high river and/or tide levels (DCC, 2011). Thus groundwater flooding, coastal inundation, main-river flooding and surface water flooding must be considered together.

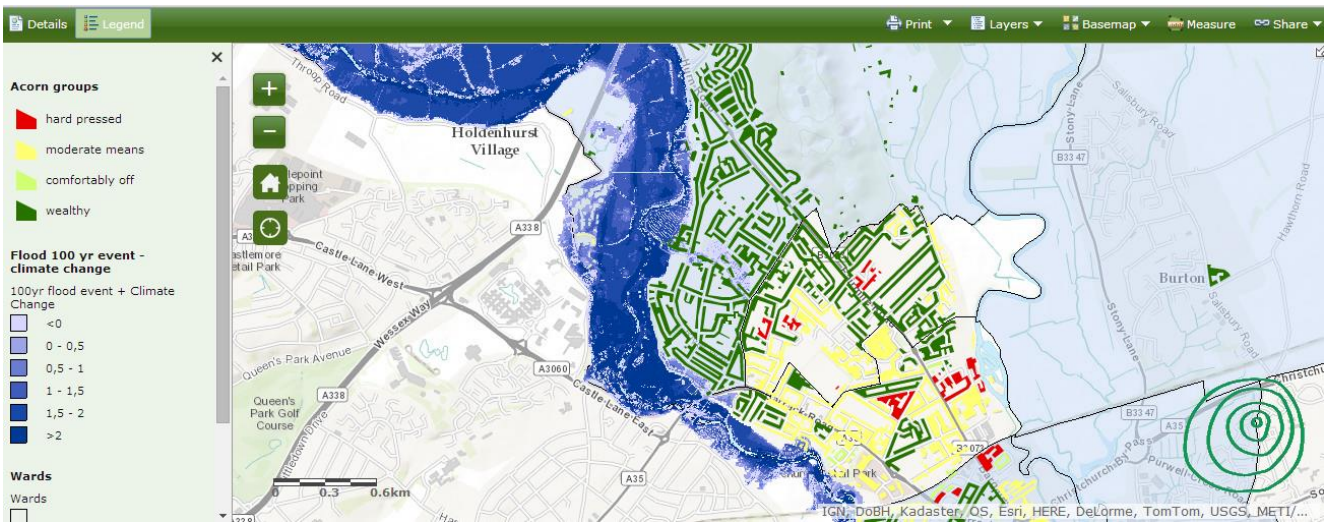


Figure 5 Detail of Christchurch showing socio-economic service needs of the population as classified by Acorn groupings, (green = wealthy, yellow = of moderate means, red = hard pressed) plus wards flooded in 2013 – 14 plus modelled 100 year flood event but not showing all sources of flooding.

[17] The Department for Environment Food and Rural Affairs, DEFRA, has ranked 'places where flood risk is an issue' by population. The DEFRA threshold is 200 people, 20 businesses or more than one critical service being flooded to a depth of 300mm. Christchurch is above this threshold, with 24 non-residential properties at risk, along with 21 residential properties and a total of 49 people (DCC, 2011).

It is interesting to note that the wards flooded in 2013-14 were not the Acorn "of moderate means" or "hard pressed" areas but "wealthy" areas. High priced real estate is often found along rivers where more affluent residents are able to afford insurance policy costs prior to and repair in the event of floods. Despite UK summers being drier overall, rainfall indicative of serious flash flooding could become almost five times more frequent (Kendon et al., 2014). With increasing flood risk, and despite the Water Bill levy-funded reinsurance scheme 'Flood Re' passed in the Commons on the 7th May 2014, some residents or holiday home business owners in Dorset may experience an increased frequency of flooding and/or find it difficult to afford flood insurance in the future (see Fig 4 below).

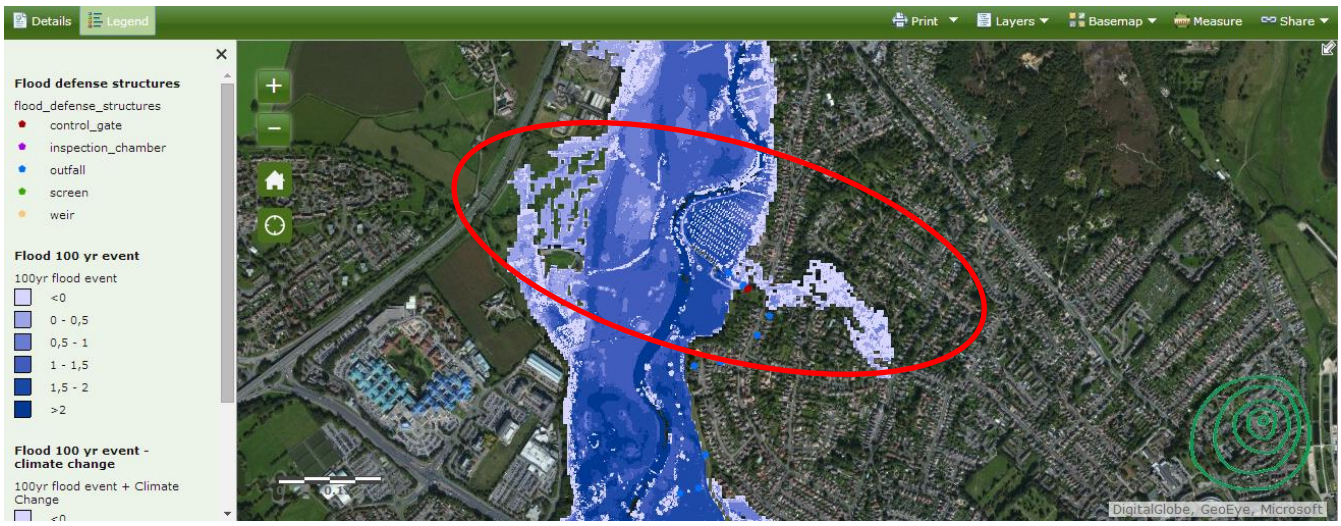


Figure 6 Closer detail of Christchurch showing a 100 year flood event, surface flooding 2013-14, plus flood defence structures. The area to the left of the River Stour is farmland and to the right is both residential land and holiday accommodation.

Within the Dorset Stour catchment as a whole, there are 1,500 people and 780 commercial and residential properties at risk in a 100 year event (EA, 2012). This risk takes into account existing flood defences such as flood walls at Christchurch and the pumping station at Blandford Forum. The estimated number of properties at risk from flooding in this catchment in the future is likely to increase to over 2,900 properties (EA, 2012). Climate change will have the greatest impact on flood risk across the catchment. Land-use will have the most significant impact on flood damages, particularly in the lower catchment due to high urban density and accumulation of increased run-off upstream (EA, 2012). The floodplains of both the Avon and Stour have been heavily developed since the 1960s with land being reclaimed and developed on both sides of Christchurch Harbour. Large areas of impermeable urban surfaces and the loss of wetlands increases run-off and exacerbates risk.

The plans to develop houses in Christchurch or within the catchments of the Rivers Stour and Hampshire Avon, which drain into Christchurch need to consider the impact of developments on flood risk from all sources of flooding. Users of resilience.io will gain deeper insight and be able to conduct more rigorous collaborative evaluation e.g. using the linked Geodan touch table for water, waste and planning scenarios than is currently possible.

5.2 Integration of data sets with existing models built by partner organisations[18]

Lack of clarity and integration between responsible parties has been cited as an obstacle to sustainable water planning (Ellis and Revitt, 2009; Pitt Review, 2007). The Flood and Water Management Act (2010) introduced the role of Lead Local Flood Authority (LLFA) which has a key role in flood management of coordinating the flood risk management activities. Within Dorset, Dorset, Poole and Bournemouth all have LLFA responsibilities. DCC's Local Flood Risk Management Strategy clarifies the roles and responsibilities of Flood Risk Management Authorities within Dorset's Administrative Boundary. resilience.io coupled with Geodan's methodologies provides the opportunity for all parties to share, assess and illustrate data beyond good solutions already being undertaken by DCC and the EA.

The model for Christchurch as it stands is intended to be a snapshot of what can be achieved using the resilience.io model. If adopted, hydrological models of rivers across Dorset and of tidal flooding would be added to give a complete picture of flooding dynamics in the region.

5.3 Live data integration

The resilience.io platform will offer a holistic suite of analysis, so that flood defence feasibility can move beyond economic cost-benefit analysis; the Joint Research Council of the European Commission, a formal partner of resilience.io with whom we worked during this feasibility study, received approximately 250,000 Tweets[19] in total either with coordinates (Lat/Long) falling within the Dorset area, or where the place name in the Tweet (e.g. South West, United Kingdom) was intersecting the bounding box around Dorset (shown in green below).

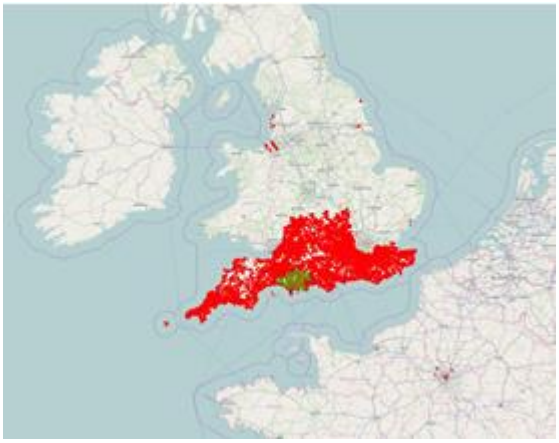


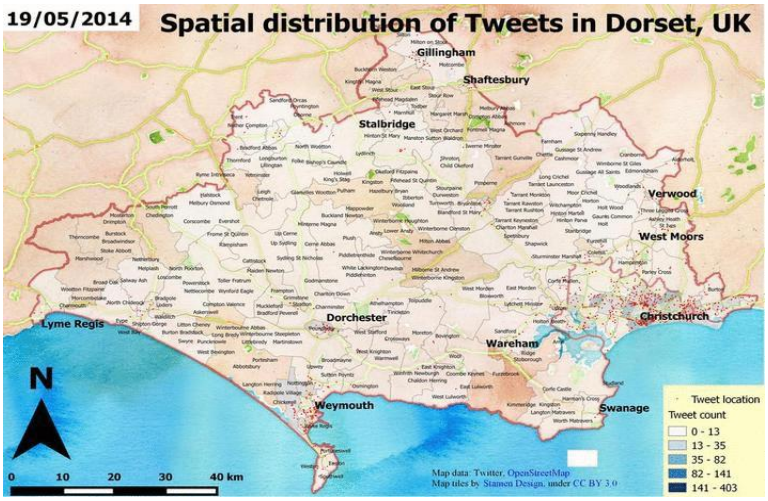
Figure 7 Spatial extent of harvested Tweets 9th May – 19th June[20] 2014 (JRC 2014)

The distribution of Tweets in Dorset is shown in the next animated figure. It should be noted, that only some 5-6% of all Tweets are geocoded (tagged by location).

[18] Such as the Environment Agency 2-D Lidar Stour model.

[19] Privacy regulations are upheld i.e. quoted Tweets, are from individuals who have consented to geocoded location tagging and sharing their Tweets.

[20] Tweets were only harvested for the period of one month for illustration purposes.



Ctrl+Click here to play animation

Figure 8 Distribution of Harvested Tweets in Dorset (JRC 2014)

Of all the harvested and geocoded Tweets, in the summer period 19th May – 19th June 2014 less than 90 included the term "flood".

THURSDAY, 26 JUNE 2014 – Dorset Echo
"Extreme weather threatens Dorset's infrastructure, warns Institution of Civil engineers South West".

time	Latitude	text	Longitude
2014-05-31 08:17:51	50.734	I think after Thursdays flash flooding you need to use a different weather forecast	-2.740
2014-06-04 11:44:38	50.979	Wet saturated Dorset ! Mega rain again. Back of our house flooded again last night. It has to dry up soon!? Re-run 2012 again!	-2.201

Table 3 Tweets relating to 'flood' during the monitoring period19th May – 19th June 2014

The results of the analysis do not show a large number of tweets related to flooding during this summer period, but they do capture the power of this medium. If local authorities launched a hash tag to report flooding issues, it might be an efficient way to complement other measures for monitoring critical areas in case of flooding or in the management of flood evacuation strategies and the protection of key roads or infrastructure.

THURSDAY, 4th JUNE 2014
We need defences.

The press is always quick to react:

FRIDAY 6th JUNE
Weather warning puts Dorset on alert!

Trained staff analyzing results such as those illustrated above in the Cloud environment[21] in more detail (and with more time), would significantly add to the rigor of regional spatial and flood planning, and help inform flood incident response and recovery. The economy benefits from start-up and added value of

[21] The vast data sets had to be uploaded to encrypted hard drives and sent by secure post to the Netherlands costing valuable research time. Web services architecture in a distributed geo cloud as outlined by OGC (Open GIS Consortium) and advised by the EU Joint Research Centre (JRC) is strongly advocated for when TEST is adopted.

resale using web infrastructure whilst reducing risk, improving safety and resilience with respect to the increasing effects of climate change[22] (in this case flooding) in Dorset.

Ellis and Revitt (2009) identified the major impediments to integrated urban drainage management as institutional and socially dependent, as opposed to technologically dependent. A key role of Dorset County Council's Flood Risk Management team is to become a Sustainable Drainage Systems Approving Body (SAB) in 2015. This will require new developments to consider the impact of developments on surface water runoff. The resilience.io Collaboratory would help inform the SAB in the decision making process regarding approval and adoption of surface water systems and to bring together the key stakeholders in Dorset flood management. The central issues revolve around stakeholder and social relationships and a shared understanding of the key issues and collective flood intelligence would support holistic flood management decisions. Improvements in governance, process and structure is critical to delivering future sustainable drainage options. It is recognised that disaggregating and quantifying the various components of surface water flooding is required in order to identify fully appropriate and cost-effective drainage options. resilience.io would bring all the required data together in one place using uniform standards which supports this advice. The development and implementation of key demonstration projects and associated training programmes would serve to build greater trust and confidence in performance of a wide range of multi-sector technical models, as well as to promote and strengthen institutional and stakeholder participation networks and protocols (Ellis and Revitt, 2009) While Dorset already benefits from existing flooding models, these would be enhanced if coupled to enable quadruple probability assessments (fluvial x2, tidal and surface water flood risk).

In section summary, the resilience.io platform gives all organizations involved the capability to utilize this web-based service architecture for the integration of global, regional and local geographical information. The extensive modeling currently carried out by the Environment Agency (EA, 2014) can be integrated with global projections, resource flows and other environmental, economic and social data. resilience.io will model, visualize and simulate whole community systems. The process will require forging strong links between different groups, simultaneously providing a forum for discussion and decision-making between key stakeholders working towards more sustainable and resilient solutions.

For instance, Dorset now has a network of approximately 120 flood wardens who work with the Relevant Flood Risk Management Authorities to help communities manage their own flood risk. This kind of collaborative working was a success story for flood management in the historic town of Pickering in Yorkshire (Whatmore et al., n.d.) in a project funded by the UK Research Councils' Rural Economy and Land Use Programme. The project had a participatory format to involve local people with science, and engaging agencies and decision-makers with scientific expertise rather than solving the flooding issue at hand per se. Extensive work was carried out with stakeholders to this end to bring them together to collectively consider and evaluate scientific models. This led to the development of a range of integrated land management practices that aimed to reduce flooding at catchment scale and with collaborative momentum behind the proposed plan the community worked hard to achieve its goals. Pickering is now a pioneer in catchment scale solutions that provide multiple benefits for local communities.

[22] The 2013 IPCC WGII report states moderate risk of increasing temperatures, changing rainfall patterns, rising sea levels and more extreme weather events in the period up to 2050 for Dorset. Some areas are within the high or Flood Zone 3 risk category (EA 2014).

During the feasibility study links with The Ecological Sequestration Trust partner GEODAN were established and the offer of high level water management expertise from the Dutch Government Water Board was offered and accepted by Dorset and training on the GEODAN Geodesign/Geoplaza methodology and TouchTable taken up.

6. Objective 3 – Commercial and industrial waste case study

The following question was posed at the resilience.io workshop: *"what are the M&E activities we could have conducted prior to investment over the past 10-15 years (not just on one project) if we had had resilience.io?"* Though this report touches on waste components identified by the preliminary analysis as presenting possible opportunities for business development, this analysis is not designed to provide the answers, merely to give an indication of the evidence available for decision-making, how this might be used and some possible options that could be taken forward for development in the Collaboratory.

"Moving businesses up the value chain to enable them to be more productive and competitive remains a key challenge" (DLEP 2014). What is certain, is that in order to move towards a circular economy, industry leaders will need to diversify and work together to rethink their business models.

For a city-region to achieve resilience against natural and man-made shocks, it is necessary first to understand where it stands today in meeting its water, food, energy and economic resource needs. This requires understanding the extent to which it relies on its regional hinterland to meet its needs and the extent to which it draws in resources from a wider geography. The Ecological Sequestration Trust's approach is to provide city-regions with this information on the 'here and now' and provide them with the means to explore the potential impacts of future scenarios.

Economic development is increasingly resource-constrained and the 'take-make-dispose' model now under threat from rising raw material costs and negative environmental costs which ultimately affects human wellbeing. Dorset farmers are already dealing with the rising prices of fertilizer as global peak phosphorous is expected in 2027[23] (Cordell et al., 2009). The move towards a regional circular and re-generative economy poses a huge opportunity for business innovation with significant economic opportunities, both short and long-term, that are available across the EU, suggested to be a recurring 3-4% GDP cost saving (Ellen McArthur Foundation, 2012). resilience.io offers the catalyst for a sector wide revolution in integrated, collaborative regional planning and development.

"Transformational change with economies fit for purpose"

Incremental development in individual fields of expertise will not deliver the necessary step changes in resource use and the required outcomes for health and wellbeing – for individuals, communities, economies, and the natural and built environments. The radical shifts required can only come from

[23] Phosphorus efficiencies are achieved through genetic engineering of crops, erosion control, and targeted application of fertilizer and more simply though growing crops close to where farm animals are raised, so manure and urine replenishes phosphate in soil. Reducing food consumption also helps.

systems innovation and active collaboration across multiple disciplines. If the resilience.io platform were to be taken forward, there would be three outputs, oriented around the circular economy paradigm.

1. A technological analysis of the materials available, local markets and new technologies that can be used to process this material
2. A spatial analysis with maps showing where waste is arising and where it might be good to identify locations for new technologies
3. An analysis of the policy and business environment, looking practically at how this kind of action could be undertaken. Some options include creating incentives, increasing taxes, mandating data collaboration or creating brokerage services.

In recent years there have been large reductions in the quantity of waste material being sent to landfill and new reprocessing technologies are being developed (e.g. CPI, 2014). However too much material continues to go to landfill and is lost as a resource. The resilience.io platform users could collect known data on the nature, quantity, location and destination of wastes. The resilience.io platform would also derive unknown data from the areas currently out of scope. It models materials ("resources"), conversions ("processes"), both natural and synthetic, and will also include business models, economics and behaviour (Figure 11). By using locally derived data locale specific logistics can be examined, innovative ways of utilising the materials generated, customer demands and technology needs assessed. It will model in a complex way looking at a wide range of alternatives. The results can be used to generate business opportunities that work from an investment and return point of view.

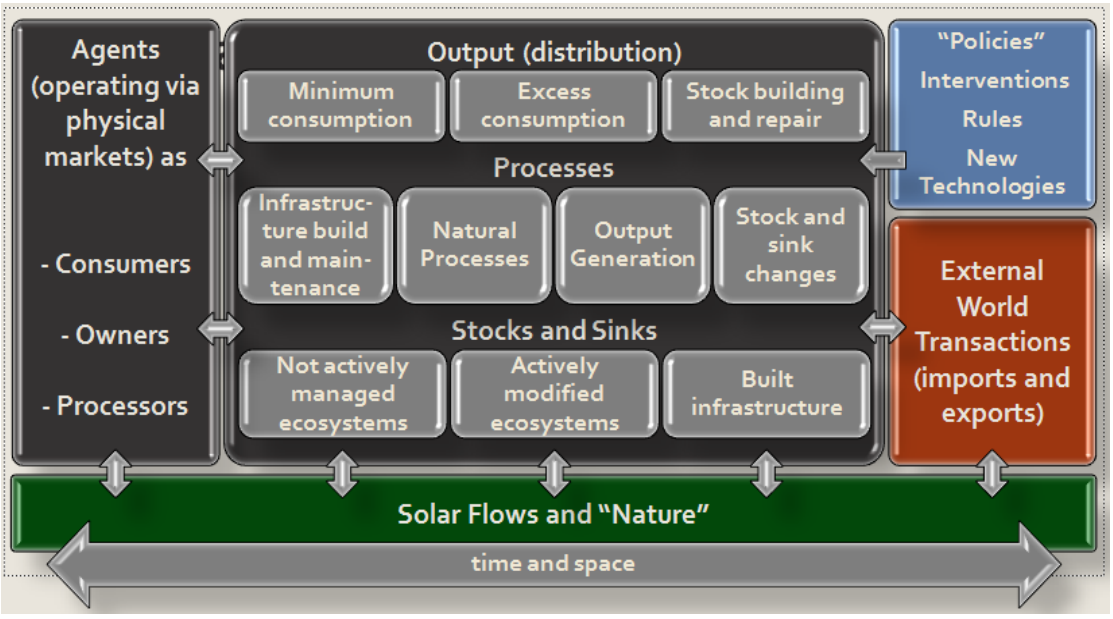


Figure 9 The structure of the resilience.io platform model

If applied to waste streams, the resilience.io platform would be considered holistically. In this case study only the commercial and industrial (C&I) waste stream are considered (although inevitably waste streams blend and there will be some consideration of waste arisings from other streams). C&I waste arises from places that are wholly or mainly used for trade, business, sport, recreation or entertainment. Also waste from factories used for, or in connection with, provision of public transport, public supply of gas, water, electricity or sewerage services, or provision to the public of postal or communication

services (DEFRA, 2011). For the purpose of the Dorset Waste Plan, C&I waste includes agricultural waste i.e. all wastes that are discarded from agricultural premises except on-farm animal and plant wastes, which fall outside the scope of the Waste Plan (DCC, 2013).

The key concept influencing this plan, and others nationally, is the 'waste hierarchy'. This is not only a guide to sustainable management but it is a legal requirement and it ranks waste management options according to what is best for the environment (Figure 12).

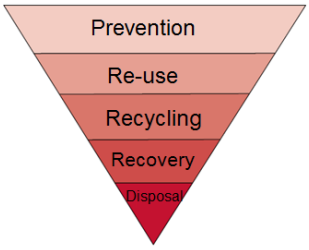


Figure 10 The Waste Hierarchy

Another guiding principle within the WFD is that waste should be disposed of, or recovered, in close proximity to where it is produced using appropriate transport and technologies to ensure a high level of protection for the environment and public health. Therefore, the waste management network needs to be designed in a way that enables self-sufficiency in waste recovery and disposal, meaning that there is sufficient capacity available for waste generated in an area to be processed within that area.

New development projects that can effectively demonstrate that they balance social, economic and environmental needs, and are therefore sustainable, will be approved without delay (DCLG, 2012).

After short consultations with Bill Davidson, Head of Strategy (Dorset Waste Partnership), Ian Manley, Contracts Team Leader (Dorset Waste Partnership) and Emma McDonald, Senior Planning Officer (DCC) and introductions by Bournemouth Borough Council to the main C&I waste processing companies operating in Dorset: New Earth Solutions, Eco Sustainable Solutions, Viridor and Sita were invited to collaborate in this study. Some of these companies shared their commercially sensitive summarized data for illustrative purposes.

Based on inherently patchy baselines, a C&I waste survey carried out by DEFRA in 2010 identified that almost 500,000 tonnes of C&I waste was generated in Bournemouth, Dorset and Poole in 2009 (DEFRA, 2011) of which around 100,000 tonnes or 24% currently goes to landfill. Of the total C&I waste arisings approximately 3% was re-used, about 53% was recycled or composted, and 0.7% was treated with energy recovery. Around 5% was transferred onwards. [24] A breakdown of waste types within the C&I waste stream can be seen in Figure 13.

[24] This only adds up to 87.5%. The remaining management methods include land recovery, thermal treatment, non-thermal treatment and unknown.

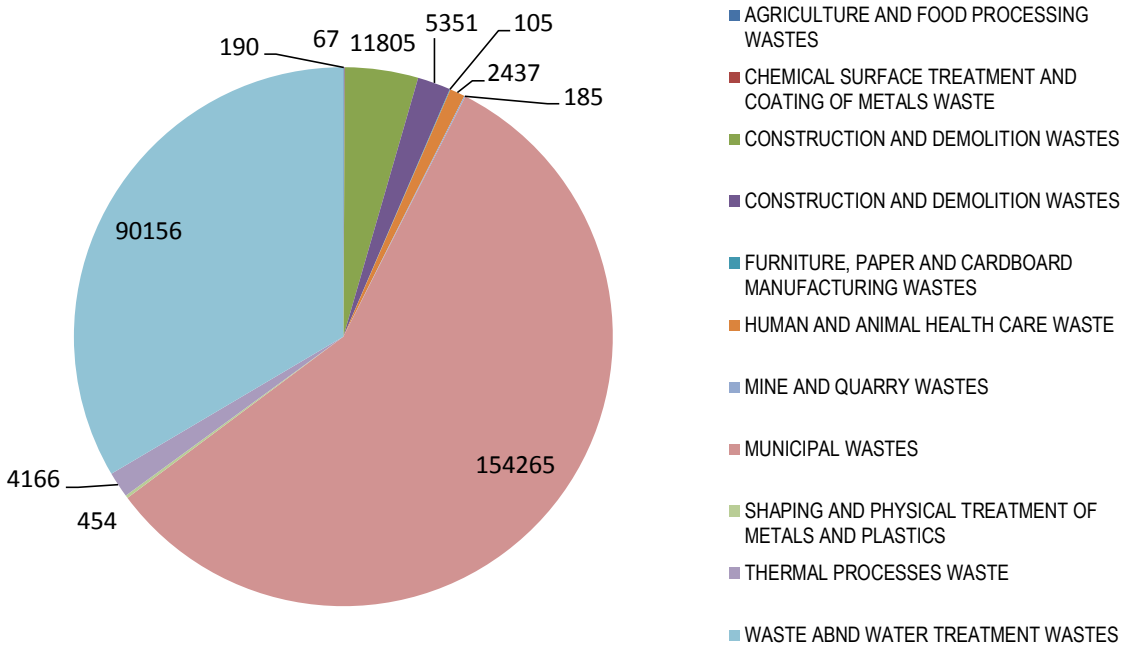


Figure 11 Types of waste in tonnes within the C&I waste stream (Adapted from EA data, 2014)

Although the UK is sending more waste to landfill than some of its European neighbours, this may, perversely, represent an opportunity; the UK's current reliance on landfill means that there is a gap in the provision of infrastructure for handling waste. This could present, for example, an opportunity for enabling the future development of a high value bio-economy—the UK needs to find ways of diverting carbon-containing waste from landfill and could achieve this by putting in place facilities and processes which extract maximum value from it (HoL, 2014). The resilience.io platform would allow Dorset to assess, quantify and evaluate the opportunity offered by this, or other circular economies.

Data was processed using the integrated resilience.io algorithms considering only organics across all waste streams:

Organic waste type	Current estimate
Green waste[25]	0.1m tonnes per annum (tpa)
Biogenic fraction of municipal solid waste (MSW) and C&I waste[26]	0.5m tpa of C&I in region, estimate 12% biogenic 0.4m tpa of MSW, estimate 30% biogenic
Agricultural waste[27]	0.1m tpa
Wastewater treatment solids[28]	0.1m tpa
Total	400,000 tpa.

Table 4 Estimation of organic waste production in tonnes per annum in Dorset

[25] Based on typical arisings and estimate of green hectares in the county.
[26] Estimates based on Dorset Waste Plan. Resilience.io estimates 30% is too low; DEFRA (2013) figure for biogenic fraction of MSW is 68%, with a 2020 range of 55-75%.
[27] Estimate based on typical arisings per ha (around 1-2 t/ha) and number of hectares under cultivation (around 50-100,000).
[28] Estimate based on the population and typical arisings.

The 2013 DCC Dorset Waste Plan Issues Consultation report estimates that 12% per annum of the total C&I waste arisings is organic waste, around 180ktpa. Collected agricultural wastes are included in this figure, however the vast majority of agricultural waste is dealt with locally (e.g. spread on land) to avoid collection fees. Here we assume that an additional 100,000 tonnes of organic waste could be made available waste that is currently processed on site.

From the data the resilience.io platform has derived the value of processing organic material rather than landfilling it is about £4m per annum; a significant contribution to the Dorset economy.

Current destinations - 7 facilities	4 x Anaerobic Digestion and 3 x composting
Total capacity (approx.)	150,000 tpa (approx. 115 kpta composting)
Value generation estimate	
Composting[29]	£60,000 pa
Anaerobic digestion[30]	£4,000,000 pa
Unknown - Value generation / tonne processed	= 0
Total current value-added	**£4.06m** [estimate]

Table 5 Anaerobic digestion calculation

Landfill tax is currently £80 a tonne. Value creation of £4m as opposed to costs of 400,000 tpa x £80 = £32m is clear incentive to process this waste rather than send it to landfill. Further to this, composting is not even a high value added activity. The Ecological Sequestration Trust philosophy is to make even better use of the routes for biogenic material and to demonstrate through the resilience.io modelling what opportunities there are in a specified area.

6.1 Upcycling of biogenic waste: systemic opportunities

Examples of opportunities arising from a more sophisticated approach to processing organic waste involve intercepting the waste at source and optimising the end use by waste type. The assumptions we have used relate to the better use of material and using it for higher value products. For example:

- Segregation of all bakery waste to use for animal feed > £100/t
- Hydrolysis of green waste and conversion to industrial biotech and chemical feedstock: value added ~ £200/t
- Gasificaiton of sludge, waste wood etc. and conversion through fermentation (e.g. Lanzatec process): value added ~ £200/t
- Maximising the benefit of AD through integrated nutrient cycling and grid integration

Potential future value-added is > £40 million p.a.; a tenfold increase through integrated analysis and new technology. Based on these results, there is a potential for a £40 million market in organic materials in and around Dorset. The House of Lords recently published a report on this topic and concur on the size of the opportunity (HoL 2014).

[29] Based on an estimate of the value of the compost (0.5 tonne compost per tonne of waste and value of £50 per tonne).
[30] Based on the typical yield of 300 m3 of gas /tonne of waste and value of 38p per m^3 of gas.

6.2 Is £40 million p.a. too good to be true?

The offset of gross profits would be the collection and reprocessing costs which conventional waste companies charge for whether they recycle or dispose of the waste. The business case would thus be to generate micro /local businesses which can do this with innovation and with low overheads. Most of the technology is standard and not very expensive, and if Dorset were to take resilience.io forward, overheads such as plant set-up costs would be investigated in detail. Even if it cost as much to recycle as the resulting profit, there are still savings from avoiding taxes and socio-economic benefits from the creation of local jobs and investment. Wages in waste collection and materials recovery are roughly in line with the national average (University of Exeter 2013).

The lack of data freely available is, and has previously been identified as the core challenge (WRAP 2009). Without this, it is difficult to establish a map of material flows in any one geographical area. Collaborative sharing of waste data between local authorities, the Environment Agency and waste management companies would lead to a more efficient use of transfer and storage facilities (e.g. for bulking) and transportation.

6.3 Benefit of spatial approach

The benefit of using the resilience.io comprehensive modelling approach is that it enables a helicopter view of what is happening now and allows one to forecast various new ways of making improvements from a carbon reduction, economic and environmental point of view.

An example from Korea shows how resource recovery / upcycling should be designed in a holistic way, so that the product, processes and chain are optimised for a circular economy system, rather than the current approach which is to bolt-on recycling processes.

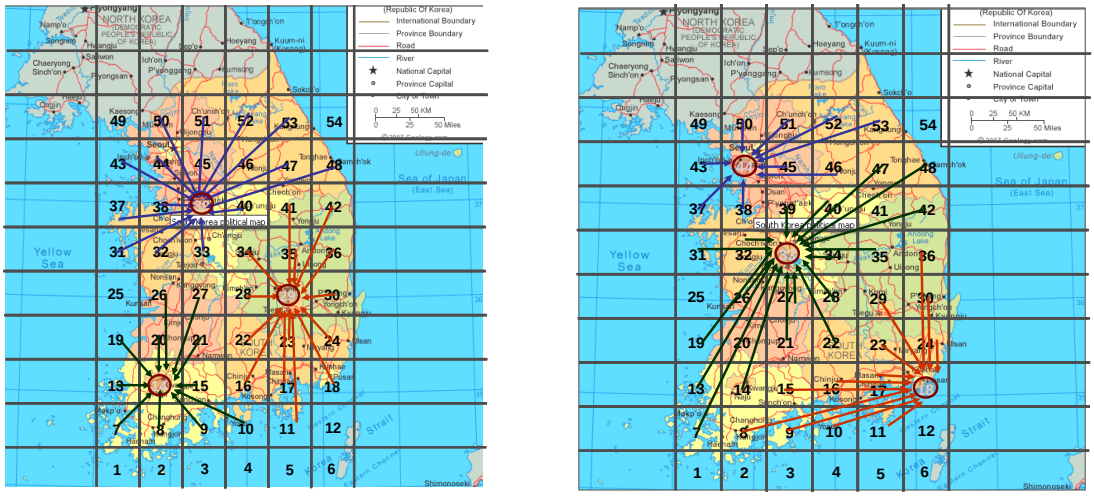


Figure 12 The existing (left) and optimised (right) transport networks for fluorescent lamp recycling in Korea

The resilience.io Imperial College team are working on fundamental techniques for supply chain design and applying them to diverse applications, including fluorescent lamps in Korea. The diagrams in Figure 14 above show their reconfiguration of a fluorescent lamp recycling logistics network; the optimised network has a 60% reduction in transport energy and carbon emissions.

In section summary, adding value to waste products is an idea with great currency. However it is hindered by a lack of data, a lack of clear business models and a need to synchronise system / infrastructure and markets. Cohesive plans for the future utilization of C&I waste would only strengthen the economy in Dorset and early adopters will reap the best rewards. resilience.io has been set up recognising these issues. Spatially-, temporally- and technologically-rich data sets will be included in the platform and proxies used where data gaps are found. Geo-localisation and data fusion will keep the system up to date, economic and activity models will be used to explore different business models and benefits can be quantified.

This case study showed how limited the collaboration between public and private sector oranisations in this field is and highlights the scope for reward if that situation was improved. EU waste targets will become tougher to achieve and some materials prices will see steep inclines in the years ahead. If Dorset does not have the means to secure processing in the UK, local industry will have to pay rising costs to continue to export waste material, giving others the benefit of processing it a a resource. However, no part of the supply chain can act without help. The resilience.io model can act as a catalyst to make the new resource paradigm work effectively. Once adopted, those interested in making the model work can work collaboratively with e.g. New Earth Solutions or Eco Sustainable Solutions to populate it with the right data and become involved in the delivery of solutions. This will future proof business, help Dorset to reduce its regional carbon emissions and, in the long-term, ensure Dorset survives for the next generation to enjoy be enjoyed as its residents do today.

7. Objective 4 – Economic resilience

The following section answers Objective 4, by reviewing the role of Dorset-based institutions in project development and ownership (the Collaboratory), providing feedback to DLEP on outcomes of potential funding beyond the feasibility study and seeks to answer whether there is the prospect of an increase in access to capital across the region to meet needs of the strategic economic plan and evolve it further.

7.1 Funding structure

Based on the overwhelming engagement and enthusiasm detected at the workshop and significant drive from within the Collaboratory, The Ecological Sequestration Trust has taken on board the initial reticence felt for a loan financing mechanism and has been persuaded to include the EU Demonstrator in two of its core funding packages from Climate-KIC and the European Space Agency.

The Ecological Sequestration Trust funding plan for building and implementing the resilience.io platform in demonstration regions is as follows, the Department for International Development is funding the development of the platform at Imperial College, London and Institute for Integrated Economic Research (in progress) £1.5m.

During the development phase of approx. 15 months (July 2014 – Oct 2015) the EU Demonstrator platform will be set up. It is envisaged that the Dorset Collaboratory will work with the developers during this time to ensure the platform is suitable for testing in Dorset. In order to do this, from February 2015, The Ecological Sequestration Trust will contribute £200k central funds for its input to Dorset and make £500k available for local organisations to become involved in creating the Collaboratory and platform. This will be backed by bids for Climate KIC-European Space Agency funds to build user

interfaces, create visualisation tools, a data brokering framework and data gathering and implementation in a region of Europe.

The Ecological Sequestration Trust has already been invited to bid for this funding and now extends the invitation to the Dorset Collaboratory to submit a full proposal by September 2014. This proposal includes a partnership with European Space Agency and ICES Foundation who are developing an earth systems modelling platform. The partnership will look at global-local linkages through integration into the systems models of satellite and local sensor data, which will enable the impact of different risk scenarios to be evaluated. OASIS (insurance framework) has agreed that a connection between resilience.io and OASIS, would enable insurance products to be taken to new markets. The platform will be a 'plug and play' framework to create value and increase the market for systems tools such as the Geodan touch table which is already being discussed with DCC/EA. The platform can also be used in community neighbourhood projects and supports carbon measurement tools.

In addition, through Geodan's engagement efforts since the workshop, the EC Joint Research Council will consider a bid of £180k for support on water management in Dorset using INSPIRE data and working with the local EA and DCC.

Demonstrator set up TEST	£200k
Demonstrator set up Dorset organisations	£500k
Dorset partnership with EC JRC and Geodan	£180k
Total	£880k

Match funding will sought from National Government with support from DLEP for £880k for the set-up of resilience.io for the first two years, then a contribution sought from National Government of another £1m from 2016 to 2018 to enable the platform to be fully operational and self-sustaining.

7.2 Investment vehicle for Public-Private-Partnerships

"The goal of the financial system is to put resources to productive use, to transform maturity, thereby contributing to the good of economic stability and full employment - and ultimately, to the wellbeing of people, in other words to enrich society." (Christine Lagarde, Managing Director IMF, Guardian, 26th June 2014)

Pension funds are constantly seeking new local good investment projects and the market growth in green, sustainable and innovation funds is strong; JP Morgan reported in its 2014 Spotlight on the Market: The Impact Investor Survey that its respondent group of 125 investors committed USD 10.6bn in 2013 and intend to invest 19% more in 2014 and citing a "shortage of high quality investment opportunities with track record" as the most limiting characteristics of the market today. In 2014, Centrica established its first £10m social investment fund, Ignite Social Enterprise, the UK's first social fund focused on energy. Over the next ten years Ignite Social Enterprise will make investments in the UK of between £50k and £2m, with its first investment of £500,000 in Midlands Together Community Interest Companies (CIC) to scale their work buying, refurbishing and selling empty homes, creating opportunities for people facing barriers to employment (HM Government 2014[31])

[31] HM Government Growing the social investment market: 2014 progress update.

It is our opinion that, as set out in the 2014 DLEP Strategy, there are already sufficient good' projects'[32] to enable resilience.io to help create a Regional Investment Fund; for example, Jurassica, a project with huge investment potential.

Initiated by The Ecological Sequestration Trust, a "Regional Accelerator Scale-up Fund" is being created, as a self-supporting source of finance in order to scale up the use of resilience.io platform in other LEP's and regions across Europe and the world, with contributions from those interested in Impact Financing. The platform provides the evidence base for this. This will enable the opening up of global opportunities for Dorset businesses which develop new business models and products that can be accessed through Apps on the platform.

Long-term maintenance of the resilience.io platform in Dorset and any other region will be supported by "platform fees" charged for its use during "good project" procurement phase and will be part of an initial agreement with any project developer. This nominal 2% fee on the capital flow into projects from the Regional development Fund will pay for the upkeep and maintenance of the platform, staff and Collaboratory, and necessary data purchases. The project developer will recoup the 2% in savings during the design and planning phase through their use of the extensive data and analysis capability of the platform in reducing development costs.

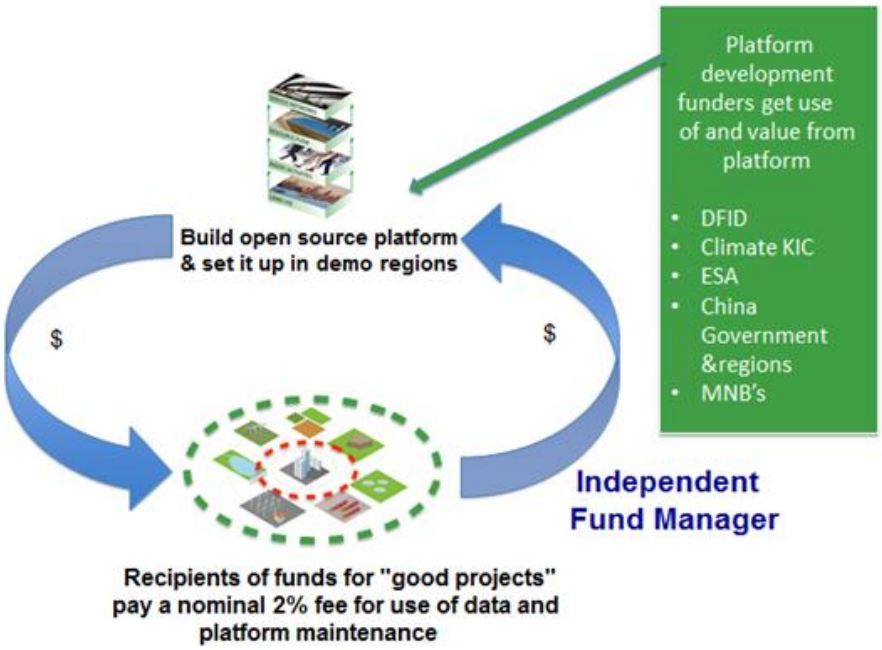


Figure 13 resilience.io Regional Accelerator Scale-up Fund

These "good projects" might be the Jurassic Coast Studies Centre which requires £1m in match funding to unlock the Wellcome Foundation offer or Jurassica to boost Heritage Lottery and Local Growth Fund contributions or Memo which without £25m in private finance will not go ahead. "Good projects" are not

[32] "Good" projects are a portfolio of PPPs that meet the social, environmental and economic objectives for the region set by the DLEP & government whilst meeting the revenue and asset value increases required by the private sector to achieve return on capital.

limited to those listed in the current DLEP strategy but include any brought to the Collaboratory for evaluation, supported with data and analysis from resilience.io platform from around the county. The afore mentioned two projects are particularly pertinent as the fact that the "*mass of SMEs in Tourism* [which] *cannot invest in large scale growth projects*" was flagged as a risk in the recent DLEP strategy and the ability to "*build on Tourism strength to adapt and develop new world class attractions"* as a strength.

Of course, 'good' investment decisions can only be made based on robust, open data and information and Dorset businesses and consumers now have an opportunity to step out of the high-carbon, resource intensive pattern of economic activity and increase resource use and efficiency and thereby productivity, if the decision is made to invest in an enhanced information base on environment, resources and social value.

7.3 Governance and the Collaboratory

The decision to secure Dorset as the EU Demonstrator Region for resilience.io has a number of implications. Please note details are still top line as this project is in the development and innovation phase rather than the planning and delivery phase.

The platform will be governed by an independent cross-sector group, the Collaboratory, building on the existing Project Steering Group and increasing its number to between 15-20 members. A formal secretariat of members with an executive board will report to its respective organisational members. For the set up phase a number of key organisations will be identified to lead e.g. the DLAP. The Collaboratory will be responsible for liaison between partner organisations and overseeing the set-up, implementation and testing phase of the project. The Ecological Sequestration Trust will support the Collaboratory with specific expertise from its Advisory Board and wide network of expert contacts.

As already discussed above, a review was made of Dorset-based individuals and institutions, with regard to their influence and impact for taking the resilience.io project forwards. Strong support and buy-in to take this project forwards has been demonstrated by an increasingly broad group, all of whom have contributed significantly to this study.

No.	*Organisation*	*Sector*	*Key contact*
1	Mouchel	Private sector	Jago Atkins
2	Bournemouth Borough Council	Government	Tony Williams
3	Bournemouth Borough Council	Government	Neil Short
4	Local Nature Partnership	Third	Simon Cripps
5	Dorset County Council	Government	Vicky Farwig
6	Environment Agency	Government	Katherine Burt
7	Bournemouth University	Academic	Ian Jones
New members: joined post 19th June workshop			
8	Cobham plc	Private sector	Carolyn Gomez-Skins
9	Association of Sustainability Practitioners	Third	Gwyn Jones

Table 6 Collaboratory members as of 17th July 2014

The Collaboratory would be supported financially for time spent in developing and delivering resilience.io for Dorset.

7.4 Academic input

Due to the communication restrictions placed on The Ecological Sequestration Trust during the study by Bournemouth University, it has not been possible to ascertain whether there is sufficient support and expertise within the university to host resilience.io at this institution. Thus flagged as a risk to the set-up and implementation of resilience.io, expertise has been sought elsewhere to cover this eventuality.

It is however proposed that Bournemouth University, the Universities of Exeter and Southampton pool their specific and complementary skills to build capacity and support the following:

1. Building the resilience.io platform for Dorset by managing the data population and data quality (hardware and resource).
2. Providing long term research support to improve the platform and its local use including building greater value to local stakeholders.
3. Establishing massive open online course (MOOC) teaching / research programmes linked to the platform, which could be used locally and globally.

Exeter host the interdisciplinary Climate Change and Sustainable Futures programme and have strong links to the southwest-based UK Met Office; Southampton host the GeoData Institute supporting environmental, social and information science applications. Both have expressed an interest in working with Bournemouth to deliver this cutting-edge programme of research. As demonstrated at the workshop, the inclusion of art and culture and social sciences is paramount to the success of resilience.io and as such, strong representation from faculties covering these disciplines is also sought.

"The cultural element was completely fantastic.
It is often lost in day to day business but is critical for success and so inspiring"(Cobham)

The total number of academic staff expected to oversee the hosting of resilience.io in Dorset has not been calculated as we suggest this is done in collaboration with the host. However, a ball-park figure is between 3-5 full time interdisciplinary staff plus a wide variety of studentships (docs, post docs, masters and MBAs).

7.5 Impacts

Impacts are seen to be positive: resilience.io and academic staff working on it will be fully financed, securing jobs and broad research opportunities of choice. Collaboration across universities in the UK will increase skills and capacity in Dorset, specifically in the fields of GIS and earth systems, visual effects, and social sciences. Specifically, the visualization of data in the cockpit design and gaming applications for Dorset youth would be an interesting project for Dorset's digital industry in collaboration with the universities, especially as Dorset forecasts growth in digital and creative industries backed by commercial partnership and strong R&D base. Exact work packages are to be developed with the academic group once buy-in is assured.

resilience.io partner INUA[33] , will be developing a Business School in the Cloud with global teaching and research programmes focus on sustainability, enterprise and innovation. Its role is to draw together the diverse interests of academia, the public sector and the corporate world using the technology of gaming,

[33] INUA independently conducted the aforementioned Complexity Mapping participant discussion sessions at the workshop.

immersive worlds and advanced learning analytics to provide personalised experiences, accredited qualifications and a platform for communities to share and learn across geographical boundaries.

International collaboration opportunities with our hosting partner organisation, the Chinese Academy of Sciences (CAS) in China, will ensure Dorset and partner academic institutions benefit from significant international exchange. The Ecological Sequestration Trust is securing demonstrators in several countries in the next 12-24 months[34], building a significant academic base for resilience.io.

The academic group will be supported financially for the development and delivery of resilience.io for Dorset.

7.6 Risks

Trust in data and its transparent evaluation is a critical factor flagged as important at the Dorset workshop. In answer, resilience.io is a facilitator without vested regional interests. All the experts who have worked on the design of resilience.io have relinquished any IP rights and thus resilience.io is IP free and uses freely available open-source data. Data use is at the discretion of each city-region. Should a city-region require additional data, funds will have to be sought and/or made available with which to acquire it or collaborative relationships and funding bids built to support this end. As exemplified during this feasibility study, this kind of collaborative, mutually beneficial outcome has been perfectly possible at small scale and without cost working with e.g. EA, Wessex Water, DCC, New Earth and Eco Solutions. Funding to cover the Collaboratory and future data acquisition will be available through the "good project" financing mechanism explained above.

Data quality control is the responsibility of the data provider[35] monitored by the local/regional academic institution(s), governed by the independent resilience.io Collaboratory. Data is kept, updated and maintained at source by the data provider e.g. INSPIRE, British Geological Survey, Ordnance Survey, the EA, who all collect and maintain their own databases'. Users draw appropriately summarized data down from the resilience.io Cloud environment as per project requirement. Large data servers are not required.

7.7 Sector specific cockpits (the user interface)

A regional group of sector specific stakeholders will work with the central resilience.io Imperial College team to assist in the specific design of the user cockpits, for example, JP Morgan for finance/insurance sector interfaces; Bourne Leisure and Poole Harbour Authority for leisure and tourism cockpit; NFU, Kingston Mauward College and LNP on the farming cockpit. RIBA have offered to support the urban planning cockpit and so their members in the region could be invited to take part.

Which sector cockpits are suitable for Dorset is to be decided by the Collaboratory; these will then be developed in partnership with Imperial College and the aforementioned universities to ensure they are fit for purpose and road tested.

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[34] DFID is funding The Ecological Sequestration Trust for an 18-month investigation into which countries to engage as demonstrator regions 2014-16. Thereafter it will fund their set up and implementation for £30-50m.
[35] The INSPIRE data quality and specifications are met by several ISO standards including EN ISO 19115 and EN ISO 19119. http://inspire.ec.europa.eu/documents/Metadata/MD_IR_and_ISO_20131029.pdf

8. Next steps and seed funding approach

1. There is no requirement for funds at this initial stage.
   To support Phase 1 of the implementation of resilience.io in Dorset, the following funding has already been ring-fenced by The Ecological Sequestration Trust based on the findings of the feasibility study and through an initial successful bid made to the European Space Agency and Climate-KIC (July 2014).
   1. £700k of which 500k for local organisations and advisors to project (available Feb 2015) and £200k to cover The Ecological Sequestration Trust costs of setting up in Dorset (available Feb 2015).
   2. £180k European Commission Joint Research Council water management using INSPIRE data working with Environment Agency (available Jan 2015).

   TOTAL = £880k
   A full proposal will need to be submitted by mid-September to secure point 1 and a proposal for point 2 would need to be worked up with TEST partners Geodan. The Environment Agency and Dorset CC have already made contact with Geodan through TEST and are keen to pursue this opportunity.

2. To enable the platform to be fully operational and self-sustaining as a UK demonstrator, and if the project is seen to be successful in the first two years National Government could be approached for a Phase 2 sum of £1m from 2016 to 2018.

3. It is proposed that Dorset becomes The Ecological Sequestration Trust EU Demonstrator region for the resilience.io platform. Formally established and steered by an Executive the independent Collaboratory (Secretariat) will be set up to govern the implementation of the platform. The next steps are:
   (i) Establish the Collaboratory
   (ii) Define roles, responsibilities, accountabilities and reporting cycles
   (iii) Prepare a funding and lobbying plan for the project

   The Collaboratory currently includes representation from:
   - DLEP
   - LNP
   - Bournemouth University
   - Mouchel
   - Environment Agency
   - Dorset County Council
   - Cobham PLC
   - Bournemouth Borough Council
   - Association for Sustainability Practitioners

"Dorset can be the place that really deepens our understanding of our fragile role in (geological) history and indeed how precarious our position is and at the same time, decides to help kick start a global movement towards a more resilient future for ourselves and the earth's ecology" (Memo, 2012)

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Annex 1 resilience.io Project Steering Group, study approach and TOR

Members:

1. Philip Warr, PH Warr Plc
2. Tony Williams, Bournemouth Council
3. Neil Short, Bournemouth Council
4. Ian Jones, Bournemouth University
5. Simon Cripps, Local Nature Partnership and Dorset Wildlife Trust
6. Anne Gray, Dorset County Council
7. Jago Atkinson, Mouchel

The key question for Dorset is *"has Dorset maximised the advantages it possesses?"* It was proposed that using the resilience.io platform to integrate and present wide ranges of data would help make collaborative decisions that are less siloed and take account of economic, environmental and social factors is advantageous for Dorset. Further, the resilience.io platform would enable outside direct investment through the establishment of a regional revolving[36] fund for "good projects"[37]. The Project Steering Group agreed the following objectives[38] to ascertain whether the resilience.io platform is a suitable option for Dorset:

Objective 1 Collabor-atory	**To increase Dorset's collaborative planning and investment decision making capacity, the contribution made by people and businesses, and their linkages with academic and/or training institutions; to assist Dorset LEP (DLEP) to make a decision on whether the resilience.io model is one of the correct decision-making tools to support Dorset's sustainable development.**	
Action/ owner	Formed by the 'Collaboratory' including but not limited to DLEP, LNP, Bournemouth University, Dorset Wildlife Trust, Mouchel, the EA and Mr Terence O'Rouke and resilience.io, the Collaboratory will research, evaluate and enrol a cross-sector selection of potential partners[39] best placed to take the RESILIENCE.IO Demonstrator forwards if adopted.	
Reason	One of the foundation concepts of the resilience.io model is collaboration between sectors, based not only on economic but also ecological and social data which current models are not. This objective will illustrate that this cross-sector group from government, academia and private sector can gather (though meetings and workshops) for non-siloed Dorset decision-making.	
Measure of success/ output	i. Small leadership group (the Collaboratory), is formed of established organisations and individuals with history of engagement and success in sustainable development practices.	i. Achieved – as a direct result of the overwhelmingly positive workshop applications were requested to expand the group by 2 members.

[36] i.e. self-sustaining and not requiring future funding bids, match or top up funding.

[37] "Good" projects are a portfolio of PPPs that meet the social, environmental and economic objectives for the region set by the DLEP & government whilst meeting the revenue and asset value increases required by the private sector to achieve return on capital.

[38] For full TOR, actions, responsibilities and outcomes see DCC contract. Full contract value = £20,000. The RNLI generously gave the workshop venue free of charge; Geodan gave all resource –T&S and internship costs for free; EA, Wessex Water, private sector organisations and DCC made no charge for data sets used in this study.

[39] This may include expertise from outside Dorset if necessary.

	ii. Group attends the "Pathway to a resilient future for Dorset" workshop showcasing both the TEST platform and the Dorset specific projects outlined in the following objectives, actively seeks to enrol their wider networks in the DLEP/TEST goals and examines the benefits of the TEST approach.	ii. 6 out of 7 institutional members were engaged: EA is now actively seeking advice from TEST partner Geodan; Mouchel is in discussion with one of the TEST key speakers on energy efficiency technologies. 6 members have sought to enrol their wider networks. 1 member did not attend the workshop however, overall this measure has been achieved.

Objective 2 Waste	**To support new business growth, resilience.io will demonstrate how data can be used to improve decision making for e.g. waste.**	
Action/ owner	Working with DLEP/LNP, the EA, Dorset County and/or the local Borough Councils resilience.io will identify willing local Dorset private sector company/ies[40] which produce and/or process industrial waste. Agreed data[41] will be uploaded into the resilience.io proxy GeoPlaza as a resilience.io case for waste management. resilience.io staff will track progress[42], highlighting opportunities and challenges encountered by the stakeholders along the way to exemplify how decision-making could be advanced by using the resilience.io platform.	
Reason	Non-municipal waste was highlighted as an area for action by the collaboratory stakeholders on 17th February 2014 e.g. growing demand for organic waste treatment technologies fuelling significant levels of interest in anaerobic digestion (DLEP strategy 2013). The pitfalls and successes of this trial will provide gap/strength analysis for DLEP and other companies regards taking resilience.io forwards, if adopted.	
Measure of success/ output	i. The EA and a local company/ies will be enrolled and their platform learnings tracked and shared amongst the Collaboratory. NOTE: Until the platform is built it is not possible to process data using the designed whole systems approach. Expert estimates have been used for the purposes of this case study.	i. Geostore data was accessed from the EA and 2 of the 4 C&I waste processing plants contacted, New Earth and Eco Solutions agreed to share summarized commercially sensitive data with TEST. Both waste companies were happy to contribute to the project and see waste as a resource rather than a disposable material. Viridor and Sita declined to engage. The relationship with New Earth and Eco Solutions needs to be strengthened for the next stage of this project.
	ii. At the workshop TEST will share the results of the above and exemplify the potential of new sustainable business solution to industrial waste processing.	ii. Using the summarized data from New Earth and Eco Solutions the Imperial College team estimated the potential value add to Dorset of over £4 mill from anaerobic digestion.

40 TEST would welcome input from the ‚collaboratory‚ on which companies may be open to this kind of approach

41 This data should be available to the local authority under EU regulations.

42 Through interviews with the selected company/ies staff.

Objective 3 Flood risk	**To reduce risk[43] to Dorset LEP business growth and innovation**	
Action/owner	Subject to collation of available data, resilience.io will demonstrate flooding scenarios using the proxy GeoDesign capability working with DLEP, LNP and the EA.	
Reason	Flooding in Dorset was highlighted as a risk by the EA in their national report of 2009[44]. Dorset County Council is now a Lead Local Flood Authority and a local Flood Risk Management Strategy is currently being drafted. A preliminary flood risk assessment has been carried out, in which data availability, access and processing issues have been flagged[45].	
Measure of success/ output	Using UK location data (INSPIRE obligatory data set) supplemented by regional and local data sets provided by Dorset LEP/county or local councils, the EA and e.g. National Flood Forecasting System, England & Wales, Delares NL, the core TEST GeoDesign methodology will be illustrated to fit in with/beyond solutions already being undertaken by DCC and the EA.	The EA, Wessex Water and DCC have responded to this project case study in style. The EA discussed, selected and shared data worth £000s with TEST; Vicky Farwig was instrumental at DCC and shared new data with TEST. Data from 10 organisations was combined to produce multiple visualizations.

Objective 4 Economic resilience	**To broaden Dorset's sources of financial support for economic growth**	
Action/owner	Working with the Dorset LEP Steering Board and private sector stakeholders, resilience.io will investigate the potential to create a Regional Investment Fund for 'good projects'. This will include outlining set-up costs, rolling funds, repayment methods and levy payments from capital flow arising from using the platform for procurement in the region and how it would be governed.	
Measure of success/output	i. Prospect of an increase in access to capital across the region to meet needs of the strategic economic plan and evolve it further. ii. Feedback to Dorset LEP on outcome of potential funding beyond the feasibility study and outline. iii. Section in final report	
Measure of success/output	i. Prospect of an increase in access to capital across the region to meet needs of the strategic economic plan and evolve it further.	i. The Regional Accelerator Fund is a new fund, being created in the City of London and in China to support demonstrator regions with investment for "good projects". PRH has held 2 meetings with Fiona Wolf, Mayor of the City of London and presented at Mansion House on 2nd June.
	ii. Feedback to Dorset LEP on outcome of potential funding beyond the feasibility study and outline.	ii. Several opportunities for funding have been presented to Dorset: (i) ETI funding call for energy cockpit development (ii) ESA/Climate-KIC funding for demonstrator region pilot
	iii. Section in final report	iii. Outline of funding for set up is presented in the main body of this report.

[43] For the purposes of this investigation, flood risk
[44] EA 2009 report http://a0768b4a8a31e106d8b0-50dc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/geho0609bqds-e-e.pdf
[45] https://www.dorsetforyou.com/localfloodrisk Preliminary Flood Risk Assessment

On the initial advice of the Environment Agency and in consultation with the DLEP resilience.io Project Steering Group, two local case studies were chosen in order to demonstrate resilience.io modelling and visualization capabilities, in addition to the staging of a "collaborator"[46] workshop and this report in plain language, to include a look at future financial support should Dorset decide to become the resilience.io European Demonstrator region.

1. The first case study focused on commercial and industrial waste highlights the algorithmic workings and resilience.io **modelling capability**.

2. The second case study focused on flooding in Christchurch highlights the **visual capability** of the resilience.io model and its practical application.

At the outset it was made clear by the EA and by staff at Dorset County Council that limited time-resource would be available to support this project. None-the-less both organisations have contributed significantly, in terms of data provided by the EA and both data and advice given by DCC to these case studies.

[46] Collaboratory is The Ecological Sequestration Trust-derived word used to describe a collaborative laboratory.

Annex 2 Budget summary

TASK	Notes	TOTAL PLANNED	TOTAL ACTUAL
Research & data collection	Leadership, research and support, reporting	8,386.00	9,137.88
Prepare & plan workshop	Delegate interviews and selection. Planning and prep.	3,735.00	3,730.65
Interim visit(s)	Presentation, travel and subsistence	2,476.00	2,634.35
Run workshop	Location, speakers, travel and subsistence	6,770.00	6,911.43
Workshop report	Drafting, copy editing and digital publication only	1,723.00	1,510.50
Final report writing & submission	Comment integration, copy editing, design, layout (hard copy publication)	506.00	718.50
Sub total planned (Contract = 20,000+VAT)		**23,596.00**	**24,643.31**
Sub total actual			**24,643.31**
Contingency 1%		**235.96**	**0.00**
TOTAL		**23,831.96**	**24,643.31**
Over/under			643.31

Notes:

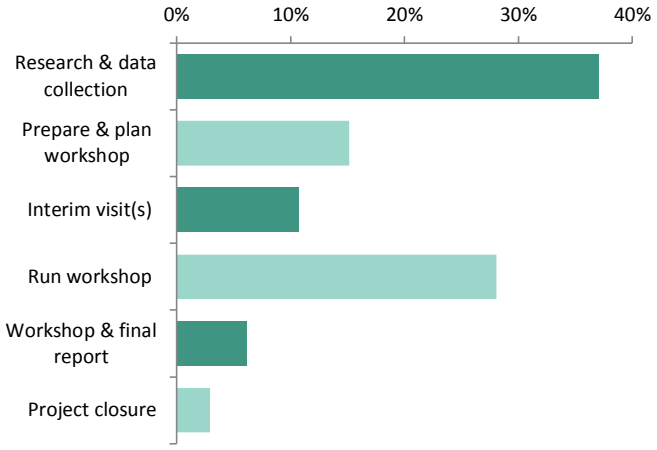
Project Management planned and attributed days = 17 (actually >50, the cost of which has been picked up by TEST)

All speakers and INUA gave time and travel (except MP flight) as an in-kind contribution; RNLI donated venue for free

These costs will be recouped if the EU Demonstrator goes ahead in Dorset

Budget line summary

Budget line summary cost categories as % of total	**24,643**
Research & data collection	37.1%
Prepare & plan workshop	15.1%
Interim visit(s)	10.7%
Run workshop	28.0%
Workshop & final report	6.1%
Project closure	2.9%
Total	**100%**



Annex 3 The resilience.io model explained

resilience.io is an open-source city-region platform[47] for collaborative, low-carbon, planning and investment, which integrates human-ecological-economic systems.

It is a system which calculates the current resource flows from human and ecological activity (e.g. in soils, air, water, industrial plants and infrastructure).

It enables economically beneficial urban-rural resource management to be funded and implemented through 'good' projects, together with insurance against extreme risks with an integrated focus on energy, water and food security.

resilience.io operates at a regional level and combines data and analyses of:

1. Spatial area as defined by e.g. the Dorset county border, its population and spatially dependent resource demands
2. Renewable and non-renewable natural resource stocks and flows, for instance (but not exclusively) sun, wind, biomass, food, nitrogen, phosphorous, water in different qualities, wastes (e.g. sewage, CO_2) and energy service demands (e.g. power, heating and cooling).
3. Networks to transport and distribute resources inside and outside the County such as transport networks, gas pipelines, power grids, water networks and telephone or internet networks.
4. Technologies and processes that are used to transform resources into a useful products and services (e.g. a digester which consumes waste and produces biogas and digestate, a CHP engine which consumes gas and produces heat and power; a water treatment facility that consumes waste water and power and produces potable water). Technologies may come in different scales reflecting different degrees of centralisation or decentralisation.

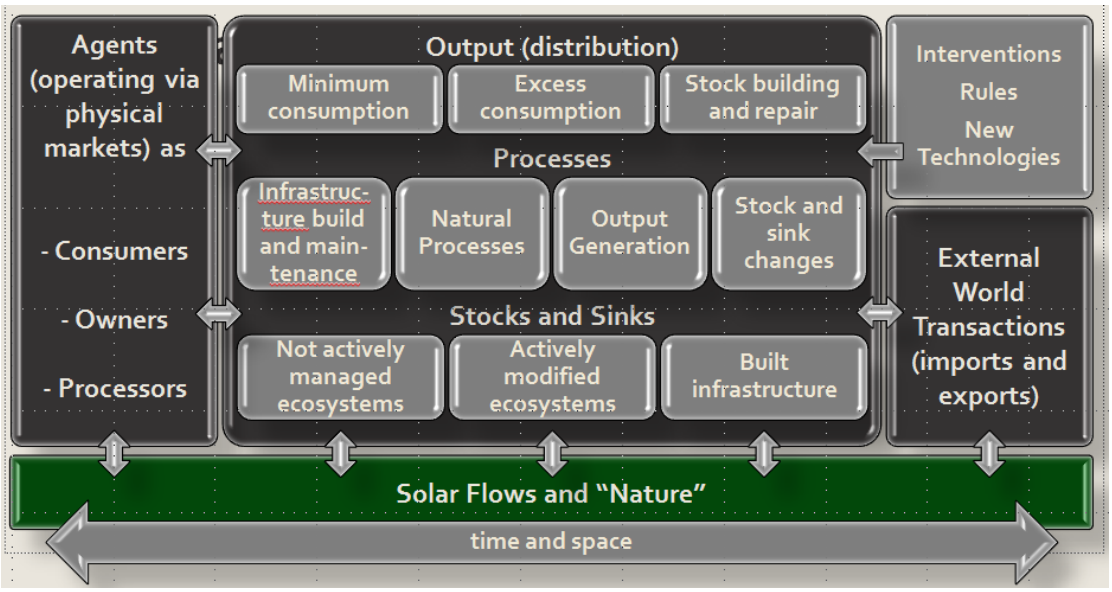


Figure 14 A broad overview of the model components

resilience.io will be suitable for:

[47] The resilience.io platform is currently being developed in the UK with support of the Department for International Development (DFID).

- Capturing the interactions between diverse resource systems (sun, water, nutrients such as N+P, and carbon in various forms).
- Connecting the resource flow system with soil and biomass yield models (e.g. pedo-transfer functions) that optimise agricultural productivity and quantify the energy conversion potentials of these systems.
- Integrating all flows with human supply/demand systems to map the generation of overall societal benefits and costs of different systems.
- Quantifying the cost and ecological benefits of alternative settlement and resource technology systems which aim to close resource loops (e.g. CO2 sequestration from heat/power production via algal systems which in turn produce energy products and fertiliser).
- Exploring the fates of anthropogenic wastes and their impacts on surrounding ecosystems.
- Calculating the trade-offs of different resource technology systems and policy options with the goal of long term system stability.

Annex 4 Technology Strategy Board 2013

Review of current Advanced Agent-based Integrated Resource and Economics Models for City-Regions

TSB objectives	Current modelling capability	
√ Objectives can be met		
Reduce local and global emissions	Resource use planning models incorporate carbon emissions impacts of numerous sectors & technology approaches, but exclude the wider economic effects of implementation beyond investment cost.	√
Collaboration for policy, business innovation and market development	Most models allow testing of specific policies & technologies within their intended use, however, only a minority have a general user interface for policy or technology adjustments to enable collaborative approaches.	√
Infrastructure interdependence and interoperability	Many models can link infrastructure planning to transport, atmospheric emissions, under given firm and population simulations, and some could be adapted to include environmental health effects, but energy and material interdependence is excluded.	√
X Current gaps in capability		
Inclusive resilient economic growth with quality of life	Broader wellbeing indicators are currently excluded and there is limited provision for simulating socio-economic dimensions within human agent behaviour.	X
Energy, food and water security	No model simulates complete supply chains of goods or commodity markets necessary to understand the impact of disruptions and resource cost changes.	X
Quality of life and poverty reduction	The macro economy when represented is only simulated at the level of aggregate sectors restricting capability to measure income distributions at the individual level	X
Sustainable production and consumption	No current model simulates complete supply chains and their technologies to simulate changes in their material & energy inputs-outputs over time	X
Integration of agriculture and ecology with regional planning	No city model links urban economic activity to agricultural provisioning in or outside the city, or to ecosystems qualities (biomass, hydrology, soils).	X

The focus of the TSB study was on identifying models providing integrated planning capabilities across multiple domains using the following criteria: (i) spatial representation at minimum of city zone level, (ii) integration of at least three domains from a detailed list of city system domains and (iii) operational deployment in at least one city. Seventeen models were identified as satisfying these criteria. These models have been developed for a range of applications, largely falling into the following three categories: (a) city development, (b) resource planning and (c) technology system optimisation.

Of the models, five out of seventeen were developed as an open-source resource freely available via the internet or after contacting their developers. The rest are proprietary remaining as in-house developments or used for commercial purposes by their developers.

Systems models with spread sheet-based structure with input-output relationships between sectors allow for understanding the resource use and environmental outflow impacts of a given city planning scenario. By using life cycle analysis they can incorporate wider supply chain effects in a static manner.

Spatial approximations for travel and the built environment are made by a spread sheet link to GIS packages to spatially establish residential, commercial, industrial, and other sectors. The setup of these model types limits their usage to testing already existing master plans on a scenario evaluation basis, by tweaking them manually for technology options related to resource use and carbon emissions, and planning policy options. This limitation arises because no dynamic components are built into these types of models, which would enable the computer to solve for optimal solutions, and thus allow changes over time to occur within the model. In these tools, all changes have to be set by the user and human behaviour cannot be simulated.

Another set of models aims at understanding how energy systems at a city level can be optimized. These *technology system optimization* models map the spatial environment of buildings and roads, on top of which a detailed spatial overlay of technologies supplying an energy resource is made, including relevant networks such as heat pipes. Subsequently, the demand of individual people and businesses across space and time for resources are calculated by a computer simulation, and the system is fed with characteristics of possible technologies to supply the resource and/or to alter demand needs. This information is used to let the model find optimal combinations of technologies and their networks supplying the resources to meet demand. Their scope is limited to understanding energy and related systems, such as transportation, and human behaviour driving energy use.

Annex 5 Data sets available and used in this feasibility study

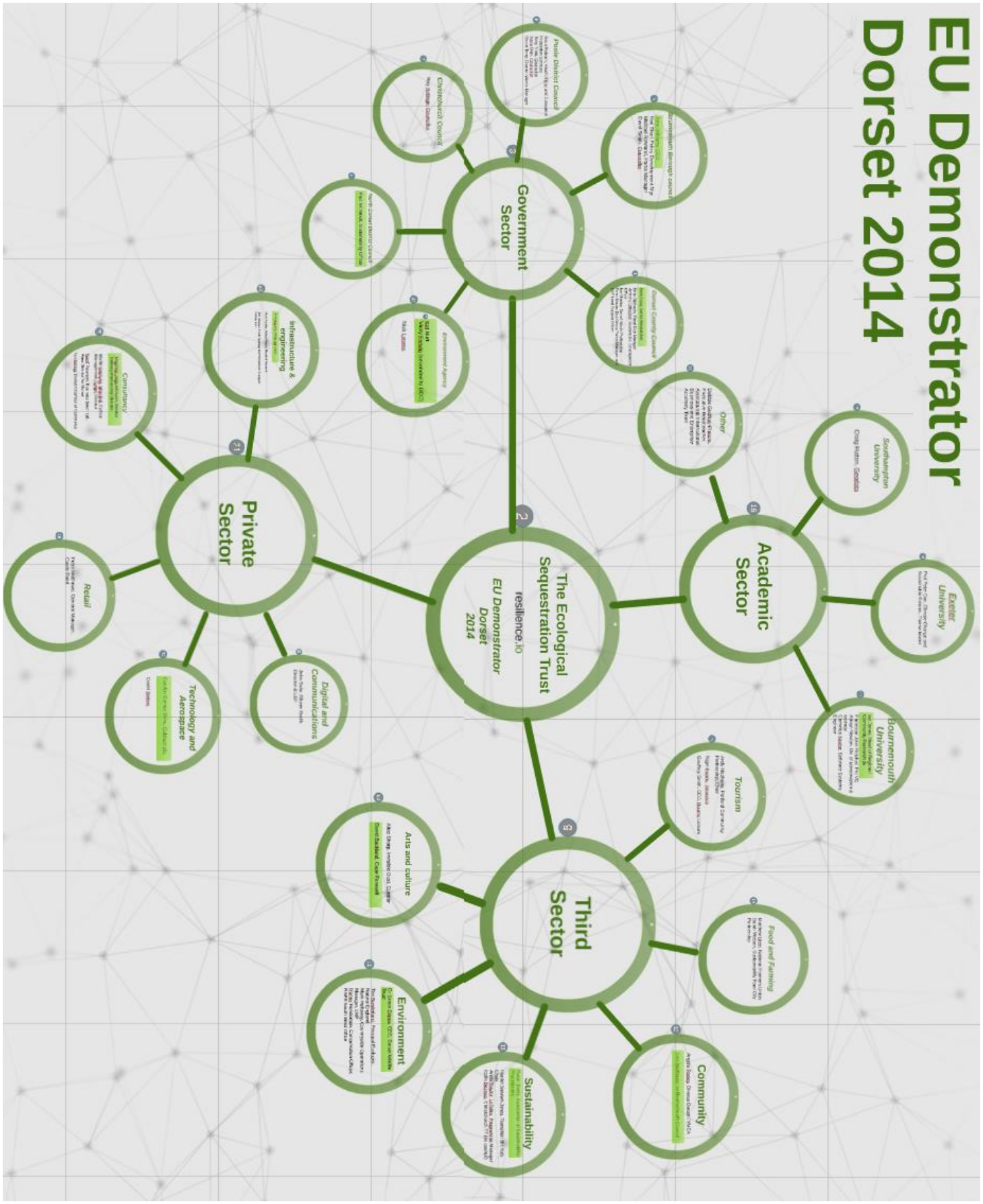
The following organisations permitted the use of their data free of charge for this flooding case study:

Company	Data
Ordnance Survey	Meridian 2 (Basemap)
	postcode
	heritage site
	boundaries (regions, wards)
	Terrain 50
Geomatics	2m LIDAR composite data
Geostore	Detailed River Network v3
	Historic Flood Map
	Historic Flood Outlines (AfA008)
Environmental Agency	Christchurch Borough Council Strategic Flood Risk Assessment Level 2 2009
	Christchurch Flood Warning Area Shapefiles (AFA054)
	Flood Map (AfA031)
	Historic Flood Incident Records for Christchurch
	Wessex Tidal Areas Benefiting from Defences Study 2008 (SW816)
	Lower Stour Hydraulic Model and Flood Study 2006 (SW697)
	Historic Flood Outlines (AfA008)
	Lower Avon Climate
	Lower Stour Climate
	Christch Tidal Climate
	Christchurch Tidal
National Data and Info Team	Surface water flood maps
Wessex Water	Sewage flooding information 12/13
	Sewage flooding information 13/14
Dorset County Council	Flood Report Data 2013/2014
	Wards Flooded 13/14
	Hospitals
	Schools
	Acorn Groups
British Geological Survey	Soilmap
Centre for Ecology and Hydrology	LCM2007 (Land Use Data)

Used

category	name	source	format	size
vulnerability	acorn groups	DCC, HG	image	1,4MB
	vulnerable objects (schools, hospitals, elderly care, heritage site)	DCC, Google, OS	vector	18,9KB
flood data	wards flooded 13/14	DC	vector	86,8KB
	surface flood 13/14	DC	vector	333KB
	sewage flooding 12/13	WW	vector	760KB
	sewage flooding 13/14	WW	vector	583KB
	stour model	EA	raster	13,4GB
	stour model + climate	HG	raster	35,1GB
administrative boundaries	postcodes	OS	vector	6,6MB
	regions	OS	vector	56,1MB
	wards	OS	vector	140KB
base map	roads	OS	vector	235KB
	rail	OS	vector	11,6KB
	station	OS	vector	10,5KB
	river	OS	vector	18,6KB
	coastline	OS	vector	20,1KB
	buildings	OS	vector	797KB
flood defense	flood warning areas	EA	vector	569KB
	flood defense structures	EA	vector	114KB
DTM	lidar	GM	raster	136MB
geology	soilmap	BGS	WMS	x
			Total	49GB

Annex 6 Engagement schematic



Annex 7 Mind-set mapping

The Complexity Map: Understanding your preferences

Choose the statement that most closely describes your current situation at work

What do you find yourself focusing on?

	a	b	
1. finding rational solutions to problems	☐	☐	challenging the way things are done
2. concentrating on day-to-day demands	☐	☐	thinking about issues of national & international importance
3. looking for new opportunities	☐	☐	championing the views of others
4. seeking input from colleagues	☐	☐	getting on with the next task
5. keeping your own feelings in check	☐	☐	sharing your experiences with others
6. looking after planning and project delivery	☐	☐	looking after budgets and income

What is most important to you in your role?

	a	b	
7. ensuring you know all the facts	☐	☐	exploring new approaches
8. keeping things under control	☐	☐	encouraging and coaching other people
9. trusting your instincts	☐	☐	relying on reason
10. achieving what you set out to do	☐	☐	ensuring things are done properly
11. maintaining effective systems	☐	☐	looking for freedom and variety
12. working collaboratively with others	☐	☐	making a difference in the world

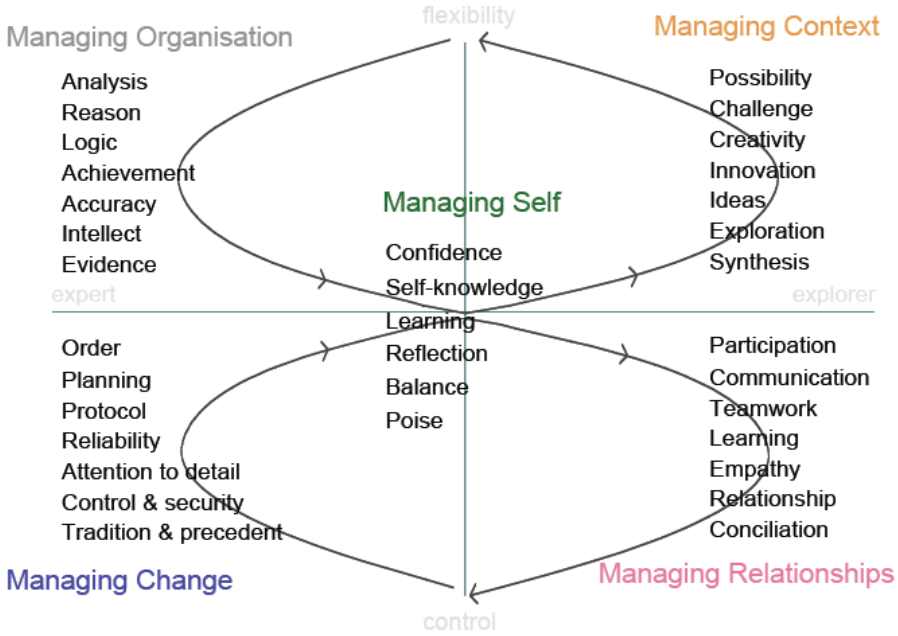
The Complexity Map: Understanding your preferences

To score your profile mark your choices on the lists below; add up the number of statements in each column

MANAGING ORGANISATION	MANAGING CHANGE	MANAGING RELATIONSHIPS	MANAGING CONTEXT
1 a	2 a	3 b	1 b
5 a	4 b	4 a	2 b
6 b	6 a	5 b	3 a
7 a	8 a	8 b	7 b
9 b	10 b	9 a	11 b
10 a	11 a	12 a	12 b
_____	_____	_____	_____
_____	_____	_____	_____

Now transfer your scores for each quadrant to the profile sheet (eg. if you have **3** points on MANAGING CHANGE, place your mark in the MANAGING CHANGE quadrant on the **3rd** line from the centre along the diagonal).

A talent for complexity



Annex 8 Supporting expertise

Prof Peter Head, Executive Chairman, Ecological Sequestration Trust

Specialism – Sustainable city-region systems engineering

Former Director Arup and a champion of sustainable development. Civil and structural engineer and recognised world leader in major bridges, advanced composite technology and sustainable development in cities and regions. Visiting Professor in Sustainable Systems Engineering at Bristol University and Eco-cities at Westminster University. OBE, Award of Merit of IABSE, the Royal Academy of Engineering's Silver Medal and the Prince Philip Award for Polymers in the Service of Mankind, Sir Frank Whittle medal of the Royal Academy of Engineering for a lifetime contribution to the well-being of the nation through environmental innovation.

Prof Nilay Shah - Director of the Centre for Process Systems Engineering and Co-Director of the Urban Energy Systems project at Imperial College, London

Specialism – Energy and resource systems modelling & engineering; bioenergy systems &technologies

Co-Director of the Porter Institute for Bioenergy, and leader of the Zero-Carbon Production Systems theme of Climate-KIC. Expert in energy systems modelling and engineering, bio-energy systems, hydrogen infrastructures, supply chain modelling and optimisation, process scheduling and optimisation, design of batch and biochemical processes, and plant safety and risk assessment. He has developed an optimisation-based design methodology for a variety of energy systems exhibiting strong spatial and temporal aspects. Advisor to private sector energy companies on sustainable future economy.

Martin Peersmann – General Manager GBKN and Geodan representative

Specialism – Geoinformatics

General Manager of the Large-scale Basemap of the Netherlands (GBKN) organization. His primary task since 2008 has been to execute the transition of this organization from a public-private partnership to the legally founded key registry. At the European level he is member of the INSPIRE expert group and the EuroGeoSurveys (EGS). Policy advisor of the Dutch national SDI coordination agency (Geonovum) and the GI-council - geoinformation and R&D program Urban Region in the Delta (URD) and public sector initiative Shared Services Organizations (PDOK). 2007 Chairman of the National Data Repositories Work Group (NDR) part of the Energistics eRegulatory Special Interest Group.

Robert Lisney - Independent Chairman of the Government's expert Committee on Packaging

Specialism – Materials Resource Recovery

Public sector organisational development consultant and Director of Project Integra, an award winning network of councils that implemented an integrated approach to waste avoidance and recovery. Involved with strategic networks in the UK, EU and the UN in the developing of policies to move to a resource conservation and value paradigm instead of 'dealing with wastes'. Advisor in the SE region for the successful EU backed 'Pathway to Zero Waste' programme.

Catherine Allinson, Director, Future Earth

Specialism – Sustainable development mediation and facilitation

Adaptation and resilience facilitator and convener of multi-sector stakeholders addressing global climate change impacts and resilience. Climate scientist and independent researcher in international development, climate change policy and implementation. Formerly AusAID/DFAT Programme Manager at Overseas Development Institute and domestic energy efficiency Engagement Manager Energy Saving Trust.

Sandy McDowell, Chairman and Liza Charlton, Pro VC INUA

INUA is a Business School in the Cloud.

Its global teaching and research programmes focus on sustainability, enterprise and innovation. Using the technology of gaming, immersive worlds and advanced learning analytics it provides personalised experiences, accredited qualifications and a platform for communities to share and learn across geographical boundaries. Its role at resilience.io is to draw together the diverse interests of academia, the public sector and the corporate world into a Collaboratory for new solutions for the future.

Kevin Bygate, Business Development Director for Tata Steel Colours and CEO, SPECIFIC

Specialism - Business Unit Strategy and product and market development

Expertise is centred on how technology can contribute towards delivering sustainable development, especially in the built environment. Kevin is a Chartered Engineer and is a board member of the Scientific Advisory Council for Wales advising on the role of innovation towards economic growth.

Rachael Kemp, Research and Project Assistant, Future Earth

Specialism – Biosystematics, Biology and Geology

Interdisciplinary researcher with expertise in the response of living organisms to environmental and earth systems change. Formerly a researcher at the Zoological Society of London, the Natural History Museum and the Royal Society, working on a range of research, communication and policy projects including evaluating the use of ecosystems in adapting to extreme weather events and climate change.

This research was supported by:

Dorset Local Enterprise Partnership

Local Nature Partnership

mouchel building great relationships

Bournemouth University