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| <p><b>Institution:</b> University of Abertay Dundee</p>   |
| <p><b>Unit of Assessment:</b> 7</p>   |
| <p><b>Title of case study:</b> Sustainability Assessment and Visualisation Enhancement, SAVE</p>  |
| <p><b>1. Summary of the impact</b> (indicative maximum 100 words)<br/> This study brings together 2 strands of research in: (1) environmental sustainability and decision taking (Gilmour and Blackwood), and (2) novel computer games technology for efficient 3D real time and interactive visualisation of complex model outcomes (Isaacs and Falconer). This research and knowledge exchange both defined sustainability indicators which informed planning of the £1 bln Dundee waterfront development (one of the largest regeneration projects in the UK) and changed practice in project design and construction processes. The application of our research has also changed how information is displayed to stakeholders, enabling stakeholders to make informed decisions.</p>  |
| <p><b>2. Underpinning research</b> (indicative maximum 500 words)<br/> This case study draws on fifteen years of research and close interaction with stakeholders, which led to the formation of an inter-disciplinary research group combining expertise in environmental science and management, mathematical modelling and computer games technology. Our work has culminated in the production of an integrated interactive visualisation framework and toolset, enabling effective incorporation of sustainable development principles, into the design of major infrastructure projects.</p> <p>The initial underpinning research by Blackwood and Gilmour (Ashley et al., 2005 &amp; 2008) was initiated in response to the requirement for the water sector to incorporate sustainability assessment within the decision making process. The research formed part of three EPSRC Consortia projects (Projects 1 to 3 as listed in section 3). Their research showed that, even for an apparently straightforward either/or question, the assessment of relative sustainability is complex. Assessment requires a combined and weighted evaluation of various social, economic, environmental, and technical aspects resulting from the implementation and adoption of alternative infrastructure developments, as well as an assessment of public responsiveness to any encouragement to change practice and use. Therefore, for the first time in the water sector, we developed a framework tool (SWARD Tool) and applied SWARD to evaluate real case studies involving practitioner decision making. We addressed concepts of sustainability assessment and showed how multi-criteria decision support systems can enhance the assessment of relative sustainability of a range of options; thereby aiding decisions being made about investment.</p> <p>The transferable insights from this research include:</p> <ul style="list-style-type: none"> <li>• <b>How decisions are made:</b> We developed techniques that enable for the first time an understanding of decision making related to sustainable urban development (project 2);</li> <li>• <b>How stakeholders can be engaged:</b> We developed methods for engagement of key stakeholders, including the public, in decision-making processes (projects 1, 2, and 3);</li> <li>• <b>How the efficacy of sustainable development can be analysed:</b> We demonstrated the benefit of decision support tools such as cost benefit analysis and multi-criteria decision analysis for sustainability decision making (project 1 and 2).</li> </ul> <p>Our research was further developed and impacted upon the sustainable development of Dundee Waterfront (Gilmour et al., 2011). With an investment of £1 bln, this is the 16th largest regeneration project in the UK (2013), and is the 3rd most active project (2013). Its development includes the Victoria &amp; Albert Museum at Dundee which will be an international centre of design for Scotland and will host major exhibitions helping people understand their cultural heritage. Using the methods above, our research combined a series of criteria for sustainable development (including energy efficiency of buildings, traffic noise, economic benefit of different building functions, social acceptance of building use and housing provision, and employment opportunities), and considered how these criteria dynamically change with time (Gilmour et al., 2011).</p> |

**Impact case study (REF3b)**

Through reviewing this work in discussions with stakeholders, we identified the need for an effective communication tool, permitting communication and interrogation of complex model outcomes to support informed decision making in the face of multiple interacting factors changing over time. Drawing upon the University's inter-disciplinary approach to research and knowledge exchange, and making use of Abertay's expertise in computer games technology, computing and engineering (Falconer and Isaacs), a new inter-disciplinary research grouping was established to address this need. This grouping initiated innovative research that combined Blackwood and Gilmour's sustainability research with parallel developments in interactive gaming technologies to create a 3D interactive visualisation platform. This Sustainability Assessment Visualisation and Enhancement (SAVE) platform:

- allows the social, economic and environmental factors to be visualised;
- informs and thus supports decision-making processes;
- provides a means of measurement, assessment or valuation of these factors; and
- offers analytical methods for the comparative assessment of these complex data.

The SAVE framework transforms static 2D planning into a 3D interactive and dynamic computer visualisation underpinned by sustainability modelling to support stakeholders in their decisions to select sustainability indicators (Isaacs et al., 2013). Visualisation overlay techniques were developed to determine the most effective way to display and communicate multiple sustainability criteria predicted by the sustainability models. The development of this framework was underpinned by funding from a range of sources and projects listed in section 3 (4-11).

**3. References to the research** (indicative maximum of six references)

- Ashley R, Blackwood D, Souter N, Hendry S, Moir J, Dunkerley J, Davies J, Bulter D, Cook A, Conlin J, Squibbs, M, Britton A, Goldie P. (2005). Sustainable Disposal of Domestic Sanitary Waste, ASCE Journal of Environmental Engineering, Vol. 131, No. 2, February, 206 – 215. [http://dx.doi.org/10.1061/\(ASCE\)0733-9372\(2005\)131:2\(206\)](http://dx.doi.org/10.1061/(ASCE)0733-9372(2005)131:2(206))
- Ashley, R., Blackwood, D., Butler, D., Jowitt, P., Davies, J., Smith, H., Gilmour, D., and Oltean-Dumbrava, C. (2008). Making Asset Investment Decisions for Wastewater Systems that include Sustainability. ASCE Journal of Environmental Engineering, Vol.134, No. 3, March, 200-210. [http://dx.doi.org/10.1061/\(ASCE\)0733-9372\(2008\)134:3\(200\)](http://dx.doi.org/10.1061/(ASCE)0733-9372(2008)134:3(200))
- Gilmour D., Blackwood, D., Banks, I. and Wilson, F. (2011). Sustainable development indicators for major infrastructure projects Proceedings of the Institution of Civil Engineers. Municipal Engineering, 164, 15 – 24. <http://www.icevirtuallibrary.com/content/article/10.1680/muen.800020>
- Isaacs, J, Falconer, R., Gilmour, D. and Blackwood, D. (2011). Enhancing urban sustainability using 3D visualisation, in Proceedings of the Institution of Civil Engineers. Urban Design and Planning, 164, 163 – 173. <http://www.icevirtuallibrary.com/content/article/10.1680/udap.900034>

**Research Awards**

1. EPSRC Sustainable Cities Initiative. Sustainable Disposal of Domestic Sanitary Waste (1996 - 1999). Blackwood and Gilmour, Researchers.
2. EPSRC The Water Infrastructure and Treatment Engineering Programme: (1998 – 2001) A multi-criteria analysis/Risk management tool to assess the relative sustainability of water systems. EPSRC grant Ref. GR/M15545. Blackwood and Gilmour. (£120,000)
3. EPSRC SUE Programme: Water Cycle Management for New Developments WAND. Led by Imperial College (2004 – 2007). Blackwood and Gilmour. (£36,000)

## Impact case study (REF3b)

4. Sustainability Assessment and enhancement of Dundee Central Water Waterfront. (2006 – date), funded by Dundee City Council. £96,000.
5. A series of projects related to Sustainable Management of Phosphates in the water cycle, funded by United Kingdom Water Research Ltd (UKWIR), led by Atkins Global. (a) Source Apportionment for Phosphorus From Domestic Sources (2007 – 2008) (b) Phosphorus Lifecycle Management, (2008 – 2010) - in association with the University of Oxford. (c) Alternatives to phosphate for plumbosolvency control, (2010- 2011). £40,000.
6. Fife Coast and Countryside Trust. Visualisation of Eden Estuary and Natura 2020. (2011/12) £27,000.
7. Fife Council. Visualisation of Strategic land use at Dunfermline Western Edge. £10,000
8. TAYplan -Strategic Implications for Land Use: What key societal, economic and climatic changes may occur over the next 20-40 years (2012/13) £9,000.
9. TAYplan -3D visualization for TAYplan strategic land-use planning £10,000.
10. Scotland's Environment Web Visioning. £17k to provide recommendations to the SEWeb (LIFE) Project on the future development opportunities of their web site and overall web presence allowing effective, useable and accessible access to Scotland's environmental information.

### 4. Details of the impact (indicative maximum 750 words)

This case study research and knowledge exchange undertaken by the Unit has had a significant impact on local government organisations and the public in terms of:

- effecting changes to public policy and services
- raising the awareness and understanding of key stakeholders
- impacting on environmental policy debate
- changing to the way key information is presented to stakeholders

#### Changes to public policy

A set of sustainability indicators were developed and are now published and used by the Dundee City Council to ensure overall sustainability of the Dundee Waterfront Development, the 3<sup>rd</sup> most active regeneration project in the UK. The University of Abertay Dundee developed indicators for Dundee Waterfront as part of their Sustainability Commission. The Performance Management Framework and Single Outcome Agreement's Performance Indicators populate the data for Sustainable Development Benchmark Indicators. In addition, Dundee City Council's practise was changed through a series of interventions that were implemented in the Council's project design and construction processes, where the range of identified sustainability indicators could be influenced. This included a new requirement for site waste management planning in Dundee City Council construction contracts (Dundee City Council Policy statement), the introduction of a Sustainability Design and Construction Checklist integrated within the Councils ISO 9001 Quality Management System (Dundee City Council Quality Management System).

#### Impact on policy debate

The SAVE approach changed organisational policy as to how development plans are communicated to the public, and influenced a data mapping framework for development plans (project 6, 7 & 9). Fife Council are developing a new approach to data mapping for development plans which is built on the SAVE concept. Our SAVE group defined the data mapping method and directed the development of Fife Council's Planning Department's communication strategy for strategic land allocations. In a second example, the SAVE method is being used by SEWeb to influence how Scottish Environmental organisations share and present information to stakeholders. The project included recommendations on aspects such as crowd sourcing and mobile data

access which are currently being implemented.

Raising the awareness and understanding of key stakeholders

Our research provided new insights into the practical application of novel methods of simulation and visualisation of sustainability indicators to a wide range of stakeholders, using interactive visualisation based on computer games technologies. The visualisation output of the sustainability assessment of the Dundee Central Waterfront was used by Scottish Enterprise to inform the public through presentations to community groups and as exhibits at science festivals and art events (e.g. Dundee Science Festival, Fife Science Festival). It was also used by Scottish Enterprise to communicate plans for the redevelopment of an area of Dundee to potential developers. Our SAVE platform has also been adapted and developed for rural development: for example, the interactive visualisation of Eden Estuary and Natura 2020 for Fife Coast & Countryside Trust has enabled effective engagement of stakeholders during the development of coastal management practices incorporating realistic scenarios.

Local Authorities have confirmed the value of this SAVE tool in stimulating engagement for informed planning decisions. Fife Council commissioned the University to apply the framework to strategic land use planning for the Dunfermline western edge development to support planning meetings and stakeholder engagement sessions. Through Project 6 the value of our interactive visualisation tool has been recognised and it has changed the way data collected by different agencies is communicated to stakeholders including the public (the interactive visualisation tool will be an exhibit at the Eden Estuary Visitor centre). Project 8, was commissioned by TAYplan “to help public sector bodies formulate policy in relation to land use change” and the results have informed policy formulation for the Strategic Development Plan for the TAYplan area.

**5. Sources to corroborate the impact** (indicative maximum of 10 references)

Documents that evidence the impact of our sustainability research and development.

1. Dundee Waterfront Benchmark Sustainability Indicators publicly available on Dundee Waterfront website Environment and Sustainability pages stating Abertay’s developed the indicators: <http://dundeewaterfront.com/Environment+and+Sustainability/>
2. Evidence of a new requirement for Site waste management planning in Dundee City Council construction contracts (Dundee City Council Policy statement).
3. Evidence of the introduction of a Sustainability Design and Construction Checklist integrated within the Councils ISO 9001 Quality Management System (Dundee City Council Quality Management System).

Beneficiaries who will corroborate the impact.

4. City Engineer, Dundee City Council will provide evidence of the impact of our work on Dundee City Council practices and procedures.
5. Director of Planning Fife Council will provide evidence of how our work has contributed to change their approach to consultation on planning issues in Fife and on the way in which planning information is communicated to Stakeholders.
6. Chief Executive, Fife Coast & Countryside Trust, will provide evidence on the use of visualisation to change approach to communication with stakeholders.
7. The Strategic Development Planning Authority for Dundee, Perth, Angus and North Fife. The SDPA Manager will evidence that our novel visualisation methods had influenced how the green network and spatial planning strategy is communicated to stakeholders (TAYplan).
8. Principal Policy Officer - SEWeb (LIFE), SEPA. Will evidence how the project led to changes in the way SEWeb and partner environmental organisations source and provide access to environmental information.