

Walter Leal Filho · Rafael Leal-Arcas
Editors

University Initiatives in Climate Change Mitigation and Adaptation

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Preface

Much research on climate change is being performed by many universities around the world. But despite this positive trend, there are only a few publications where an interdisciplinary set of researchers may be able to tackle climate change issues from a variety of perspectives: social sciences, natural sciences, economics, etc. This book is an attempt to fill in this gap.

This publication involves researchers in the field of climate change in the widest sense, not only from traditional climate science, but also from the fields of environment, human geography, business and economics, arts, administration, and media studies.

The aims of this book are twofold:

- I. To provide researchers at universities from across the world performing research on issues pertaining climate change with an opportunity to present their works and research projects and also educational initiatives;
- II. To introduce innovative methodological approaches and projects which aim to offer a better understanding of climate change across society and economic sectors.

Moreover, a further aim of this book, consistent with the philosophy of the “Climate Change Management Series,” is to document and disseminate the wealth of experiences on climate change research at universities taking place today.

This book is divided into two parts:

- Part I contains papers which describe experiences from climate change research, education, and studies.
- Part II describes experiences and lessons from climate change and related projects.

We thank the authors for their willingness to share their knowledge, know-how, and experiences, as well as the many peer reviewers, which have helped us to ensure the quality of the manuscripts.

Enjoy your reading!

Hamburg, Germany
London, UK
Summer 2018

Walter Leal Filho
Rafael Leal-Arcas

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Summer 2018

Prof. Dr. Rafael Leal-Arcas

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Part I
Experiences From Climate Change
Research, Education and Studies

Introducing the International Climate Change Information Programme (ICCIP)



Walter Leal Filho

Abstract This final chapter introduces the International Climate Change Information Programme (ICCIP) and describes some of its activities, outlining what the Hamburg University of Applied Sciences is doing in respect of climate change adaptation. It also outlines various opportunities for cooperation with universities interested on matters related to climate change.

Keywords Climate change · Adaptation · Training · Information-research

1 Introduction

Over the past 15 years, a noticeable increase in the level of attention given to climate issues has been observed. Finding practical, workable and cost-efficient solutions to the problems posed by climate change has become a priority to many countries. Also, even though the engagement of the private sector on climate matters is not as high and it could be, non-governmental organisations as well as the general public are interested on climate matters in a way not seen before.

But even though climate change is a matter of great scientific relevance and of broad general interest, there are many problems related to its communication (e.g. Moser 2007). There is a need to consider the importance and difficulties inherent in talking about climate change to different types of publics using various types of communication tools and strategies (Nerlich et al. 2010). For instance, climate change is often regarded as too broad in scope, as too abstract in respect of its implementation, too complex and therefore too difficult to understand. Yet, much could be gained by ensuring matters related to climate change are better understood

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and if people—especially the youth (Leal Filho et al. 2010) are motivated to engage in the global efforts to address the challenges posed by climate change.

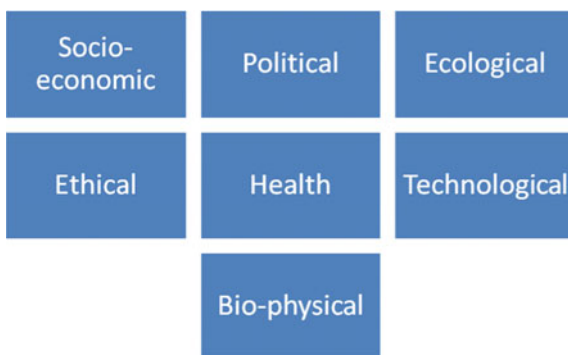
There is thus a perceived need for concrete action in order to address the problems inherent to the communication of climate change and to undertake a set of information, communication, education and awareness-raising initiatives which may allow it to better understood. It is on the basis of this reality that the “**International Climate Change Information Programme**” (ICCIP) has been created.

The need for the “**International Climate Change Information Programme**” was identified during “Climate 2008”, the world’s first scientific conference on climate change held online on 3–7 November 2008. The effectiveness of Climate 2008—which was followed by various other online climate conferences since (Leal Filho et al. 2015) and is an initiative led by the Hamburg University of Applied Sciences in Germany, allowed it to extend it further, in partnership with a wide range of national and international organisations such as UNEP, UNESCO, WMO, IPCC, FAO and many others agencies.

Since the governments of 195 nations endorsed the Paris Agreement in 2015, a new momentum was provided towards efforts aimed at reducing global greenhouse gas emissions. The Paris Agreement establishes the principle that future national plans will be no less ambitious than existing ones, which means that national climate action plans will provide a firm floor and foundation for higher ambition. In addition, countries will submit updated climate plans—called nationally determined contributions (NDCs)—every five years, thereby steadily increasing their ambition in the long term. Climate action, according to the Paris Agreement, will also be taken forward in the period before 2020. Countries will continue to engage in a process on mitigation opportunities and will put added focus on adaptation opportunities. This, in turn, means that the global demand for information on climate change has increased, and so has the need for mechanisms which allow a broader understanding of what it means and how it affects people’s lives.

Due to its scope, it is necessary to consider climate change as a process influenced by various variables, as outlined in Fig. 1. Therefore, the search for solutions to the problems caused by climate change cannot be uni-dimensional: it needs to be pursued in an integrated way.

Fig. 1 Some of the variables that influence climate change (Leal Filho 2009)



The creation of the “**International Climate Change Information Programme**” is a concrete step towards the goal of “climate change understanding for all”, supporting the ongoing efforts towards the search for solutions for the problems associated with climate change, an issue which is global in nature, but which needs to be supported by concrete regional and local efforts.

2 Aims of the “International Climate Change Information Programme”

The aims of the “**International Climate Change Information Programme**” are:

- to disseminate the latest findings from scientific research on climate change, including elements related to its environmental, social, economic and policy aspects in a way that allow them to be understood by the non-specialist audience. This will take place by means of books, chapters, journal articles and information via the media;
- to undertake education, communication and awareness-raising projects on matters related to climate change in both industrialised and developing countries in cooperation with UN agencies, universities, scientific institutions, government bodies, NGOs and other stakeholders;
- to network people and organisations ways to discuss the problems, barriers, challenges and chances and potentials related to communication on climate change.

Based on the fact that personal interactions are important in order to foster a dialogue and the search for new solutions, ICCIP also organises specialist events round the world. These events have over the years encouraged more networking and information exchange and have catalysed many new cooperation initiatives and projects.

3 Target Groups

The ICCIP aims to reach a broad audience which consists of:

- Scientists,
- Decision-makers,
- Enterprises,
- NGOs,
- Universities,
- Schools,
- Local communities and
- Interested individuals

All these groups have benefitted from the activities undertaken as part of the ICCIP, since its creation in 2008.

4 Activities

Some of the most common misconceptions related to climate change (Leal Filho 2009) are:

- i. *Climate change is too abstract an issue*
- ii. *Climate change is too broad a topic*
- iii. *Climate change is mostly a technical matter where calculations and forecasts are made*
- iv. *There are no trained people to handle the approach of climate change topics in an understandable way*
- v. *The amount of resources needed to communicate climate change do not justify it*
- vi. *Climate change has too wide a scientific basis*

If one carefully examines them, the above outlined misconceptions have quite deep roots. It is thus important to understand them so as to allow misconceptions to be overcome. The following activities have been performed by the “**International Climate Change Information Programme**” since its creation in 2008:

- Organisation of information events on different aspects of climate change, including environmental, social, economic and policy aspects, which were attended by over 5.000 delegates to date. Some of the events in 2018/2019 are:
 - 7–9 February 2018: World Symposium on Climate Change Communication, Graz, Austria
 - 3–5 April 2018: World Symposium on Climate Change and Biodiversity (WSCCB-2018), Manchester, UK
 - 10–12 April 2018: International Symposium on Climate Change and Museums: critical approaches to engagement and management, Manchester, United Kingdom
 - 14–15 May 2018: Symposium on Climate Change Adaptation, University of Ibadan, Nigeria
 - 19–21 June 2018: Symposium on Climate Change and Coastal Zone Management, University of Prince Edward Island, Canada
 - 3–5 July 2018: International Scientific Conference on Climate Change Adaptation in Eastern Europe, Banja Luka, Republika Srpska, Bosnia and Herzegovina
 - 13–15 February 2019: World Symposium on Climate Change and Tourism, Bariloche, Argentina

20–21 February 2019: Symposium on Climate Change Adaptation in Latin America, Lima, Peru

11–13 September 2019: 3rd World Symposium on Climate Change Adaptation, Akure, Nigeria

- Production of books, chapters, on climate change, tackles its various ramifications. The book series “Climate Change Management” was initiated with Springer in 2009 <http://www.springer.com/series/8740> which has published over 30 volumes to date, including ground-breaking publications such as:

Universities and Climate Change (2010)

The Political, Social and Economic Aspects of Climate Change (2011)

Climate Changes and Disasters Risk Management (2012)

Handbook of Climate Change Adaptation (2014)

Climate Change Research at Universities (2017)

Handbook of Climate Change Communication (2018)

- The publication of scientific papers in peer-reviewed journals. Some of the recent papers published by the ICCIP team and associates are:

Leal Filho et al. (2016) An assessment of smallholder soil and water conservation practices and perceptions in contrasting agro-ecological regions in Zimbabwe. In *Water Resources and Rural Development*, <https://doi.org/10.1016/j.wrr.2016.09.001>

Leal Filho, W., Ayal, D. (2017) Farmers’ perceptions of climate variability and its adverse impacts on crop and livestock production in Ethiopia. In *Journal of Arid Environments*, <https://doi.org/10.1016/j.jaridenv.2017.01.007>—<https://authors.elsevier.com/a/1UPwBVu7-iGLd>

Leal Filho, W., Modesto, F., Nagy, G., Saroar, M., Toaukum (2017) Fostering coastal resilience to climate change vulnerability in Bangladesh, Brazil, Cameroon and Uruguay: a cross-country comparison. In *Mitig Adapt Strateg Glob Change* (2017) <https://doi.org/10.1007/s11027-017-9750-3>

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Leal Filho, W., Chérif, S., Azeiteiro, U. (2017) The role of farmers’ perceptions in coping with climate change in Sub-Saharan Africa. *Journal of Global Warming*, Vol. 12, Nos. 3/4, 2017. pp. 483–498. <https://doi.org/10.1504/ijgw.2017.10005907>.

- The “International Journal of Climate Change Strategies and Management”, created in 2009 <http://www.emeraldgroupublishing.com/ijccsm.htm>, is a fully indexed journal and is since 2017 an open-access periodical;
- Execution of education, communication and awareness-raising projects on matters related to climate change in both industrialised and developing countries;

- Organisation of joint activities in cooperation with UN agencies, universities, scientific institutions, government bodies, NGOs and other stakeholders.

The “**International Climate Change Information Programme**” has also a mailing list, which networks people and organisations ways to discuss the problems, barriers, challenges and chances and potentials related to communication on climate change.

Ultimately, the “**International Climate Change Information Programme**” breaks the barriers seen when one tries to communicate climate change and suggest measures to address the existing deficiencies.

5 Partnership

The “**International Climate Change Information Programme**” is an initiative led by the Hamburg University of Applied Sciences in Germany, working in cooperation with Manchester Metropolitan University, UK and a wide number of organisations. These are:

- United Nations Environment Programme (UNEP)
- World Meteorological Organisation (WMO)
- Intergovernmental Panel on Climate Change (IPCC)
- United Nations Educational, Scientific and Cultural Organisation (UNESCO)
- European Space Agency (ESA)
- Food and Agriculture Organisations of the United Nations (FAO)
- Global Environment Facility (GEF)
- Caribbean Community Climate Change Centre (CCCCC)
- Emerald Group Publishing Ltd.
- Sahara and Sahel Observatory
- Information Board of Climate Change Communication (IOCCC)

In addition, ICCP has worked with various **media partners** which have reported on its activities:

- WELT Gruppe
- NDR Info
- TIME Magazine
- The Economist
- European Sustainability Review
- Baltic Sea Magazine

The fact that climate change is now seen and perceived as being a major challenge to both industrialised and developing countries, means that substantial efforts are now being seen, in order to address the problem and its various ramifications.

The “**International Climate Change Information Programme**” has over the years engaged on a variety of projects, one of which is the project “ACP-EU

Technology-Transfer Network on Rainwater Harvesting Irrigation Management for Sustainable Dryland Agriculture, Food Security and Poverty Alleviation in sub-Saharan Africa” or AFRHINET <http://afrhinet.eu/>.

Through AFRHINET, the implementation of integrated theoretical and practical capacity-building, and the development of technology-transfer and demonstration projects in the field of rainwater harvesting irrigation (RWHI) took place in a sample of African countries (Ethiopia, Kenya, Mozambique and Zimbabwe). In addition, the knowledge and use of RWHI management for small-scale irrigation in rural dryland areas of sub-Saharan Africa were enhanced.

Moreover, AFRHINET set in motion the development of research and technology-transfer centres, and a transnational network, as platforms for cooperation and the exchange of experience in RWHI management. The network comprises micro-enterprises, non-governmental and public actors, academic/scientific institutions, and rural dryland local communities, especially farmers, women and youth groups.

Parallel to the international efforts being undertaken in respect of the mitigation of climate change and of its impacts, there is a perceived need for sound climate change adaptation strategies, which may be implemented by means of concrete projects, all of which need to have measurable and tangible goals, so as to yield the expected outputs. **Climate change adaptation projects** are important for two main reasons:

- firstly, they offer the possibility to cope with the impacts or consequences of climate change in the **short or medium term**, hence alleviating the pressure on people and on ecosystems suffering from it, especially in developing nations;
- secondly, climate change adaptation projects—especially if implemented in the context of adaptation strategies at the macrolevel—can serve the purpose of mobilising public and private stakeholders, engaging them in the problem-solving process.

Since there is a perceived need to develop evaluation techniques for climate change projects, ICCIP also started the project **Evaluating Climate Change Adaptation**, whose structure is described in Box 1.

Box 1 The Project Evaluating Climate Change Adaptation

Worldwide, there are in excess of 300 internationally funded climate change adaptation projects being implemented at present, whose combined budget is well in excess of US\$1 billion. All of them have specific targets and goals, but a few of them make provisions for external assessments of their effectiveness, cater for proper quality control procedures, or have—apart from periodical reports—systems in place which allow them to fully address current and future problems in a pre-emptive way. This states of affairs illustrates the need for a research project which looks at the evaluation of the effectiveness and impacts of climate change projects in a dynamic way. It is for

this purpose that the project **Evaluating Climate Change Adaptation** is being undertaken.

Aims of the project

The project **Evaluating Climate Change Adaptation** aims to:

- (a) investigate the elements which prevent climate change adaptation projects from being fully successful, including structural and logistical problems, as well as other implementation issues;
- (b) review, by means of a survey of individual projects, the extent to which quality control is embedded into projects and the effectiveness of current mechanisms aimed at improving the quality of their delivery;
- (c) provide recommendations for further improvements, identifying needs and shortcomings, as well as factors that currently hinder—or may in the future endanger—the achievement of a project’s targets or from achieving its expected results.

Thanks to its scope and approach, the project **Evaluating Climate Change Adaptation** will provide project teams with an opportunity enhance the delivery of their projects, hence honouring the commitments in respect of funding and staff time.

Expected Outputs

The project **Evaluating Climate Change Adaptation** will produce a report which will outline the main problems, issues and barriers seen in implementing climate change adaptation projects. This state-of-the-art document will be useful in offering guidance and supporting the delivery of the hundreds of climate change adaptation projects currently being undertaken, worldwide.

6 Conclusions and Opportunities for Collaboration

Since its creation in 2008, ICCIP has evolved to become the world’s largest non-government funded information, communication and education programme on climate change. Thanks to the inclusive approach and diversity of activities, it is highly attractive and engages thousands of people around the world, who benefit from its works, publications and events.

ICCIP is keen to cooperate with academic and research organisations, in the execution of the research projects, events and preparation of joint publications. Please contact the ICCIP Team in Hamburg to discuss possible cooperation opportunities: info@iccip.net.

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Educating Students and Their Future Employers to Minimise Environmental and Climate Impacts Through Cost-Effective Environmental Management Strategies



Kay Emblen-Perry and Les Duckers

Abstract Traditionally, internal views from UK businesses expect the maximisation of profits and delivery of value for the customer; the external view expects realistic profits and provision of employment. However, this view is changing, with customers increasingly demanding products and services that also demonstrate environmental responsibility and minimise climate impacts. Although the cause–effect relationship between business operations, negative environmental impacts and climate change is well established, there is now an enhanced appreciation that environmental challenges are systemic, interlinked and cannot be addressed in isolation. Despite the proliferation of ‘low-cost’ or ‘no-cost’ technological and behavioural opportunities, businesses struggle to realise opportunities that address these interlinked challenges, demonstrate environmental responsibility and minimise climate impacts, as they are embedded in economic systems in which improvement equals investment. Environmental improvement interventions have become synonymous with cost consumption rather than cost saving—frequently at odds with corporate financial strategies. In an attempt to change this view, support the mitigation of climate change through the reduction in environmental impacts and develop successful employment-ready graduates skilled in effective environmental improvement techniques, an innovative Environmental Strategy Module engaging postgraduate students in environmental management strategy design is taught at Coventry University. This offers students a more financially accessible approach to environmental improvement: a self-funding environmental management strategy created through the Environmental Value for Money Framework. This paper presents a conceptual study of the Environmental Value for Money Framework and its engagement of students as future employees in creating self-funded, economically

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viable environmental management strategies. It also offers this framework as a mechanism to encourage businesses to engage in carefully planned and economically viable strategic environmental improvements.

Keywords Environmental management strategy · Environmental responsibility
Environmental impacts · Environmental Value for Money Framework

1 Introduction

Over the last 3 decades, there has been a growing recognition from pressure groups, trade organisations, politicians and the public of the need to rethink businesses' role on creating sustainable futures. Firstly, there is an acknowledgement that organisations can severely affect climate change through their day-to-day operations and therefore need to minimise their environmental impacts (Finke et al. 2016; Carbon Trust 2015). Secondly, as highlighted within the Sustainable Development Goals (SDGs) 4 and 12, there is a growing expectation that educational systems should contribute to developing a sustainable society (United Nations 2017). UNESCO (2017) argues that the momentum for Education for Sustainability (EfS) has never been stronger but to achieve the development of skills, values and attitudes required to develop sustainable futures, education systems must introduce pedagogies that empower learners to transform the way they think and act.

The understanding of the cause–effect relationships of environmental challenges from the use of natural resources, generation of waste and creation of environmental pollution (which are key environmental impacts of businesses) and climate change has evolved in recent years. It is now generally accepted that these challenges are systemic in nature and cannot be tackled in isolation (European Environment Agency 2015). This paper therefore supports the mitigation of climate change by provoking environmental impact reduction.

Although there is widespread external pressure for organisations to demonstrate environmental responsibility, a positive, proactive response has not been forthcoming across all UK commercial sectors. Whilst it has become normal for large UK organisations to recognise their actual and/or potential environmental impacts and implement a strategic response, it is still uncommon for SMEs to adopt formal environmental management strategies (Graafland and Smid 2016). Rather, where environmental responsibility is accepted, it is more usual for SMEs to adopt an ad hoc approach to reduce and mitigate environmental impacts (Panwar et al. 2016).

During the authors' attempts to recruit smaller companies for a previous student-led, live environmental audit project, it was recognised that whilst many businesses expressed an interest in minimising their impact on the environment very few were familiar with environmental management practices or how to implement environmental improvement processes. Cassells and Lewis (2017) found a similar lack of engagement with environmental management strategies despite growing expectations from stakeholders to behave environmentally responsibly and

adopt principles and practices of environmental management. Larger organisations generally recognise that management systems, auditing processes and certification schemes (e.g. ISO14001, ISO50001, EMAS) offer tested approaches for improving environmental sustainability performance that can give them a badge of environmental responsibility.

However, there is a lack of appropriately trained staff to drive the sustainability agenda within organisations, which is reducing their ability to contribute to environmental protection and minimise climate impacts. EfS has lagged behind the sustainability interests of businesses (Benn and Dunphy 2009; Lambrechts and Ceulemans 2013) so that management curricula have not adequately prepared students to deal with sustainability issues (Waddock 2007). This growing sustainability skills gap has left only 13% of UK organisations possessing the skills required to compete successfully in a sustainable economy (IEMA 2014). Universities are now playing an increasingly important role in closing this skills gap, with increasing resource invested in enhancing graduate employability (Cashian et al. 2015) and adopting real-world settings within learning and teaching (Wiek et al. 2014) to develop employment-ready graduates.

In response to this demand for environmentally literate students and to potentially reduce the environmental impacts of businesses, the authors have designed an innovative postgraduate Environmental Strategy Module that is an integral part of the Environmental Management M.Sc. at Coventry University. It focuses learning, teaching and assessment (LTA) around the creation of a proactive, self-funded five-year environmental management strategy for a simulated business utilising the Environmental Value for Money Framework (EVFM Framework). This engages students in a real-world scenario to enhance EfS and feed forward practical skills that are able to reduce environmental impacts through cost-effective environmental management strategies to their future employers.

This paper presents a conceptual study of a practical approach to EfS that contributes to the minimisation of environmental impacts that are linked to climate change, energy consumption, pollution and use of natural resources. It explores the Environmental Management Strategy Module, with a particular focus on the EVFM Framework as a dual-purpose tool. Firstly, a learning, teaching and assessment approach generates academic success through the engagement of students in environmental strategy design in a simulated real-world setting. Secondly, it facilitates an innovative methodology for environmental management strategy design for organisations seeking a cost-effective approach to environmental improvements. This self-funded approach to environmental strategy design is particularly valuable for organisations that do not currently benefit from the value for money environmental improvement interventions that are widely available as they expect them to require initial financial investment. The authors have linked these two aspects of the EVFM Framework to provide a 'feed forward' experience for students who can take this knowledge and academic experience into their business careers.

This paper adds to the discourse on LTA for EfS and offers experience-based guidance to other educators implementing active learning in real-world settings. It

also offers a tool that may help mitigate climate change by provoking environmental impact reduction.

2 Environmental Management Strategy in an Organisational Context

An Environmental management strategy is important as it allows an organisation to contribute to sustainable development through the application of environmental management processes (Shrivastava and Shrivastava 1995). Benefits from adopting an environmental management strategy include cost savings, reduction of risk, increased stakeholder engagement and demonstration of responsibility (Fothergill et al. 2017), regulatory compliance (Khalili and Duecker 2013) and more market-focused benefits such as client demands and image benefits (Potoski and Prakash 2004; Campos 2012).

Environmental audits are a fundamental part of an environmental management strategy. These voluntary, essential management procedures allow organisations to detect problems before they effect operations (Beckett and Murray 2000), develop systematic approaches to improving environmental performance (Hillary 2004), avoid or manage environmental harm whilst improving economic performance (Viegas et al. 2013) and provide a benchmark from where to measure subsequent change (Clark 1998).

Whilst it is normal for large organisations to have an environmental management strategy, conduct environmental audits and possibly obtain accreditation, most smaller companies in the UK appear reluctant to adopt such strategic approaches so that many environmental issues remain peripheral to the day-to-day running of the business (Studer et al. 2008). Khalili and Duecker (2013) consider financial constraints the key to this disengagement and suggest the biggest challenge facing organisations is access to resources to support the development of an environmental management strategy. They highlight the limiting effects of the conflict of maximising financial performance whilst minimising negative environmental impacts. The perception of intervention costs, rather than their reality, may also act as a barrier to formal environmental management (Ervin et al. 2012). Reluctance to engage formally in environmental management may also involve cultural barriers and challenges. Large (2012) suggests accreditation forces a specific approach to environmental improvement that may not suit a number of businesses, particularly SMEs.

An environmental management strategy can contribute to the achievement of Sustainable Development Goals 9 and 12 that promote the adoption of sustainable practices so that organisations do more and better with less (United Nations 2017). SDG 12 advocates awareness raising, education and the provision of adequate information to encourage sustainable production whilst SDG 9 supports the achievement of environmental objectives through technological progress (United Nations 2017). An environmental audit as part of an environmental management

strategy also supports the adoption of sustainability reporting promoted by SDG 12. However, the lack of a standardised framework to integrate environmental excellence into a business strategy discourages the adoption of strategic interventions to minimise climate impacts.

3 Environmental Management Strategy in a Learning, Teaching and Assessment Context

Both students and their potential employers now expect academics to promote employment skills within LTA (Pegg et al. 2012) so that employment-ready graduates and postgraduates with environmental sustainability knowledge and appropriate employability skills are able to join organisations after completing their studies. This contributes to the achievement of SDG 4, which targets all learners to have relevant skills for employment and the knowledge and skills needed to promote sustainable development (United Nations 2017). The promotion of employment skills within Higher Education (HE) is particularly important in the UK, as 85% of graduate roles now require environmental sustainability knowledge (Drayson 2014). However, an environmental skills gap exists, and in many cases, the environmental knowledge of the graduates does not meet business needs (Laurinkari and Tarvainen 2017).

Alongside the need for environmentally literate employees, students' preferences for interactive, experiential learning have also reshaped the practice of Education for Sustainability (EfS) in HE (HEFCE 2013; Higher Education Academy 2016). Together, these are replacing traditional instructivist approaches to learning, teaching and assessment with participatory and collaborative user interactions (Conole and Alevizou 2010).

The need for sustainability advocates and drive for sustainable futures requires more integrated and practical solutions that engage future sustainability professionals in proactive actions rather than reactive resolutions. However, EfS programmes frequently exclude such proactive approaches to the inherently complex environmental sustainability (Viegas et al. 2016). Ferreira et al. (2006) suggest this proactive, integrated learning develops by combining environmental management with project-based learning to provide a holistic view of reality.

The inclusion of an environmental management strategy project as a LTA methodology provides a significant opportunity to develop students' theoretical and practical work. This stimulates self-directed learning (Moalosi et al. 2012), increases integrated thinking which creates knowledge through collating and synthesising information (Nonaka 1994) and enhances softer employment skills such as commitment and responsibility (Ferreira et al. 2006). Crosthwaite et al. (2006) suggest these generic and transferable employability skills are more likely to develop when students engage with realistic and relevant experiences in contexts that they find meaningful.

Oblinger and Oblinger (2005) and Wiek et al. (2014) emphasise the importance of educating students in real-world settings. This learning, teaching and assessment approach is intended to trigger students' thinking, which develops learning for insight (Beech and MacIntosh 2012), and challenge preferences for just-in-time learning to achieve the long-term transformation rather than short-term victories advocated by Sharp (2012). The authors consider that utilising a company brief-driven environmental management strategy assignment immerses students in real-world project-based and solution-orientated learning and supports the positive outcomes of 'learning by doing'—engaging students (Dewey 1916) and complex problem-solving (Wiek et al. 2014). Corcoran and Wals (2004) recognise that an audit project is both an outcome and a process of learning.

4 The Design of the Study

This conceptual study focuses on the authors' experiences of the creation and application of an innovative, cost-effective environmental management strategy that has been adopted as the LTA methodology for the postgraduate Environmental Strategy Module. It makes use of observations of students' in-class and post-study applications of the EVFM Framework and analysis tools provided to support in-class and assignment activities. Secondary research has been undertaken to provide the evidence base for the strategic interventions presented in the EVFM Framework example. The authors have undertaken this research to offer other educators in the sustainability community a practical tool for EfS that may encourage students' long-term transformation to successful environmental practitioners and sustainability advocates and provide practical support to organisations seeking cost-efficient environmental improvement opportunities.

5 Environmental Management Strategy in the Module Context

The Environmental Strategy Module forms a fundamental part of the Environmental Management M.Sc., providing vital sustainability knowledge, skills and values and practical employment skills to promote environmental responsibility within individuals and organisations. The authors aim to encourage students to develop an individual and collective sense of responsibility that Burgess (2006) and Ellison and Wu (2008) consider able to motivate learning for good practice. The authors designed the module to introduce students to the opportunities available to organisations that can minimise climate impacts through cost-effective environmental management strategies. This learning, teaching and assessment approach aligns with the SDGs, which advocate utilising resources more effectively and

doing more and better with less (United Nations 2017). It is the authors' intention to train students in the use of tools and techniques and develop environmental knowledge, skills and values that can feed forward into their future workplaces to provoke environmental responsibility and climate action.

The module runs in six, 4-h sessions held weekly. Each session includes the foundation knowledge of business sustainability appropriate for postgraduate students, practical activities to promote the integration and synthesis of this information and exploration of potential solutions to emerging issues. This enables students to explore the effect of sustainable and unsustainable behaviours on businesses, particularly their internal and external pressures from and impacts on stakeholders. The authors also provide audit process and skills training throughout the module in formal and informal training sessions.

The module assignment comprises of two elements; firstly, students are required to undertake an environmental audit of the simulated, real-life company presented in the form of a mixed-media case study, and secondly, they utilise the audit findings to design a five-year self-funded environmental management strategy utilising the EVFM Framework. Within this, the students are required to generate an Environmental Fund to create a budget to pay for larger interventions that can generate more significant mitigation impacts and financial savings. Whilst students create a theoretical environmental management strategy, the approach is equally valid for real-world organisations.

In preparation for the module's taught sessions and assignment, each student receives a company briefing document that contains a detailed profile of a simulated real-life engineering company based in the UK's West Midlands region. This company brief includes mixed-media information (text, photographs, data sheets, etc.) on the company's size, history and operational activities, including supply chain transport and material handling. In order to complete an effective environmental audit, the results of which provide baseline data for the EVFM Framework, the student is able to request additional information in an 'audit meeting' in which one of the authors acts as the company's auditee. Additional company data requested typically include site plan, energy consumption and utility bills, raw materials purchased, waste quantities, environmental incidents, stakeholder complaints and chemical storage. The authors note that they do not provide a split of energy data between heating and process energy to engage students in tools and techniques for energy consumption analysis such as Degree Day Analysis.

The student undertakes a detailed environmental audit of the simulated company utilising the company brief and information obtained from the audit meeting. Their audit can identify areas of good practice, detect problems and provide the benchmark from which to recommend subsequent strategic change. This audit, the initial part of the assignment, then feeds forward into the assessed five-year improvement strategy for the case study company.

As part of the in-class support, the authors present additional environmental performance analysis tools and techniques to assist students to design the 'no-cost' foundation year of their strategy. Examples of these tools are presented within the interventions explored below. Undertaking and understanding the value of more

detailed performance evaluation can raise awareness, educate and encourage both students and organisations to measure and analyse their own performance. This can, in turn, enhance organisational performance improvement and provoke sustainability reporting in line with the aims of SDG 12. The incorporation of investment in environmentally sustainable technologies in the environmental management strategy supports SDG 9.

The authors take this self-funded approach to strategic environmental management to demonstrate that environmental performance can be improved without relying on fixed and variable asset budgets that could be used elsewhere within an organisation to improve competitiveness. The ‘no-cost’ starting point is incorporated to encourage students and organisations to rethink assumptions that environmental improvement is costly and research simple starting interventions that are able to be implemented in all sizes of organisation to extend and provoke environmental responsibility within silent and ad hoc environmental actors.

6 The EVFM Framework

The EVFM Framework provides the students and educators a LTA tool that comprises the core of the module assignment and facilitates in-class activities and independent study that can enhance formative and summative feedback. It also, perhaps most importantly, provides a tool that students can use to demonstrate their environmental skills and knowledge within their future workplaces and promote a new, value for money, ‘no-cost’ approach to environmental management and minimising climate impacts.

The framework captures the current costs of facilities and operations that have an environmental impact in the ‘Environmental Activity’ column. Evidence-based improvement interventions are then proposed and recorded as a ‘Saving Measure’ along with their financial benefits (shown as a positive cost) and implementation costs (shown as a negative cost). Over the five-year period of the strategy, the interventions and actions combine to form a self-funded environmental management strategy.

The EVFM Framework captures and evaluates improvement opportunities against the benchmark of the current activity cost to demonstrate the cost saving available from each improvement intervention and the long-term cost and environmental benefits of the initiative implemented. Savings achieved against the current operating cost (for students this is calculated from information provided in their case study brief) during each year are identified and balanced to create the total for the year. This savings total is then transferred to the following year’s ‘Environmental Fund at the start of the year’, to create the investment budget for costlier and more impactful improvement interventions. The savings raised in each year do not have to be spent in the following year; budget surpluses can accumulate over the current strategy period. In practice, a planned surplus could also be deliberately built up and carried forward into future strategy periods to allow

high-cost interventions to be funded. As the EVFM Framework generates a self-funded environmental strategy, the Environmental Fund starting balance is zero by design.

Although the EFVM Framework captures the benefits of environmental improvement interventions and efficient utilisation of resources as financial savings, the authors recognise that these could also convert into environmental impact savings such as reduced carbon emissions or water consumption reduction. Financial parameters are adopted, as organisations are most likely to change practices if they can benefit financially (Hillary and Burr 2011). The financial savings achieved in the environmental management strategy example presented below highlight the value offered by the self-funding approach to environmental performance improvement through the EVFM Framework, particularly for financially constrained organisations.

7 Cost-Effective Environmental Management Strategy

Figure 1 contains an example of a self-funded, cost-effective environmental management strategy generated through the EVFM Framework. This example, taken from a student's assignment, utilises the material provided in the company brief and the additional information obtained through participating in the audit meeting.

Environmental performance improvement interventions are included in the example presented to demonstrate the process and positive outcomes of this self-funded approach to minimisation of climate impacts. The EVFM Framework in Fig. 1 includes short descriptions of the actions proposed; additional details are included below, along with benefit calculations and some analysis tools presented in class. These provide students a sense of agency in their strategy design and are of use to organisations adopting this strategic approach to environmental performance improvement. The environmental management strategy presented here highlights the learning available from this innovative approach to EfS and the potential financial benefits emanating from environmental impact minimisation for real-world organisations.

8 Self-funded Environmental Management Strategy in Practice

1. Energy consumption reduction: Good housekeeping

Implementing good housekeeping is an effective intervention that can introduce long-term 'no-cost' behavioural change. Switching off unwanted heating, lights, production equipment and IT, closing windows, etc., could reduce consumption of electricity by 30% (Carbon Trust 2011). In addition, ensuring effective control of

Environmental Fund balance at start of year		Year 1		Year 2		Year 3		Year 4		Year 5	
		£0	£0	£67,200	£23,460	£167,435	£329,840				
Environmental Activity	Current Cost	Saving Measure	Saving	Saving Measure	Saving	Saving Measure	Saving	Saving Measure	Saving	Saving Measure	Saving
Lighting	£126,000	Good housekeeping measures	£6,300	Continued good housekeeping measures	£6,000	Continued good housekeeping measures	£5,500	Continued good housekeeping measures	£4,800	Continued good housekeeping measures	£4,000
Lighting		Programme of installing LED lighting as conventional bulbs fail	£12,600	Continued saving	£18,900	Continued saving	£25,200	Continued saving	£31,500	Continued saving	£37,800
Motors	£83,000			Replace low efficiency motor with high efficiency motor and variable speed drive	£10,790	Continued saving	£14,210	Continued saving	£14,210	Continued saving	£14,210
Gas Space Heating	£200,000	Good housekeeping and Degree Day analysis	£8,000	Continued saving	£8,000	Continued saving	£8,000	Continued saving	£8,000	Continued saving	£8,000
Gas Process Heating	£600,000	Good housekeeping	£10,000	Replace with process efficient equipment (50% funded by Local Authority energy efficiency grant)	£30,000	Initial saving	£264,000	Continued saving	£264,000	Continued saving	£264,000
Water		Good housekeeping measures	£8,000	Continued saving	£8,000	Continued saving	£8,000	Continued saving	£8,000	Continued saving	£8,000
Water	£100,000					Install lower flow water equipment	£30,000	Continued saving	£22,500	Continued saving	£15,600
Water								Rainwater harvesting/reuse system	£50,000	Initial saving	£19,000
Waste	£50,000	Good housekeeping measures	£2,000	Good housekeeping measures	£1,700	Good housekeeping measures	£1,450	Good housekeeping measures	£1,230	Good housekeeping measures	£1,045
Waste		Establish contract for sale of waste metal	£20,000	Solvent consumption reduction	£22,000	Continued saving	£21,800	Continued saving	£21,600	Continued saving	£21,400
IT	£10,000	Good housekeeping measures	£300	Continued saving	£300	Energy efficient IT equipment	£20,725	Continued saving	£3,900	Continued saving	£1,000
Material handling	£4,800			Replace leased LPG forklift truck with electric	£650	Fuel saving	£1,000	Fuel saving	£1,000	Continued saving	£1,000
Drain System and Storage Bund						Install new drains with interceptor and new storage bund	£131,000				
Power system										Install Combined Heat and Power Plant	£320,000
Balance at year end			£67,200		£23,460		£167,435		£329,840		£75,055

Fig. 1 Environmental management strategy created through the EVFM framework

the heating system (the heating is gas powered in the simulated company) can reduce energy consumption. For example, reducing building temperatures by 1 °C can reduce heating costs by 8% (Carbon Trust 2011). Good housekeeping continues in all years within this strategy. The financial benefit of energy-efficient lighting reduces year-on-year as the lighting gradually changes to LEDs (see subsequent intervention).

2. Energy consumption reduction: Lighting

Traditional energy-inefficient lighting within the workplace represents approximately 20% of total electricity consumption (Carbon Trust 2015). Conventional light bulbs are extremely energy intensive compared to fluorescent tubes and Compact Fluorescent Bulbs (CFBs). European Directive 2005/32/EC is phasing them out. Despite being costlier, lighting systems integrating Light Emitting Diodes (LEDs) offer significant longer-term financial benefits; LED lighting can use 50% less energy than fluorescent tubes or CFBs (Carbon Trust 2015). However, as they are up to 300% more expensive than fluorescent bulbs and CFBs (Carbon Trust 2015) and require different light fittings, a cost-efficient short-term strategy would be to replace CFBs as they fail. The strategic priority would be to generate the