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UNESCO Biosphere Reserves Towards Common Intellectual Ground

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1. Introduction

This chapter emerges from ongoing research and teaching at one Canadian university, and provides a review of theoretical and empirical literature, statutory frameworks and policy documents defining the United Nations Educational, Scientific and Cultural Organization's (herein UNESCO's) three interconnected, interdependent dimensions for evaluating *sustainability science*. These dimensions include conservation of biodiversity, sustainable economic and human development, and logistic support (or capacity building) for research, monitoring, education and training. As Francis (2004, p. 21) astutely observes sustainable development…

> *…implies the existence of the appropriate knowledge and governance capacity to maintain economic vitality with social inclusiveness in opportunities and benefits, provide for ecological sustainability and the protection of biodiversity to guide the use of resources, and promote social equity within and across groups and generations. All three are necessary and no one of them alone is sufficient. These requirements must also hold across a range of spatial and temporal scales.*

The chapter also builds upon findings from a preliminary study (Mitchell, 2011a) with a new aim of establishing common theoretical ground for cross-scale adaptation of this research by stakeholders within UNESCO's current constellation of 564 Biosphere Reserves. The authors draw upon a transdisciplinary selection of resources including a synopsis from a two-day experts' workshop with Swedish and Canadian collaborators that analyzed socio-ecological inventories (SEIs) in two biosphere reserves (Schultz, Folke, and Olsson, 2007; Armitage and Plummer, 2010; Gafarova, May and Plummer, 2010; Mitchell, 2011b; Velaniškis, 2010), and pedagogical resources from a senior undergraduate assignment. These resources have been organized utilizing principles from international frameworks that underpin the UN Decade of Education for Sustainable Development (see also Lundholm and Plummer, 2010; Krasney, Lundholm and Plummer, 2010; Plummer, 2010; Schultz and Lundholm, 2010), and UNESCO's Man and the Biosphere Program (UNESCO, 2010).

The following sections move to an overview of contemporary thinking within sustainability research alongside teaching and service initiatives being taken up at this mid-sized southern Ontario institution. Beginning with theoretical and institutional developments that

supported the emergence of a new research program founded on the same evaluative dimensions in all biosphere reserves, it includes findings and recommendations from a first-ever carbon footprint measure (Mitchell and Parmar, 2010). In addition, recommendations from a senior undergraduate report looking at how the campus might further operationalize UNESCO's framework to enhance its strategic planning and main academic functions are included. The sections are organized under the following themes to include a theoretical framework, an overview of social-ecological inventories (or SEIs), international frameworks currently being utilized to understand and evaluate resilience within complex adaptive ecosystems, and some additional resources emerging from the research program of the Brock Environmental Sustainability Research Unit (BESRU) aimed at cross-scale adaptation.

2. Theorising sustainability through transdisciplinarity

Building on Taylor's (2004) arguments for theorizing resilience and building capacity through biosphere reserve research, a common framework is presented – both a conceptual and political approach that offers the broadest possible understanding of UNESCO's dimension of sustainable human and socio-economic development. Theorising the "logistics function" from four Canadian biosphere reserves was also the focus of Whitelaw, Craig, Jamieson and Hamel (2004, p. 65) through a "'place based' framework" for ongoing research and periodic evaluations (see also Pollock's [2004] similarly conceived framework in the same volume).

It is clear that comprehensive, multi-systemic and inclusive approaches that reach beyond traditional hierarchical university structures are evolving to include the development of permanent partnerships with community-based stakeholders, Indigenous communities, governmental and non-governmental organizations, student and union leaders, faculty, administrative and alumni champions. This conceptual and methodological approach is increasingly being mirrored in academic literature of the social sciences, humanities, healthcare and scientific journals as "transdisciplinarity" (Holmes and Gastaldo, 2004; Giroux and Searls Giroux, 2004; Koizumi, 2001; Mitchell, 2010; Moore and Mitchell, 2008; Nicolescu, 2002; Robinson, 2008).

In their comprehensive literature review, Choi and Pak (2006, p. 351) note that "[t]he terms multidisciplinary, interdisciplinary and transdisciplinary are increasingly used in the literature, but are ambiguously defined and interchangeably used". Moreover, Mitchell (2011a, pp. 9-10) observes "[s]ustainability is not a contemporary phenomenon, but the solutions undertaken on the most successful Canadian campuses have taken an innovative turn (see also Beringer, 2006). Sustainable ways of life have been embedded within and across many cultures throughout history especially through North American Indigenous ways of knowing (Malott, 2008; Ralston Saul, 2008)". Human societies around the globe have organized their worldviews based upon rich experiences relating to the environments wherein they find themselves. Recently, these other knowledge systems are being referred to as traditional ecological knowledge, Indigenous or local knowledges declare Nakashima, et al. (2000).

From the University of British Columbia, Canadian geographer John Robinson (2008, pp. 72-3) declares that "[i]ssue-driven interdisciplinarity" is required for sustainability initiatives because of their "inherently complex, multi-faceted and problem-based focus" and this field

of sustainability represents the "paradigm case" for applying the concept. He asserts that this intellectual and political project of forging new types of sustainability coalitions is one of being "undisciplined" in the sense that "practitioners of this style of interdisciplinarity do not find themselves at the margins between disciplines, but in the sometimes uncomfortable borderlands between the academy and the larger world". He further contends that such "transdisciplinarity" has less to do with new theoretical frameworks and the unity of knowledge "than with the emergence of problem- and solution-oriented research incorporating participatory approaches to address societal problems" (Robinson, 2008, p. 71; also Mitchell, 2011a). Visser (1999) and Nicolescu (2002) consider the contours of **transdisciplinary education** in the early twenty-first century:

- Learning is an underdeveloped concept, but is necessary for all humans to be able to adapt to continuous and ever-faster change in an increasingly complex world. Fundamental changes are urgently required in the way school systems throughout the world are organized that must include more holistic conceptualizations of schools themselves as only one part of a comprehensive learning environment.
- Learning has to do with the capacity to interact creatively and constructively with problems. In most current pedagogical practices such problems are often concealed or ignored altogether. In a manner similar to Brazilian educator Freire (1970, 1999), learning therefore needs to be re-focused on problems, including their historical and epistemological contexts.
- Learning is a transdisciplinary concept related to overarching concerns such as change and growth; community-based processes and development; complex, diverse, and emerging adaptive expressions; new designs for systems of knowledge construction interacting with, and building upon, existing knowledge bases; lifelong learning at different levels of organizational complexity; neuroscience and lifespan cognitive development; the interconnections and distinctions between and among data, information, knowledge and wisdom; and new technologies for learning, languages, cognition, and meta-cognition.

Perhaps not surprisingly, the institutionalization of transdisciplinarity within universities also has UNESCO antecedents beginning in 1987 through the creation of the International Centre of Transdisciplinary Research and Studies (Centre International de Recherches et Études Transdisciplinaires, or CIRET) in Paris. In 1995, Rumanian physicist Basarab Nicolescu co-founded the Reflection Group on Transdisciplinarity with UNESCO - a project initially involving 16 scientific and cultural personalities in the implementation of transdisciplinary methodologies in various fields of international research. Similar to Visser (1999), one of its main aims is the implementation of these principles in education, and slowly but decisively, transdisciplinarity has gained an international impact especially in superior educational settings as universities the world over have opened themselves to experimenting with transdisciplinary curricula, research activities, and conferences (Dincă, 2011).

3. Brock University applies global principles

The year 2011 is marked by important global challenges that have affected humanity as never before. While globalisation has had a positive effect on millions of people by helping

them rise out of poverty, a global crisis of unusual proportions - economic, financial, social, and environmental - endangers fulfillment of the most important agenda of present-day multilateralism, the United Nations Millennium Development Goals[1]. These events coincide with a review of UNESCO's Madrid Action Plan for Biosphere Reserves (2008-2013) as well as the 40th anniversary of the Man and the Biosphere Program (MAB). MAB invites stakeholders within the World Network of Biosphere Reserves (WNBR) to engage in fostering more harmonious integration of people and nature for sustainable development through participatory dialogue, knowledge sharing and improvement of human well-being. The Madrid Action Plan notes a "commitment to innovative time-bound socio-ecological and policy actions integrating the three biosphere reserve functions and the willingness to share data, information, experience and knowledge are vital…for biosphere reserves to be learning sites during the Education for Sustainable Development (ESD) 2005-2014" (p. 10).

Lundholm and Plummer (2010) emphasize how a growing interest in environmental education has contributed to greater literacy in sustainability "dating from the 1977 UNESCO conference in Tblisi to the current Decade of Education for Sustainable Development" (2005-2014) which reached mid-term in 2009 (p. 475). Pigozzi (2010) further observes that through ESD, UNESCO seeks to integrate principles, values, and practices of sustainable development into all aspects of education and learning to address social, economic, cultural and environmental problems faced by humans in the 21st century. Nevertheless, as Lundholm and Plummer (2010) astutely inquire, in terms of "the political and pedagogical aspect of resilience, is the concept working as a heuristic cognitive tool in guiding us to look critically at ourselves [positively in terms of both human resourcefulness and strengths, and our shortcomings]?" (p. 486). It is clear that UNESCO offers internationally available conceptual and political tools for mobilizing domestic public opinion, and intellectual and academic communities in pursuit of these values and priorities. In Canada, researchers, practitioners, multidisciplinary professionals, and local, governmental and NGO stakeholders have begun to engage more fully in the current national cadre of fifteen sites shown in the map below (see also CBRA, 2011).

UNESCO embraces 193 Member States and six Associate Members, and its original mandate is still highly relevant in the 21st century where building knowledge-based societies is an imperative, where culture is crucial to any meaningful debate on sustainable development, and where science and innovation mark a new research era in fields such as climate change and water. As learning sites of excellence the 564 ecosystems comprising the current WNBR constellation offer one of the premier planetary frameworks for the development and building of international capacity to manage complex socio-ecological systems. This is achieved through greater dialogue at the science-policy interface, through environmental education and through multi-media outreach to wider communities interested in more sustainable development (adapted from UNESCO's 2008-2013 Madrid Action Plan for Biosphere Reserves). In this context it is also useful to note, as Dutch feminist Sevenhuijsen

[1]At the United Nations Millennium Summit in New York 6 to 8 September, 2000, the largest gathering of world leaders in history adopted Eight Millennium Development Goals to be achieved by 2015: 1 – To Eradicate Extreme Poverty and Hunger; 2 – To Achieve Universal Primary Education; 3 – To promote Gender Equality and Empower Women; 4 – To Reduce Child Mortality; 5 – To Improve Maternal Health; 6 – To Combat HIV/AIDS, Malaria and Other Diseases; 7 – To Ensure Environmental Sustainability; and 8 – To Develop a Global Partnership for Development.

(1999) has argued, that documents such as these "[p]olicy texts are sites of *power*…by establishing narrative conventions, authoritative repertoires of interpretation and frameworks of argumentation and communication, they confer power upon preferred modes of speaking and judging, and upon certain ways of expressing moral and political subjectivity" (also cited in Moss and Petrie, 2002, p. 81, emphasis added).

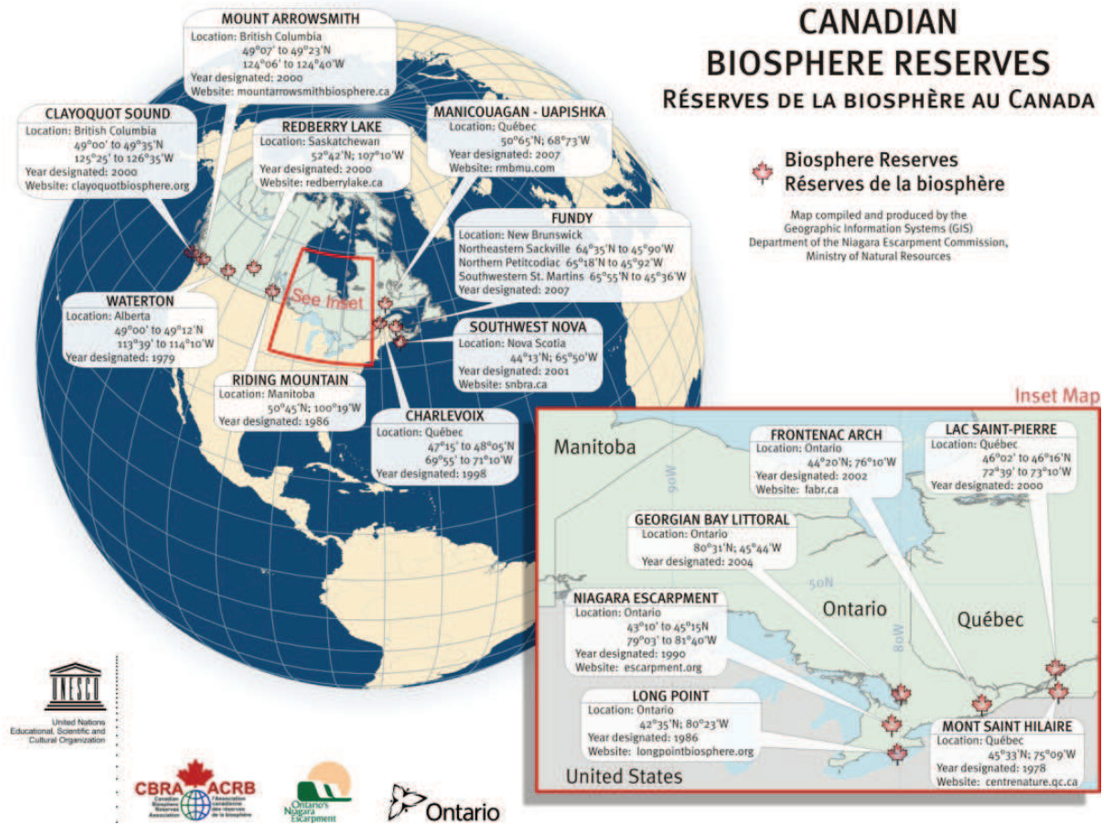

Fig. 1. Map of 2011 Canadian Biosphere Reserves under UNESCO's MAB Program (reprinted with permission from Niagara Escarpment Commission, Ontario Ministry of Natural Resources).

3.1 Brock environmental sustainability research unit

Schultz, Duit and Folke (2010, p. 663) recount how biosphere reserves were designated by UNESCO with the mission of maintaining and developing ecological and cultural diversity and securing ecosystem services for human wellbeing (see also UNESCO, 2008, p. 8) in collaboration with a suitable range of actors, often including local communities and various scientists. Since 1995, biosphere reserves have been expected to fulfill the three functions stated in the Statutory Framework and the Seville Strategy (UNESCO, 1996): (1) conserving biological and cultural diversity, (2) fostering sustainable social and economic development, and (3) supporting research, monitoring, and education. These three functions have been applied and implemented by BESRU researchers along with several of the evaluative criteria of biosphere reserves which correspond to features of adaptive co-management since they focus on monitoring and an integrated approach to conservation and development along

with participation of a suitable range of actors. Based upon their case study in Sweden and the mission, functions and criteria of UNESCO's Man and the Biosphere Program (MAB), Schultz, Duit and Folke (2010) have also proposed that biosphere reserves "constitute potential sites for testing the effectiveness of participation in general and adaptive co-management in particular" (p. 663).

Nestled in the Niagara Escarpment Biosphere Reserve (designated in 1990), Brock University is one of a small but growing cadre of Canadian academic institutions located within these areas. As previously noted conservation, sustainable socio-economic development, and education are suggested as the basis for improvements in relationships between humans and their ecosystems. In the journal Environments, however, Jamieson (2004) observes that Canadian biosphere reserves have thus far tended not to function very well in achieving UNESCO's goals (see also Francis and Whitelaw, 2004) since "the average Canadian knows nothing about biosphere reserves ….Current public ignorance about biosphere reserves in Canada is partly the result of our unique situation relative to Europe - Canada has extensive areas of relatively undisturbed wilderness" (pp. 103-104). Key to any academic contribution with respect to research programs within biosphere reserves must be the commitment of a dedicated core of readily-identifiable individuals engaged in UNESCO objectives.

Responding to this gap in domestic knowledge, the Brock Environmental Sustainability Research Unit (BESRU) has begun to interrogate the scientific, pedagogical and cultural intersections of its geographical location more precisely as a proposed site of excellence. In 2011, BESRU was developed to reflect this commitment with an overall goal to:

> *pursue innovative and interdisciplinary research concerning the environment, sustainability and social-ecological resilience (BESRU, 2011a)*

Sustainability science concepts (Kates, et al., 2001) are used to identify and address problems of interest in the areas of water, innovation and resilience, environmental governance, social-ecological systems and social justice, and the challenges faced by many of Canada's First Nations communities in a way that creates hubs and networks (BESRU, 2011a). Integral to this is the role of the university in training and educating students in sustainability science (BESRU, 2011a).

Reflecting the core values of sustainability, transdisciplinarity, and collegiality, BESRU's strategic plan involves forward-thinking research in such diverse areas as adaptation and impacts research, climate change and plant response, First Nations and source water protection, carbon pricing policy, and biosphere reserve periodic reviews (BESRU, 2011b).

3.2 Research utilising Social-Ecological Inventories (SEIs)

Social-ecological inventories (SEIs) were developed as a community-based approach for assessing resilience in Sweden's Kristianstad Vattenrike Biosphere Reserve by Lisen Schultz during her doctoral research, and as "a means to identify people with ecosystem knowledge that practice ecosystem management" (Schultz, Folke, and Olsson, 2007, p. 140). These authors highlight how SEIs are dynamic and propose their application during the preparation phase of conservation and resilience assessment projects. SEIs are a way of approaching the social landscape as carefully as the biophysical landscape with a systematic

mapping of actors, their values, motives, activities, experiences over time, and networks. These authors note how the approach "complements stakeholder analyses and biological and ecological inventories, and assesses existing management systems behind the generation of ecosystem services, thus providing a starting point for participation" (Schultz, et al., 2007, p. 141).

The methodology has been further applied in the Niagara Escarpment Biosphere Reserve in Ontario, Canada since 2009. During the process "bridging organizations" are identified as those "coordinating and connecting many of the local steward groups to organizations and institutions at other levels" (Schultz, et al., 2007, pp. 140-141). The inventory complements stakeholder analyses as well as biological or ecological inventories by assessing existing management systems behind the generation of ecosystem services. As such, groups such as these "represent an undervalued and sometimes unrecognized source of knowledge and experience for ecosystem management" (Schultz, et al., 2007, p. 141).

In March, 2011 a two-day experts' workshop with Swedish and Canadian collaborators was held to compare and analyze findings from socio-ecological inventories (SEIs) undertaken in two biosphere reserves – Kristianstad Vattenrike BR in Sweden (Schultz, Folke, and Olsson, 2007), and the Niagara Escarpment BR in Canada (Armitage and Plummer, 2010; Gafarova, May and Plummer, 2010; Velaniškis, 2010). Entitled "Social-ecological inventories: Building Resilience to Environmental Change within Biosphere Reserves" (Mitchell, 2011b), the event was hosted at the Brock University main campus in southwestern Ontario by core faculty from BESRU (see http://brocku.ca/brock-environmental-sustainability-research-unit).

The workshop engaged scientists, academic researchers, practitioners and students familiar with SEIs, those in governmental and non-governmental leadership roles, those familiar with research within UNESCO Biosphere Reserves, and those familiar with similar participatory methodologies outside and beyond the boundaries of biosphere reserves. The event (as with ongoing developments within BESRU's research program) was organized utilizing principles from relevant international frameworks including those underlying the UN Decade of Education for Sustainable Development (see also Lundholm and Plummer, 2010; Krasney, Lundholm and Plummer, 2010; Plummer, 2010; Schultz and Lundholm, 2010) with the following aims:

- To advance lessons and commonalities from the application of SEIs in Sweden and Canada with those engaged in similar processes
- To develop a document outlining some common methodological and conceptual grounds

While SEIs have been framed using much of the language of conservation biologists, they involve participatory mapping of existing stewardship and monitoring of landscape management processes that facilitate baseline achievement of UNESCO's "Man and the Biosphere Program" goals (UNESCO, 2010). It is also the case that many regions of the world lie beyond the boundaries of biosphere reserves but would nonetheless benefit from adopting the SEI within their own national parks, protected areas and ecosystems under pressure from human activities. During the workshop common frameworks for interpreting and understanding SEIs emerged that could facilitate their cross-scale adaptation, and the following points reflect these participatory values:

- Since human well-being is an underlying principle and the motivation behind development of the SEI, common conceptual frameworks defining human health could facilitate identification of "bridging organizations" for those conducting the SEI within or beyond biosphere reserves.
- Due to the mission and functional criteria of biosphere reserves, accomplishing the aims of the SEI will allow greater fulfillment of their role as sites of excellence comprising the three inter-related dimensions of conservation, human and socio-economic well being, research, evaluation and education.
- Due to the globalized nature of corporate, institutional and individual *power relations*, SEIs were seen as a participatory pathway to allow these actors to be identified locally.

These same authors further observe how the means to map, analyze and facilitate stakeholder engagement in order to develop participatory conservation projects have been discussed in previous literature. They caution, however, that while 'participation' by a variety of stakeholders may be desirable from a "democratic perspective, it is not in itself a recipe for successful ecosystem management. Participation has to be connected to management practices that generate ecological knowledge, draw on experience, and learn about and respond to ecosystem dynamics". Conducting an SEI allows local actor groups "generally operating at the level below municipalities, who effect management of ecosystems and their services on the ground" to be identified (Schultz, et al., 2007, p. 141). It has also become apparent from application that the SEI prepares the methodological ground for democratic, active and meaningful stakeholder participation. "We do not claim that the SEI is complete" (Schultz, et al., 2007, p.142), and an iterative, ongoing process is envisioned that will be enhanced by those further applying SEIs in cross-scale adaptation (see particularly Shultz, Plummer and Purdy, 2011,
http://www.resalliance.org/index.php/resilience_assessment).

From an analysis of preliminary phases of the Niagara Region SEI, Velaniškis (2010) maintains "a key factor in understanding social-ecological system interactions is identifying linkages or lack of linkage among the actors who are directly involved in ecosystem and risk management" (p. 14). It was confirmed during the workshop by those engaged in further application of the Niagara SEI that the preparatory phase of identifying bridging organizations and actors rests upon trust-building and researcher transparency. Participants emphasized the importance of not being overly proscriptive and to communicate expectations from the outset highlighting the collaborative ownership of the process as well as outcomes. Clear expectations and well-defined research protocols are to be communicated since those engaged in conducting the SEI could well be understood as agents of change themselves, and as researchers even becoming a type of bridging organization (Shultz, et al., 2007) and through the exercise of reflexivity.

3.3 Measuring Brock University's carbon footprint

While there may yet remain some highly contested terrain, it is widely accepted across most disciplines that global warming and climate change are the foremost environmental challenges facing the world today (see for example the Nobel Lecture by Intergovernmental Panel on Climate Change chair Dr. Rajendra Pachauri, [2007]). It is also clear that these

issues will only be tackled effectively when actors at all levels of developed and developing societies - including governments, NGO's, corporations, institutions of higher learning, communities and individuals - each take responsibility for, and attempt to minimize their own, Greenhouse Gas (GHG) Emissions.

These challenges have been taken up by Brock University through a baseline measurement of its carbon footprint (herein carbon audit) undertaken in two phases with the initial exploratory phase beginning in autumn 2008. Findings from a series of qualitatively framed interviews, participant observations, and documentary analyses were first published in the *International Journal of Sustainability in Higher Education* (Mitchell, 2011a). One notable outcome from the study included development of a transdisciplinary, campus-wide steering committee under the auspices of the University's Provost and Vice President Academic. Brock's Sustainability Coordinating Committee now consists of student representatives and senior administrative, academic, and facilities management personnel who quickly undertook a second phase of the audit from 2009-2010.

The methodology was framed by the GHG Protocol Corporate Accounting and Reporting Standard - the most widely adopted methodology for conducting corporate carbon footprints in the world. The principal investigators included the Committee's faculty co-chair and a partnership with international consultants HRCarbon to collate and analyze available data. The research was first bound by time with data only from the calendar year January 1, 2008 to December 31, 2008 and utilised the International Organization for Standardization (ISO) 14064, the emerging standard on Greenhouse Gas accounting and verification consisting of three parts:

- **Scope 1**: Direct emissions from sources that are owned or controlled by the organization/company (those from combustion of fuels in boilers, furnaces and turbines)
- **Scope 2**: Indirect emissions associated with the generation of purchased electricity consumed by the organization
- **Scope 3**: All other indirect emissions as a consequence of the activities of the organization that occur from sources neither owned nor controlled by the organization (outsourced distribution)

The research was further bound by data concerned with operations on the Main Campus only, and excluded satellite campuses, as well as university-related travel due to concerns for confidentiality although these data were recommended to be included in future audits. Findings included the following.

Scope	1	2	3
Research Year 2008	22,364 CO_2 Metric Tonnes	525 CO_2 Metric Tonnes	11,716 CO_2 Metric Tonnes

Table 1. Overall Brock University GHG (Carbon) Footprint
(Adapted from Mitchell and Parmar, 2010)

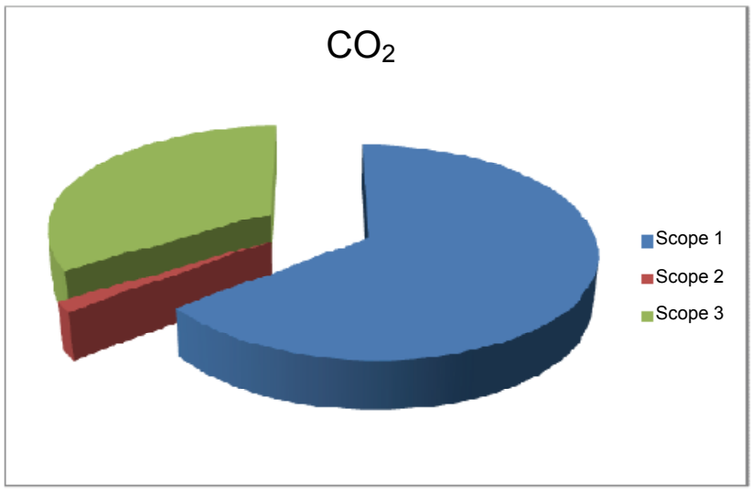

Fig. 2. Overall Brock University GHG (Carbon) Footprint Chart
(Adapted from Mitchell and Parmar, 2010)

The majority of 2008 Scope 1 and 2 emissions were generated by the burning of fossil fuels (Natural Gas) to generate electricity and a small portion to heat the Main Campus facilities. Commuting by employees, faculty and students is the second largest source of GHG emissions. The important metric of 22, 364 Mt. Tonnes of CO2 allows for a comparative analysis against other institutions and an ability to enter into other discourses and conversations on climate change with peers around the globe. This should only occur, however, with the caveat that the research was bound by a number of factors noted previously. The final report highlighted that a more comprehensive GHG Emissions Inventory will better facilitate this comparative conversation.

The key recommendation from this initial audit (submitted to the Committee as a whole in May, 2010) included directions to "undertake a more comprehensive Carbon Audit for all facilities, functions and activities that generate emissions" (Mitchell and Parmar, 2010). The University has now acted upon this directive by joining a regional carbon monitoring initiative known as the Niagara Sustainability Initiative (see Brock University News Release, 2011). In 2012, the University will engage with NSI to continue its role in modeling carbon auditing within the Region, and as part of its ongoing commitment as one of UNESCO's 'sites of excellence' in the Niagara Escarpment Biosphere Reserve. NSI is a not-for-profit organization whose mission is to be a key interface between government, industry, community and academia, and whose aim is to promote sustainability in the Niagara Region (http://niagarasustainability.org/). In this pursuit, its main vehicle is the *Carbon Project* whose focus is in corporate greenhouse gas emission reduction.

3.4 Pedagogy

In 2011, Brock University students enrolled in a third year required Environmental Management course were asked to develop a "Brock in the Biosphere Project" (the Project). The Project was undertaken for a number of reasons. First, as noted previously, Brock University is situated on the Niagara Escarpment Biosphere Reserve. Second, the ongoing

significance of this is that academic institutions have as part of their mandate a responsibility to "incorporate sustainability projects associated with these initiatives into appropriate curricula" (Mitchell, 2011a, p. 18). Third, a recently developed Sustainability Committee had been tasked with preparing a carbon audit for the university campus. Finally, a gap was identified between the UNESCO Man in the Biosphere guiding principles outlined above and Brock University's recently approved strategic plan (Brock University, 2010). This afforded students a window of opportunity to analyze the university's stated strategic direction and make recommendations as an important constituency on how to take up a more direct leadership role in biosphere reserves.

The Project required students to determine what key pillars could be used in order to operationalize Brock's strategic plan and strive to become the leading environmental steward of the Niagara community. They were then tasked with developing a 5-10 year plan of various initiatives. The Project involved the use of the Resilience Assessment workbook (Resilience Alliance Workbook, 2011) to structure information gathering and analysis. Teams met weekly with the course instructor to chart progress with work plan elements. Results from the Project were summarized by presentations to the faculty client and consultant reports. There were nine teams of between three and four members each. The following four recurring pillars were identified:

1. Education and Research
2. Community Involvement, Awareness and Partnerships
3. Protecting Biodiversity
4. Conserving Natural Resources

3.4.1 Education and research

All of the student projects identified education and research as a strategic pillar for the University to become an environmental steward and leader. Each group described various initiatives that stem from Brock University's unique geographic location. There was an opportunity identified to take advantage of this to become more "biospheric" in focus. There was also an opportunity identified to educate students on the significance of the ecosystem in which the campus is located. This could lead to greater awareness of how action taken can influence sustainability. Recommendations from the student reports encouraged departments to increase the number of environmentally related courses offered. The development of cross-referenced courses in different programs to take an interdisciplinary approach to higher education would expose students to environmental issues and sustainability. In keeping with the UN's Decade of Education for Sustainable Development (Lundholm and Plummer, 2010; Krasney, Lundholm and Plummer, 2010), the University could also work with local elementary and secondary schools in developing programs that allow students at all levels to interact and learn about the diverse Niagara ecosystem.

The broader community was also encouraged to play a role in research in the Niagara Escarpment Biosphere Reserve. Community involvement can be accomplished through environmental education, participation, plans, policies and practices about the biosphere. Research and monitoring is needed to determine the health of the Escarpment's forests and wetland habitats. Since community activities potentially impact the biosphere, research is

needed to determine and understand how these human activities impact the biodiversity of the Escarpment. A network of educators and researchers needs to be built in order to exchange the necessary information to educate the community about their role in the region regarding the biosphere; this tool will help achieve sustainability.

In addition, education and research are needed to implement sustainability plans in the Niagara Region. The broader community needs to be made aware of innovations and measures in place so that they remain competitive and are able to use the new technology. An informed community promotes, and is capable of, change. Guest lecturers speaking at public events will help stimulate research at a community and post-secondary level. Annual sustainability reports can be made and be available to the public, further expanding the Region's information exchange. Organizations like the Ontario Public Interest Research Group (OPIRG) and Sierra Youth Club already in existence at Brock, welcome members to learn and inform communities about issues in their region.

3.4.2 Community involvement, awareness and partnerships

Community involvement and awareness were closely linked with education and research within the student reports. Brock students need to play a critical role in engaging the Biosphere and broader Niagara communities. Volunteers can be engaged to educate younger school children about the biosphere through different programs. The faculty can join these student efforts in on-campus naturalist groups to spread awareness through activities like trail walks, creating monthly newsletters to distribute or posters to promote sustainability within the community.

Community involvement is needed in order to positively impact the Niagara Region and allow various conservation and sustainability initiatives to be successfully executed. Members of the community can be included in meetings allowing them to give input in strategic plans and engage in meaningful discussion. The university can play a role in ensuring accurate and reliable scientific information is available so that the community can be confident when making decisions. Community support can be used to leverage funding in the implementation of initiatives, research and monitoring of the biosphere.

Collaboration and cooperation among stakeholders are critical to satisfy all parties involved in decision-making and increase potential for the best possible outcome. Brock is an emergent leader of sustainability in Niagara and can provide outreach and educational opportunities for the community by way of guest lectures, committees, meetings, interest groups and annual sustainability reports. The formation of partnerships among stakeholders is a powerful tool to achieve sustainability; different opinions and inputs are used to form the most effective plans.

3.4.3 Protecting biodiversity

Protecting biodiversity and the conservation of natural resources, discussed next, are interrelated. Identifying, promoting and regulating conservation are important first steps. Buffer zones could be established with accompanying bylaws and policies to further protect the unique nature of the Niagara Escarpment as well as immediate surroundings. The introduction of these zones would restrict development in biologically unique areas and

allow an increase of green space and corridors of uninterrupted land for species of plants and animals.

Rehabilitation and restoration projects are needed to help protect biodiversity. Improvements made to landscapes that have been altered to previously accommodate human activity can help stop any further or potential negative impacts. Restoration projects provide habitat connectivity for wildlife so they may continue to spread to areas where they were once eliminated or previously uninhabited. The protection of land and biodiversity allows endangered species to re-establish their presence within the biosphere to a level that eliminates their threatened or endangered status.

3.4.4 Conserving natural resources

Conserving natural resources was identified as a related factor in aligning with biosphere objectives, as well as promoting sustainability in the Niagara Region. The Project plans observed that the university can play a leadership role in conserving the diversity of plants, animals and microorganisms so that the natural environment can thrive within significant ecosystems.

Concepts such as natural capital and ecosystem services should be incorporated into the University's daily operations. Institutional policies and practices that reflect these ideas need to be introduced or further implemented. These initiatives include but are not limited to resource conservation, recycling, composting, energy reduction and reusing materials. In order to monitor the success rate of conserving natural resources, the development of annual reports is needed to demonstrate the University's progress. As can be expected from the diversity of student backgrounds there were a number of secondary ideas developed. These are summarized in the following Table 2.

It was a novel experience for instructional staff, students and members of the Brock community who acted as consultants. Student learners were enthusiastic about applying the environmental management techniques they were learning about to a concrete problem-solving situation (Purdy, 2011). While at first the freedom afforded them was daunting, they became increasingly more comfortable with the consultant role and the challenges of working as a member of a collaborative team (Purdy, 2011). Instructional staff was intrigued by the opportunity to target a core environmental management course to a specific issue of relevance to the Niagara Region and Biosphere Reserves more generally. They were impressed with the novelty and sophistication of the research projects, some of which included multi-media in presentations. The Project helped to strengthen understanding not only of how to better make use of the university's unique position in the Biosphere Reserve but to align its policies with MAB program principles. The faculty consultant for the Project was gratified to see that a complex theoretical concept like transdisciplinarity could be practically applied for collaboration in sustainability; in addition efforts as a result of the Project and the previously discussed carbon audit has led to the University becoming involved in the broader regional NSI initiative (Mitchell, 2011c). In summary, research projects such as the "Brock in the Biosphere" Project can be used to make the application of learning relevant, proactive and useful. Not only were environmental management concepts applied by students, but the results can be used to further inform institutions within biosphere reserves in meeting their international obligations.

MONITORING	Allow individuals to undertake various initiatives and measure progress. The health of the natural environment can be measured in addition to any changes within the Niagara Escarpment and provide input into the local community
BROCK COMMUNITY	Educate and involve all students, faculty and employees in sustainability initiatives that benefit the Niagara Escarpment. Continue to invite stakeholders to the campus though hosting events (e.g. Ontario Fruit and Vegetable Growers Conference) and educational programs. Strengthen Brock's reputation as an environmental steward in influencing and shaping the Niagara community and developing sustainable initiatives.
INFRASTRUCTURE	Examine strategies to improve transportation, renewable energy production and building energy efficiency and model energy envelopes; investigate green roof technologies; For new development prevent damage to the surrounding environment and ecosystems; implement "waste to landfill" reduction plans that include recycling and composting; effectively enforce waste reduction programs and require enforcement to ensure success.
SUSTAINABLE DEVELOPMENT	Promote businesses in Niagara that practice sustainability; monitor with standards to ensure green washing is avoided; ensure all three pillars of sustainable development are considered.
ECONOMIC/ HUMAN DEVELOPMENT	Involve Chambers of Commerce and levels of government to promote economic vitality, industry diversity, partnerships and cooperation in the development of a sustainable community; develop a sustainability directory.
CULTURE	Use the biosphere to symbolize identity and heritage. Develop the concept of biosphere as a branding tool to demonstrate stewardship and sustainability. Integrate the Arts, environment, science and technology to link together topics of interest.

Table 2. Secondary Strategic Pillars Identified by Teams for the Brock in the Biosphere Project

4. Conclusion

Post-secondary institutions who find themselves situated in one of UNESCO's current (and ever-expanding) 564 Biosphere Reserves have an important obligation to ensure they reflect the goals and principles set out in international agreements and conventions. Within their strategic plans, for example, the core mission of innovative research, pedagogy and service

can be adapted with little challenge to reflect UNESCO's three key functions of conservation of biodiversity, sustainable economic and human development, and logistic support (or capacity building) for research, monitoring, education and training. Entities such as the Brock Environmental Sustainability Research Unit (BESRU) can play an important bridging role in connecting with other researchers, the local community and the University itself (students, faculty, and administration).

More specifically, the chapter identified how Brock University through its support in the development of an inclusive new Environmental Sustainability Research Unit, and the application of participatory tools such as the Social-Ecological Inventory, is making progress at applying internationally accepted conservation metrics. Through their carbon audits, and proactive striving to offer socially- and academically-relevant experiential learning opportunities in the classroom and the community, the University is also taking aim towards fulfilment of UNESCO's mandate for all biosphere reserves as sites of sustainability excellence.

The emerging discourse on transdisciplinarity, as identified and defined herein, provides additional guidance on how to approach the important notion of biosphere connectivity and how to gain traction in local initiatives with UNESCO's meta-framework for sustainability science. In a case study of an Indigenous Peruvian project similarly framed by an application of transdisciplinary thinking, Apgar, Argumedo and Allen (2009, 255) declare:

> *The most critical problems humanity faces today are complex problems, characterized by high levels of uncertainty, multiple perspectives and multiple interlinked processes from local to global scales….Traditional research inquiries with specialized experts are unable to make the connections required to manage complexity. Transdisciplinary approaches can help different stakeholder groups to share and use their knowledge and experience for problem-focused inquiry. Facilitating transdisciplinarity requires good dialogue processes and the development of holistic frameworks.*

The sections above have highlighted a variety of empirical and theoretical dialogues occurring within two Biosphere Reserves – one in Sweden and one in Canada – and a concomitant transfer of knowledges that has taken place as a result. These efforts may be further summed up by a quote from Thomas Homer-Dixon who describes the need for a prospective mind, "… an attitude toward the world, ourselves within it, and our future that's grounded in the knowledge that constant change and surprise are now inevitable [and] … aggressively engages with this new world of uncertainty and risk. A prospective mind recognizes how little we understand, and how we control even less" (2007, 29). In this sense, it is all the more important that academic institutions undertake the kind of integrative work presented here, and make use of the resources and capabilities offered them to enhance evaluation, education and capacity building within and beyond Biosphere Reserves.

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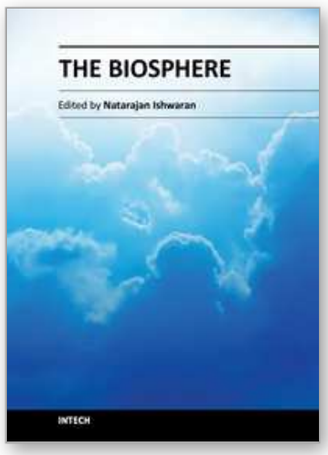

The Biosphere

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In this book entitled "The Biosphere", researchers from all regions of the world report on their findings to explore the origins, evolution, ecosystems and resource utilization patterns of the biosphere. Some describe the complexities and challenges that humanity faces in its efforts to experiment and establish a new partnership with nature in places designated as biosphere reserves by UNESCO under its Man and the Biosphere (MAB) Programme. At the dawn of the 21st century humanity is ever more aware and conscious of the adverse consequences that it has brought upon global climate change and biodiversity loss. We are at a critical moment of reflection and action to work out a new compact with the biosphere that sustains our own wellbeing and that of our planetary companions. This book is a modest attempt to enrich and enable that special moment and its march ahead in human history.

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