Assessing Sustainability in Developing Country Contexts: The Applicability of Green Building Rating Systems to Building Design and Construction in Madagascar and Tanzania

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ABSTRACT

Buildings have significant and complex impacts both in their construction and in their use. Green building rating systems have been developed and promoted in more economically-advanced countries to offer guidelines to reduce negative impacts and to promote sustainable practices of building construction and operations. The green building rating system called Leadership in Energy and Environmental Design (LEED), established in 1995 by the U.S. Green Building Council, is increasingly accepted as a meaningful measure for sustainability in building design and construction in the U.S. The Building Research Establishment Environmental Assessment Method (BREEAM) rating system in the U.K. and the Green Star rating system in Australia serve similar roles in their respective areas. How applicable are these green building rating systems to countries with different building cultures, climates and economic parameters?

The research is based on my work as an architect and participant observer using case study analysis of several buildings that I have designed in Madagascar and Tanzania.
The research indicates that several important aspects particular to the developing country contexts of Madagascar and Tanzania – such as labor and security - are not addressed by existing green building rating systems that have been developed in the context of more economically-advanced countries. Such rating systems typically give prominence to aspects such as mechanical systems and indoor air quality that are of limited relevance to the contexts of Madagascar and Tanzania.

The results have implications for the development of green building rating systems that address the particular contexts of developing countries. By taking into account parameters such as those found in Madagascar and Tanzania and similar developing countries, the benefits of using an accepted measure of sustainability can be more effectively extended to the developing country sector.

Dedication

In honor of my wife and co-pilot, Mary Bakken,
and in honor of my parents,
Karlis Ozolins and Sulamit Ivask Ozolins.

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With profound thanks to my PhD committee members, past and present,
for believing in me and in what I have to contribute.

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List of Acronyms and Abbreviations

ASHRAE	American Society of Heating Refrigeration and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Measurement
AU	African Union
BREEAM	Building Research Establishment's Environmental Assessment Method
CCM	Chama Cha Mapinduzi
Centre ValBio	Centre pour la Valorisation de la Biodiversité
CO_2	carbon dioxide
DAC	Development Assistance Committee
DANIDA	Danish International Development Agency
DCC	developing country context
DCCTM	developing country context such as that of Tanzania and Madagascar
DCMC	Dodoma Christian Medical Center
DTHD	Dodoma Tanzania Health Development
EAC	East African Community
ELCT	Evangelical Lutheran Church in Tanzania
EPA	Environmental Protection Agency
GB	Great Britain
GBRS	green building rating system
GDP	gross domestic product
GTZ	Deutsche Gesellshaft fur Technische Zusammenarbeit
HVAC	heating ventilating and air conditioning
IAQ	indoor air quality
ICTE	Institute for the Conservation of Tropical Environments
IMF	International Monetary Fund
IORA-RC	Indian Ocean Rim Association for Regional Co-operation
ITDG	Intermediate Technology Development Group
KWH	kilowatt hour
LEED	Leadership in Energy and Environmental Design
Mad	Madagascar
MICET	Malagasy Institut pour la Conservation des Environnements Tropicaux
O&M	operations and maintenance
OECD	Organization for Economic Co-operation and Development
PV	photovoltaic
SADC	Southern African Development Conference
US	United States
USGBC	United States Green Building Council
TZ	Tanzania
VOC	volatile organic compound
WHO	World Health Organization

Foreword

This research addresses the applicability of ‘green building’ rating systems – building rating tools developed to promote sustainable building design and construction – to the developing country contexts of Madagascar and Tanzania. I have practiced sustainable architecture in sub-Saharan Africa since 1983, first as a resident of Madagascar from 1983 until 1987, and then of Tanzania from 1987 until 1992. Since then, I have continued to design projects in a number of African countries from my base in the U.S. In my practice of green building, I have seen a mismatch between green building rating systems and the context of building design and construction in countries like Madagascar and Tanzania.

The first chapter introduces the main concepts and intentions of the research, providing background to green building and what it means. The second chapter reviews the literature of sustainable development as it relates to the developing country context. It also reviews the major green building rating systems currently in use in the English-speaking world. The third chapter describes the qualitative methods, specifically the participant observer and case study methods upon which the research is based. The fourth chapter describes three case studies in Madagascar and Tanzania, their locations and clients, with a description of the green building strategies incorporated in each as well as the type of construction and how the projects were delivered. The fifth chapter reviews the criteria of the ‘green building’ rating systems and how they apply to the case study buildings and the contexts of Tanzania and Madagascar.

The final chapter summarizes the elements of sustainable development that are not found to be addressed by green building rating systems currently used in more economically developed countries and looks at lessons that can be learned for the development of a green building rating system that would be appropriate and useful in the developing country contexts of Madagascar and Tanzania. It further suggests to what extent the findings can be generalized to other developing countries. The conclusion recommends improvements to existing rating systems and suggests areas for further research.

Chapter 1 Introduction – Sustainability Here and There

1.1 Research Question and Purpose

Sustainability is defined in a broadest and most general sense as leaving our children and grandchildren with the same opportunities for quality of life as the present generation. Efforts at sustainability have focused mainly on reducing the negative environmental impacts of human activities. Among the main impacts are those owing to the amount of non-renewable energy the world consumes. This consumption is by and large by the more developed economies. In the U.S. it is calculated that 39% of total energy and 74% of electricity is used by buildings.[1] In addition to this impressive statistic, building construction and demolition contribute 40% of the material that ends up in the nation's landfills.[2] Beyond reducing the negative environmental impact of human habitation on the planet, more radical efforts at sustainability strive to make human intervention a net benefit for the planet by creating buildings that are net producers of energy and that serve the environment by incorporating strategies such as minimizing demolition and waste by making buildings of parts that can be re-used in different configurations as needs change.[3]

In an effort to define, standardize and quantify just what environmentally responsible building design, construction and operations are, various rating systems have been developed since the early 1990's. The term 'green' has been a synonym for environmentally responsible since the 1970's. Building that is environmentally responsible has come to be called "green building" both in the building professions and in the popular culture. The rating systems that have been developed to define and measure such green building are known as "green building rating systems". These green building rating systems (GBRS's) describe and reward strategies that reduce environmental impact such as reducing energy demand through conservation, increasing

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[1] USGBC. 2009. LEED Reference Guide for Green Building Design & Construction. Washington D.C.: USGBC, p. 213.
[2] USGBC. 2009. LEED Reference Guide for Green Building Design & Construction. Washington D.C.: USGBC. p. 335.
[3] McDonough, William & Michael Braungart. 2002. *Cradle to Cradle: Remaking the Way We Make Things*. New York: North Point Press. p. 90.

efficiency of equipment and increasing insulation. The rating systems strive to be comprehensive by describing and including a wide variety of aspects related to the sustainability of buildings and neighborhoods. The many facets of sustainable issues are divided into broad categories dealing with building sites, water, energy, materials and indoor environment. Achieving enough points in each of these categories allows a building to be certified as compliant with the rating system and therefore considered a sustainable or "green building".

The United States Green Building Council (USGBC) – a non-governmental organization established in 1995 – has developed a rating system called Leadership in Energy & Environmental Design (LEED). Its purpose is to promote and foster market acceptance of green building. Since its introduction in 1998, the LEED green building rating system has achieved wide acceptance in the U.S. as a measure of sustainability in building design and construction with more than 2,700 buildings certified through April 2009 and 26,000 more registered and in process of becoming certified. [4] The vast majority of these buildings – more than 97 % - are in the U.S. The remaining 3% are located in more than 35 countries led by the United Arab Emirates, Canada, China, India and Mexico.

By far the largest and oldest of the green building rating systems, the Building Research Establishment's Environmental Assessment Method (BREEAM) was introduced in the U.K. in 1990. Since that time more than 115,000 buildings have been certified in the U.K. with an additional 700,000 registered for eventual certification. Australia's Green Star green building rating system was launched in 2003 and has certified 148 projects through April 2009. Green building rating systems such as LEED, BREEAM and Green Star attempt to be comprehensive by addressing as many sustainability concerns as can be readily quantified such as energy use, air quality, urban sprawl. In fact, their success is in large measure due to this fact of quantification of the components of an issue whose complexity defies simple description and resolution. By offering a method for quantifying and ranking the choices related to sustainability, the green building rating systems make possible comparisons between alternative strategies and between buildings. It offers a way to say that one building is greener, more sustainable than another.

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[4] USGBC. Registered LEED Project List as of 8 May 2009.

The USGBC states that the LEED green building rating system “encourages and accelerates global adoption of sustainable green building and development practices through the creation and implementation of universally understood and accepted tools and performance criteria”. In contrast to the USGBC’s goal of global adoption of LEED, both BREEAM and Green Star are promoted for use exclusively in their country of origin. For projects outside of the U.K. and Australia, respectively, both BREEAM and Green Star offer to help countries or regions develop a green building rating system appropriate for their particular context using BREEAM or Green Star as a starting point. In this way, BREEAM has developed BREEAM Europe and BREEAM Gulf States and Green Star has helped South Africa’s Green Building Council develop Green Star South Africa.[5]

The LEED rating system, on the other hand, has been used in other parts of the world – most widely in India and China with little or no modification. India has 28 LEED-certified projects and a further 74 projects registered and in the process of certification while China has 19 LEED-certified projects and 155 projects registered as of April 2009.[6] In fact, the India Green Building Council has adopted the LEED rating system with the approval of the USGBC, calling it LEED India while making a few minor modifications.[7][8] These LEED projects in India and China reflect the interest in green building that transcends national boundaries. The interest is not only in green building but also in a means of evaluating and comparing the level of green building achieved between buildings and across national boundaries. International corporations are a prime example of this transnational interest in green building. The facilities managers of corporations with facilities in various countries would like to be able to compare the performance of buildings across a variety of locations so as to evaluate and determine whether given building strategies meet performance targets or not. While the desire to compare green building

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[5] BREEAM. *BREEAM International*. http://www.breeam.org/page.jsp?id=96. (retrieved 11 October 2009). and Australia Green Star. *Home Page*. http://www.gbca.org.au/green-star/. (retrieved 11 October 2009) and Green Star South Africa. *Home Page*. http://www.gbcsa.org.za/home.php. (retrieved 11 October 2009).

[6] USGBC. *Projects Listing*. http://www.usgbc.org/LEED/Project/CertifiedProjectList.aspx. (retrieved 11 October 2009).

[7] India Green Building Council. *LEED India for New Construction*. http://www.igbc.in:9080/site/igbc/testigbc.jsp?desc=22905&event=22869. (retrieved 12 January 2010).

[8] Changes include deletion of open space criteria and the addition of criteria for water use in cooling systems.

performance and strategies across national boundaries is certainly understandable, the use of the LEED green building rating system transnationally gives rise to the question: to what extent are green building design and construction strategies and performance comparable between contexts that differ from each other in economy, culture, and climate among other aspects? Are there really "universally understood and accepted tools and performance criteria" as the USGBC claims?

1.2 Genesis and Development of Ideas

I lived and worked as an architect in Madagascar and Tanzania from 1983 to 1992 and since then have continued to practice there, as well as in several other African countries: Kenya, Malawi, and Ghana. Since my first days working overseas, I was struck by the enormous difference in building design and construction of such developing countries and that of the U.S. where I grew up and received my architectural education and that of France and other European countries where I have also lived and traveled. Once confronted by the realities of designing and building in Madagascar and Tanzania, everything I had learned about architecture, design and construction had to be re-processed through the lens of this new context that I was asked to work within. The task was not so much to see what was different but rather to try to identify the commonalities that would give me a foothold of understanding from which to begin to do my work.

I confess that I came to my work in Madagascar and Tanzania with certain preconceptions about the buildings that I would design. Since what I knew about African countries up to that point was informed primarily by travel and ethnographic documentaries featuring traditional dwellings of local materials – think round mud huts with thatched roofs – and news stories about droughts, famines and military coups, I thought that I would be studying the forms of traditional dwellings and how people used them to develop a design vocabulary that they would identify with.

While my clients were very patient with me and forgiving of my patronizing preconceptions, I quickly learned that my clients had an ambivalent attitude at best concerning their traditional dwellings. For both my Malagasy and Tanzanian clients, their traditional dwellings were often associated in their minds with backwardness, with illness or lack of sanitation. But beyond the ambivalent relation my clients had with their traditional dwellings, I learned that the modern world had already reached these countries in the form of their colonizing powers some 100-150 years before my arrival. The colonizers had brought with them their culture and economy, as well as their building types: schools, administrative offices, warehouses and their technologies for building these new building types. And they had been training indigenous builders and craftsmen in those technologies for all that time providing them with that framework of reference.

Another of my pre-conceptions soon to fall was that the attitude of the colonized to the former colonizer would be negative. The attitude I found was ambivalent but positive for the most part towards the colonizing power. The colonizer's culture was the lens through which the colonized learned about the world at large for better or for worse. The colonizer provided the measure against which to evaluate. The colonizer certainly represented negative experiences in some ways and that was what I had thought would be predominant. But the colonizing power offered modernity, and progress in health, in longevity, in education, and in material aspirations for parents of children in largely subsistence farming communities.

So, as an architect, I was asked to design buildings of types introduced one hundred years before by the colonizing power, making best and most economic use of the existing building technologies already present and familiar to the inhabitants. Building contractors, workers, and trades people already knew these technologies and this way of building: roles, materials, techniques, expectations and standards that had been introduced and already adapted to the local climatic context over decades of practice. I was the one in dire need of learning the way things were done. And yes, I was expected to respond to the local culture, but not as I had anticipated. It was not through a reference to the former traditions of a particular tribe, but rather through an understanding of what the people value in common, how they relate to each other and how they make use of space. For instance, many activities occur outside, such as socializing, cooking, food preparation, grooming, hair styling, and meeting. I had to recognize the Malagasy and Tanzanians as social people who identify strongly with their community. They take social conventions and considerations very seriously. It is a strong contrast to an individualistic society such as the U.S. In designing hospitals and clinics, I had to recognize that patients do not come alone. They come with family and often from a great distance. If the patient becomes an inpatient, the family will stay nearby, if not on the hospital grounds, and cook for the patient since food is not typically available in hospitals. So some kind of accommodation is needed, such as a camping area with cooking facilities and water. In a pediatric ward, the mothers stay and sleep with the children, so the ward needs to be bigger and will be busier. All this turned on its head what I had learned about hospital design. In fact hospitals there, at least in the rural areas where the majority of people live, provide care in the context of a family campground.

In essence what I am asked to do in Madagascar and Tanzania is not to create buildings inspired by traditional forms, as appropriate as that might have seemed to me initially. Rather, I am asked to create buildings with locally available technologies for the benefit of the local inhabitants that correspond to their needs, their use of space and their values and corresponding to the constraints and opportunities of the particular climate and topography of the particular place.

Perhaps this difference can be illustrated by an example. Suppose that I was born and raised in a log cabin in an area where everyone lived in log cabins. When I go to attend school, I do not necessarily expect or desire that the school would be or look like a larger log cabin. It is something else. But I would indeed expect that the school would correspond to how learning is done in my community, that it would correspond to how people in the community interact with each other and be appropriately responsive to the local climate and topography of the place.

I am asked to create within a cultural, economic and environmental milieu as part of a continuum that reaches back to traditional dwellings, acknowledges the significant colonial influence and lens through which the society approaches the world and the modernizing and globalizing context in which the Tanzanians and Malagasy live.[9]

[9] For more detail about the process and challenges of building design in Tanzania, see Ozolins, Peter. 1994. *Traditional, Colonial and World Cultures: The Architecture Profession in Tanzania*. 1994 Working Paper Series, Vol. 57. International Association for the Study of Traditional Environments (IASTE) presented at the 1994 IASTE conference.

Figure 1.2.1 – Map of Africa and Madagascar. Source: http://www.lib.utexas.edu/maps/africa/txu-oclc-238859671-africa_pol_2008.jpg.

This dissertation has its roots in this overseas work as an architect (see figure 1.2.1). The issues of how to design and implement building projects in such a way as to make them sustainable were ones that I dealt with on a daily basis. In the earlier years of my time abroad, we spoke of appropriate and intermediate technologies as more viable alternatives to pursuing the full-on industrialization of developing countries that tries to copy the more developed economies of Europe and North America. We tried to maximize the use of locally-available materials and labor to ensure that the projects would benefit the local community and be easier to maintain within the locally available resources and materials.

Endemic problems of poverty and the resulting pressures on the environment were evident in deforestation and rural-to-urban migration. The unique flora and fauna of Madagascar and the magnificent wildlife of Tanzania were and remain threatened by such pressures. The interest and opportunity afforded by the present focus on green building within the design and building communities is that such issues be viewed in a comprehensive manner that recognizes how issues of environment are interlinked and interdependent with economic and social issues. A larger frame of reference offers hope that solutions will address the multi-faceted nature of sustainability.

1.3 Objectives and Hypotheses

This research explores the extent to which green building rating systems such as LEED apply to the developing country contexts of Madagascar and Tanzania. The question is whether such green building rating systems offer an accurate and comprehensive system for evaluating sustainability-related choices for building design and construction in the context of developing countries such as Madagascar and Tanzania. This research seeks to identify the elements of such rating systems that apply and those that do not and how such rating systems could be modified to better apply to developing country contexts such as those of Tanzania and Madagascar. Do the categories of sustainability that have been identified in LEED adequately cover the aspects of sustainability relevant to the developing country context such as it is found in Madagascar and Tanzania?

Furthermore, what characteristics of sustainability in the developing country context are not addressed in the current green building rating systems and could be addressed in order to give a fuller picture of sustainable building design and construction in countries such as Madagascar and Tanzania? The importance of this question is that a rating system that does address issues of sustainability as they are manifest in such developing countries would be a very useful tool in evaluating and comparing choices and alternatives in the developing country context just as the green building rating systems do in the UK and US context. To the degree that a green building rating system is an accurate, comprehensive and consistent measure of sustainability, it allows a comparison between buildings; a means to evaluate alternative strategies and to say that one building is generally more sustainable than another.

The LEED rating system was developed in the U.S. and with the U.S. context in mind just as the BREEAM rating system was developed with reference to the UK context. As such, there are aspects of the sustainability discussion that are given prominence that may not be justified in another context. Similarly, there are sustainability aspects that are not addressed that may be essential in another context. An example is the emphasis in the LEED rating system on the energy efficiency and commissioning of mechanical systems that can account for more than 15% of the total points towards LEED certification[10]. This makes sense in the U.S. context where mechanical systems can represent more than 30% of a given construction budget. However, in the developing country context such as that of Madagascar and Tanzania, where the mechanical system can consist of operable windows and perhaps a ceiling fan, this is not justified and doesn't accurately represent the range and relative importance of the various choices related to sustainable building design and construction in those contexts.

The objective of the research is also to identify those elements related to sustainability in Madagascar and Tanzania that are not addressed in the green building rating criteria and to propose that their incorporation into a green building rating system would more accurately reflect the range of issues and contexts of such countries. My hypothesis is that sustainability is not a homogenous concept but rather has aspects that differ in importance depending on the cultural, environmental and economic context in which they are addressed. Such aspects as are found in different contexts are also amenable to evaluation and can be incorporated into green building rating systems that are specific and relevant to that given context.

1.4 Theoretical Underpinning

The theoretical underpinnings of this research hearken back to the work of Christopher Alexander, architect and theoretician, whose work has been very influential for generations of architecture students seeking to design humane and livable environments. Alexander's early work resulted in his book, *Notes on the Synthesis of Form*, in which he describes human-designed forms as a fit or misfit with respect to the myriad forces acting upon them[11]. The more successful form is one that responds appropriately to all or most of such forces. The example is given of the free-standing high-rise building in the modern style surrounded by open space.

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[10] USGBC. 2009. Green Building Design and Construction: LEED Reference Guide. Washington D.C: USGBC.
[11] Alexander, Christopher. 1966. *Notes on the Synthesis of Form*. Cambridge: Harvard University Press.

While this type of building did respond to certain forces, such as the need for open space and daylighting and the desire for an expression of modernity, it did not address or recognize other critical forces like the need for a feeling of control over one's surroundings and being part of a recognizable spatial subset.[12] It was therefore not ultimately successful.

His ideas were developed further in his work on *pattern language* in which he and his colleagues sought to identify familiar and life-sustaining patterns of habitation that all parties involved in the enterprise of building, that is, everyone, would share and understand.[13] Alexander looks with particular interest to traditional building, not in the interest of copying those forms, but in the fact that, in those contexts, all the participants in the building enterprise share the same understanding of the forms used and their meaning, that is, the same pattern language.[14] By contrast, the modern process of design and building is characterized by a diversity of specialized interests, each with its own set of patterns that are particular to that interest group and without particular meaning for other participants. In his pattern language work, Alexander and his colleagues sought to recreate the experience of building in traditional societies by identifying patterns of the use of space and forms that everyone would agree are life-sustaining and harmonious and that everyone could use to create their own places. In my professional work as an architect, this idea of harmonious and life-sustaining patterns of habitation has always been at the base of my design work through which I seek to create beautiful, functional and memorable places.

In addition to this already monumental and contentious task of elaborating a pattern language, Alexander added the idea that not only could people successfully design their own dwelling or building through use of the pattern language, they could also build for themselves using simple low-technology construction techniques.[15] Alexander championed such user-designed and user-built buildings in several projects in the U.S., Peru, Mexico and Japan.

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[12] King, Ingrid F. 1993. Christopher Alexander and Contemporary Architecture. *Architecture & Urbanism Special Issue* August 1993. p. 16-22.
[13] Alexander, Christopher. 1977. *A Pattern Language: Towns, Buildings, Construction*. New York: Oxford University Press.
[14] Alexander, Christopher. 1966. *Notes on the Synthesis of Form*. Cambridge: Harvard University Press. p.50.
[15] Alexander, Christopher. 1985. *The Production of Houses*. New York: Oxford University Press.

The U.S. architect and educator, Howard Davis, is a former colleague of Christopher Alexander. Building on Alexander's notion of the importance of understanding and addressing the forces that impact a form, Davis looks at how and why the built environment comes to be built as it is. In place of Alexander's emphasis on self-design and self-building, Davis explores how and why the built environment of a given place comes to be as it is. He identifies the critical role of the *culture of building* which he defines as "the coordinated system of knowledge, rules, and procedures that is shared by people who participate in the building activity and that determines the form buildings and cities take".[16] Without an understanding of how and why a built environment comes to be as it is, one cannot hope to change the resultant built environment. As well-intentioned as the idea of self-designing and self-building is, the fact is, that this is not the way the built environment is created anywhere but in traditional societies.

As mentioned above, as a U.S. architect designing and getting projects built in Madagascar and Tanzania for both indigenous and expatriate users, I soon recognized that I would have very little success without an in-depth appreciation and understanding of how buildings come to be in those given contexts. While it sounds self-evident, it is nothing of the sort, as architects are trained to design buildings within certain structural and legal parameters but not to recognize the whole of the building culture as the "coordinated system of knowledge, rules, and procedures that is shared by people who participate in the building activity" that Davis identifies. This perspective helps the architect to see her/his place within this system and to understand what is achievable and how innovations can occur in a given place.

This idea of a culture of building helped me to see my work in Madagascar and Tanzania in the broader context of the local building culture of those places. While I always resonated with Alexander's ideas on the pattern language and tried to put them into practice in my work, his emphasis on self-building and self-design never fit in with my experience as a practicing architect. In Madagascar and Tanzania I had clients with time and budget constraints who needed buildings as soon as possible that would last for a hundred years with minimal maintenance. I was never asked to coordinate a building brigade of volunteers to build something nor was I

[16] Davis, Howard. 2006. *The Culture of Building*. New York: Oxford University Press. p. 3.

asked to experiment with materials to find a better and cheaper way of building. Rather, I was asked to design many buildings in different places with barely adequate budgets for construction, no budget for maintenance and long delayed unmet needs. While these same parameters existed for my previous work as an architect in the U.S., I was familiar with the building culture in that context and knew its constraints and opportunities implicitly. Davis' notion and research on building culture gave me a framework of understanding for my experience as an architect practicing in a new setting. An appreciation of the building culture of a place was necessary for an intervention in the built environment to be successful.

The contention of this research is that present efforts at sustainability as expressed in green building rating systems developed in the U.S. and in other more economically-developed countries, while laudable and helpful, do not adequately address the whole or wider range of forces that impact sustainability. This is particularly so when a green building rating system, developed for use in one particular economic, environmental and cultural context, is used in a whole different context with its own particular parameters.

This research builds upon both Alexander's idea of meaningful shared patterns of habitation and Davis' concept of building culture to explore the broad ideas of sustainability as they apply to building design and construction in Madagascar and Tanzania. Their work provides a grounding upon which this research seeks to identify green building that fits for the developing country contexts of Tanzania and Madagascar. The broader view of sustainability, as it will be explored in Chapter 2, Section 2.2, indicates that built environment interventions need to relate to how users use space and to values that they hold for them to be sustainable. Chapter 1, Section 1.2 and Chapter 2, Section 2.4 point to the importance of an in-depth understanding of how the built environment is created in a given place. This knowledge of the local building culture is necessary to design and build in the most sustainable way for a given place.

Further theoretical insight concerning the importance of familiarity with the local can be found in the architectural writer and critic, Kenneth Frampton's writings about critical regionalism. Frampton promotes a modern architecture that doesn't seek the mythical blank slate upon which to create works of modernity, but rather embraces and responds to the topography, climate and the light of a place. He writes about a building being 'layered' into a site rather than built upon a flattened topography. He writes that "through this layering into the site, the idiosyncrasies of place find their expression without falling into sentimentality".[17] He is concerned with a response – and an architecture of resistance – to the "phenomenon of universalization" in which a single technology produces the same forms and aesthetics everywhere resulting in a homogenization of places. Another well-known architectural writer, Christian Norberg-Shulz, also discusses a "new regionalism" in which the 'genius loci' – or spirit of the place – finds expression in the built form.[18] Along with Frampton, he is concerned about a creeping loss of place, the placelessness of certain modern built environments. Davis' concept of building culture is helpful in understanding that significant differences exist – and persist – between various regions of the world and are not in danger of disappearing anytime soon. Davis demonstrates that, around the world, the regional is alive and well, even if it is not thriving within a single large industrialized economy such as the U.S. Norberg-Shulz's concern that "meaningful traditions are swept away in no time and substituted by the worst kind of vulgar modernism"[19] is countered by Davis' explanation of the depth of the roots of the building culture that, by definition, occurs locally.

What is strikingly absent in both Frampton's and Norberg-Shulz's analysis of the regional are the people. The inhabitants and users with their culture, use of space and values are absent from their analysis. It is they who are the focus of Alexander's search for a pattern language and they whose culture and values will continue to seek for expression in the local built environment.

This research, then, is very much about the regional and the local and the people that are found there. It is about the characteristics that are found locally that differentiate one place from another and that are keys to what sustainability is and can be in a given place.

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[17] Frampton, Kenneth. 2002. *Labour, Work and Architecture: Collected Essays on Architecture and Design*. London: Phaidon Press, Inc. p. 87.
[18] Norberg-Shulz, Christian. 2000. *Priniples of Modern Architecture*. London: Andreas Papadakis Publisher. p. 89.
[19] Norberg-Shulz. Ibid. p. 91.

1.5 Significance and Limitations

The significance of this research is the identification of the limits of generalization of measures of sustainability across economic and cultural contexts. It is also important for bringing to light aspects of sustainability that are important to the developing country context that can be incorporated into a meaningful green building rating system. This can in turn be instructive for a better understanding of sustainability in the more developed countries. The limitations of this research are the extent to which the results can be generalized to developing country contexts beyond those of Madagascar and Tanzania (see figure 1.5.1). While many parallels exist – such as high unemployment, shortage of skilled labor, limited availability of manufactured building materials – careful consideration should be given to the specific contexts of other developing countries. Significant differences exist between countries and between regions that make direct comparisons difficult. For example, the degree of urbanization and the population density of the Indian subcontinent (364.4 per square kilometer) make it substantially different from relatively sparsely populated countries such as Tanzania and Madagascar (46.3 inhabitants and 33.4 inhabitants per square kilometer, respectively) and this difference could indicate an emphasis on different aspects of sustainability that would be appropriate.

Figure 1.5.1 - View of western Indian Ocean showing eastern Africa and Madagascar. Source: Google Earth and Fieldwork.

1.6 Madagascar: Historical Background

Madagascar has a colorful and exotic history. It is primarily known today as the home of flora and fauna absolutely unique in the world, due to its separation from the African continent some 175 million years ago. It is considered one of two areas in the world – along with the Amazon – with the highest degree of biodiversity and has been rapidly losing its forests due to human encroachment for fuel, cultivation and grazing of livestock.[20] Situated 250 miles (400 km.) off the coast of Mozambique in southeastern Africa in the Indian Ocean, Madagascar is the world's fourth largest island (see figure 1.6.1). It has an area of 226,597 square miles (587,041 square kilometers) – approximately 1000 miles (1600 kilometers) north to south and 300 miles (480 kilometers) east to west – about the combined size of France, Belgium and the Netherlands.

Figure 1.6.1 - Map of Madagascar. Source:http://madagascar.mongabay.net/images/ madagascar_map_tex.jpg.

[20] Lanting, Frans. 1990. *Madagascar: A World Out of Time*. New York: Aperture Foundation, Inc.

Madagascar’s 19.6 million inhabitants belong to 18 different tribes who all speak one language – Malagasy – or minor variations of it. Most of Madagascar’s inhabitants are believed to be of Austronesian ancestry. They are thought to have arrived only about a thousand to 1500 years ago by boat from the area near Indonesia for purposes of trade. There is however also oral historical evidence of a people called the Vazimba who are said to have inhabited Madagascar prior to the Austronesian inhabitants and who are thought to have been related to the bushmen tribes of southern Africa.[21]

Starting around 800 A.D., Arab traders began visiting the island and established some settlements along the coasts. This Arab contact is evidenced by the use of Arabic words for days of the week and the introduction of the calendar. The earliest written versions of the Malagasy language used Arabic script. Other visitors to Madagascar included the Portuguese who had substantial trading interests all along the route around South Africa’s Cape of Good Hope. Pirates also had a foothold in Madagascar’s east coast from where they could attack ships on these same main trading routes from Europe to India.

In the 1790’s, the Imerina tribe in the central highlands attempted to extend their dominance over most of the island. They established a monarchy that would be recognized by means of treaties with Great Britain and other European powers and would last for more than 100 years until the annexation of Madagascar by the French in 1896. [22] Madagascar remained a French colony until its independence in 1960 after which it remained squarely in the French zone of influence until 1975 when a military coup brought in a new leader, Didier Ratsiraka. Ratsiraka sought to develop new trading partners among the communist nations, particularly North Korea and the Soviet Union. By the mid 1980’s, Madagascar’s increasing poverty, shortages of basic goods and isolation brought it back towards its traditional trading partnership with its former colonizer, France. Bank liberalization and the re-introduction of multi-party democracy in the early 1990’s brought much-needed foreign investment. In 2001, then mayor of the capital city Antananarivo,

[21] Randrianja, Solofo & Stephen Ellis. 2009. *Madagascar: A Short History*. Chicago: The University of Chicago Press. p. 70.
[22] Campbell, Gwyn. 2005. *An Economic History of Imperial Madagascar, 1750-1895*. Cambridge: Cambridge University Press. p. 324.

Marc Ravalomanana, a self-made entrepreneur who made his fortune selling milk products, challenged Ratsiraka in the presidential elections. Both sides claimed victory and a standoff ensued between the two contestants with Ravalomanana holding rallies and prayer meetings daily in the center of the capital and the incumbent emptying the treasury and retreating to his home area of Toamasina on the east coast, declaring it a sovereign nation. A four-month standoff ensued with Ravalomanana's supporters holding the capital city and surrounding area while Ratsiraka's supporters blockaded the capital, destroyed bridges and roads, and hired French mercenaries. After it became clear that Ratsiraka's position was getting weaker, he and his top ministers fled the island for exile in France. Ravalomanana established his government which encouraged investment and trade relations, particularly with the United States. He also developed strong economic relations with the newly democratic economic powerhouse of South Africa, encouraging investment in tourism and mining. Ravalomanana won re-election in 2006 and continued aggressive economic development, making major improvements to roads especially in and around the capital city. He also established environmental regulations to safeguard Madagascar's unique natural heritage. There were increasing complaints about corrupt practices and favoritism towards the president's business interests. The benefits of the new investments were felt mainly by the middle class while the lower classes continued to feel marginalized and left behind by the economic developments. The increasing discontent was reflected in the rise to political life of a disc jockey in the capital city, Andria Rajoelina, who used his radio program as a platform from which to launch a successful campaign for mayor of Antananarivo. He subsequently exploited the rising discontent by fomenting a military coup d'état in 2008 by junior military officers with financial backing of French business interests allied with former president Ratsiraka. Ravalomanana, two years into his second term as elected leader, fled to South Africa. As of March 2010, the situation is still not resolved as the African Union (AU), Southern African Development Community (SADC) and other African and Western countries have condemned the coup and demanded the restoration of the elected leader or at the least the holding of new elections under international auspices. The former disc jockey has so far refused to relinquish power or to reschedule new elections as he has repeatedly promised. As a result of the impasse, Madagascar's economic and political life is at a standstill, waiting to see what the solution will be. In addition to that, there is increasing lawlessness and violence as the lack of a legitimate central authority has allowed criminal activity to flourish. In the environmental sector, the exploitation of the endangered rosewood, which had been curtailed under Ravalomana's environmental initiatives, has accelerated dramatically with no authority capable or interested in enforcing the laws. Foreign investment and international aid has been interrupted pending resolution of the crisis.[23]

The capital city, Antananarivo, which means "at the city of a thousand (warriors)", is located in the central highlands with a population of 1.5 million. There is one main port city, Toamasina, located on the east coast, with a rail line in addition to the main tarmac road linking it to the capital city. There is no other urban area to rival Antananarivo in size or importance but there are two other highlands cities with populations of about 150,000 – Antsirabe and Fianarantsoa – while at the northern tip of the island, Antsiranana is a port and regional center which would be more important if there were effective roads linking it to the capital city and the highlands area. Other coastal cities of minor economic importance are Mahajanga and Toliary on the west coast, and Tolagnaro on the southeast tip of the island.[24]

Approximately 45% of the Malagasy people identify themselves as Christian, evenly divided into Protestant and Catholic. About 7% are Muslim, while the remaining balance, and even a good percentage of those professing other faiths, hold traditional beliefs that emphasize the connection between the living and their ancestors. Very important to these beliefs are the taboos – or *fady* – that are numerous and circumscribe daily life.[25] Muslims are found along the northern and northwestern coasts where Arab traders had influence. Christians are found in the towns and the traditional believers in the rural areas. The Malagasy do not identify themselves as African, feeling separated by geography and ethnic origin from mainland Africa. They identify most strongly with France, their former colonial power. After France, they identify with their fellow Indian Ocean islands of Comoros, Seychelles, La Reunion and Mauritius. It is easy to see a

[23] Several resources exist that detail Madagascar's dramatic and confusing recent political history. The recently published book by Solofo Randrianja and Stephen Ellis, previously cited, provides a summary of political events through 2008 and their effects. See Randrianja, Solofo & Stephen Ellis. 2009. *Madagascar: A Short History*. Chicago: The University of Chicago Press.

[24] See Lanting, Frans. 1990. *A World Out of Time: Madagascar*. New York: Aperture Foundation, Inc.

[25] This fascinating and complex aspect of Malagasy culture is explored in a classic text by Jorgen Ruud who explains that the root of the Malagasy word 'fady' is Indonesian. See Ruud, Jorgen. 1960. *Taboo: A Study of Malagasy Customs and Beliefs*. Oslo: Oslo University Press.

connection to Southeast Asia and Indonesia in the paddy rice cultivated widely on terraces in highland areas. Most of the eighteen tribes – particularly the highlands tribes – have features identified with Southeast Asia or Indonesia: black straight hair, round-shaped faces and chestnut-colored skin. Culturally, they are typically very polite and reserved, never wanting to respond in the negative to a question and self-deprecating to the point of starting from the assumption that anything foreign is superior to that which is made in Madagascar. It is challenging when working in Madagascar to get what we in the U.S. would consider a straight and complete answer to a question. Answers are intended generally to, first, be pleasing to those who ask, and only secondarily, to be informative.[26]

Traditional building construction in the highlands areas consists of rectangular two-story mud-walled houses with thatched roofs (see figures 1.6.2 and 1.6.3). In the hotter coastal areas, the dwellings are also rectangular but one-story with walls of woven leaves, an elevated floor and thatched roof (see figure 1.6.4). These traditional dwelling types are still ubiquitous today.

Figure 1.6.2 –Madagascar: traditional houses in the central highlands. Source: Fieldwork.

[26] See Decary, Raymond. 1951. *Moeurs et Coutumes des Malgaches*. Paris: Payot for a colonial-era overview of the Malagasy culture.

Figure 1.6.3 –Madagascar: traditional highlands dwelling. Source: Fieldwork.

Figure 1.6.4 –Madagascar: traditional coastal dwelling. Source: Fieldwork.

Several modifications to the traditional highland dwelling type occurred due to the influence of European contact in the mid 1800's. One of these was the introduction of sun-dried brick-making technology in the highlands. Another was the incorporation of a balcony along one of the long walls of the dwellings which expanded the upstairs living space and contained the stairs accessing the upper level (see figure 1.6.5). In Antananarivo today, one can see the mix of the various influences at play in the architecture of the city (see figure 1.6.6).

Figure 1.6.5 –Madagascar: highlands dwelling showing colonial influence through use of burnt bricks and veranda. Source: Fieldwork.

Figure 1.6.6 – Madagascar: central Antananarivo, the capital city with its eclectic mix of building styles reflecting traditional and colonial influences. Source: Fieldwork.

1.7 Tanzania: Historical Background

Tanzania is located on the east coast of Africa, along the westernmost reaches of the Indian Ocean. It lies north of Mozambique and south of Kenya. Inland to the west of Tanzania, are Rwanda, Burundi and Zambia. The tallest mountain in Africa, Mount Kilimanjaro at 5895 meters high (19,336 feet), is located in the north of Tanzania along its border with Kenya. In the north of Tanzania is also the famous Ngorongoro Crater and the Serengeti Plains with their abundance and variety of large wildlife.

The United Republic of Tanzania was formed in 1964 from the union of Tanganyika and Zanzibar (see figure 1.7.1). Tanganyika was unified as a political entity by German colonizers in 1880. After the German loss in World War I, Britain acquired Tanganyika and held it as its colony. Tanganyika became independent in 1961 and Zanzibar became independent in 1963. Tanzania has a population of 43.7 million in a land area of 364,898 square miles (945,203 square kilometers) roughly the combined size of Texas – 268,820 sq.mi. (696,241 sq. km.) and Oregon – 98,466 sq. mi. (255,026 sq. km.). Tanzania's population consists of 126 mainly Bantu ethnic groups each with its own language or dialect. Any Tanzanian who has been to school speaks the national language – Swahili – a language which developed around the 1400's as a result of interaction between Arab settlers and the tribes local to the coastal areas.

Figure 1.7.1 – Map of Tanzania. Source http://www.africa.upenn.edu/CIA_Maps/Tanzania_19886.gif.

Figure 1.7.2 – Tanzania: into the central plains area. Source: Fieldwork.

By the tenth century, Arabs were already trading and settling along the East African coast. They established warehousing locations on the mainland and on nearby islands to facilitate their trading activities. These locations evolved into permanent communities dependent on the trade in ivory and slaves. The Portuguese took control of these trading centers by the early 1500's and controlled them until the early 1700's when Arabs again became dominant.[27] The British came in the mid 1800's in an effort to establish their colonial rule, followed by the Germans. Following agreement between the German and British, Tanganyika's colonial period began with Germany which ruled from 1890 until 1917 when, after World War I, Tanganyika was given to the British. The British ruled until independence. Zanzibar was controlled by Arabs until its independence in 1963.

Julius Nyerere served as Tanzania's first president after leading Tanzania's drive to independence. He was also the leader of the only political party, Chama Cha Mapinduzi (CCM), which means the Revolutionary Party. Nyerere found the ideals of socialism a close fit to the traditional ways of life and led Tanzania into what was termed "African socialism" through the establishment of communal villages called *ujamaa* – or family – villages where land was held

[27] Ofcansky, Thomas P. & Rodger Yeager. 1997. *Historical Dictionary of Tanzania: Second Edition*. Lanham, MD: The Scarecrow Press, Inc. p. 48.

and worked in common. The intention with the new villages was to deemphasize tribal affiliations and to build up a national identity. Another important component of the effort to establish a national, rather than a tribal, identity was the institution of Swahili as the national language and to have all instruction through the high school level be in Swahili, with English taught as a second language. University level instruction is conducted in English.[28] The Ujamaa villages ended in disaster as the concept underestimated the innate entrepreneurial spirit of the people, which was in many ways antithetical to socialist ideals, and the strength of tribal identity. Gradually, the government had to turn away from the socialist experiment which resulted in disastrously lower yields of the traditional cash crops such as coffee, tea and sisal as well as maize, their traditional staple food. With the economy in dire straits by the mid-1980's, Tanzania turned to the International Monetary Fund (IMF) for loans to enable importation of food and goods. Nyerere resigned the presidency in 1985 after establishing his vice-president, Ali Hassan Mwinyi as president. Along with the economic reforms came increasing pressure for multi-party politics due to corruption and entrenched interests within the single ruling party. Several parties have gradually made headway in regional and national elections although the CCM remains predominant.

Dar-es-Salaam, with a population of 2.5 million, located on the east coast is the main port and largest city. It is the capital of its region and de facto capital of the country, although Dodoma, at the geographic center of this large country was made the capital in 1973 in the interest of promoting the economic development of the whole country. The parliament meets in Dodoma, which has a population of 350,000. The President, government officials and members of parliament have offices and residences there although much of government work occurs in Dar-es-Salaam, the former capital. The town of Arusha in the north of Tanzania with a population of 300,000 is the headquarters of the East African Community, whose members are Tanzania, Kenya and Uganda, and is central to Tanzania's tourist industry, serving as a gateway to the Serengeti Plains and Ngorongoro Crater with their large animals. The town of Moshi at the base of Mount Kilimanjaro has a population of 150,000. In the western part of Tanzania, at the southern tip of Lake Victoria, Mwanza is the second largest city in Tanzania with a population of

[28] Iliffe, John. 1979. *A Modern History of Tanganyika*. Cambridge: Cambridge University Press.

500,000. Other smaller cities in the west are Bukoba on the northwest shore of Lake Victoria and Kigoma on Lake Tanganyika. Mbeya is the largest town in the southwest of Tanzania with a population of 300,000, near to the border with Zambia, while Mtwara in the southeast along the coast is near to Mozambique and has a population of 80,000.

Tanzanians are roughly 1/3 Christian, 1/3 Muslim and 1/3 traditional beliefs. Muslims are located primarily on Zanzibar and along the coast while Christians are found in towns throughout Tanzania. The majority of Tanzanians are still rural, and this is where one finds those holding traditional beliefs. In contrast to the Malagasy, the Tanzanians seem more self-assured and confident in their identity as Tanzanians and Africans. They are proud of their country and its achievements and identify themselves as Tanzanians as well as members of their particular tribe. While Swahili is spoken as the lingua franca in Kenya, Uganda and the Congo, it is only in Tanzania that Swahili is the language of instruction and therefore the most widely spoken. The other East African countries admire Tanzania for this fact and for their leadership in the non-aligned movement of the 1970's in which various countries united to form a counter balance to the polarizing politics of the Cold War.

Figure 1.7.3 – Tanzania: one type of traditional dwelling. Source: Fieldwork.

Figure 1.7.4 – Tanzania: central Dar-es-Salaam with its mix of colonial influences. Source: Fieldwork.

1.8 Shared and Distinguishing Characteristics of Tanzania and Madagascar

In reviewing the history, culture and ethnicities of Tanzania and Madagascar and how they look today, they seem to be so very different one from the other: the one a former British (and German before that) colony overlaid on 126 mostly Bantu tribes, and the other, a former French colony overlaid on 18 tribes of mostly Austronesian origin. Nevertheless, they have many similarities, each having extensive coastlines in the same corner of the Indian Ocean. They have a shared history of trade and conflict; they both have had extensive contact with Arab, Portuguese, and British cultures through traders coming to their areas either peacefully or through coercion. Tanzania additionally had contact with German culture as a colonizer for 30+ years before the British gained control in 1917. Madagascar was a French colony from 1895 until 1960. Madagascar and Tanzania had extensive involvement in the slave trade, both serving as an important source of slaves for the plantations of the Mascarene Islands which includes La Reunion and Mauritius. In Tanzania, it was foreigners – the Arab expatriate population along the coast – who directed and profited from the slave trade; while in Madagascar it was the dominant tribes that did so.[29]

The population density of Madagascar is 33.4 inhabitants per square kilometer (86.6 per sq.mi.), similar to that of the U.S. – 31 per sq. km. (80 per sq. mi.). The population density of Tanzania is greater, at 46.3 inhabitants per square kilometer (119.9 per sq. mi.). While this is 40% greater than that of Madagascar, it is still well below that of France at 115 per square kilometer (297 per sq. mi) and Denmark at 127.9 per square kilometer (331.2 per sq. mi.). Just to indicate the extremes of population density, India has a density of 364.4 per square kilometer (943.9 per sq. mi.). This information tells us that in both Madagascar and Tanzania, there is a great deal of space for the number of inhabitants, though a significant portion of the land is not particularly suitable for human habitation or agricultural production.

The early Arab traders built permanent trading settlements along the coasts of both Madagascar and Tanzania to facilitate their commerce. These were comprised of dwellings and warehouses and were built of locally available coral and wood in a manner familiar to their Arab builders. Along with the European colonizers came their buildings that housed their needs: administrative buildings, schools, hospitals, warehouses, houses. These buildings were built using techniques adapted from the colonizers' industrialized country of origin. These rectangular structures made extensive use of reinforced concrete, brick, stone, tile and then metal roofs, glass and dimensional lumber. Later, they included electricity and plumbing as these technologies became available.

One significant defining characteristic of both Tanzania and Madagascar is that they are societies in rapid transition from traditional and colonial cultures, with their corresponding worldviews and values, to modern interconnected globalizing societies. The transition is fraught with contradictions and conflicts between new and old values and understandings. Amos Rapoport, in his research in man-environment relations, calls attention to the importance of distinguishing

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[29] Randrianja, Solofo & Stephen Ellis. 2009. *Madagascar: A Short History*. Chicago: The University of Chicago Press. p. 99.

core from peripheral elements of a culture in seeking to design successful buildings for a given culture.[30] Which are the underlying values that are central to the culture being served? Which aspects of a culture can change while leaving intact the defining structure? Historically, the dwelling was practically the only structure that traditional cultures built and they were built in ways and with materials developed over millennia that acquired meaning and significance for that culture. Some types of traditional Malagasy houses are all built with the entry door facing the same direction corresponding to the direction from which evil and benign spirits were believed to emanate. Each of the four interior corners of the one-room dwelling were designated for particular members of the family including one corner for the ancestors. See figure 1.8.1 for the plan of a coastal house with its openings, orientations and its relation to the cardinal directions, months of the year and days of the month.[31]

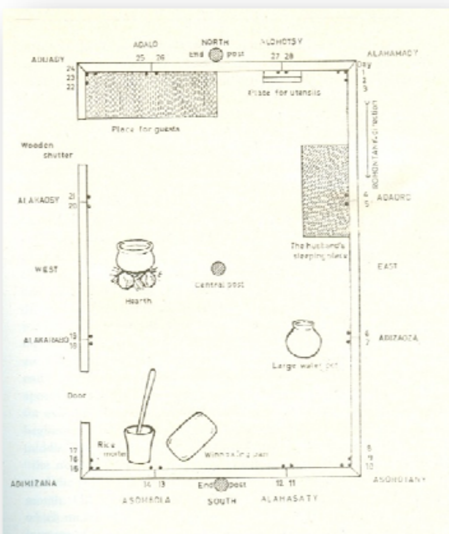

Figure 1.8.1 – Madagascar: plan of coastal house showing relations to days and months. Source: Ruud, Jorgen. 1960. Taboo: A Study of Malagasy Customs and Beliefs. Oslo: Oslo University Press.

The question is: what is the relevance and importance of these traditional practices and beliefs to the Malagasy now? Do some of these practices and beliefs contradict what a modernizing

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[30] Rapoport, Amos. 1983. "Development, Culture Change and Supportive Design". In *Habitat International* 7:5-6. p. 256.
[31] Ruud, Jorgen. 1960. *Taboo: A Study of Malagasy Customs and Beliefs*. Oslo: Oslo University Press. p. 29.

Malagasy culture seeks or believes? One traditional Malagasy belief held that the birth of twins was a sign of evil and one of the twins was killed at birth to avoid bad luck for the family. This is an extreme example but it illustrates the point that traditional beliefs and practices are not simply to be respected and replicated wholesale. They are to be evaluated and understood for what they mean and bring to the society in question.

Another aspect of traditional beliefs and practices is the extent to which their emphasis would serve to undermine the nation-building efforts that try to de-emphasize tribal identities while making efforts toward a national identity. Tanzanian President Nyerere made great strides in the establishment of a Tanzanian national identity by making Swahili the national language and emphasizing the shared responsibilities of a national citizenship. Madagascar has an easier task owing to their geographic isolation as an island and their single shared language. Nonetheless, there are significant and deep-rooted tensions between dominant and weaker tribes that are always present and occasionally explode into violence that surprises no one.

This leads to the importance of the architect as participant-observer, which will be addressed in more depth in Chapter Three. It takes time and listening, living and working with a given culture and group of cultures in order to begin to have an understanding of essential characteristics and how existing traditions interface with modernizing influences. The architect called upon to design for another culture has to be careful to not simply mimic traditional forms without understanding why they exist and what aspirations the inhabitants have for their lives and culture.

Thatched roofs are a good example of something that looks like a great idea: made of renewable materials, built by local craftspeople and possessing good thermal qualities. But it also affords an excellent habitat for vermin, insects and bats, burns easily (a particular risk if people cook indoors) and requires frequent maintenance or replacing. It is understandable that inhabitants would hope for something healthier and safer for their families. The continued or renewed use of thatch would require these issues to be successfully addressed for it to be a more viable alternative than lightweight, long-lasting, though hot, galvanized iron sheets.

The architect as participant-observer must listen and look carefully to understand how a culture's aspirations, values and way of life can be supported and enhanced by a building. S/he must be attentive to how the users view their traditions and their traditional buildings and what expectations they have about a new addition to their built environment. One characteristic of new buildings that I designed in Tanzania that I initially resisted because it had no precedent that I could see in traditional buildings was multi-story buildings. The people that I was designing for saw a two-story building as a sign of modernity and also an opportunity for fun: to stand on an upper level veranda and survey the landscape. The task of the architect is to gather and sift through all the available information and come up with a building design that the users will embrace as embodying their lifestyle and their own aspirations.

How do we then get something built in a culture that is other than our own? How do we come to an understanding of how buildings get designed and built in a different culture and setting? Howard Davis' definition of the concept of *building culture* as "the coordinated system of knowledge, rules, and procedures that is shared by people who participate in the building activity and that determines the form buildings and cities take"[32] is extremely helpful in understanding the way buildings are built in Madagascar and Tanzania. An awareness of the building culture helps us to understand how things come to be built as they do and what can be expected when striving for innovation such as in the promotion of green building in the developing country contexts of Madagascar and Tanzania.

The concept of building culture also helps explain why buildings continue to be built today in certain ways. While basic colonial building materials were similar in both Madagascar and Tanzania, there are significant differences in the building techniques based on how buildings were built in the colonizer's home country and how these were adopted to local conditions. These differences continue to be seen in how buildings are built today. For example, roof trusses are more common in Tanzania than in Madagascar (see figure 1.8.2).

[32] David, Howard. 2006. *The Culture of Building*. New York: Oxford University Press. p. 3.

Figure 1.8.2 – Tanzania: roof trusses on case study building in Dodoma, Tanzania. Source: Fieldwork.

In Madagascar, the use of gable masonry walls – both interior and exterior – makes roof trusses and rafters unnecessary in some smaller buildings since bigger purlins can span laterally between the gable walls. The preferred location for septic tanks is an interesting difference. In French colonial building, the septic tank is located as close to the source of waste as possible so that the waste travels the shortest distance. The preferred location of the septic tank is just outside the wall against which the toilet is located, for example, under the floor of an interior courtyard. In British colonial building, however, the septic tank is located at a distance of 20, 30 or 40 feet from the source of waste. Light switches in Madagascar are located 36" off the floor and down is off, up is on. In Tanzania, they are 48" off the floor and down is on, up is off. In Tanzania, casement windows open out, while in Madagascar they open to the inside with a thick sill piece to shed water to the exterior when they are closed (see figure 1.8.3). For the architect tasked with designing successful and appropriate additions to the built environment, it is critical to have an appreciation and understanding of such aspects of the local building culture so that s/he is not swimming upstream needlessly.

Figure 1.8.3 – Madagascar: inswing wood casement windows in the case study building in Ranomafana. Source: Fieldwork.

All in all, owing to the similarities in the industrial materials and building techniques used in Madagascar and Tanzania, the similarities of their agricultural exports-based economies, and their colonial experiences with respect to the built environment, there is more that unites them than divides them for the purposes of this research into the applicability of green building rating systems. Any significant differences that arise between the Tanzania experience and that of Madagascar in the review of the case study buildings will be noted. A larger question that is beyond the scope of this present research is that of the applicability of the findings of this research to other developing country contexts. My experience in other sub-Saharan African countries – Ghana, Malawi and Kenya – tells me that many of the characteristics of building in Madagascar and Tanzania hold true for these countries as well. Therefore, the conclusions regarding green building rating systems in those contexts will most likely be relevant. Further than that, it is an open question whether the conclusions would be applicable to countries of South and Central America or Southeast Asia. Many differences exist between building design and construction in the U.S. and that of China and India, for example. My experience in Africa tells me that criteria developed for the U.S. context cannot be meaningfully applied to another completely different cultural, economic and climatic context without thorough review.

Chapter 2 Sustainable Development and Green Building Rating Systems

2.1 Introduction

This review of previous research focuses on:

- sustainable development as it relates to developing countries; and
- green building rating systems and their relation to the goals of sustainable development.

From these two areas in combination with my extensive professional experience in design and building in Madagascar and Tanzania, the relation of green building rating systems to the developing country context of those two countries can be explored. First, we need to explore the link between the larger idea of sustainable development and the goals and objectives of green building.

2.2 Sustainability in the Developing Country Context

Before we address the question of what sustainability means in the developing country context, we need to look at the main ideas underpinning sustainability. In 1986, Robert Repetto, noted economist and Yale University professor, formerly with the World Bank, wrote that "the core idea of sustainability is that current decisions should not impair the prospects for maintaining or improving future living standards"[33.] This general notion of sustainability has been echoed by numerous analysts[34] as the basis for discussions and strategies regarding sustainability because it succinctly summarizes the basic situation that we find ourselves in: the way we humans live is damaging that which sustains us and it is fundamentally unjust to leave our children worse off than we are.

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[33] Repetto, Robert C. 1986. *World Enough and Time: Successful Strategies for Resource Management*. New Haven, CT: Yale University Press. p. 15-16.

[34] Former German president Willy Brandt included in the Brandt Commission report a definition of sustainability that still rings true today and is widely cited as a starting point that all can agree on. See Independent Commission on International Development Issues. 1980. *North-South: A Programme for Survival*. London: Pan Books.

Sustainability is further defined in more detail as consisting of three principal dimensions: environmental, economic and social. Each of these three dimensions must be successfully addressed for a solution to be sustainable. This was expressed by the Development Assistance Committee (DAC) of the Organization for Economic Co-operation and Development (OECD), stating that

> "…sustainable development means integrating the economic, social and environmental objectives of society, in order to maximize human well-being in the present without compromising the ability of future generations to meet their needs."[35]

The German government's agency for assistance to developing countries, Deutsche Gesellshaft fur Technische Zusammenarbeit (GTZ), refers to sustainable development that is economically viable, socially equitable and ecologically sound. GTZ says that sustainable development "means economic growth for more prosperity, equal opportunities for rich and poor, North and South, men and women, and natural resource use for the benefit of present and future generations."[36]

Nancy Alexander, Don Reeves and David Beckmann, in their 1993 discussion paper regarding U.S. foreign aid, apply the sustainability discussion to the developing country context defining four essential and interrelated objectives of sustainable development which encompass and expand on the three dimensions mentioned above:

> "expanding economic opportunities (especially for poor people);
> meeting basic human needs (food, clean water, shelter, health care, education and fulfillment of the human spirit);
> protecting and enhancing the environment; and
> promoting pluralism and democratic participation (especially by poor people)."[37]

The citations above make clear that sustainability is much more than environment and economics which, in simplistic arguments, are pitted against each other as if they were mutually exclusive. Without the consideration of cultural and social parameters, efforts in the direction of

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[35] Organization for Economic Cooperation and Development (OECD). 2001. The DAC Guidelines: Strategies for Sustainable Development: Guidance for Development Co-operation. p. 11.
[36] Deutshe Gesellshaft fur Technische Zusammenarbeit (GTZ). 2005. *Sustainable Development: The Way We Work*. p. S2.
[37] Alexander, Nancy, Don Reeves & David Beckmann. 1993. *Foreign Aid: What Counts Toward Sustainable Development and Humanitarian Relief?* Washington D.C.: Bread for the World Institute. p. 1-2.

sustainability are not likely to be sustainable. Michael M. Cernea maintains that sustainability must be "socially constructed", suggesting that a sociological perspective provides

> "First …a set of concepts that help explain social action, the relationships among people, their complex forms of social organization, their institutionalized arrangements, and the culture, motives, stimuli, and values that regulate their behavior vis-à-vis one another and natural resources. Second …it offers a set of social techniques apt to prompt coordinated social action, inhibit detrimental behavior, foster association, craft alternative social arrangements, and develop social capital."[38]

The cultural and social aspects of sustainability are not as easily recognized or quantified as environmental and economic aspects. Not only is the cultural and social difficult to count; from inside a given culture its characteristics can be invisible to us while from the outside they can be incomprehensible. Rogers, Jalal and Boyd describe the social domain

> "as a complex set of interacting cultural and institutional systems that vary from one place to another. All have bodies of knowledge for adapting to the physical environment; modes of producing and exchanging goods and services; systems for finding partners, raising children, and inheriting property; arrangements for public decision making and conflict management; bodies of belief and related rituals; and systems of prestige or ranking, and aesthetics. From the outside the complexity and dynamism of these interacting systems are mind boggling. Viewed from the inside by the people who constitute a society, they fit together in a sensible and seamless way, and individuals' attitudes and behaviours reflect the values and pressures that they have internalized while growing up."[39]

But more than even the addition of social and cultural considerations, poverty must be addressed for sustainability to be attained. Rogers, Jalal & Boyd identify poverty as "the most significant socioeconomic dimension of sustainable development. As such, development activities that do not address poverty in contexts where poverty and the problems of poverty are endemic would be difficult to characterize as sustainable"[40]. Rogers et al. suggest that "poverty must be reduced by meeting basic needs: health, education, shelter, productive employment, control over common property, and population management."[41] While it is unrealistic to expect every proposed project

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[38] Cernea, Michael M. 1994. The Sociologist's Approach to Sustainable Development. In *Making Development Sustainable: From Concepts to Action. Environmentally Sustainable Development Occasional Paper Series No. 2*. Washington, D.C.: The World Bank. p. 7.
[39] Rogers, Peter P., Kazi F. Jalal & John A. Boyd. 2008. *An Introduction to Sustainable Development*. London: Earthscan.p. 218.
[40] Rogers et al. ibid. p. 219.
[41] Rogers et al. ibid. p. 51.

to attempt to resolve or even address all these issues, it is clear that socio-economic aspects, and poverty chiefly among them, are critical to sustainable development, particularly in the developing countries. A 2001 World Bank study– "Consultations with the Poor" – indentifies the following three keys to overcoming poverty:

> "Security from violence, hunger and physical deprivation;
> Opportunities for health, education and decent employment; and
> Empowerment in both personal and public decision-making."[42]

These studies underline the importance of strategies of poverty reduction and of the provision of sustainable livelihoods to the goals of sustainability. More broadly, the social dimensions of sustainability refer to the need for equity. Another World Bank Study, in 2002, called "Building a Sustainable Future: The Africa Region Environment Strategy" states its aims as follows:

> "Make the transition to sustainable economic development through improving environmental and natural resource management.
> Empower communities and individuals to make a sustainable living based on the natural resource endowments of the region and to take responsibility for managing them.
> Reduce the burden of diseases and poor health by improving the quality of the environment in which people live.
> Reduce the vulnerability of people and economies of the region to natural disasters and severe climatic events.
> Manage and conserve the unique biological diversity of the region for themselves, their future generations, and the world.
> Establish an enabling environment and build the capacity to achieve these objectives and maintain them over the long term."[43]

Broad and Cavanagh, in their review of development directions over time, maintain that, based on evaluation of past experiences, "development strategies will not succeed and endure unless they incorporate ecological sustainability, equity, and participation, as well as effectiveness in raising material living standards."[44] Dr. Paul Farmer of Partners in Health identifies equity as the key issue to address in their work in Haiti, Rwanda and elsewhere: equal access to health care and to opportunity for everybody.[45]

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[42] World Bank. 2001. *World Development Report 00/01: Attacking Poverty*. Washington D.C: World Bank. p. ?
[43] World Bank, 2002. Building a Sustainable Future: The Africa Region Environment Strategy. Washington D.C: World Bank. p.18.
[44] Broad, Robin and John Cavanagh. 2009. *Development Redefined: How the Market Met Its Match*. Boulder: Paradigm Publishers. p. 34.
[45] Farmer, Paul. 2009. Public lecture on the work of Partners in Health at Virginia Tech. March 2009.

The key role of labor and opportunities for livelihoods in developing countries as a critical component of sustainability is important to appreciate. It is part of a broader understanding of what sustainability is in the developing country context where unemployment and underemployment are so consistently high. Robert Chambers and G.R. Conway note that

> "a livelihood is environmentally sustainable when it maintains or enhances the local and global assets on which livelihoods depend, and has net beneficial effects on other livelihoods…and which can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and … provide opportunities for the next generation."[46]

Serageldin and Steer claim that "the entire mainstream paradigm of development has been expanded to include investment in human resources as an essential, possibly the most essential, ingredient of development strategy."[47]

The following listing summarizes the defining characteristics of sustainability in the developing country context, dividing them into environmental, economic and social/cultural issues. These are characteristics of sustainability that should be reflected in a green building rating system for use in the developing country context if it is to effectively point in the direction of sustainability. These issues are used in Table 2.2 in Section 2.6 that explores the relation of these issues to the green building rating systems criteria.

Environmental Dimensions

- Deforestation
- Loss of habitat
- Loss of arable land
- Water availability & conservation
- Renewable energy production
- Energy use
- Promotion & protection of native vegetation
- Pollution reduction
- Responsiveness to climate
- Environmental stewardship

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[46] Chambers, Robert and Conway, G.R. 1992. Sustainable Rural Livelihoods: Practical Conceptes for the 21st Century. Institute for Development Studies Discussion Paper 296. London: Institute for Development Studies. p. 7.

[47] World Bank. 2002. Ibid. p. 31.

Economic Dimensions

- Promotion of local labor
- Development of sustainable livelihoods
- Transfer of technology & skills
- Locally available building materials
- Promotion of regional economy
- Reduction of poverty
- Development of transportation options & efficiency
- Access to credit via loans and microloans
- Minimize and facilitate needed maintenance

Social and Cultural Dimensions

- Build on, reflect and strengthen local culture
- Understand and build on traditional and colonial history
- Reflect social practices and values
- Strengthen community
- Refer to local and regional building culture
- Enhance security
- Promote equity and social justice
- Provide access to education and training
- Improve health
- Participation in decision-making

How are these issues then embodied in the built environment? As previously cited, MER studies address issues of appropriate response to social and cultural design parameters. Economic considerations were key to the development of the concept of appropriate and intermediate technologies.

2.3 Appropriate and Intermediate Technology

Prior to the ubiquitous use of the now well-worn term ‘sustainability’, other concepts had great currency in development work in less economically developed countries. These concepts embodied many of the same goals as sustainability. These concepts were appropriate technology and intermediate technology. Among the major proponents were Fritz Schumacher and the Intermediate Technology Development Group (ITDG), now known as Practical Action. The non-governmental organization, Practical Action, began its life in 1966 as the Intermediate

Technology Development Group (ITDG). Fritz Schumacher was one of its founders. His ground-breaking book, *Small is Beautiful*, pointed to a more humane way of thinking of economics and a more human-scaled approach to development based on technologies that corresponded to the skills and needs of the people being served.[48]

Up to that point, aid policies were by and large based on attempts to transfer to developing countries the large-scale and capital-intensive technologies of the more developed countries. This was a reflection of the 'stages of development' school of thought as expressed by the noted economist and presidential advisor, Walt Rostow, who posited that all societies go through the same stages of economic development. Development aid thus consisted of helping less developed nations along the path to modernity and industrialization as it is found in the Western economies.[49] This strategy led to many failures and so-called 'white elephants' that were inappropriate to the context in which they were inserted. The ITDG argued for a shift to intermediate technologies that would be appropriate to the technical level and economic context of the target country and would therefore be more likely to work. Instead of re-inventing the wheel, ITDG tried to make available existing technologies that were efficient and labor-intensive but that had fallen into disuse in favor of more modern and energy-intensive technologies.[50] ITDG identified its aims as:

> "Promoting the systematic assembly and documentation of all data relating to intermediate techniques and technologies;
> Drawing attention to them by publishing information about them, promoting the concept of intermediate technology, and advertising the group's services; and
> Offering advice and assistance to overseas projects in order to demonstrate the practical use of intermediate technologies in helping poor people to help themselves."[51]

These ideas have had broad resonance in development thinking as they pointed a way forward that was based on the conditions on the ground and that was not simply an imitation of the most economically developed countries. They have influenced a generation of development thinking seeking solutions that fit with the given context and target population. They continue today in the

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[48] Schumacher, E.F. 1973.*Small is Beautiful: Economics as if People Mattered*. New York: Harper and Row.
[49] Rostow, Walt. 1973. The *Stages of Economic Growth: A Non-Communist Manifesto*. New York: Cambridge University Press.
[50] Practical Action. 2009. *About Us*. http://practicalaction.org/about_us?id=history. (retrieved 29 September 2009).
[51] Ibid.

construction sector, underpinning efforts at developing regionally appropriate and cost-effective building techniques using locally available materials such as bamboo as seen in the work of the South American architects, Simón Vélez and Juvenal Baracco.[52]

2.4 Building Design and Construction in Madagascar & Tanzania

As in the more developed economies, the construction industry represents a large and important segment of the economy of developing countries like Madagascar and Tanzania. In addition to the percentage of the labor force that have regular employment in the construction sector there – up to 10% – it is also a large employer of occasional and unskilled labor. This is so particularly because a large amount of building construction in developing countries like Madagascar and Tanzania is done in the informal economy. As a result, the actual percentage of the labor force employed in building construction is significantly higher and very difficult to quantify. Add to that the number of workers involved in upstream sectors, notably the production and sale of building materials, and downstream, those who work and dwell in the buildings created and you have a large percentage of the labor force involved directly and indirectly, formally and informally with the construction industry.[53] The importance of the construction sector in developing countries gives rise to the opportunity to have a significant impact on the environment there. This opportunity is similar to that identified by the USGBC through identifying the significant energy use and contribution to the nation's landfills by the construction industry in the U.S.

In an economy such as that found in Madagascar and Tanzania, there is a range of types and quality of building construction going on at any given moment. At the low end of the cost range, there is the lowest cost construction that people build for themselves for their shelter or

[52] Rodriguez-Camilloni, Humberto. 2009. "Rethinking Bamboo Architecture as a Sustainable Alternative for Developing Countries: Juvenal Baracco and Simón Vélez" in *Proceedings of the Third International Congress on Construction History*, Cottbus, Germany: Brandenburg University of Technology, vol. 3, 2009, p. 1243-1252.
[53] Wells, Jill. 1986. The Construction Industry in Developing Countries. London: Helm Croom.

livelihood without professional hired inputs such as building contractors or architects and engineers and without seeking official approval[54] (see figure 2.4.1).

Figure 2.4.1 – Tanzania: self-built housing. Source: Fieldwork.

These people are building with the lowest cost, if not free, components that are available in their context. They build with what comes to hand and in the manner to which they have been exposed. Howard Davis, in his research on building culture in India, has described the manner and type of construction of this sector of the building economy.[55] These low-cost self-built structures are also the closest to the traditional forms of construction. Structures at this low end are the self-built shelters one finds in shanty towns around the major cities as well as the traditional dwellings one finds upcountry in the agricultural areas.[56]

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[54] There is a rich literature focusing on vernacular traditional dwellings throughout the world. One of the classics is Bernard Rudofsky's *Architecture without Architects*. (1964) New York: Doubleday. Others include: *Architecture of the Ancient Ones* (2000) Salt Lake City: Gibbs Smith Publisher by A. Dudley Gardner and Val Brinkerhoff and *A Shelter Sketchbook: Timeless Building Solutions* (1997) White River Junction, VT: Chelsea Green Publishing Company by John S. Taylor. For vernacular building in Madagascar, see *Architectures de Madagascar* (1997) Nancy: Berger-Levrault by Jean-Louis Acquier and Ranaivo Harijaona.

[55] Davis, Howard. 2003. *The Culture of Building*. New York: Oxford University Press. p. 37-42.

[56] The architect and planner, John F. C. Turner, has contributed much to the understanding of urban self-built housing in Latin America, much of which is applicable to such housing in urban centers of Africa. Among his influential works are *Freedom to Build: Dweller Control of the Housing Process* (1972) New York: Macmillan and *Housing by People: Towards Autonomy in Building Environments* (1976) London: Marion Boyars Publishers.

At the high end of the cost range are the buildings that the economically and politically advantaged build for their shelter or livelihood. This privileged sector has access to building materials and techniques that are not commonly available or are too prohibitive in cost for middle and lower income people to afford. This sector looks beyond their national borders for models of what and how to build. This highest range of building includes large corporate and sometimes government office buildings, hotels and other large institutional structures such as universities and hospitals, and residences for the country's political and economic elite. At this high end one finds glass-skinned corporate office buildings. In Dar-es-Salaam, this glass skin is often only that: a skin installed on the outside of the more common building materials of reinforced concrete, concrete block and steel or aluminum windows. It thus gives the appearance of the internationally recognizable glass box or tower that connotes modernity. (see figure 2.4.2)

Figure 2.4.2 – Tanzania: glass façade connotes modernity. Source: Fieldwork.

Between these two economic extremes lies the majority of building projects built within existing building cultures inherited from the colonial period. Such buildings make use of building techniques and materials introduced initially from the colonial home country and adapted by the colonists and their subjects to the developing country context. These adaptations concerned the climate, available materials, building types and social and cultural forces at work in the colonial setting. (see figure 2.4.3). The construction budget for such mid-range building projects has to maximize available materials and techniques in order to be affordable for the client and maintainable over time.

Figure 2.4.3 – Tanzania: high school in Dar-es-Salaam. Source: Fieldwork.

Examples of buildings from this middle tier are school buildings, local hospitals, clinics, warehouses, hotels, restaurants, small office and commercial buildings, and middle to upper middle class houses (see figure 2.4.4). A small and interesting sector of building in developing countries is that associated with ecolodges and ecotourism. Built of local traditional materials and forms, sometimes at considerable cost, these buildings invite visitors to appreciate the ecology of a place, strive to educate visitors about the local culture and ways of life while minimizing their environmental impact on the place. [57]

[57] More information about this sector can be obtained in Hawkins, Donald E., Megan Epler Wood and Sam Bittman, eds. 1995. *The Ecolodge Sourcebook*. North Bennington, VT.: The Ecotourism Society and Lindberg, Kreg and Donald E. Hawkins, eds. 1993 and 1998. Ecotourism: A Guide for Planners and Managers, Volumes I and II. North Bennington, Vermont: The Ecotourism Society.

Figure 2.4.4 – Tanzania: colonially inspired built environment. Source: Fieldwork.

Howard Davis and his idea of 'building culture' is most useful in understanding the built environment and its creation and maintenance in a given context. It is of great utility, helping to understand the underpinnings and what gave rise to a given built environment and how innovation is in large measure a continuation of the traditional. [58] It in fact has to be so, in order to be successfully adopted. This is important when we are talking about the adoption and propagation of sustainability concepts in the building industry. The colonial power is historically the most important reference for the creation of the 'modern' built environment. Any new ideas have to be understood within that context in order to have a chance to take hold and be adopted.

Very little has been written about the built environment in Madagascar and Tanzania, or in developing countries such as these. Jill Wells' 1986 book on the construction industry in developing countries based on her experiences and research in Tanzania, is one of the very few and addresses more the structural and economic aspects of the construction industry and not the product of that industry.[59] There are archives of colonial-era documents waiting to be sifted through for clues as to how colonial building developed. This research is a step towards

[58] Davis, Howard. Ibid. p. 274.
[59] Wells, Jill. 1986. The Construction Industry in Developing Countries: Alternative Strategies for Development. London: Croom Helm.

understanding the nature and lasting influence of colonial-era building culture on countries like Tanzania and Madagascar.[60]

2.5 Overview of Green Building Rating Criteria

There are four major green building rating systems currently in use in the more economically developed English-speaking countries. The largest and oldest of the green building programs is the Building Research Establishment's Environmental Assessment Method (BREEAM), launched by the Building Research Establishment in 1993. It boasts more than 500,000 buildings registered for certification and more than 110,000 buildings already certified. Canada's Green Globes rating system grew out of the BREEAM system and was launched in 2000. It is used in Canada and to a lesser degree in the U.S.

The USGBC's LEED family of green building rating tools, first established in 1998, is widely used in the U.S. As of July 2009, more than 26,000 projects have been registered for the program while 3,000 have completed the program and have achieved certification. More than 100,000 professionals are accredited by the LEED program.[61] Australia's Green Star system was established in 2003, drawing on the experience of the BREEAM and LEED models. It has 185 buildings registered so far.

How does the USGBC view sustainability and building? In their seminal 1996 publication on green building – the Sustainable Building Training Manual – they echo the consensus view defining sustainable development as

> "the challenge of meeting growing human needs for natural resources, industrial products, energy, food, transportation, shelter and effective waste management while conserving and protecting environmental quality and the natural resource base essential for future life and development."[62]

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[60] For the French government's national archives, see www.archivesnationales.culture.gouv.fr/ and click on 'archives nationales d'outre-mer' for those related to France's overseas colonies. Great Britain's archival information is available at www.nationalarchives.gov.uk/.

[61] USGBC. 2009. *Green Building, USGBC and LEED*. https://www.usgbc.org/ShowFile.aspx?DocumentID=1991 (retrieved: 21 January 2010)

[62] USGBC. 1996. *Sustainable Building Training Manual*. Washington, D.C.: Public Technology Inc. p.1.

The Manual describes a ‘sustainability ethic’

> “based on the principles of resource efficiency, health and productivity and whose realization involves an approach in which a building project and its components are viewed on a full life-cycle basis. This cradle-to-cradle approach … considers a building’s total economic and environmental impact and performance, from material extraction and product manufacture to product transportation, building design and construction, operations and maintenance, and building reuse or disposal.”[63]

Interestingly, this sustainability ethic contains no mention of a social or cultural component of sustainability. The USGBC website contains the following Code of Conduct to which their members must agree which emphasizes minimizing energy use, maximizing efficiency and improving environmental quality:

> “As a member of the U.S. Green Building Council, I hereby agree to adhere to the principles of improving the energy and environmental efficiency of the whole building environment. This includes following and promoting the concepts of: improving energy efficiency and conservation; improving indoor environmental quality; increasing resource and material efficiency; improving occupancy health and productivity; improving environmental quality including air, water, land, limited resources and ecosystems; promoting sustainability as defined as ‘providing for the needs of the present without detracting from the ability to fulfill the needs of the future”.[64]

The USGBC sets the following ambitious goal for its green building rating system and makes a bold claim regarding their rating criteria:

> “The LEED Green Building Rating System encourages and accelerates global adoption of sustainable green building and development practices through the creation and implementation of universally understood and accepted tools and performance criteria.”[65]

This contrasts with other green building rating systems such as Great Britain’s BREEAM, Canada’s Green Globes and Australia’s Green Star which define their country of origin as their field of application. However, the various green building rating systems share a common approach and understanding of what constitutes green building. The following is taken from the USGBC’s description but is similar to other rating systems:

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[63] USGBC. ibid. p.1.

[64] USGBC. 2009. *Members’ Page*. https://www.usgbc.org/store/renewcompany.aspx. (retrieved 30 September 2009).

[65] USGBC. 2010. LEED Rating Systems webpage. http://www.usgbc.org/DisplayPage.aspx?CMSPageID=222 (retrieved 18 March 2010).

> "LEED is a third party certification program and the nationally accepted benchmark for the design, construction and operation of high performance green buildings. LEED gives building owners and operators the tools they need to have an immediate and measurable impact on their buildings' performance. LEED promotes a whole-building approach to sustainability by recognizing performance in five key areas of human and environmental health: sustainable site development, water savings, energy efficiency, materials selection and indoor environmental quality."[66]

Each of the five performance areas of the LEED rating system has its particular goals. The intent of the Sustainable Sites category of credit is to encourage the re-use of existing buildings and sites, careful land use and to minimize adverse environmental impacts of new developments. It further strives to:

- protect and/or restore sites;
- reuse existing buildings and/or sites;
- protect natural and agricultural areas; and
- reduce need for automobiles.

Among the goals of the Water Efficiency category of credit are:

- water use reduction;
- reduce quantity of water needed; and
- reduce municipal water supply and treatment burden.

The main goals of the Energy and Atmosphere category of credit are:

- optimize energy efficiency and system performance;
- encourage renewable and alternative energy sources; and
- support ozone protection protocols.

The Materials and Resources category of credit aims to reduce life-cycle environmental impact of materials, construction waste and to encourage material re-use and recycling. It strives to:

- reduce the amount of materials needed;
- use materials with less environmental impact; and
- reduce and manage waste.

The Indoor Environmental Quality credit category aims to:

- establish good indoor environmental quality;

[66] USGBC. 2010. LEED Rating Systems webpage. http://www.usgbc.org/DisplayPage.aspx?CMSPageID=222 (retrieved 18 March 2010)

- eliminate, reduce and manage the sources of indoor pollutants;
- ensure thermal comfort and system controllability; and
- provide for occupant connection to the outdoor environment.[67]

The LEED criteria certainly focus on the environmental dimension of sustainability: on minimizing energy use and environmental impact of building construction and maintenance. The USGBC also addresses the economic dimension in the careful assessment of the cost of adoption of green building strategies and standards. Their basic contention is that most of the technologies and materials used in green building are available commercially in the marketplace (that is, in the U.S. marketplace) at little to no additional cost and that any additional initial cost is more than offset by lower running costs and thus, lifecycle building costs.

The LEED green building rating system is of the most interest to this research first, because of its claim to universal applicability, and second, because the manner in which the LEED rating system has been adapted for a variety of building types offers a model of how green building in the developing country context could be incorporated into a major green building rating system while still acknowledging the unique opportunities and constraints of that context.

Of the four main green building rating systems in the English-speaking world, the LEED system is the only one to be actively promoted for use outside of its country of origin. Of its 26,000 registered projects, 280 are outside the U.S. and Canada in 35 countries around the world. By contrast, the Green Globes specify that it is intended for the Canadian and U.S. markets. Both BREEAM and Green Star stipulate that they are intended for use in their country of origin and offer guidance for the development of green building rating systems for other countries or regions based on their model. The BREEAM model has been adapted to create a system for the Gulf region in BREEAM Gulf. Green Star has been adopted by the South African Green Building Council with some modifications to create Green Star South Africa. The LEED rating system was adapted by the Indian Green Building Council with virtually no changes. A new green building rating system called Estidama Pearls has been established in 2009 for use in Abu

[67] USGBC. 2009. unpublished Powerpoint presentation.

Dhabi. Built upon the experience of the other available green building rating systems, it addresses issues of particular interest to the Gulf region.

Table 2.1 provides a comparison of the criteria of these six green building rating systems: LEED, LEED India, BREEAM, Green Star, Green Star South Africa, and Estidama Pearls. Many of the criteria are shared between these six rating systems. There are also a number of criteria that are particular to one or another of the systems. The table lists first the criteria of the LEED rating system and indicates which of them are shared by the other systems. Following these LEED criteria are others that are contained in other systems that have relevance to the developing country context of Madagascar and Tanzania. The systems that incorporate these additional criteria are noted. The LEED criteria and these additional criteria from other systems will be reviewed in detail in Chapter Five which will include evaluations of their relevance to the contexts of Madagascar and Tanzania.

While the 280 LEED projects outside the U.S. and Canada represent only a little more than 1% of the registered projects, it does suggest that there is a desire or a need for a rating system that crosses national boundaries, allowing trans-national comparison of green building performance. The USGBC's claim to be the "nationally accepted benchmark for the design, construction and operation of high performance green buildings" seems to be borne out by statistics. However, if 'global' refers literally to worldwide – and not simply widespread – adoption of green building standards, then the rating system has to be studied in the variety of contexts in which it may find itself used to determine its applicability to such diverse contexts.

2.6 Green Building Rating Systems and the Developing Country Context

The accompanying Table 2.2 lists the six main categories of the LEED green building rating system - site and land issues, water use and conservation, energy and atmosphere, building materials, interior space quality, and innovative and regionally-specific strategies that correspond generally to those of the other main green building rating systems. In addition to these categories from LEED, there are listed selected criteria from other reviewed green building rating systems that have relevance to the contexts of Madagascar and Tanzania.

Table 2.1 - Comparison of Green Building Rating Systems and their Respective Criteria for Evaluation

		Green Building Rating Systems	LEED for New Buildings - US	LEED India	BREEAM - UK	BREEAM - Gulf	Green Star - Australia	South Africa Green Star	Estidama Pearl
LEED Criteria for Evaluation	Site-related Issues	Construction Activity Pollution Prevention	X	X	X	X			X
		Preferred Site Selection: not farm, wetland, wildlife habitat. Previously developed preferred	X	X	X	X	X	X	X
		Development Density & Community Connectivity	X	X	X	X		X	X
		Brownfield Redevelopment / unfavorable sites	X	X	X	X	X	X	X
		Public Transport Access	X	X	X	X	X	X	X
		Bike storage & changing rooms	X		X		X	X	X
		Low-emitting & Fuel Efficient Vehicle Parking & Fuel	X	X			X	X	X
		Minimum Car Parking + Van/Bus Parking	X	X	X	X	X	X	X
		Site Development: Protect or Restore Habitat	X	X	X	X	X	X	X
		Site Development: Maximize Open Space	X						
		Stormwater: Reduce runoff volume / peak	X	X		X			
		Stormwater: remove pollutants from runoff	X	X	X	X	X	X	X
		Reduce Heat Island Effect: Non-roof surfaces	X	X					X
		Reduce Heat Island Effect: Roof Surfaces	X	X					X
		Light Pollution Reduction	X	X	X	X		X	X
	Water Efficiency	Potable Water Use Reduction	X	X	X	X	X	X	X
		Use less potable water for landscaping	X	X		X	X	X	X
		Limit potable water use for air conditioning make-up		X			X	X	X
		Innovative waste/storm water: recycling & capture	X	X		X	X	X	X
	Energy & Atmosphere	Commissioning of the Building's Systems	X	X	X	X	X	X	X
		Better Energy Performance	X	X	X	X	X	X	X
		Non-CFC based refrigerant use	X	X	X	X	X	X	X
		On-site Renewable Energy Production	X	X	X	X			X
		Measurement & Verification of Energy Use	X	X	X	X	X	X	X
		Purchase of Green Power from Grid	X	X		X			
	Materials & Resources	Storage & Collection of Recyclables	X	X	X	X	X	X	X
		Building Reuse: Maintain existing	X	X	X	X	X	X	X
		Construction Waste Management: Divert from disposal	X	X	X	X	X	X	X
		Use salvaged / refurbished building materials	X	X	X	X	X	X	X
		Use materials with recycled content	X	X	X	X	X	X	X
		Use regionally produced materials	X	X	X	X		X	X
		Use rapidly renewable materials	X	X	X	X			X
		Use certified wood	X	X	X	X	X	X	X
	Indoor Environmental Quality	Meet ventilation standards	X	X	X	X	X	X	X
		Eliminate / control tobacco smoke	X	X		X		X	X
		Monitor Outdoor Air Delivery & CO2	X	X	X		X	X	X
		Increased outdoor air ventilation	X	X	X	X	X	X	X
		Control air quality during construction	X	X					X
		Flush out air before occupancy or test air qualiy	X	X					
		Low-Emitting Materials: Adhesives & Sealants	X	X	X	X	X	X	X
		Low-Emitting Materials: Paints & Coatings	X	X	X	X	X	X	X
		Low-Emitting Materials: Flooring Systems	X	X	X	X	X	X	X
		Low-Emitting Materials: Composite Wood & Agrifiber Products	X	X	X	X	X	X	X
		Indoor Chemical & Pollutant Source Control	X	X				X	X
		Controllability of Systems: Lighting	X	X	X	X	X	X	
		Controllability of Systems: Thermal Comfort	X	X	X	X	X	X	X
		Design to meet thermal comfort standards	X	X	X	X	X	X	X
		Post-occupancy thermal comfort verification survey	X	X					X
		Daylighting of interior spaces	X	X	X	X	X	X	X
		Views to outdoors from interior spaces	X	X	X	X	X	X	X
	Innovation	Innovative strategies	X	X	X		X	X	X
		Exemplary performance per credit	X	X	X		X	X	X
		Rating system accredited professional on design team	X	X			X	X	
Additional Criteria	Management	Considerate Builder re: safety, noise, clean site, environmental impact			X	X	X		X
		Low polluting maintenance plan							X
		Provide building users' guide			X	X	X	X	X
	Design	Design for flexibility and adaptability							X
		Building efficiency: good floor area ratio							X
		Indoor Community Space							X
		Integrated design process							X
		Use less materials to achieve building, e.g. water-free urinals use no piping, certain materials require no finish					X	X	X
		Design for disassembly					X	X	X
		Security through crime prevention measures			X				
		Life-cycle environmental assessment							X
		Life-cycle cost analysis for building				X			X
		Provide outdoor private space							X
		Provide space to air-dry clothing to conserve energy				X			
		Provision of home office infrastructure in residences				X			
	Energy	Air-tightness testing						X	
		Energy-efficient cold storage systems				X			
		Energy-efficient equipment and appliances				X			X
		Reduce peak energy demand					X	X	X
	Lighting	Glare control			X	X	X	X	X
		Provide high-frequency fluorescent ballasts			X	X	X	X	X
		Provide appropriate lighting levels			X	X	X	X	X
		Energy-efficient exterior lighting			X				
		Low-energy artificial lighting					X	X	
	HVAC	District cooling systems							X
		Cool building strategies							X
		Humidity control							X
		Provide for natural ventilation			X				X
		Prevent refrigerant leaks			X	X	X	X	
	Acoustics	Appropriate acoustic performance	X		X	X		X	X
		Noise attenuation internal and/or towards nearby buildings			X	X	X		X
	Transport	Easy access to daylit stairs as alternative to elevators							X
		Energy-efficient interior transport: elevators, escalators			X	X			
		Provide for bicycle & pedestrian exterior circulation			X	X			
		Plan for travel to reduce use of cars (remote conferencing)			X	X			
		Public transport information				X			
		Accommodate delivery & maintenance vehicles				X			
	Water	Water use modelling							X
		Metering of water use			X	X	X	X	X
		Water leak detection & prevention			X	X			
		Water cutoff to sanitary fixtures			X	X			
		Limit potable water for fire sprinkler testing					X	X	
	Materials	Use modular materials for ease of replacement (carpet)							X
		Low polluting ceiling systems							X
		Use alternatives to PVC					X	X	X
		Vehicle-washing with water recovery				X			
		Low-impact life cycle materials			X	X			X
		Durability of exposed building parts - low maintenance			X	X			X
		Ease of maintenance during life of building				X			X
		Use less Portland cement					X	X	X
	Pollution/health	Control air quality in enclosed car parking areas							X
		Hazardous material survey					X	X	X
		Mould prevention					X	X	
		Prevent legionellosis from spray of HVAC systems			X	X	X	X	X
	Site	Urban exterior passive cooling strategies							X
		Walkable community / pedestrian friendly							X
		Improve quality of soil							X
		Living systems assessment							X
		Management plan to enhance environment				X		X	
		Protect and reuse topsoil on site					X	X	X
	Equity	Material source has fair labour practices							X
		Material sourced from emerging economy: Fair Trade							X
		Equitable development - Public benefit							X
		Equitable development - guest worker housing							X
	Misc.	Provide Waste Compactor				X			
			LEED for New Buildings - US	LEED India	BREEAM - UK	BREEAM - Gulf	Green Star - Australia	South Africa Green Star	Estidama Pearl - Abu Dhabi

Table 2.2 - Intersection of Green Building Rating Criteria (columns) & Key Criteria of Sustainable Development in Developing Country Contexts (rows)

Sustainable Development Issues in the Developing Country Context	Goal to be met	Construction Activity Pollution Prevention	Preferred Site Selection: non-farm, wetlands, wildlife habitat	Development Density & Community Connectivity	Brownfield Redevelopment / unfavorable sites	Public Transport Access	Bike storage & changing rooms	Low-emitting & fuel efficient vehicle parking & fuel	Minimum car parking & van/bus parking	Site Development: Protect or Restore Habitat	Site Development: Maximize Open Space	Stormwater: reduce runoff volume / peak	Stormwater: reduce pollutants from runoff	Reduce Heat Island Effect: Non-roof surfaces	Reduce Heat Island Effect: Roof Surfaces	Light Pollution Reduction	Water Use Reduction	Water Efficient Landscaping: 50% reduction of potable water use	Innovative Wastewater Technologies	Commissioning of the Building's Energy Systems	Better Energy Performance	Non-CFC based refrigerant use	On-site Renewable Energy Production	Measurement & Verification of energy use	Purchase of Green Power from grid	Storage & Collection of Recyclables	Building Reuse: Maintain existing	Construction Waste Management: Divert from disposal	Use salvaged / refurbished building materials	Use materials with recycled content	Use regionally produced materials	Use rapidly renewable materials	Use certified wood	Meet ventilation standards	Eliminate / control tobacco smoke	Monitor Outdoor Air Delivery & CO2	Increased outdoor air ventilation	Control air quality during construction	Flush out air before occupancy or test air quality	Low-Emitting Materials: Adhesives & Sealants	Low-Emitting Materials: Paints & Coatings	Low-Emitting Materials: Flooring Systems	Low-Emitting Materials: Composite Wood & Agrifiber Products	Indoor Chemical & Pollutant Source Control	Controllability of Systems: Lighting	Controllability of Systems: Thermal Comfort	Design to meet thermal comfort standards	Post-occupancy thermal comfort verification survey	Daylighting of interior spaces	Views to outdoors from interior spaces	Innovative strategies	Exemplary performance per credit	Rating system accredited professional on design team	Considerate Builder re: safety, noise, clean site, environmental impact	Low polluting maintenance plan	Provide building users' guide	Design for flexibility and adaptability	Use less materials to achieve building	Security through crime prevention measures	Provide outdoor private space	Provide space to air-dry clothing to conserve energy	Cool building strategies	Provide for natural ventilation	Water cutoff to sanitary fixtures	Durability of exposed building parts – low maintenance	Ease of maintenance during life of building	Management plan to enhance environment	Protect and re-use topsoil on site	Training component for technology transfer	Labor-intensive to provide employment	Maximize use of local building technique	Design relevant to local culture	Design responsive to local climate
	Category	LEED Criteria: Sustainable Sites															Water Efficiency			Energy & Atmosphere						Materials & Resources								Indoor Environmental Quality																	Innovation			Criteria from other green building rating systems															Suggestions for Developing Country Context				
Environmental	Deforestation																																																																								
	Loss of habitat																																																																								
	Loss of arable land																																																																							
	Water Availability & Conservation																																																																							
	On-site renewable energy production																																																																							
	Minimize Energy Use																																																																							
	Native Vegetation																																																																							
	Pollution Reduction																																																																							
	Climate-responsive																																																																							
	Environmental Stewardship																																																																							
Economic Development	Locally Available Labor																																																																							
	Sustainable livelihoods																																																																							
	Technology Transfer																																																																							
	Locally Available Building Materials																																																																							
	National / Regional Autonomy / Self-reliance																																																																							
	Promote Local Economy																																																																							
	Poverty reduction																																																																							
	Enhance Transportation Options & Efficiency																																																																							
	Access to Credit																																																																							
	Minimize & facilitate needed maintenance																																																																							
Social / Cultural	Build On, Reflect & Strengthen Local Culture																																																																							
	Understand & Build on Traditional and Colonial History																																																																							
	Reflect social practices and values																																																																							
	Strengthen Community																																																																							
	Refer to Local / Regional Building Culture																																																																							
	Enhance Security																																																																							
	Promote Equity; Social Justice																																																																							
	Access to Education / Training																																																																							
	Health Improvement																																																																							
	Participation in Decision-making																																																																							

Table 2.2 juxtaposes these green building rating system criteria with characteristics of sustainable development identified here in their component categories of economic, social/cultural and environmental issues. The intersection of the two axes demonstrates the extent to which sustainability issues in the developing country context are addressed by the green building rating criteria of LEED and other green building rating systems. The role of the matrix is to facilitate an examination of the whole spectrum of sustainability-related issues in the developing country context as they relate to building design and construction and to pose the question of how a green building rating system might be structured to more adequately address these issues.

The table demonstrates that environmental aspects of sustainability, such as reduction of energy and water use and protection of greenfield sites (sites without previous development), predominate in the green building rating systems reviewed. Some of the additional criteria listed from rating systems other than LEED – BREEAM and Estidama Pearls – give evidence of steps in the direction of addressing economic and cultural/social aspects, such as the criteria that rewards the builder's efforts to minimize negative impacts of the construction and the provision of space to air-dry laundry, although there are significant gaps such as the issue of the use of local labor and building technique.

To approach the research question of the applicability of green building rating systems to the developing country contexts of Tanzania and Madagascar, we start by seeing how these rating systems view their role in relation to sustainability goals and issues.

In the introduction to the LEED green building rating system, the USGBC states that

> "green design not only makes a positive impact on public health and the environment, it also reduces operating costs, enhances building and organizational marketability, potentially increases occupant productivity, and helps create a sustainable community."[68]

This mention of 'sustainable community' is one of the few that one finds in the descriptions of the green building rating systems that address the social aspects of sustainability. The majority of

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[68] USGBC. 2009. *LEED for New Construction 2009*. Washington D.C: USGBC. p. 3

other issues mentioned in LEED and in the other green building rating systems relate to the environmental and some of the economic aspects of sustainability. In other words, they are not addressing sustainability as it is defined in the sustainable development literature for the developing country context (DCC). They are addressing only two of the three legs of the sustainable development stool: environmental and some economic but not social aspects. Furthermore, the environmental and economic dimensions are understandably addressed from the perspective of the northern and colder climates, where heating and cooling systems are an integral part of virtually every building and a major consumer of a project’s financial and energy budgets. It is also a context where markets for building materials are larger and transportation and merchandising infrastructure is highly developed to get raw materials and finished goods from one place to another.

Nevertheless, the LEED green building rating system has been used in the developing country context, most frequently in China, India and the UAE but also in the Philippines, Sri Lanka and in Central and South America. The owners of these largely commercial buildings make the effort to have their projects certified for the same reasons as their developed country counterparts: third-party confirmation of their efforts in the direction of sustainability and by referencing the same green building rating system used in the developed countries, comparison is facilitated.

The example of Texas Instruments’ (TI) wafer-producing facility in the Philippines and its relation to its other facilities in the U.S. and elsewhere demonstrates the advantages of a common rating system to measure environmental performance. Texas Instruments’ LEED certification of its Philippines facility is a verifiable demonstration of its commitment to implementing good energy and environmental principles at their manufacturing sites. The building has several green building features that enable it to operate more efficiently and with less environmental impact when compared to similar manufacturing facilities. It is oriented with respect to the sun path to minimize unwanted heat gain and maximize natural daylighting. The building is also well insulated and has a reflective roof to further reduce heat gain. The efficiency measures resulted in a 24 percent reduction in energy use. Extensive water reuse and recycling resulted in a 70 percent reduction in water consumption. More than 85 percent of the employees at the site ride in local or TI provided mass transportation to the facility. Texas Instruments says that it is working with other semiconductor manufacturers through the International SEMATECH Manufacturing Initiative to develop LEED application guides for complex semiconductor manufacturing facilities.[69]

While the environmental commitment of Texas Instruments is demonstrated by their LEED certification and by their reported collaboration with USGBC to develop LEED guidelines for their specific building type, one unanswered question is: How do Texas Instruments and their facilities in the Philippines support sustainability particular to the Philippines context? It is striking that no mention is made of sustainability aspects peculiar to the Philippine context that are present in their buildings and for which the LEED rating system takes account. Surely there are environmental challenges and opportunities proper to a site such as that in the Philippines that would necessitate a unique response. Is the rating system designed to accommodate the particularities of a very different site and context?

Since the LEED rating system was designed for the first world, when it is used in the developing country context, the only mechanism to adjust the rating system for this different context with its own issues of sustainability is the availability of four ‘innovation’ points, designed to cover measures not addressed by other categories in the rating system. In 2006, the Indian Green Building Council adopted and adapted the LEED rating system for New Construction for use in India. The LEED India NC rating system keeps virtually all the same points and categories as that of the US. The modifications to the rating system consist simply of replacing some references to US environmental and building regulations with corresponding Indian regulations, eliminating a criterion related to the preservation of open spaces and the addition of a water efficiency point for not using potable water in air conditioning systems.

Evaluating the ecolodge project built by the non-governmental organization, Birambye International, in Rwanda , architect and board member Kat Pecoraro used the LEED green building rating system and found that it does not address issues of social equity and economics. Other issues she found lacking were passive environmental systems, which includes building

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[69] Texas Instruments. 2009. *Texas Instruments' Philippines, Inc. building earns the first LEED certification in the country*. http://focus.ti.com/pr/docs/preldetail.tsp?sectionId=594&prelId=c09017. (retrieved: 21 January 2010).

orientation and configuration for example to capture dominant breezes or avoid solar penetration to the interior. She found also that LEED doesn't address efforts to limit deforestation in areas surrounding a project, nor does it address poverty alleviation and eradication, which, as has been argued above, is a necessary condition for sustainable development.[70]

What is not addressed in the main green building rating systems are cultural and social aspects, which admittedly are not particularly amenable to quantification. But sustainability is not only the physical aspect. What makes a building sustainable is also the fact that people hold it in esteem. If they value it, they will want to maintain it. A sustainable building is one that has value to the users / inhabitants. How does a building have value for people? It relates to their culture and ideas. It contains elements that are important to the people.

To take Howard Davis' example cited in his book *The Culture of Building,* you could build a convenience store in an environmentally sensitive manner with materials from regenerating sources and it is true, it would not harm the environment and it could be made in such a way that eventually it would return to dust.[71] But is it then sustainable? Such an ostensibly green building would not meet the criteria of sustainability as defined in the sustainable development literature. For it to be sustainable, a green building would contain building elements that the users would recognize as forming part of their world and history and reflective of their worldview. An example of such an element in the context of Tanzania and Madagascar is a covered veranda along the front of a building that corresponds to how people use buildings there (see figure 1.6.5). Such an element forms a transitional space between inside and outside that is used for many purposes and serves to extend and moderate the interior space. Such a covered veranda space is functional and serves a purpose. To eliminate it risks losing an opportunity to make the building sustainable. With such elements that relate to how people use and move through their built environment, a building is more likely to have value to its users over time and is more likely to be cared for. It therefore is not disposable and responds to a deeper notion of sustainability. Davis' concept of building culture is an important concept in evaluating the

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[70] Pecoraro, Kat. 2008. *Birambye International's Rwandan Investment: An Assessment of the LEED Rating System for the Birambye Lodge*. Unpublished report.
[71] Davis, Howard. Ibid. p. 155.

sustainability of a given building. It speaks to whether the building has a relation to how one builds in a given area so that it is more likely to be understood, accepted and capable of being maintained.

Chapter 3 The Architect as Participant Observer

3.1 Appropriate Research Methodologies

This research makes use of qualitative research methodologies to assess the applicability of green building rating systems developed in more economically developed countries to building design and construction in the developing country contexts of Madagascar and Tanzania. This subject and the issue of sustainability more generally, of which it is a subset, is not conducive to quantitative methods owing to the complex and nuanced nature of the subject matter and the paucity of data available for analysis. Working from a base of participant observation, as defined by James Spradley[72], this research focuses on three case studies for analysis, following Robert Yin[73], and subsequently develops recommendations using logical argumentation as described by Linda Groat and David Wang[74].

As the primary researcher, I acted as a participant observer during the design and construction of numerous building projects in Madagascar and Tanzania during the period from 1983 through 2006. In this research, I use a case study methodology to study three of these buildings – two in Madagascar and one in Tanzania – to evaluate the nature of sustainability issues in their design and construction and the applicability of green building rating systems' criteria. I finally, then make recommendations for a green building rating system more applicable to the contexts of Tanzania and Madagascar and explore the extent to which such recommendations could be relevant beyond those two countries.

This research has its roots in my practice as a U.S. architect designing – and getting built – small to medium projects primarily for faith-based organizations in Madagascar and Tanzania. I did this while living in those two countries over a period of nine years – 1983 - 1992. In the 18 years since then, I have continued to design and build projects in those two countries. Additionally,

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[72] Spradley, James. 1980. *Participant Observation*. New York: Holt, Rinehart & Winston. p. 61.
[73] Yin, Robert. 1989. *Case Study Research: Design and Methods*. Newbury Park: Sage Publications. p.98.
[74] Groat, Linda and David Wang. 2002. *Architectural Research Methods*. New York: John Wiley & Sons. p. 307.

since that time, I have worked or am currently working on building projects in several other developing countries: Kenya, Malawi, Ghana and the Kurdish region of northern Iraq.

The projects were designed and built to fit in with the local culture and use of space – the clients and users were primarily local inhabitants and sometimes foreign residents – and to respond to the site and climatic opportunities and constraints. There was generally little in the way of reliable utilities infrastructure – water, electricity, sewage – so the buildings had to be autonomous to the extent feasible given the budget constraints. This was true even insofar as security concerns since neither was there generally available a reliable police force or other security infrastructure.

The projects were designed to cost as little as possible because funding was always extremely tight, maximizing use of locally available materials and labor in a manner that would cost the least and require the least amount of maintenance for the longest time. My goal was and is always creating buildings that will last for one hundred years. The cost of building in those contexts, while inexpensive by western standards (costing from a tenth to a fourth of what buildings for a similar function would cost in more economically developed countries) is a huge expense for the local people and organizations. Funding for the projects that I did came from overseas partner agencies. But that funding was a one-time event not likely to be repeated so the buildings had to last and had to require the minimum amount of maintenance because there was simply no operating budget for it.

When I returned to live in the U.S. and began my PhD studies, I realized that the experience described above is a very rich source of knowledge and that it fits under the type of qualitative research known as participant observation. Spradley writes in his book about participant observation that “the highest level of involvement for ethnographers probably comes when they study a situation in which they are already ordinary participants.”[75] He mentions that many studies have come from researchers “who have turned ordinary situations in which they are

[75] Spradley. p. 61.

members into research settings."[76] Spradley cautions however that "the more you know about a situation as an ordinary participant, the more difficult it is to study it as an ethnographer….The *less* familiar you are with a social situation, the *more* you are able to see the tacit cultural rules at work."[77] It appears from this description that my years of work as an outsider participating fully in local design and construction allowed me to both understand at a deep level what is going on around me and yet to recognize patterns of behavior because they were other than those that I grew up with. Linda Groat and David Wang, in their book about architectural research methods, state that "the strategy of qualitative research is one of first-hand encounters with a specific context. It involves gaining an understanding of how people in real-world situations 'make sense' of their environment and themselves, and it achieves this by means of a variety of tactics. It acknowledges, rather than disavows, the role of interpretation in the collection and presentation of data."[78] Ethnography is the study of people. This research is not about studying people as much as the actions that people do or can do in a given context in order to create the built environment. On the one hand, this information is more accessible, since it is not in the realm of people's thoughts, beliefs, or motivations but rather in the realm of actions taken whose effects are visible and tangible. Groat and Wang provide the following summary of attributes of qualitative research design based on previous researchers' descriptions:

> "*Holistic*. The goal of qualitative research is to gain a holistic (systematic, encompassing, integrated) overview of the context under study.
> *Prolonged Contact*. Qualitative research is conducted through an intense and/or prolonged contact with a 'field' or life situation.
> *Open Ended*. Qualitative research tends to be more open-ended in both theoretical conception and research design than other research strategies.
> *Researcher as Measurement Device*. Since there is relatively little use of standardized measures- such as survey questionnaires, the researcher is essentially the main measurement device in the study.
> *Analysis through Words*. Since an emphasis on descriptive numerical measures and inferential statistics is typically eschewed, the principal mode of analysis is through words, whether represented in visual displays or through narrative devices.
> *Personal Informal Writing Stance*. In contrast to the typical journal format of experimental or correlational studies, the writing style of qualitative work is typically

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[76] Ibid. p.61.
[77] Ibid. p. 61.
[78] Groat, Linda and David Wang. 2002. *Architectural Research Methods*. New York: John Wiley & Sons. p. 179.

> offered in a personal informal writing stance that lessens the distance between the writer and the reader."[79]

I find the above description of qualitative design characteristics goes a long way towards describing the aims and strategies of the present research. Groat and Wang go on to discuss a research method they call "logical argumentation". At its more cultural and discursive end, they cite design treatises as examples of such a research method. Such treatises justify calls for given architectural actions by appealing to larger transcendental contexts.[80] In the case of this research, the actions are those that would be components of a green building rating system that more accurately reflects the reality and the goals of sustainable development in the developing country context of Madagascar and Tanzania.

Nine years' experience working as a resident development professional involved in the design and construction of the built environment in Madagascar and Tanzania and the last seventeen years still working on such projects in those and other countries from a base in the U.S. has given me a deep understanding of building design and construction in those developing country contexts and that which is sustainable, and that which is not, in those contexts. This combination of insider's and outsider's knowledge makes for a unique and powerful kind of participant observation. Based on my long-term observation of and participation in the creation and modification of the built environment in developing countries, this research grounds my experiences and observations in policy considerations related to sustainable development issues in developing countries. It seeks to transform this understanding into more generalizable knowledge by informing it through study of the international development and sustainability literature and policy statements and projects of aid agencies and government documents.

This dissertation is about creating a sustainable built environment in the developing country contexts of Madagascar and Tanzania based on elements that are already known and familiar to inhabitants. These are elements that can be used in a more sustainable manner and those involved in the built environment in such contexts can be encouraged to do so. To answer the research

[79] Ibid. p.179
[80] Ibid. p. 307.

question concerning applicability of green building rating systems to the developing country context, a most direct means is as a participant observer directly involved in building design and construction in one or more developing countries. In addition to the information gleaned as a participant observer and through direct observation of building design and construction in the developing country context, information in response to the research question is gained through my practice as an architect in the U.S. in which I work with green building rating systems, in particular with the LEED rating system of the USGBC. It is through this practice in both types of context that a participant observer can gain an understanding of what elements of a green building rating system have relevance and what aspects of sustainability are not being addressed by a given rating system.

Three buildings that I have designed and whose construction I have overseen in Madagascar and Tanzania will be analyzed as case studies for which the applicability of green building rating systems will be evaluated. Archival records – building plans and site information including geographical and climate information – will serve to illustrate the case studies along with physical artifacts: the completed buildings themselves. The result will be a multiple case holistic case study where more than one case is studied with the individual building as the unit of analysis. It is holistic because there is a single unit of analysis: the building. The research does not attempt to address either the broader or the more detailed scale such as the markets for building materials. The case study evidence comes from the following five sources:

Documents –Studies, articles about sustainability in developing countries and about green building rating systems.
Archival records –Plans of buildings and site plans will tell about how the buildings respond – or do not – to their situation.
Direct observation – Visiting and studying buildings and construction in these contexts.
Participant-observation – My own experience here is important as one who had decision-making responsibility regarding sustainability issues.
Physical Artifacts – The buildings as constructed and experienced are the physical evidence of what the study is about.

For an example of a similar methodology, the ground-breaking work of Howard Davis and his concept of building culture already cited is very instructive. Davis looks at what and how people build buildings in a given place for clues as to what is valued in that context, how decisions are made and who and what controls the process of construction. Far from being the result of random convergences, he describes the built environment as being exactly the result of knowable economic and cultural processes, actors and decisions that are well understood by the various actors. The importance of this concept is that if one hopes to introduce any change or improvement in a given built environment context, as is the case with the promotion of green building and green building rating systems, one must begin from a detailed understanding of the local building culture: how the built environment comes to look and be shaped as it is. It is only from such an understanding that one can hope to influence the various actors and the outcome of their activities.[81] Just in such a manner, this research posits that only from an in-depth understanding of the economic, cultural and environmental context of a place and its buildings, can we define both what sustainability and by extension, green building is for a given place and how to achieve it.

Other researchers in the built environment that employ a similar approach in their work are Christopher Alexander and his work in California, South America and Japan as described by Howard Davis[82], Charles Correa and Laurie Baker in India[83], and John Turner and his work in South America. John Turner describes two kinds of experts: those that live in a given situation and experts that study them from the outside. He states that cooperation between these two realms of knowledge is necessary for a 'whole view and full understanding' concluding that "no amount of sociological surveys can substitute for the insiders' knowledge of their own personal, household and neighborhood situations, needs, priorities and the resources they have with which to satisfy them…The only way to make use of this (insider knowledge) is to work along with those who have it."[84]

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[81] Davis, Howard. Ibid. pp 37-42.
[82] Ibid. pp 245-252.
[83] Baker, Laurie. 2009. http://lauriebaker.net/work/work/baker-on-laurie-baker-architecture.html (retrieved 10 October 2009).
[84] Turner, John F. C. 1983. Architects for Another Development, in Architectural Education 2. London: Riba Magazines. p. 61-62.

3.2 How Do We Know What We Know?

One of the potential pitfalls of some qualitative research that is based on interviews and short-term contact with the target study area and population is validity: that is, is the information gathered true? And if the information is considered true, then the next question is: is that the whole story and the truest picture of reality? Felicitas Becker, in the introduction to her book on how southeastern Tanzanians came to be Muslim, conducted many interviews. In her introduction, she notes her interviewees' reaction to the 'taint of state power' that attached to her since they were often selected for her by local government officials. She describes efforts to exclude some people from talking with her based on criteria of power or privilege. It was hard to speak with women, for example, who, in the company of men, particularly their sons or husbands, would defer to the men or would just not get heard. Becker notes that "women spoke much more freely and directly in domestic situations that were female by definition." In addition to issues of gender, issues of local power and with it, access to resources, also played a significant factor in the choice of interviewees and in how they would respond to Becker's questions.[85]

Given this situation, it is fair to ask, is the researcher getting the whole, the accurate story? What kind of things do people not want to talk about, for example? One wonders how her information would have been different if Becker had had the opportunity to live in one of the target communities for a period of years teaching agricultural methods, for example, and learning about her neighbors' religious upbringing through casual conversations. Would that not bring with it a higher level of validity? If one lives in a place as much as possible as a normal inhabitant, working as others do, so that one's whole focus of activity is not on extracting desired information, it stands to reason that one has a better chance of observing and understanding reality. It is the familiar situation of coming across some important bit of information when one is not particularly looking for it. My years working in the field have provided me with ample

[85] Becker, Felicitas. 2008. *Becoming Muslim in Mainland Tanzania 1890-2000*. Oxford: Oxford University Press. p.11.

opportunity to observe and participate in decision-making regarding the built environment in Madagascar and Tanzania in a wide variety of projects and contexts.

Since the research identifies case study buildings that still exist in Madagascar and Tanzania and the context in which they were created still is extant, other researchers could look at these same case study buildings or other similar ones and reach conclusions similar to mine. In this way, the data base is separate from the researcher's reporting so that others can look at the same or similar data and reach their conclusions. Yin asserts that this separation of data base from report increases the reliability of the case study conclusions.[86]

Yin explains how knowledge is gleaned from case studies. He contrasts statistical generalization with the analytic generalization appropriate to case study research:

> "A fatal flaw in doing case studies is to conceive of statistical generalization as the method of generalizing the results of the case. This is because cases are not 'sampling units' and should not be chosen for this reason. Rather, individual case studies are to be selected as a laboratory investigator selects the topic of a new experiment. Multiple cases, in this sense, should be considered like multiple experiments (or multiple surveys). Under these circumstances, the method of generalization is 'analytic generalization', in which a previously developed theory is used as a template with which to compare the empirical results of the case study. If two or more cases are shown to support the same theory, replication may be claimed. The empirical results may be considered yet more potent if two or more cases support the same theory but do not support an equally plausible, rival theory."[87]

3.3 Matrices for Analysis

A first analysis matrix is used in Chapter Two to list and compare criteria used for various green building rating systems (GBRS's) presented. The criteria first listed are those found in the LEED GBRS. The X's indicate which of these criteria are also common to the other green building rating systems reviewed. Below these first criteria are those that are found in these other GBRS's but not in LEED. The X's indicate which of these additional criteria are found in which of the other GBRS's.

[86] Yin, Robert. 1989. *Case Study Research: Design and Methods*. Newbury Park: Sage Publications. p.98.
[87] Yin, Robert. Ibid. p.38

A second matrix is presented further in Chapter Two to examine the relation between green building rating system criteria and the characteristics of sustainable development in developing countries as reviewed in an earlier section of the same chapter. In this second matrix, the criteria of green building rating systems are located on one axis and the characteristics of sustainable development in the developing country context along the other axis. The shaded boxes mark the intersections of these two axes, where they address similar issues. The number of shaded boxes is evidence of the extent to which these two approaches to sustainability overlap. Additional rows and columns are left for aspects that are proper to the case studies or are not addressed in such systems, such as aesthetics, culture, labor, poverty, and building maintenance.

The three case study buildings serve as examples of buildings from the broad middle range of construction activity described in Chapter 2, Section 2.4. They serve to illustrate the application of green building rating system criteria and the broader sustainability concepts described in Chapter 2, Section 2.2 to the developing country contexts of Tanzania and Madagascar. The case study buildings and the application of the sustainability concepts and criteria form the basis for the analysis and for the subsequent logical argumentation.

Chapter 4 Case Studies in Madagascar and Tanzania

4.1 The Case Study Buildings and their Context

Three case studies are presented here. Their importance to this research is not that they are the best exemplars of green building in the contexts of Madagascar and Tanzania. Their importance, rather, is that, through them, the issues and opportunities of sustainability can be examined in their particular context. Through them, the local building culture and its influence on building design and construction can be made apparent. All three case studies are buildings from the wide middle tier of building projects as described in Chapter 2 Section 2.4. Their relevance and importance lies in the applicability of their experience to the broader economy in which they are situated. They are not so marginal to the economy, as in the case of self-built shelter, or expensive, as in the case of the constructions of the privileged, to be of limited relevance to the larger economic context in which they are found. The three case studies are useful in understanding how sustainability issues, as presented in green building rating systems, look in the developing country contexts of Madagascar and Tanzania. The design of all three case studies responded to topographic and climatic imperatives and to other parameters of the site. Each of them maximized local labor, building materials and techniques with the aim of minimizing both first cost and life-cycle expenditures for maintenance.

Two of the case studies – the Centre ValBio and the Biodiversity Center – are research-related buildings in Madagascar. In each of these two cases, the client is a partnership between Malagasy and U.S. scientific institutions. The first of them is located in a relatively remote area – Ranomafana – the site of one of the first national parks of Madagascar. Ranomafana means ‘hot water’ in Malagasy and is the location of some hot springs around which a resort was developed in the colonial period. Ranomafana National Park was established in 1991 and consists of 43,500 hectares (108,000 acres) of rainforest on the eastern escarpment of Madagascar.[88] It is flanked on

[88] See the website of the Institute for the Study of Tropical Environments at the State University of New York – Stony Brook for information about the park and research conducted there. http://icte.bio.sunysb.edu/pages/ranomafana.html (retrieved 24 April 2010)

the north by national highway 25, a two-lane blacktop winding road that is the only road connecting the southeastern coast of Madagascar with the central highlands (see figure 4.1.1).

Figure 4.1.1 – Map of Madagascar indicating locations of Ranomafana and Antananarivo. Source: Pneu Michelin and Fieldwork.

The second Madagascar project is located in the densely populated center of the capital city, Antananarivo, adjacent to the Tzimbazaza National Zoo. Antananarivo – which means 'city of a thousand (warriors)' – is located in the central highlands (see figure 4.1.1).

The third case study is a guest house and small conference center for a church-related institution in a suburban residential area of the capital city of Dodoma, Tanzania. Dodoma is located at the geographic center of Tanzania, along the national highway that links the main city of Dar es Salaam on the east coast with the cities of Mwanza on the southern shore of Lake Victoria and Kigoma on the eastern shore of Lake Tanganyika. This east-west highway intersects at Dodoma with the north-south highway that links the northern towns of Arusha and Moshi with the southern expanses of Tanzania (see figure 4.1.2).

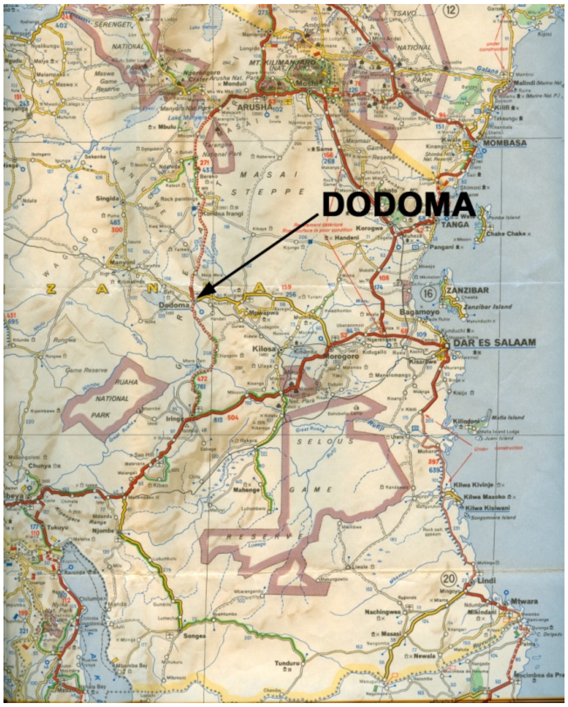

Figure 4.1.2 – Map of Tanzania indicating location of Dodoma. Source: Pneu Michelin and Fieldwork.

The following are salient aspects of building design and construction in the developing country contexts of Madagascar and Tanzania that need to be adequately addressed in order for sustainability-focused efforts to be successful there:

- the culture with its values and practices embodied in a particular use of space
- the unique building culture with its attendant materials, labor and practices
- endemic and widespread poverty
- high unemployment
- limited skilled labor
- resource-poor clients
- mild climate and continuum of outdoor to indoor space
- passive means of cooling / heating are often adequate for comfort
- lack of government-provided security
- lack of utilities and transportation infrastructure.

One of the most obvious aspects to be addressed is that of designing buildings appropriate for their culture. Whether the designer is a local, or foreign architect, the building design, its component elements and their layout, and the materials used, need to have a relation to the culture, values and beliefs of the people who will be using the building. If such a relation is absent, the users are not likely to see the building as part of their environment and may not adopt it as theirs. Amos Rapoport, cited earlier, writes that

> "environments may be defined as good to the extent that they are supportive for the people who live in them … To evaluate whether environments are supportive, … one needs to identify the relevant group, describe and analyze its important characteristics and understand how these interact with various elements of the built environment. Generally, what is supported are the social structures (kinship groups, rituals, language, food habits, activity systems, etc.)." [89]

Related to this cultural aspect is Howard Davis' concept of building culture as manifest in local building practices. A sustainable building will be conceived and built with an in-depth understanding of the "coordinated system of knowledge, rules, and procedures that is shared by people who participate in the building activity".[90] This understanding involves the range of building undertaken in a given context, from traditional and colonial building methods to present-day building. Without such an understanding, a building will not be built as efficiently or cost-effectively as it could and will be more costly to maintain.

Another important aspect of these contexts is that of the endemic poverty of the inhabitants and users of buildings in Madagascar and Tanzania. In the rural areas where the majority of the people live, most of the people are subsistence-type farmers. Unemployment is high and skilled building labor is rare. In the urban areas, unemployment is often even higher, though it is possible to find skilled building labor, such as masons, carpenters, plumbers and electricians. Building projects have to deal with this availability of skilled labor, simply in order to get a project built. The benefit is that high unemployment means unskilled labor is in ready supply. A project that strives for sustainability will want to address the issues of labor and with it, poverty reduction. What is called for is actually the opposite of labor-saving devices or techniques, such as we find called for in more economically-developed countries. Design and construction that

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[89] Rapoport, Amos. 1983. "Development, Culture Change and Supportive Design". In *Habitat International* 7:5-6. p. 256.
[90] Davis, Howard. Ibid.p.3.

maximizes use of local labor and in fact incorporates measures of technology transfer through training of local labor in building skills are important steps in the direction of sustainability.

The local owners / users of building projects in these contexts have very limited financial resources. The cost of a building, though a fraction of the cost for a comparable building in the more economically-developed countries, represents an unattainable sum for most people and organizations in Madagascar and Tanzania. Funds for building projects come most often from foreign partners / donors who are typically not particularly interested in providing funding for buildings but consider it at times necessary. For this reason, all efforts need to be made to minimize both first cost and running costs for any building in these contexts. The most evident means to minimize these costs is to maximize use of locally available materials and labor, to build in such a way as to minimize needed maintenance and mechanical systems and to make such maintenance as will be needed able to be accomplished with local means and labor.

Madagascar and Tanzania enjoy generally mild climates. Average 24 hour winter temperature (July/August) for the central highlands is 59º F while average 24 hour summer temperature (December/January) is 75º F. Average 24 hour winter temperature at the coasts of Madagascar is 68º F and that of the summer is 78º F. Average 24 hour winter temperature for central Tanzania is 68º F and that of the summer is 75º F.[91] Owing to this generally mild climate, people continue to live and work to a great extent outdoors as they always have. The indoor environment does not differ greatly from the outdoors in many cases. Exterior spaces are used for a wide variety of functions. Among these functions are circulation between interior spaces, stairways, waiting areas, meeting spaces, classroom spaces, dining, food preparation, dish-washing, laundry washing, drying and ironing and, in hotter and dryer areas, sleeping. The concerns with exterior spaces have to do with providing shade from sun, protection from rain, privacy for some functions, security for valuables such as furnishings and equipment. The generally mild climate in fact serves to extend a building’s programmed space with minimal cost.

[91] http://www.worldclimate.com/ (retrieved 20 April 2010)

In many cases, passive means of moderating climatic extremes are mostly adequate in such mild climates. Passive means include building orientation to modulate solar access and natural ventilation from prevailing winds, the use of roof overhangs to block unwanted solar access and to provide shade for exterior spaces, location of window and other openings on opposite exterior walls to facilitate cross-ventilation, and having an adequate ceiling height to encourage natural circulation, allow for stratification of the air, and to accommodate ceiling fans if needed.

There is typically little in the way of reliable police or other security presence as exists in more economically-developed countries, so deterrence is important to achieve physical security in a building. Deterrence is achieved primarily by means of social accountability within the surrounding community where people know each other and look out for one another. If someone unknown or threatening is around, community members alert each other. Since it is not really possible to keep someone out of a building if they have enough time, the intention of physically deterrent methods is to not make it easy for thieves and to facilitate visual surveillance by neighbors or users. Simple methods – such as bars on windows and fencing around the perimeter area with locking gates - are the most effective in deterring opportunistic theft. Making building access locations visible from various vantage points makes it less likely that thieves could get in and out unnoticed.

Utilities infrastructure is available generally only in urban areas and is not very reliable there. Rapid population growth in urban areas results in the existing infrastructure being overextended, so the service is reduced in volume (voltage and water flow) and quality. Electricity in urban areas is typically produced by diesel-powered generators and when diesel is rationed or otherwise not available, power is often available only at certain times of the day. Even then, the voltage can vary a great deal because of trying to service so many people. Existing water mains are typically too small for the number of lines tapping off them. The result is that at the end of the line, there is very little to no water available. Water then in that case, is available at only certain times of the day. Municipal sewerage systems are rare and suffer from the same problems of overextension and lack of maintenance. Most sewage is handled by septic tanks on the building site. A benefit of the ubiquity of cell phones is that the land line phone service network which is so expensive to establish and maintain is being made obsolete. As a result, communications infrastructure is now available in most places.

As a result of the limited and unreliable access to utilities infrastructure, building projects have to be self-sufficient to as great an extent as possible. This means having adequate window areas in all habitable rooms so that daylighting is sufficient when the electricity is off. Making use of passive means of modulating the environment described above means less reliance on electrically-powered mechanical means such as air conditioning or even ceiling fans. Elevators are rare in buildings under five stories tall unless it is a hospital. The limited utilities infrastructure makes back-up electrical generation a necessity for continuity of service in institutions like hospitals. In rural locations, local electrical generation is the only option available. Renewable energy systems have great promise in such locations since diesel generators are expensive and need a continuous supply of fuel and maintenance capability to run them. Capturing rainwater and re-using greywater make a lot of sense when water supplies are spotty or dependent on electrically-powered submersible pumps. Available water infrastructure does not offer potable water in any event so the use of rainwater and greywater is easier to justify since all water must be treated to make it potable.

The transportation infrastructure of roads and railways is limited in extent and quality. Both Madagascar and Tanzania are large countries with relatively small populations. Madagascar has 19.6 million inhabitants within its area of 587,041 square kilometers (226,657 square miles), while Tanzania has 43.7 million within its area of 945,203 square kilometers (364,943 square miles). Each of the countries has one main population center and a number of smaller peripheral centers. Tanzania's main city, Dar-es-Salaam has a population of 2.5 million while Madagascar's capital and largest city, Antananarivo has a population of 1.4 million. As noted above, the majority of the population is still rural and not well-served with rail and roads. The distances thus are great between manufacturing centers, where goods are readily available, and most non-urban project locations. The costs of transportation are relatively greater when the roads are inadequately maintained or simply do not exist. This increases construction cost for anything that involves materials or labor not locally available.

4.2 Colonial Context and the Building Culture

Madagascar and Tanzania, the location of the three case studies, are very different from each other in their colonial history and culture as described briefly in Chapter 1, Sections 1.6 – 1.8. Their building cultures, as defined by Howard Davis, are also distinct.

Figure 4.2.1 – Madagascar: traditional Malagasy highlands house and coastal house. Source: Fieldwork.

The traditional highland structures of Madagascar are rectangular, two-story mud brick houses with thatched roofs. In the coastal areas, houses are built of woven local vegetation and elevated on stilts (see figure 4.2.1). French construction techniques and styles were imported along with the colonial administration. These were based on construction in France as well as on the French experience in their other colonies. Following Madagascar's independence in 1960, the colonial influence was and still is dominant, especially in the construction sector. Since traditional vernacular structures were mainly dwellings, the colonial was the only model for other structures – governmental, commercial, educational, health-related and industrial.

Stone was widely used in Madagascar for building roads, retaining walls and foundations in the colonial period. Reinforced concrete has supplanted stone in a number of areas and roads are made generally of tarmac. However, retaining walls are still made of stone used as a wedge-shaped gravity retaining wall without steel reinforcing. Since it is also less expensive than an equivalent reinforced concrete retaining wall, it was decided to use it for the roads, retaining walls, exterior steps, courtyards and foundation walls of the case study buildings in Madagascar (see figure 4.2.2).

Figure 4.2.2 – Madagascar: stone retaining walls and foundations in case study building at Ranomafana. Source: Fieldwork.

Burnt bricks are also widely used in the central highlands since their use was introduced in the 19th century (see figure 4.2.3). They are fired over a period of weeks in unused rice paddies. Unfortunately, this process uses a great deal of firewood which is in short supply. Local masons are plentiful and know how to work with the bricks and with the stone.

Figure 4.2.3 –Madagascar: Malagasy highlands house of brick with upper veranda. Source: Fieldwork.

Reinforced concrete structural frames were widely used in colonial era buildings and continue to be used today, even for single-story applications such as residences and classroom buildings. The infill brick walls then bear only their own weight and serve to brace the concrete frame.

Plumbing, sewerage and electrical systems follow the French model. Light switches are located 90 centimeters (36 inches) above the floor and up is on and down is off, as is the practice in the U.S. Any deviation from the standard French practice in these systems is strongly resisted to the point of refusal. The craftspeople are proud to know what the French system requires and will typically entertain no other.

Traditional structures in Tanganyika were of various types. Among the most common were round structures with thatched roofs and walls of sticks or mud (see figure 4.2.4). The German colonial experience brought along with it its own construction techniques. Stone-walled schools and government buildings remain from that period.

The British colonial period brought with it construction techniques and materials from its extensive experience in India among other colonial locations. Zanzibar, occupied by Arab traders and their economy from at least the 1400's on up to the 1960's has its own unique coastal building culture making use of blocks of coral harvested from the ocean for walls and having flat roofs made of timber with rubble infill. Again, following the colonial period, the newly independent country of Tanzania continued and continues to this day to refer to its most recent colonial heritage as the source of information for its building construction techniques.

Figure 4.2.4 – Tanzania: traditional Maasai dwellings. Source: Fieldwork.

Figure 4.2.5 – Tanzania: site-made solid concrete blocks curing in the sun in Dodoma. Source: Fieldwork.

Walls are generally made of solid concrete blocks. They are typically mixed and made on site or in workshops nearby (see figure 4.2.5). They are really the only choice for permanent wall construction in most of Tanzania. There has been in the Dodoma area a brick-making factory the products of which are everywhere visible in the houses of the area. But that factory is closed and no one is making the effort to re-open it. Similarly, one sees beautiful stone walls in old buildings from the German colonial period of the early 20th century. But when you ask for that material, no one knows of any craftsman capable of working with stone. Reinforced concrete frame construction is widely known and used for any building over one story. Perhaps owing to the solid walls possible with the solid concrete blocks, single story buildings are built without the reinforced concrete frame. They typically have a reinforced concrete footing under the foundation wall and a reinforced concrete ringbeam at the top of the exterior walls. The electrical, plumbing and sewerage systems of Tanzania refer to British standards for wiring, switches, pipe sizes and types of fittings and fixtures. The switch plates are big and clunky and located 122 centimeters (48 inches) above the floor. Down is on and up is off; the opposite of the French electrical switch.

There are significant differences between the way buildings are built in Madagascar and Tanzania owing to differences in their building culture. For example, while it would be possible to build in Tanzania in the manner in which one builds in Madagascar, it would be prohibitively expensive because of the additional cost of using unfamiliar materials or using materials in unfamiliar ways. The practitioners within a building culture know how to build within their context. They are not typically going to be successful in building within an unfamiliar context.

4.3 Centre ValBio - Ranomafana, Madagascar – 2000-2003

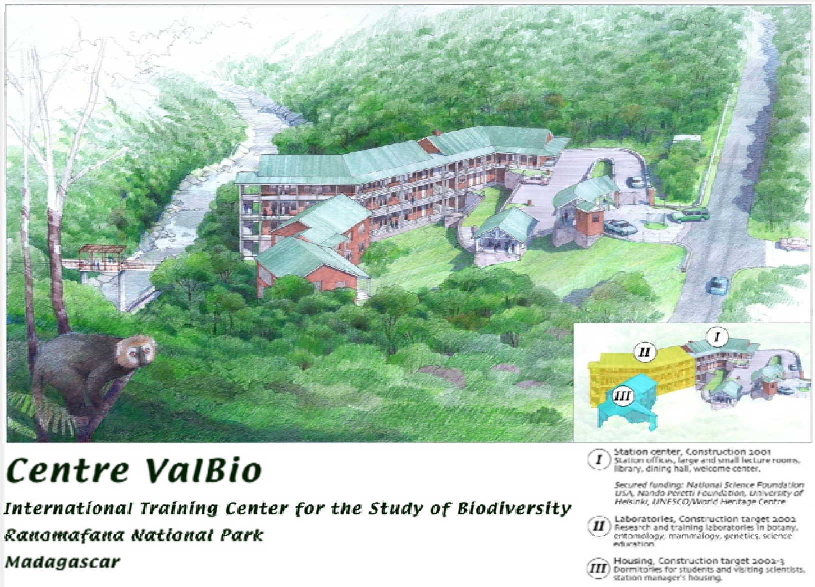


Figure 4.3.1 Madagascar: rendering of Centre ValBio as projected to be completed. The structures indicated with Roman numeral I have been completed to date. Source: Fieldwork.

4.3.1 Project Description

The Centre ValBio (Centre pour la Valorisation de la Biodiversite) was built for the Institute for the Conservation of Tropical Environments (ICTE) at the State University of New York (SUNY) at Stony Brook and its Malagasy counterpart, MICET (Malagasy Institut pour la Conservation des Environnements Tropicaux. It is located across the Namorona River from the 43,500 hectare (108,000 acre) Ranomafana National Park and some 5 kilometers (3.1 miles) west of the town of the same name on the eastern escarpment of Madagascar. There are many scientific research activities in the park conducted by scientists from the various Malagasy and international institutions that make use of the Centre ValBio.

The intention of the Centre ValBio is to augment the capacity of two temporary research cabins that were erected in the 1990's within the perimeter of the park. Prior to the construction of the Centre ValBio, the activities of the researchers, who were camping in some 24 tented sites adjacent to the two original research cabins, were having a detrimental effect on the park. There was no water, sanitation or electrical systems to serve their activities since the research cabins were within the park and were intended to be temporary.

Figure 4.3.2 Madagascar: impacted site of the Centre ValBio adjacent to main highway. Source: Fieldwork.

The Centre ValBio is situated on a steeply sloping site of about 0.88 hectare (2.2 acres) between the Namorona River and the main (and only) highway leading down to the southeastern coast from the central highlands. The site had already been modified from its original rainforest state for use in rice cultivation before being acquired for the construction of the Centre (see figures 4.3.1 and 4.3.2). A significant portion of the project work was that needed to develop the retaining walls and access drive to make the steep site useable (see figure 4.3.3).

Figure 4.3.3 Madagascar: site retaining wall work at the Centre ValBio. Source: Fieldwork.

At the top of the site is an entry area with viewing/waiting area that overlooks the site, the Namorona River and the Ranomafana National Park beyond. There is a small guard's shelter and scenic overlook incorporated into the entry area. Stone stairs down into the site lead to an outdoors covered classroom area. A vehicular drive from the entry area leads down to the top floor of the Centre and to a small parking area with a storage building and workshop built into the retaining wall (see figures 4.3.4 and 4.3.5).

Figure 4.3.4 Madagascar: view up towards entry to Centre ValBio. Source: Fieldwork.

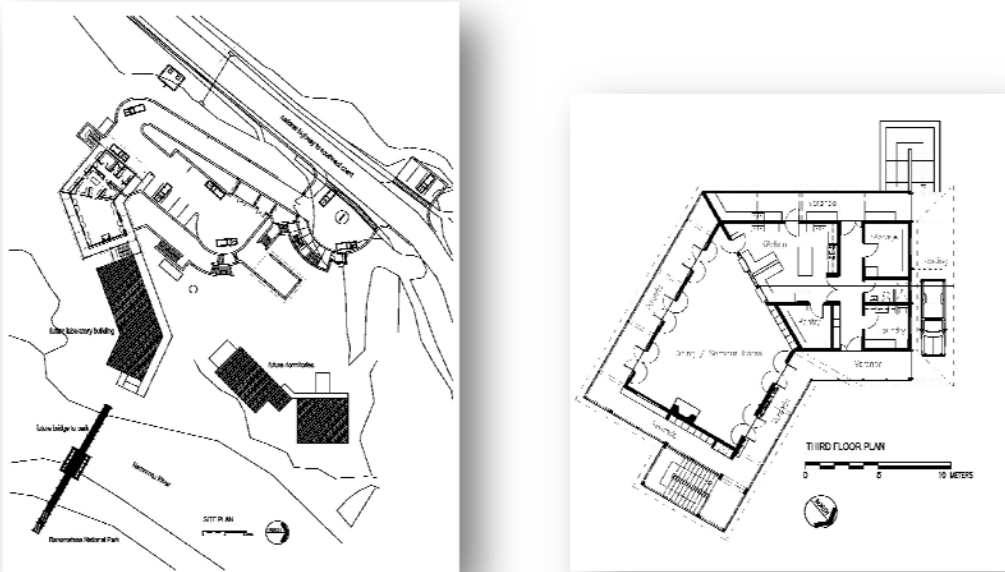


Figure 4.3.5 Madagascar: site plan and third floor plan of Centre ValBio. Source: Fieldwork.

The main building consists of 420 square meters (4,500 square feet) of enclosed space on three levels with another 290 square meters (3,100 square feet) of covered area at the perimeter of the building. The top level of the Centre contains the dining / seminar room, kitchen, storerooms, laundry and staff bathroom. There is a wide veranda on three sides for extra dining area, viewing the forest, working on projects or drying clothes (the Centre is located in the rainforest). The middle level contains the administrative offices and conference room, research offices and an exterior working courtyard. The lowest level contains a laboratory/classroom with seating for 40 people (see figures 4.3.5 and 4.3.6).

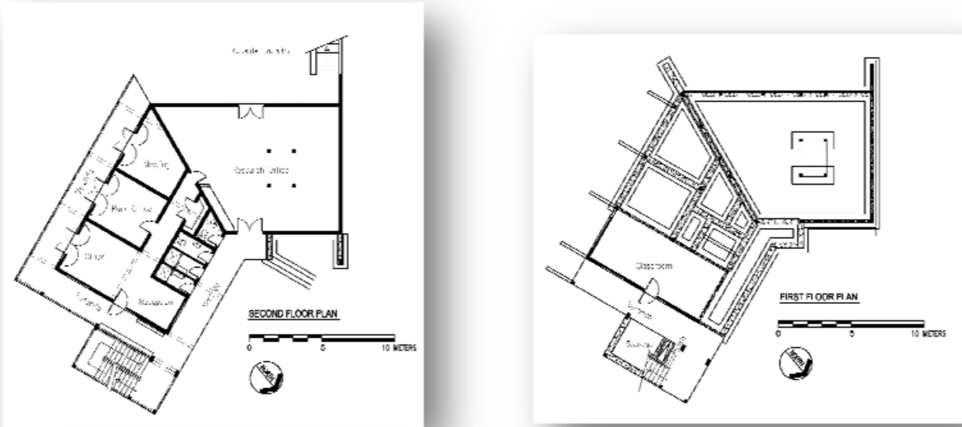


Figure 4.3.6 Madagascar: second and first floor plans of Centre ValBio. Source: Fieldwork.

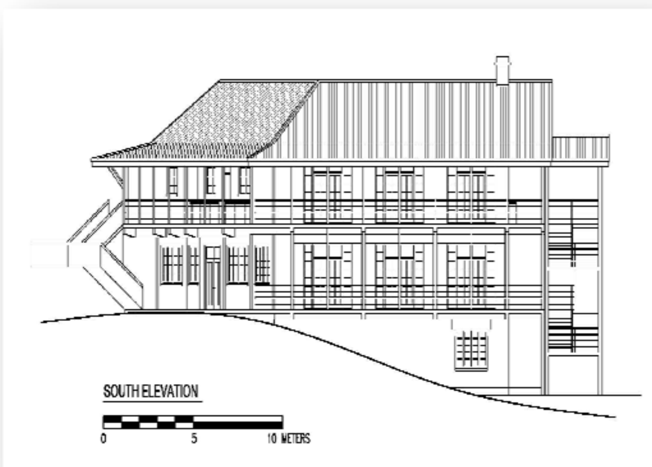


Figure 4.3.7 Madagascar: south elevation of Centre ValBio. Source: Fieldwork.

4.3.2 Environmental Strategies Employed

An initial strategy in the design of the Centre was to make use of an already impacted site at the perimeter of the national park instead of altering land within the boundaries of the park. The only access to the park is across a footbridge which has washed away before during the rainy season.

If the project site had been within the park, as some of the client group wanted, a larger and possibly vehicular bridge would have been needed for the full operation of the Centre, resulting in a much more severe impact on the park than even the temporary research cabins were having. In addition to having already been impacted, the selected site borders the national highway along which run the main power lines bringing electricity from the region's hydroelectric dam down to the southeast coast. Thus the site benefits from proximity to transport and utility infrastructure. There are also spring fed streams on two sides and the Namorona River on a third side of the site. An existing spring is tapped at the top of a hill across the highway from the site and the water piped down to a $30m^3$ concrete water tank at the top of the site. Another site-related strategy was to situate the buildings at the perimeter of the restricted site area to preserve the available open space at the center of the site. Preserving this open space expanded the amount of usable programmable space for the activities of the Centre since the mild climate allows various activities to occur in the outdoors. The topography and existing terraces of the steeply sloping site determined the building location and orientation. A turn-off from the main road and a vehicular entrance drive were necessary to gain access to the site both of which took up a good deal of the available site area.

Figure 4.3.8 - Madagascar: wide verandas surround the Centre ValBio. Source: Fieldwork.

The building has wide roof overhangs on all sides that protect the exterior walls from sun and rain. On the top level, this overhang serves to cover the unloading area on the side nearest the road. On the other sides, they cover the verandas that serve multiple functions. The use of covered verandas extends the indoor space as the verandas are used for a variety of activities: dining, work space, drying clothing, forest observation (see figures 4.3.8 and 4.3.9). They are also used for circulation between spaces instead of interior hallways which are more expensive and need light and ventilation. The covered verandas also encompass the exterior stairs. The use of the verandas and the change in roof pitch that they entail serve to tie the building to local architectural forms. Traditional highlands houses have steep pitched roofs with lower-pitched roofs over a covered veranda along one long side of the rectangular house. This form of covered veranda is a familiar building form to the inhabitants of the area as well as the users of the Centre.

Figure 4.3.9 - Madagascar: many uses of covered veranda space at the Centre ValBio. Source: Fieldwork.

The use of covered verandas for exterior circulation between spaces allows the interior spaces to extend from one side of the building to the other, and therefore to have windows on at least two sides which promotes natural through-ventilation and daylighting of interior spaces. Natural ventilation and daylighting are further promoted by high white ceilings and transom level windows (see figure 4.3.10).

Figure 4.3.10 - Madagascar: daylighting of dining / lecture space at the Center ValBio. Source: Fieldwork.

Locally-available building materials and labor were used to the extent possible. Materials were also chosen that would require no further finish and therefore would necessitate minimal maintenance. The granite stones were cut and transported from a nearby quarry. The bricks were made in rice paddies in the southern highlands some 50 kilometers (31 miles) from the site. Sand was available locally. The wood for the roof trusses is eucalyptus, an exotic species that grows from the stump once cut. It is widely used for firewood and is considered a weed. Once dried, it works well for trusses and can even be used for flooring.

In addition to the stone foundation and retaining walls and the brick interior and exterior walls, the suspended concrete floors made use of another building technology known and used in Madagascar since colonial times. This type of floor consists of baked clay ‘hourdi’ set in rows between reinforced concrete beams (see figure 4.3.11). This floor has better acoustic isolation properties than the usual reinforced concrete slab.

Figure 4.3.11 - Madagascar: hourdi type suspended concrete floor of the Centre ValBio. Source: Fieldwork.

The skilled labor came from the nearby southern highlands city of Fianarantsoa about 50 kilometers (31 miles) distant or from the capital city, Antananarivo, about 300 kilometers (186 miles) away. Extensive use was made of local labor for the unskilled labor needed. This type of construction is labor-intensive; at times there were more than 300 workers engaged at the site. This project had a significant positive impact on the local economy of Ranomafana during the construction and it continues through the training and employment of maintenance staff, cooks, local guides and research assistants for the work of the Centre.

Even though the site is in a rainforest, there are nevertheless, sunny days and a thermal solar system was installed to provide hot water to the extent possible (see figure 4.3.11). For days without adequate sunshine, a thermostatically-controlled electrical backup element is in the hot water storage tank.

The use of a turbine set into the adjacent Namorona River for power generation was considered at the outset of the project as an example of what could be done to generate local power. However, the reality of its cost coupled with location of overhead power lines at the edge of the site persuaded us not to use the limited project funds for this purpose.

Figure 4.3.12 - Madagascar: solar hot water heater with electric backup at the Centre ValBio in the rainforest of the eastern escarpment. Source: Fieldwork.

4.3.3 Details about the Building

The retaining walls, exterior stairs, roadways, parking areas, outdoor classroom and courtyards are made of granite blocks locally quarried and cut by hand. The retaining walls reach 25 feet in height and are more than 8 feet wide at their base. The retaining walls are of traditional colonial design requiring no steel reinforcing, using only their own weight and shape to resist the pressure of the earth behind them (see figure 4.3.3).

The building consists of a three level reinforced concrete frame with locally-quarried granite stone foundation walls and locally-burnt brick exterior and interior infill walls. The exterior face of the exterior walls is fair-faced, that is, jointed bricks, while the interior face has cement and lime plaster. The reinforced concrete frame is finished on the outside where visible, with cement plaster. Windows are French type (inswinging) casements made from locally-harvested varongy wood (see figure 4.3.13). There are site-built roof trusses of eucalyptus wood, an invasive introduced species that is widely used for firewood and is difficult to kill since it re-grows from the stump like a weed. Pre-painted galvanized metal roofing sheets are used for the roof, made from imported rolls of roofing sheet that are shaped and cut in Madagascar.

Figure 4.3.13 - Madagascar: inswing wood casement windows in the Centre ValBio. Source: Fieldwork.

The ground floor is of poured concrete on a gravel and rock substrate. The two elevated floors are made of bell-shaped hollow clay blocks called “hourdis” supported by reinforced concrete beams cast integrally over and in between the blocks. Interior finishes consist of locally-harvested pine wood ceilings, lime-cement plaster walls, Italian ceramic tile floors, French hardware on doors and windows and French plumbing fixtures – sinks, faucets, toilets, shower heads.

Water is channeled to the 30,000 liter reservoir at the top of the site from a spring-fed creek further up the slope of the surrounding mountains. From the reservoir, water is gravity-fed to the sinks, toilets and showers and exterior taps of the building. Sewage is handled on site by means of a septic tank with adjacent soakage pit for effluent. Electricity is taken from the national electrical grid that runs along the national highway at the top of the site. This electricity comes from a major hydroelectric dam further up the river.

4.3.4 Means of Project Delivery, Cost and Project Dates

A contractor based in the capital city, Antananarivo, was engaged after a bidding process with three bidders – one local to the area and two from Antananarivo. The site is 15 hours from Antananarivo by car with the roads sometimes impassable during the rainy season (see figure 4.3.14).

Figure 4.3.14 - Madagascar: main road to Centre ValBio in the rainy season. Source: Fieldwork.

The contractor brought skilled craftspeople from the capital city and also from the regional capital, Fianarantsoa, some three hours drive from the site. Unskilled labor was hired locally. The project was very labor-intensive with up to 300 workers working on the site at its busiest. As mentioned above, much cut granite was used throughout the project which was all quarried by hand. Owing to the difficulties of working with the steep terrain, concrete was brought to the formwork by means of shallow metal pans on laborers' heads from the central mixing area at the top of the site. Construction began in November of 2000 and was completed in January of 2003. Cost of the construction was 3,678,129,160 Malagasy Francs or about US$ 560,000.

In light of the importance of knowing and working within the local building culture, it is essential to have close local collaborators and good working relationships. For the Madagascar projects, I worked with a Malagasy consulting firm that consists of building engineers that helped me navigate the local conditions (see figure 4.3.15). While the working drawings and specifications were written in French, the de facto national language for technical matters, explanations and discussions took place in Malagasy, so the local building engineers' help was indispensable.

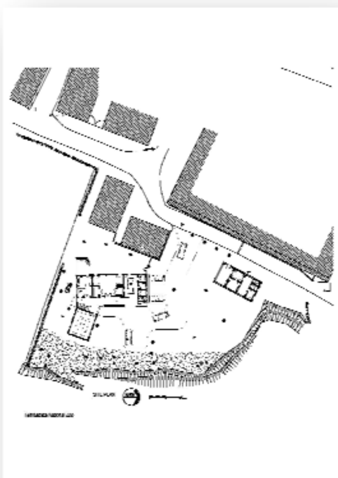
Figure 4.3.15 - Madagascar: local supervising engineer and building contractor for Centre ValBio. Source: Fieldwork.

4.4 Tsimbazaza Biodiversity Center - Antananarivo, Madagascar – 2003-2006

Figure 4.4.1 - Madagascar: Biodiversity Center built on a dump site among existing native trees. Source: Fieldwork.

4.4.1 Project Description

The Tzimbazaza Biodiversity Center is located adjacent to Tzimbazaza National Zoo in the center of the Malagasy capital, Antananarivo. It is operated by the Entomology Section of the California Academy of Sciences in San Francisco, California in collaboration with Tzimbazaza National Zoo. It is owned by the California Academy of Sciences with the stipulation that ownership conveys to the park after a set number of years. The Biodiversity Center houses the entomology museum and collections of the park. The exhibits serve as reference material for the other work of the Center: the classification of insects gathered from all over Madagascar through systematic field research that aims to study the insect life of the entire island.



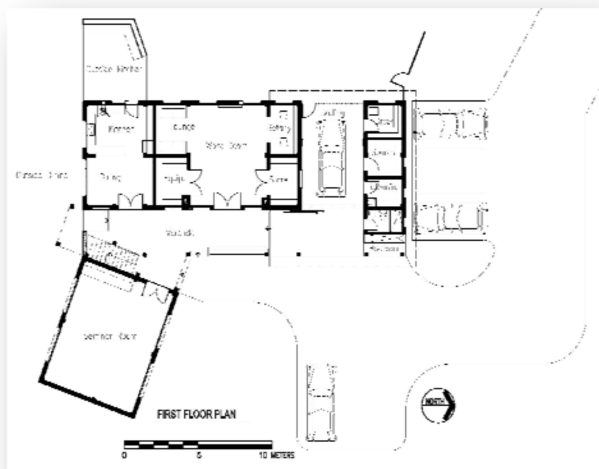


Figure 4.4.2 - Madagascar: site plan and first floor plan of Biodiversity Center. Source: Fieldwork.

The small site has an area of about 0.3 hectare (0.7 acre) and is located at the edge of the Zoo between it and the Ministry of Education in what was formerly a dumping ground and informal public toilet. Owing to the difficulty in procuring a suitable site within the confines of the park, this derelict site was selected, reclaimed and fenced with a brick wall. It contained a variety of native trees around which the building design was developed (see figure 4.4.1). The building has an enclosed area of 550 square meters (3,250 square feet) on three levels with another 185 square meters (2,000 square feet) of covered verandas and stairs. At the entry, the caretaker’s house has an area of 90 square meters (968 square feet) (see figures 4.4.3 and 4.4.4).

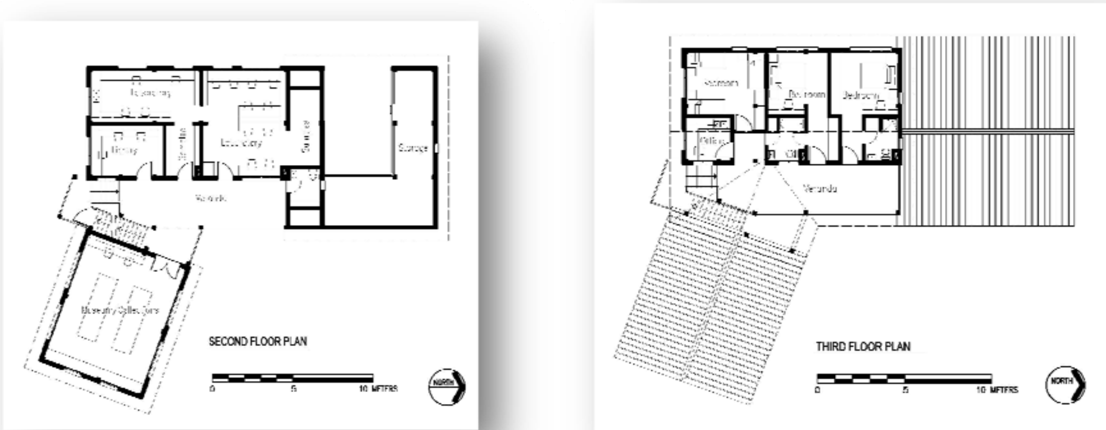


Figure 4.4.3 - Madagascar: second and third floor plans of Biodiversity Center. Source: Fieldwork.

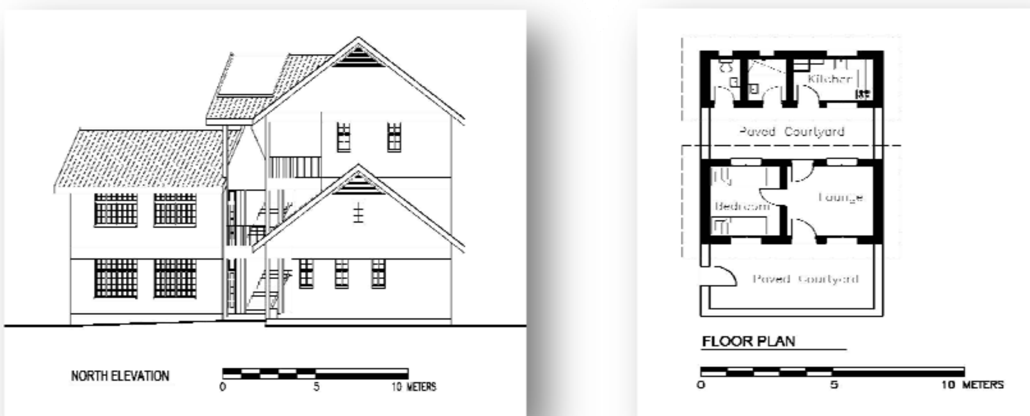


Figure 4.4.4 - Madagascar: north elevation of Biodiversity Center and plan of guard's house. Source: Fieldwork.

The three-story building has, on the ground floor, a large seminar room, a field preparation room with storage rooms, office and lounge giving off of it, a kitchen and dining area, a bay for loading and unloading the field vehicle. Off of the loading bay are store rooms, a drying room and staff bathroom. Above the loading bay and accessible from it is more open storage for tires and other field equipment. Also on the middle floor is the insect collections museum, sorting and categorizing laboratories, and a small office/library. The top floor contains an office, a bunk room, and two self-contained guest rooms for visiting researchers.

At the entry to the site is a small house for the site caretaker / guard and his family consisting of an entry courtyard and front building containing two rooms. Behind this building is a laundry and food preparation courtyard behind which is a rear building with kitchen, storeroom, shower and toilet (see figures 4.4.4 and 4.4.5).

Figure 4.4.5 - Madagascar: Caretaker's house at entry to Biodiversity Center site. Source: Fieldwork.

4.4.2 Environmental Strategies Employed

Reclaiming this neglected piece of property at the perimeter of the National Zoo allows the Biodiversity Center to be located where it needs to be – in close proximity to the National Zoo – while not taking up any of the valuable and jealously guarded real estate within the Zoo grounds. The site has water and electricity at the site since it is bordered on two sides by the grounds of the Ministry of Education. It also has a driveway that connects it to a main road of this part of the city. The component buildings of the Biodiversity Center are sited at the perimeter of the site to maximize the open space of this small site. The open space is needed for parking, a barbecue area, gardens and for spreading out and cleaning off all the tarps and equipment used on the frequent bug-hunting expeditions to remote areas of the island (see figure 4.4.6).

Figure 4.4.6 - Madagascar: Central open space at the Biodiversity Center site. Source: Fieldwork.

The three-story main building makes use of covered verandas for exterior circulation between rooms and to augment the interior spaces. The wide covered verandas are used as impromptu meeting space, for additional workspace and dining space (see figure 4.4.7). The stairs are also located off of the covered verandas to minimize the more expensive interior space.

Figure 4.4.7 - Madagascar: Covered verandas for exterior circulation and auxiliary program space at the Biodiversity Center. Source: Fieldwork.

The exterior circulation allows interior spaces to have windows on opposing exterior walls thus promoting natural cross-ventilation and daylighting. High white ceilings and high large windows also help. Wide overhangs protect the exterior walls from sun and rain. The covered verandas, steep gable roofs, pointed brick walls and stone foundations recall traditional and colonial Malagasy architecture.

Locally-available building materials were used to the extent possible. Granite came from nearby quarries. Bricks were made in nearby rice paddies. Sand and wood were available near to the city. Metal roofing sheets were shaped and cut in Madagascar from imported pre-painted galvanized roll stock. Pointed brick and stone were used to minimize painted surfaces and their maintenance. Labor for the project came from the surrounding capital city. Rolling galvanized shutters on ground floor openings, horizontal bars on windows at upper verandahs and a steel gate at the bottom of the exterior stairs provide security from theft (see figure 4.4.8).

Solar panels for domestic hot water were planned initially, but their cost turned out to be so much more than electric hot water heaters, that the idea was abandoned since the budget for construction was very tight.

Figure 4.4.8 - Madagascar: rolling steel shutters on ground floor windows for security at the Tsimbazaza Biodiversity Center. Source: Fieldwork.

4.4.3 Details about the Building

The building construction type and materials are similar to the Centre ValBio in Ranomafana – a three story reinforced concrete frame with burnt brick infill walls exterior and interior. In the case of the Biodiversity Center, the reinforced concrete frame is not visible from the outside, being covered by the exterior brick walls. The building has locally-quarried granite stone foundation walls and parking areas. The exterior face of the exterior walls is fair-faced. The interior face and the other interior walls have cement and lime plaster finish.

Figure 4.4.9 - Madagascar: 'hourdis' stacked up for use in the floor of the Biodiversity Center. Source: Fieldwork.

Windows are inswinging casements made from locally-harvested varongy wood. The ground floor windows have rolling galvanized steel security shutters. The roof trusses were built on site of eucalyptus wood. The roof is of prepainted galvanized metal roofing sheets made from imported rolls of roofing sheet that were shaped and cut in Madagascar. The ground floor is of poured concrete on a gravel and rock substrate with terrazzo tile flooring. The two elevated floors were made of bell-shaped hollow clay blocks called 'hourdis' supported by reinforced concrete beams cast integrally over and in between the blocks (see figure 4.4.9).

Figure 4.4.10 - Madagascar: Terrazzo tile on first floor and ceramic tile on third floor of the Biodiversity Center. Source: Fieldwork.

The finished floor is locally fabricated terrazzo tiles on the first and second floors and imported ceramic tiles on the third floor (see figures 4.4.10). The ceilings of the top floor are of locally-harvested pine from a forest plantation. The door and window hardware are of French manufacture as are the plumbing fixtures – sinks, faucets, toilets, and shower heads.

Figure 4.4.11 - Madagascar: Outdoor cooking and laundry area at the Biodiversity Center. Source: Fieldwork.

Electricity and water come from the city supplies available at the site. Sewage is treated on site in a septic tank and soakage pit behind the building. There is an exterior cooking and laundry area as well as an exterior dining area with barbecue facilities (see figure 4.4.11).

4.4.4 Means of Project Delivery, Cost and Project Dates

Two Malagasy building contractors in the capital city known to the design team were invited to bid on the project. The lowest bidder was selected for the construction of the building. Skilled and unskilled labor came from the surrounding areas of the capital city. The same Malagasy consultants assisted on this project as with the previous Centre ValBio. Continuity and shared understanding and expectations regarding quality were important in getting a good finished product. Construction began in November of 2004 and was completed in March 2006. Cost of the construction was 553,110,818 Malagasy Ariary or about US$ 300,000.

4.5 Guest House and Conference Center – Dodoma, Tanzania – 2003-2004

Figure 4.5.1 - Tanzania: view of Guest House/ Conference Center from street in front. Source: Fieldwork.

4.5.1 Project Description

This building for the non-governmental organization Dodoma Tanzania Health Development (DTHD) and the Central Diocese of the Evangelical Lutheran Church in Tanzania (ELCT) is used for short-term staff housing and as a small conference center (see figure 4.5.1). It is located on a small site of 0.25 hectare (0.6 acre) in the suburbs of Dodoma. The site already contained the diocese' 10 room guest house. The Guest House / Conference Center is intended for use as housing for short-term medical personnel that come from overseas to work for one to six months at the nearby referral hospital – Dodoma Christian Medical Center (DCMC) built and run by DTHD. It also serves as a small conference facility for both partners. The building has a surface area of 380 square meters (4,100 square feet) enclosed on its two levels with another 105 square meters (1,100 square feet) of covered areas and stairs.

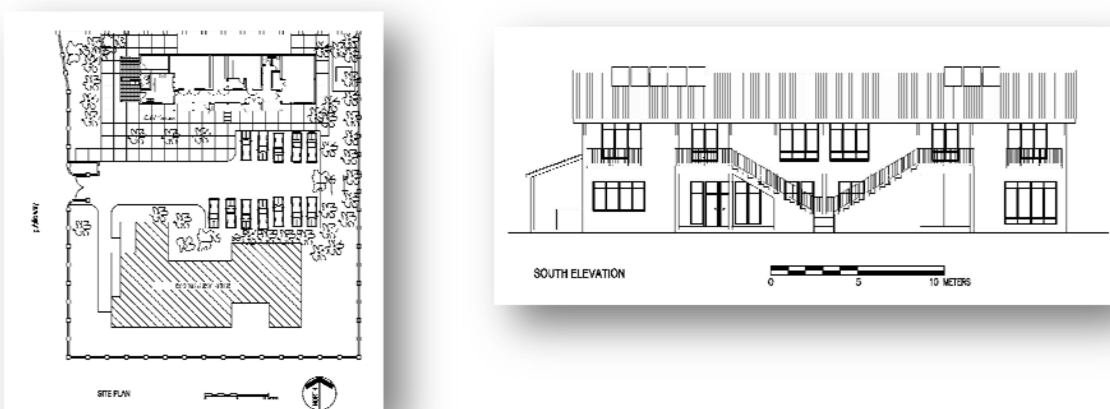
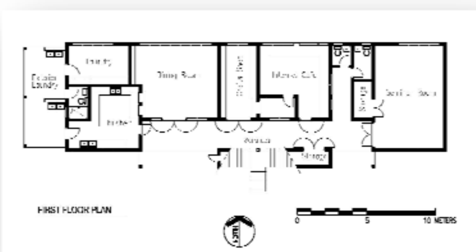


Figure 4.5.2 - Tanzania: site plan and south elevation of Guest House / Conference Center. Source: Fieldwork.

There are four one-bedroom apartments on the upper level accessed by an exterior terrazzo stair. The two end apartments are a bit larger than the middle ones containing balconies and small eating areas. The middle two apartments have a communicating door that can transform them into a studio and a two-bedroom apartment if need be. On the lower level there is a conference room with seating for 35, an internet café, a crafts shop, a dining room for 24 with adjacent kitchen and laundry facilities, both of which also have an exterior covered work area. There is also an outside laundry drying area. Also outside is a dining patio next to the kitchen. Between the new building and the existing guest house is a new parking area with concrete pavers. (see figures 4.5.2, 4.5.3 and 4.5.4)

Figure 4.5.3 - Tanzania: central courtyard created at the Guest House/Conference. Source: Fieldwork.



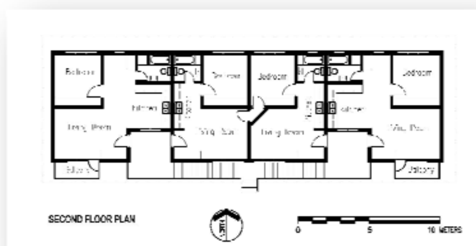


Figure 4.5.4 - Tanzania: first and second floor plans of Guest House / Conference Center. Source: Fieldwork

4.5.2 Environmental Strategies Employed

The intention was to maximize the existing 0.25 hectare site already owned and used by the Diocese. The site was already serviced by utilities and transport infrastructure. It had municipal water and electricity as well as a dirt road in front of the gate. The almost square site is aligned with the compass points. The rectangular building was laid out along the east-west axis against the northern perimeter wall with all windows facing north and south in order to minimize solar incidence on walls and penetration into the building. There are no openings in the east elevation and the doors and window in the west elevation are shaded by a wide roof over the adjacent exterior cooking and laundry area. This east-west orientation along with the site's location at 6 degrees south latitude means that the sun stays pretty much directly overhead during the day. An open space was left in the site between the existing guest house along the south wall and the new building along the north wall of the site. This open space extends from the eastern entrance gate to the western back perimeter wall and serves as parking, garden and outdoor dining area, making the site feel as large as possible (see figure 4.5.3).

The stairs to the guest apartments upstairs are on the outside to minimize enclosed finished interior space. Similarly on the ground floor, circulation between interior spaces occurs by means of an exterior hallway that minimizes interior finished space and allows the interior spaces to have windows on opposite exterior walls for daylighting and natural ventilation. The high white ceilings and large north and south-facing windows serve to maximize daylighting and natural ventilation. Wide overhangs keep the rain off the exterior walls and minimize the sun hitting the exterior walls.

Figure 4.5.5 - Tanzania: north-facing thermal solar panels and gravity tank on 8 meter high metal stand at Guest House / Conference Center. Source: Fieldwork.

Thermal solar panels are situated on the north-facing slope of the roof for maximum solar exposure. Hot water storage tanks located in the attic space have electric back-up heating elements for cloudy days. The municipal water supply is only intermittently available and then, only at a low pressure. To supplement this inadequate supply, rainwater is collected by means of gutters and downspouts and stored in an underground storage tank and subsequently pumped as needed to a 8 meter (26 foot) high storage tank that provides gravity feed to the building (see figure 4.5.5).

Locally-available building materials were used throughout. Solid concrete blocks were made on site or nearby in a manual steel block-making machine. The blocks were left to cure before use in foundations and exterior and interior walls. They were finished on the exterior with a cement plaster and on the interior surface with a lime/cement plaster and painted. Unfortunately, the cement plaster exterior was also painted which is the typical exterior finish. The problem is that, although the paint is of good quality, it only looks good for several years before requiring re-painting which is usually beyond the financial reach of local institutions. The alternative of leaving the cement plaster without paint is also done but the resulting grey is not very attractive. Another alternative to painting cement plaster is to color the cement plaster with iron oxide to give it a rust color and then to spray it onto the wall. The result is at least more attractive than the cement plaster which is not saying much. Local labor was used for the unskilled labor while skilled labor came from the main coastal city, Dar-es-Salaam, about 460 kilometers (286 miles) to the east. Horizontal bars on ground floor windows and rolling steel grilles at entries are used for security from theft (see figure 4.5.6).

Figure 4.5.6 - Tanzania: security bars and grilles at the Guest House / Conference Center. Source: Fieldwork.

4.5.3 Details about the Building

The building is a two-story reinforced concrete frame structure with solid concrete block exterior and interior infill walls. The walls are finished on the exterior with painted cement plaster and on the interior with lime cement plaster. The main floor is concrete slab-on-grade while the upper floor is a 6” thick reinforced concrete slab. The floors throughout are finished with cast-in-place terrazzo (see figure 4.5.7). The upper level ceilings are of gypsum wallboard.

Figure 4.5.7 - Tanzania: seminar room of the Guest House/Conference. Source: Fieldwork.

The sliding windows throughout and the storefront doors to dining, conference room and internet café are of aluminum and glass. The aluminum profiles come from Dubai and are cut and assembled in Dar es Salaam into doors and windows. Other doors are solid wood made of 2x6's. The electrical and plumbing fixtures are either of English manufacture for the most part with some Indian or Chinese manufactured goods as well. The building is connected to the municipal water and electricity supplies while the sewage is treated in a septic tank on site. Since the municipal water supply is intermittently available, there is an in-ground water tank as well as an elevated water tank to get gravity-fed water. The rain gutters connect to the in-ground tank from which an electric pump conveys the water to the elevated tank.

4.5.4 Means of Project Delivery, Cost and Project Dates

Three building contractors based in Dar es Salaam were invited to bid on the project. Two were Chinese companies and one was a Sikh-owned Tanzanian company. We were unable to identify a reliable indigenous-owned building contractor and also unable to identify any reliable building contractor in Dodoma. The Sikh-owned enterprise gave the most competitive bid. Their skilled labor and project manager came from Dar es Salaam, a five hour drive from the site. Unskilled labor was hired from the surrounding area. For projects in Tanzania, I partnered with a local architecture and engineering firm whose participation gave me valuable insight into the local building culture (see figure 4.5.8). Construction began in March of 2004 and was completed in December of the same year. Cost of construction was 242,500,000 Tanzanian Shillings or about US$ 220,000.

Figure 4.5.8 - Tanzania: partnership with local architects helps to navigate local building culture which included the Sikh building contractor. Source: Fieldwork.

4.6 Summary of Sustainability Strategies in the Case Study Buildings

As described above, the three case study buildings incorporate a variety of sustainable design and construction features, some of which correspond to green building rating system criteria and some of which do not. The strategies corresponding approximately to LEED criteria are:

Sustainable Sites

- Use of brownfield contaminated type of site
- Use of previously impacted site – preserving sites in their natural state
- Choose site near to existing transport and utilities infrastructure
- Maximizing open space on the site
- Retaining natural features on site

Water Efficiency

- Rainwater collection for re-use
- Capturing spring water for storage and use

Energy and Atmosphere

- Roof-mounted thermal solar hot water panels

- Ceiling fans and windows are the only cooling systems used

Materials and Resources
- Use of locally available materials: wood, brick, stone
- Close to 100% spontaneous recycling of construction waste

Indoor Environmental Quality
- Larger and higher windows to maximize daylighting

The following strategies used are similar to criteria found in the BREEAM and Estidama Pearl green building rating systems:

- Use of low maintenance materials such as brick and stone
- Controlled access for security
- Security measures such as steel grilles and steel shutters to prevent theft

These following sustainability strategies were employed in the case study buildings. However, they are not found in the green building rating systems reviewed:

- Use of locally available labor
- Use of labor-intensive building methods
- Use of covered verandas for exterior circulation in place of interior hallways
- Use of familiar building techniques (for economy of construction & ease of maintenance)
- Use of familiar building forms that relate to traditional architecture
- High ceilings to maximize natural ventilation
- Interior spaces with opposing doors/windows for natural ventilation.
- Building orientation to minimize solar penetration
- Wide roof overhangs to minimize sun and rain on walls.

Some sustainable features were considered in the case study buildings but not implemented usually for reasons of cost or availability. For example, photovoltaic (PV) solar panels were too expensive with too long of a payback period. Maintenance of a photovoltaic system was also seen to be problematic due to the lack of qualified technicians to service such systems. Security to safeguard the system components from theft seemed to be a problem after experiences with theft of PV panels at a different site. A water-powered turbine was considered for the site of the Centre ValBio located adjacent to the Namorona River, but it was found to be prohibitively expensive since electricity from the hydroelectric dam up the river was available overhead.

Chapter 5 Green Building Rating Systems, Tanzania and Madagascar

5.1 Green Building Rating Systems and the Context for which They Were Created

The present research examines specific buildings in the developing country context to evaluate the relevance of the United States Green Building Council's (USGBC) green building rating system called Leadership in Energy and Environmental Design (LEED) – the predominant one used in the U.S. – that makes claims for universal applicability. In order to evaluate applicability of developed world green building rating systems in the context of developing countries such as Madagascar and Tanzania, a first step is to identify the assumptions that underpin the rating system, including the understanding and definition of sustainability.

What assumptions are made about the context for which the given rating system has been developed? For example, the requirement for building commissioning – the testing and calibrating of a building's systems, usually mechanical systems – assumes both that such mechanical systems are used in the building, and that a number of professionals are qualified and available to perform such building commissioning. Another example is the reference in the LEED rating system to energy performance requirements and heating, cooling and ventilating standards developed by a separate national organization, the American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE). The assumption is that the referenced energy standards have relevance to the building and context in which the rating system is being applied. A third example is the requirement for the use of materials that are manufactured to certain specified energy and material criteria, which assumes that there is a certain range of building materials available from which to select the most appropriate – be it low energy or sustainably harvested. The definition of sustainability, implicit or explicit in the documentation found in the USGBC and the British Research Enterprises Environmental Assessment Method (BREEAM), sees the most critical issue as that of reducing energy use and CO2 emissions.[92]

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[92] USGBC. 2009. *USGBC Facts*. http:// www.usgbc.org (retrieved 21 January 2010).

Other critical issues identified by the USGBC include depletion of resources and promotion of human health.

By contrast, sustainability in the developing country context such as that of Madagascar and Tanzania puts energy independence very close to the top of critical issues because reliable energy sources are not usually available, and the costs associated with energy are already relatively very high. In the developed country context, energy is cheaper[93] and more reliably available, so energy independence is not at the top of the list of sustainability concerns. For these reasons, in the US and other of the more developed economies, alternative energies still cannot compete with established grid energy sources since the payback is unacceptably long for the investment incurred.[94] Another important assumption to identify is that the client, for which a given building is being built to green building standards, has the means to maintain and monitor its building. Certain of the LEED credits refer to extensive evaluation and monitoring periods which are not likely to be feasible in a context of clients with extremely limited resources.

BREEAM was introduced in 1990 in Great Britain and is widely in use there. It does not promote the use of the BREEAM system as developed for GB outside of GB. For areas outside of GB, they have developed modified versions of the rating system that are particular to the region in question, for example, the Gulf region and for continental Europe. Similarly, the Australian Green Star rating system does not sanction use of its system outside of Australia, but encourages regions to develop their own standard based on the Green Star rating system. In November of 2008, the South African Green Building Council adopted the Green Star South Africa rating system, having modified certain of the Australian criteria to fit more closely the South African context primarily with respect to referenced standards, but without reference to substantive sustainability issues found in the developing country context. Despite its location in sub-Saharan Africa, the Green Star South Africa rating system is primarily aimed at urban high

[93] The lowest rate in the U.S. in 2008 with per capita income of $15,000 was in West Virginia with $0.0718 per kilowatt hour (KWH), while the highest was in Hawaii with $0.3499 per KWH. New York was the second highest state with $0.1975 per KWH. (http://cityroom.blogs.nytimes.com/2008/11/17/some-relief-seen-on-electric-rates/ - retrieved 19 March 2010) In Dar-es-Salaam, Tanzania, with a per capita income of $350, electricity presently costs about $0.1039 per kilowatt hour. In Madagascar with a per capita income of $250, electricity costs about $0.2483 per KWH in Antananarivo.

[94] Average payback for a photovoltaic system in Virginia is about 10 years if no government subsidy is available.

rise buildings, and office buildings, in particular. There is an assumption of significant energy use in cooling and ventilating buildings. [95] In other words, it seems to be intended for more of a developed world context.

The USGBC's LEED rating system has been used extensively as it was developed in the US, for projects outside of the US. There is an understandable desire to have a single rating system that would allow projects in different locations to be compared. This is of particular interest to transnational companies with operations in various countries who would like to make comparisons of the environmental performance of their facilities across national and climatic boundaries. As of November 2008, 475 buildings outside of the United States have been registered – that is, they have committed to attempting LEED certification. As of November 2008, 59 buildings have been LEED-certified outside of the U.S. and Canada. Of these, 23 are in India and 15 are in China.[96]

The following analysis will take as its starting point the LEED rating system and its categories, since it is a major green building rating system that makes a claim to universal applicability, and is used to evaluate buildings outside of the U.S. Up to now the USGBC has not formalized an attempt to adapt to conditions and context outside of the U.S., despite its considerable use beyond the borders of the U.S. The LEED green building rating system is also of interest because of the manner in which it has been adapted for various building types. This offers a model on how green building in the developing country context could be incorporated into a major green building rating system as a separate building type, while still acknowledging the unique opportunities and constraints of that context.

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[95] The South African Green Star makes extensive reference to HVAC systems. While these are indeed a large consumer of energy, many of the buildings in South Africa will not have this kind of energy-intensive mechanical system.

[96] USGBC. *Projects Listing*. http://www.usgbc.org/LEED/Project/CertifiedProjectList.aspx. (retrieved 11 October 2009).

5.2 Green Building Rating Criteria and the Contexts of Tanzania and Madagascar

In the context of the most industrialized countries, green building is generally about reducing energy and resource use to a minimum in order to conserve rapidly depleting resources and to curb CO_2 emissions. While this is of global importance, the energy and resource use situation in some developing countries is quite different than that of more economically developed countries. In many developing country contexts, the changes brought on by the Industrial Revolution, particularly since the 19^{th} century, have not yet been widely felt. Energy and resource use is, correspondingly, quite modest. Energy use in buildings in Madagascar and Tanzania is extremely low already in comparison to that of more developed countries. A significant portion of energy use in the US context is related to the heating, ventilating and cooling systems. In Madagascar and Tanzania, doors and windows fulfill these functions with ceiling fans being typically the highest technology mechanical device used. Some air conditioning is found in the form of split systems with a wall-mounted air-handling unit and remote condenser but that is more prevalent in government offices and tourist hotels.

In such a context, it is difficult to make the case for reduced energy and resource use when the use is already so small. So in that context, what does green building represent? If, in the US and European contexts, green building means reducing energy and resource use, what does it mean in a developing country context where many buildings have limited electricity and running water and were built already with mostly locally available materials? What does green building mean in a place where recycling is a fact of daily life simply owing to the poverty of the inhabitants? Are they already green?

In developing green building rating criteria for the developing country context of countries like Madagascar and Tanzania, it is important to build on what is already present in traditional and colonial building. Traditional buildings were always, and still are, sustainable. They are already green, being built from the most local of building materials which are mostly renewable. The traditional building forms are adapted to the climate and reflect the culture of their users since millennia. The colonial building also was adapted to climate by necessity, and the production of building materials for colonial building, while not indigenous, was instituted by the colonial authorities to supply the local colonial building market. Green building rating criteria for the developing country context must include and build on these traditions of sustainability.

Utilities infrastructure of electricity, water and, in some cases, sewer in urban areas of Tanzania and Madagascar were usually built in the colonial period. Improvements necessary to such infrastructure have not kept pace with rapid urban growth due to rising birth rates and rural-to-urban migration. The electrical grid, water supply and sewers are used beyond their capacity with residents often tapping the utilities illegally. As a result, the services are unreliable and prone to disruption. Electricity in countries such as Tanzania and Madagascar is most often powered by diesel generators. The electricity is not 100% reliable even in the major cities. It is not always available, and there is a significant swing in the voltage delivered. It is also very expensive compared to the buying power of the local inhabitants. Due to the relatively high cost of electricity and its intermittent availability, the aspect of green building that focuses on renewable locally available energy is of particular importance in the developing country context. Rainwater collection, water conservation and greywater re-use are similarly very important in that context.

Another critical issue for sustainability is the availability of skilled labor to build in the first place, and then to perform the required maintenance and replacement. It is important that the local context in which a building is inserted have the labor capacity to maintain the building in order for it to be sustainable. For reasons of economic sustainability, it is also important that a building be built using locally available expertise to the extent possible. If that expertise is not available, a training component can be made part of the building project to train local labor in the construction and eventual maintenance of the building and others like it.

Maintenance of buildings is a major concern in the developing country contexts of Tanzania and Madagascar. When institutions are chronically underfunded, there is simply no budget for maintenance and repairs are only done on a crisis basis. DANIDA, the development arm of the Danish government, recognized the importance of preventive maintenance, and building maintenance generally, in extending the life expectancy and life-cycle cost of buildings of the Tanzanian government. With DANIDA's help, the Tanzanian government instituted a program of training for building maintenance in the Ministry of Education.[97] These concerns raise issues of the expected life cycle and maintenance requirements for selected building materials and systems. Durable and easily maintainable building materials and equipment are especially important for sustainability in the developing country context.

Examples of critically important issues to green building in the more developed countries that are not so crucial in the developing country context of Tanzania and Madagascar are indoor air quality and lowered energy use. Indoor air quality has its own whole section of the LEED green rating criteria. It has built-in references to norms developed by US professional organizations governing the number of air changes per hour among other criteria. The attention paid to the presence of volatile compounds in paint, stains and joint sealants reflects the fact that people in these contexts typically spend 90% of their time indoors in climate-controlled environments.[98] This is not the case in Tanzania and Madagascar, where people spend a good deal of their time out of doors, and when inside, are not in climate-controlled spaces, but rather, spaces that are enclosed loosely by doors and windows and other openings whose function is not primarily to isolate the interior from the exterior climate.

The following are salient aspects of a developing country context that differentiate it from that of developed countries and that need to be addressed for sustainability to work there:

- Security – no reliable police presence so deterrence is important and security relies on social accountability
- Minimize needed maintenance due to limited financial and human resources
- People live and work outdoors. Exterior space should be incorporated into the needed program space.
- Indoor environment is not so very different from the outdoors. Passive means of moderating climatic extremes are mostly adequate, such as appropriate building orientation, use of roof overhangs to shade exterior walls, promotion of natural cross-ventilation of interior spaces through judicious placement of openings, and the maintenance of adequate ceiling height (such as 10 feet (3 meters)) to allow for stratification of warmer air.

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[97] Together with DANIDA, Tanzania's Ministry of Education set up a program to train staff in basic building maintenance procedures and repairs. As part of that program, they published a manual in both Swahili and English for use in Tanzanian public schools. See Ministry of Education. 1985. *General Maintenance Manual*. Dar es Salaam: Ministry of Education.

[98] USGBC. 2008. *LEED for Homes Reference Guide*. Washington D.C.: USGBC. p. 269.

- Incorporate local building culture as manifest in local building practices
- Build on availability, skill and expertise of local labor
- Due to endemic high unemployment, give priority to labor-intensive building materials and techniques
- Consider access from the project site to manufacturing centers and sources of building materials
- Availability of transportation and infrastructure at project site
- Control and reduction of dust in the dry season and stormwater in the rainy season

5.3 LEED Green Building Rating Criteria in Light of the Case Studies

The LEED criteria are selected as the starting point for this analysis because the USGBC is the only one of the major green building organizations that makes the claim to universal applicability. The LEED criteria are already being used in projects in over 35 countries outside of the U.S., among them India, China, Sri Lanka, Costa Rica and Rwanda. Other green building rating systems, such as BREEAM and Green Star, clearly state that a separate rating system should be developed to assess the sustainability of a given building with respect to its particular regional, cultural and climatic context.

Throughout the LEED point system, references are made to standards developed for use in the US context, such as the standards for use of water and electricity. Each of these instances needs review and assessment of their relevance to the developing country context. Such referenced standards typically refer to a much higher level of consumption than is the norm in countries such as Tanzania and Madagascar. To make the criteria relevant, these standards need to be rethought. While it is not bad that the green building criteria would, in effect, give credit to buildings in the developing country context for their already meager use of water and energy, it would be more helpful to the goal of sustainability, if the criteria were to provide guidance in water and energy use, among others, relevant to the developing country contexts of Tanzania and Madagascar (hereinafter referred to as the DCCTM).

The following analysis consists of a description of each of the LEED criteria and their relevance to the case study buildings. Following the criteria title for each of the subsections is the criterion reference number in the LEED rating system. This review of the relevance of the LEED criteria is followed by a description of selected criteria from other green building rating systems that have relevance to the DCCTM.

5.3.1 Building Site Selection including Transportation Aspects

The choice of the building site is as critical to the sustainability of a building project in the developing country contexts such as that of Tanzania and Madagascar, as it is in more economically developed countries. Since environmental regulations in Tanzania and Madagascar are few and not stringently enforced, it is important that each building project that would strive to be sustainable and environmentally sensitive, address the issues of how best to insert itself into the environment with minimum disruption and in fact, to do so in a manner that would result in the building being a net positive for the area of the project site.

The control and use of stormwater runoff and the careful disposal of waste products – sewage and trash – from the site is of critical importance when the stormwater and waste disposal infrastructure are limited, if they exist at all. As in more economically developed countries, sites should be privileged that already have utility and transport infrastructure nearby. Such infrastructure will be on a different scale, and will be in need of upkeep and repair in the developing country context. The rating criteria should accommodate these differences. For example, transport infrastructure would most likely mean that there exists adjacent or near to the site a public road. That alone is already a significant positive attribute of a potential site because transport and utilities infrastructures are scarce. Access to public transport near to the site might be evident only by the proximity of private mini-van routes since there is usually little else that serves as public transport in many developing countries.

5.3.1.1 Construction Activity Pollution Prevention (SS Prerequisite 1)

An erosion and sedimentation control plan for every project is required by LEED in order to minimize degradation of the site and surrounding areas as a result of construction activities. Something of this kind can be reasonably expected of construction projects in developing countries such as Madagascar and Tanzania. It is a good idea to institutionalize thinking about the impact that construction activities have on a site and its surroundings and the fact that potentially negative impacts can be minimized or controlled. However, this criterion is based on U.S. Environmental Protection Agency (EPA) standards or local standards or codes, whichever is more stringent. It is very likely that there are no such codes locally, and conforming to US requirements would very likely be difficult for the developing country context (hereinafter referred to as the DCC), particularly since there is no government agency to review reports of inspections and other requirements of the EPA regulations.

5.3.1.2 **Site Selection** (SS Credit 1)

Parameters for the selection of building sites are given, such that sites not be located in environmentally sensitive areas. This is relevant and helpful to the developing country context. There is considerable environmental degradation owing to deforestation, slash-and-burn agriculture and lack of regulations and enforcement among other pressures.[99] It is important to consider these kinds of criteria when selecting a building site to steer clear of areas that are too sensitive or too damaged.

Figure 5.3.1 - Madagascar: original site of the Centre ValBio was within the national park. Source: Fieldwork

[99] See, for example, the Madagascar Environmental Threats and Opportunities Assessment 2008 Update by the Biodiversity Analysis and Technical Support Team of USAID - http://pdf.usaid.gov/pdf_docs/PNADL907.pdf (retrieved 21 April 2010).

In the case of the Centre ValBio in Ranomafana, Madagascar (see Chapter 4, Section 4.3), the client initially favored a project site quite a ways inside the 43,500 hectare (108,000 acre) national park that is accessible only by a single pedestrian bridge (see figure 5.3.1). The client's research took place within the park and their temporary research facilities were also located there. After review and discussion, it was decided that the impact of the new Centre ValBio on the park would be too detrimental and that it would be best to seek a site outside the park and near to the national highway.

The category of building sites addresses the choice of land for use in building. It involves both the current use of that land, and its former use, giving preference to land that is already used for building activities, and to land that has been already impacted by some sort of industrial or other detrimental use. The intention is to preserve open and fertile land to the extent possible. This strategy is just as important in the developing country context where arable land is often at a premium owing to population pressures, as well as cultural practices, such as the dividing of inherited land among children, resulting in ever smaller pieces of land available for farming.

Definitions of appropriate land for development refer to US Department of Agriculture definitions of prime farmland, US Code of Federal Regulations definition of wetlands and the US Clean Water Act of 1977. The intent of these various regulations would have to be studied and adapted to the DCC. For example, it would not be generally desirable to take land out of food production for a building site as was done in the case of the Centre ValBio. In that case, there was no other impacted site available for the development of the Centre and the only other option was to locate the Centre in the Park.

5.3.1.3 Development Density & Community Connectivity (SS Credit 2)

This criterion has to do with the immediate vicinity of a proposed project. It addresses the density of the resulting community and the proximity of the proposed project to goods and services. There are two paths indicated to achieve this point: building in a high-density existing community or near to an existing dense residential area with at least 10 community services located nearby and accessible to the public on foot.

This is as important in the DCC as in more economically-developed countries. An important difference, though, would be the definition of community services. Fitness centers, museums, and fire stations may be difficult to find nearby in the DCC, but open-air markets, bicycle repair, tailors and auto mechanics could very well be (see figure 5.3.2). The requirement also stipulates only one of each of the listed community services can be counted with the exception of restaurants, of which two can be counted. One would have to look at the context for what would be appropriate. A lot of small shops sell similar items in towns in Madagascar and Tanzania and are located next to each other. Since there is a variety of merchandise available in them, more than one or two should be allowed to count for the community services. The Biodiversity Center in Antananarivo, Madagascar (See Chapter 4, Section 4.4) is located in a densely populated area in the center of Antananarivo and would qualify under an adapted version of this criterion that would take into account the types of shops and services available nearby.

Figure 5.3.2 - Madagascar: commerce along a typical street in central Antananarivo. Source: Fieldwork.

Another aspect of Site Selection that is important in the developing country context is the role a proposed structure can play with respect to its neighbors. A sustainable project in the DCC will have upstream and downstream positive impacts, such as job creation, the provision of needed services, and the addition of needed infrastructure to the area. Some of the questions to ask are: What does the project bring to the local community that is beneficial to it? Are there educational components? What job opportunities does the project bring? Does the project offer services to the community? For example, if the project produces electricity, can it make some available for sale to the community? Can it offer potable water for sale to the community? Such integration of and contribution to the local community adds to the project's sustainability in that community. Building in an already developed community also lowers the relative cost of infrastructure since its cost can be shared between the buildings of the community.

5.3.1.4 **Brownfield Redevelopment** (SS Credit 3)

In the absence of meaningful environmental regulations in the DCCTM, there are industrial and other sites that have been used and left in their polluted states. While brownfield remediation can be an expensive undertaking, it would be worthwhile to consider what it would take to reclaim, remediate and re-use industrial and other impacted sites, and thereby to encourage their re-integration into the healthy life of the community. Extensive and expensive remediation of highly polluted sites may well be beyond the means available to projects in the developing country context. Nevertheless, modalities could be developed to show people what is possible to be done. Perhaps a range of interventions could be developed to deal with the results of pollution from mild to severely impacted sites.

The LEED rating system refers to ASTM Environmental Site Assessment protocols and U.S. EPA regulations. Appropriate standards would have to be researched for use in determining parameters for this point in the DCC.

The brownfield redevelopment idea can be expanded to include sites that are marginalized or not desirable for various reasons. In the case of the Tsimbazaza Biodiversity Center in Antananarivo, Madagascar, the site was a leftover one at the edge of the national zoo.

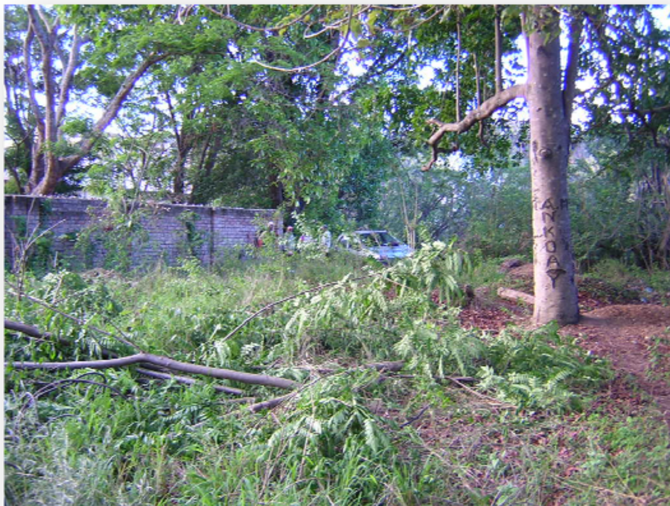

Figure 5.3.3 - Madagascar: site of the Biodiversity Center was a dump and informal public toilet. Source: Fieldwork.

It was considered without value owing to its location behind an automobile warehouse and was used as a dump and public toilet (see figure 5.3.3). Making use of this derelict site in the center of the capital city adjacent to the national zoo is a good example of an appropriate site selection where the result is a net positive for the area since very few of the existing trees were removed and more were planted. The resources of the National Zoo were enhanced without making its use any more dense than it was before the project.

5.3.1.5 **Public Transport Access** (SS Credit 4.1-4)

This point gives credit for the use of a site that has access to available public transit. In the DCCTM, there is no public transit. The transportation of the population is undertaken by private companies that run fleets of small vans within cities and towns and buses between them (see figure 5.3.4). This point would have to be restated to refer to proximity to existing van and bus routes.

Figure 5.3.4 - Madagascar: private mini-van: the available 'public' transport. Source: Fieldwork.

5.3.1.6 **Bike Storage and Changing Rooms** (SS Credit 4.2)

To encourage use of bicycles, this criterion stipulates the provision of bike storage racks, changing rooms with lockers and showers for bike riders. Bicycles are important for personal and commercial transportation in Tanzania, especially since the introduction of relatively inexpensive Chinese-made bicycles into the market. Therefore it is important to accommodate their storage and security while their owners are in the given building. However, the provision of changing rooms and showers is of doubtful utility when building project budgets are so tight and people do not normally have as many clothes as those in more developed countries. Bicycle riders especially do not have any special bike-riding clothes such as bike-riders wear in the U.S. The recommendation here would be that secure bicycle storage be provided, but not necessarily the lockers and showers.

5.3.1.7 **Low-Emitting and Fuel Efficient Vehicles** (SS Credit 4.3)

This credit seeks to encourage the use of vehicles with low emissions or that are particularly fuel efficient. This is appropriate in the DCC since fuel is relatively much more expensive and every effort should be made to encourage efficient vehicles. The criterion references standards developed by the California Air Resources Board and the American Council for an Energy Efficient Economy. These references should be reviewed for their applicability to the DCC. This criterion could also be adapted to apply to very lightweight high gas mileage vehicles and scooters that are widely used in the DCC.

5.3.1.8 **Parking Capacity** (SS Credit 4.4)

The intent of this credit is to reduce pollution and development impact from automobile use. Although automobile use is on the increase, there are significantly fewer cars in use in the DCC generally, with the exception of rapidly industrializing countries like India, China, Brazil and South Africa where automobile use is increasing rapidly. This credit could be modified in countries where cars do not have the same kind of impact as in more developed economies. A threshold of per capita car use could be established over which this point comes into play or the point could be modified to address parking for scooters, bicycles and other low-impact means of conveyance.

5.3.1.9 **Site Development: Protect or Restore Habitat** (SS Credit 5.1)

This is an extremely important environmental aspect in both developed and developing country contexts where development threatens the naturally occurring ecosystem. This point helps raise awareness of the impacts of land development and provides strategies to minimize that impact. It is critical in the DCC to raise awareness of the importance and role of habitat and the fact that natural sites continue to be vulnerable to irreversible damage from uncontrolled development. This was an important aspect of the decision to select a site for the Centre ValBio outside of the national park: as a demonstration of the importance of leaving the delicate environment of the park intact. There should be more of an educational or awareness-raising aspect to this criterion in recognition of this challenge.

5.3.1.10 **Site Development: Maximize Open Space** (SS Credit 5.2)

This credit is similar to the previous one that helps raise awareness of the importance of land in its natural state and rewards the strategy that maintains open land for nature to do her work and for the enjoyment of the building's users. Interestingly, none of the other green building rating systems reviewed in the Chapter 2 matrix of green building rating systems include this open space criteria. In the case of India, this may be because of the high opportunity cost of leaving open space in a densely-populated context.

In all three of the case studies discussed in Chapter 4, the buildings were situated at the perimeter of the project sites leaving open and vegetated space in the center. This was done not only to preserve open space but in response to the fact that a project's programmed space is both interior and exterior in mild climates such as are found in Tanzania and Madagascar. The intention is to not relegate the exterior spaces to the perimeter of the site around the building, but rather to have the exterior spaces be an integral part of the project spaces and defined by the building(s) (see figure 5.3.5).

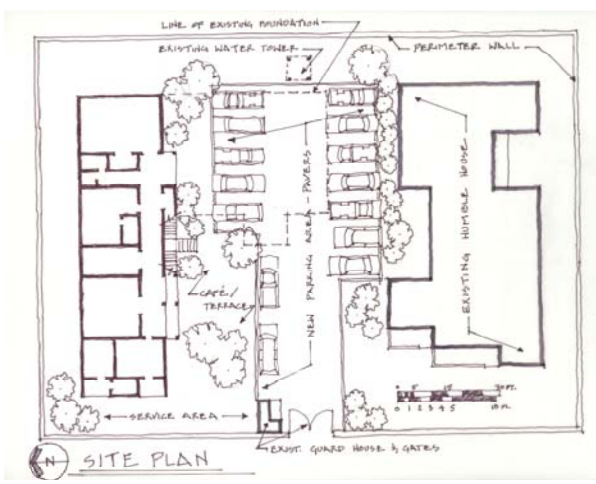

Figure 5.3.5 - Tanzania: buildings defining central open space of the Guest House / Conference Center. Source: Fieldwork.

5.3.1.11 **Stormwater Design: Quantity and Quality Control** (SS Credit 6.1-2)

This criterion strives to retain stormwater on site, thereby giving it the chance to infiltrate down into the ground and not overburden off-site stormwater facilities. Such stored stormwater can be used for non-potable water use such as irrigation or flushing toilets. Since domestic water in the developing country context is often non-potable anyway, this stored stormwater could conceivably be re-used in the buildings in conjunction with a settling tank or other filtration system. Control of stormwater is critical in the DCC where, most often, no sewers of any kind exist and stormwater has devastating effects on communities. Planning for control and use of stormwater would be a big step in a right and sustainable direction (see figure 5.3.6).

Figure 5.3.6 - Madagascar: storm water runoff control by means of stone channels at the Center ValBio. Source: Fieldwork.

At the Guest House / Conference Center, there was no stormwater system or even roads of any kind in the suburban area around Dodoma, Tanzania where the project was located (see Chapter 4, Section 4.5). The land had been subdivided and sold with right-of-ways reserved for future roads (see figure 5.3.7). Town water and electricity followed the right-of-ways generally and could be made available at individual plots, but no other infrastructure such as roads, storm and sanitary sewers have been built and do not seem likely to be built in the near term. On the extremely small site there was no place to locate a stormwater retention facility. Rainwater was collected from the downspouts to an underground cistern. Once it was full, however, the surplus was simply directed outside of the lot to the right-of-way. Another option would be to build a stormwater retention facility of broken stone under the parking lot which is surfaced in concrete pavers. This is a stormwater retention strategy in the U.S. and would be a way to provide stormwater retention in densely populated areas where there is no room for other stormwater structures such as retention ponds.

Figure 5.3.7 - Tanzania: suburban context of the Guest House / Conference Center with no paved roads or storm drainage. Source: Google Earth and Fieldwork.

5.3.1.12 **Heat Island Effect: Non-Roof Surfaces** (SS Credit 7.1)

The point of this credit is to reduce hot paved areas around buildings by paving with materials that are either porous or have high reflectivity, or by shading the hard-surfaced areas with trees or structures of high reflectivity such as tent materials. Fortunately for the DCC, asphalt is often not easy to come by and it is prohibitively expensive. Interlocking concrete pavers offer an alternative that is more reflective than asphalt and can easily accommodate shade trees. In

Tanzania, murram – a fine volcanic gravel – is widely available and used for roads, driveways and parking areas. This allows stormwater to percolate through and does not absorb heat as asphalt does. Fabric tent structures on aluminum frames are increasingly used in parking lots of urban areas to shade cars and parking areas.

5.3.1.13 **Heat Island Effect: Roof Surfaces** (SS Credit 7.2)

This credit aims to reduce the increased ambient temperature that occurs in and around buildings with dark heat-absorbing roofs. The idea is to have either a highly reflective roof that would reflect solar energy or a vegetated one that will absorb and retain the sun's energy. In the DCC, highly reflective roofs are desirable to reduce the absorbed solar energy that would otherwise be transferred to the interior. Metal roofs are very common as they are the least expensive and require the least maintenance. A light colored metal roof would be the most likely alternative for the DCC. A vegetated roof generally is dependent on relatively high levels of technical skill to install and to maintain. Its first cost and maintenance requirements make it not a very likely choice for the DCCTM.

5.3.1.14 **Light Pollution Reduction** (SS Credit 8)

This criterion's goal to reduce excess light that spills over from the project site onto the neighboring site and up into the sky is hard to justify in the context of Madagascar or Tanzania, where electricity is not always available and is relatively very expensive to the consumer. The existence of such light spillover has a relation to security which has to do with the lack of a consistent and equitable police presence in the community. There's really no government entity to call in case of emergency. One has to rely on one's neighbors and the fact that most people know one another in a given community. In sum, security and survival concerns would result in the neighbors' gratitude for free nighttime illumination that increases their security level with respect to theft. Therefore, this criterion would not have much applicability to the DCCTM.

5.3.2 Water Use and Conservation

This is a critical aspect of sustainable design and construction in the DCC where water is such a precious commodity and municipal water supply systems are overextended and inadequately maintained. If municipal water is available in towns in Madagascar and Tanzania, it typically might be available only for certain times during the day. Stormwater collection, rainwater collection from roof surfaces and greywater collection and filtering for re-use are all strategies that make a lot of sense in the DCC and should be emphasized and rewarded.

5.3.2.1 Water Use Reduction (WE Prerequisite 1 & WE Credit 3.1-2)

Water is a critical issue in most developing countries, especially the availability of clean potable water. Water use in countries like Madagascar and Tanzania is a fraction of that of more economically-developed countries. Therefore, standards such as those referenced in the LEED criteria, such as those developed by the American Society of Mechanical Engineers (ASME) and others are of marginal relevance. In place of the referenced standards for water use, water use criteria could mandate low-flow fixtures and self-closing taps. Motion-activated taps would satisfy such a criterion but batteries are not likely to be replaced. More useful would be the kind of water faucets that work by means of a spring or other mechanical delayed shut-off mechanism. This type of tap helps in areas of public access where people risk not being good stewards of water.

In addition to the importance of minimizing water use would be the provision of potable and non-potable water to the surrounding communities. A building could be planned so that its water system was sized to offer also water to the surrounding community through an accessible water source such as community tap.

In the case of the Centre ValBio in Ranomafana, Madagascar, the water supply came from a year-round spring that was tapped at the top of a nearby hill. The supply pipe ran from the spring down to a 30,000 liter (30 m^3) concrete storage tank at an elevation high enough to provide the necessary pressure to all the fixtures of the Centre (see figure 5.3.8). In effect, the Centre simply tapped into an existing spring that ran along the site.

Figure 5.3.8 - *Madagascar: 30m3 water tank in upper right of photo collects water from spring at top of hill. Source: Fieldwork.*

5.3.2.2 Water Efficient Landscaping (WE Credit 1.1)

The intent of this criterion is to reduce the use of water, and potable water in particular, for the irrigation of grass lawns and other landscaping. This idea has relevance for commercial office buildings in suburban areas with their vast expanses of green grass. This issue is not really relevant to the DCCTM because the alternative to water efficient landscaping does not really exist. Even where water is more abundant, lawns are not typically planted.

5.3.2.3 Innovative Wastewater Technologies (WE Credit 2)

This is an important aspect of every building in the developing country context. Water is often in short supply. Sanitation is mostly handled on site (see figure 5.3.9). Recapturing the maximum amount of greywater and holding it / treating it for re-use makes eminent sense. A number of filtering systems are available for treating greywater and some of them are practical in the developing country context, such as a sand filter.

Figure 5.3.9 - Madagascar: covers of septic tank for the Centre ValBio visible along stone path. Source: Fieldwork.

5.3.3 Energy Use and Atmospheric Pollutants

Buildings in the U.S. use about 39% of the total energy and more than 74% of the electricity produced annually. Producing electricity is a dirty process that pollutes.[100] Electricity in the U.S. is relatively cheap so people use it freely. For these reasons, this section of the rating system is critical to LEED. It deals with minimizing energy use in buildings (and harmful refrigerant use in air conditioning systems) and with verifying that building mechanical systems are performing as designed.

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[100] USGBC. 2009. LEED Reference Guide for Green Building Design and Construction . Washington D.C.: USGBC. p. 213.

Figures are not available for the allocation of energy use in Madagascar and Tanzania, but the mechanical systems for buildings there typically consist of water and sewerage plumbing, ceiling fans and, infrequently, air conditioning of key spaces. Of course there are exceptions in the capital cities where there are a few larger and relatively new buildings that have elevators and central air conditioning systems. But these are extremely rare and present immense challenges for the maintenance of such systems. Even the larger governmental buildings often consist of four or five stories with access by means of an exterior stair with exterior covered verandas serving as corridors. The building footprints are typically not deep in plan so that most spaces have windows for natural lighting and natural ventilation on opposite sides of the building. The question for a green building rating system applicable to the DCC is how to build on this already exemplary restraint in the use of energy in buildings?

5.3.3.1 **Commissioning Building Systems** (EA Prerequisite 1 & EA Credit 3)

The purpose of building commissioning is to ensure that the mechanical systems, particularly the HVAC systems, are functioning as designed. Mechanical systems can represent up to a third of initial building costs in the more developed economies. They also account for a large percentage of the energy used by a building and they play a critical role in 'sick building syndrome'[101]. For these reasons, building commissioning has a crucial role to play in making for better and more efficient buildings in the more developed economies. However, it does not have much relevance to the DCC since there is very little to commission in buildings with virtually no mechanical systems. It is certainly good to check that the building is working as it should – lights, plumbing, locksets – so that the clients ends up receiving what they paid for. Post-occupancy evaluations can serve a similar purpose in the DCC, verifying that everything works as intended and to verify that occupants are satisfied.

[101] Mechanical systems were found to be the source of contamination in Legionnaire's disease and are also where mold can take hold if care is not taken to prevent it.

5.3.3.2 **Energy Performance** (EA Prerequisite 2 & EA Credit 1)

This prerequisite and credit requires that a computer simulation model be used in conformance with US-based standards to calculate the energy expected to be used in the building compared to a so-called baseline building. The intent is to reduce expected energy use below that of the baseline building by a certain percentage. While data does not exist for various building types in the DCC, it is clear that the energy use in that context is only a fraction of that in the more economically developed countries. Meager though the energy use of buildings in the DCC is, it is still important to minimize needed energy use because of the relatively high cost of energy in the DCC.

This attention to the reduction of energy use would need to be formalized in a credit that rewards maximization of daylighting to augment or replace artificial lighting, use of thermal solar systems for domestic hot water and other strategies, such as daylight sensors. In all three of the case study buildings, it was assumed that electricity might not always be available. Therefore, all main spaces have significant daylighting from opposite sides of the building so that artificial lighting would often not even be necessary.

5.3.3.3 **Refrigerant Management** (EA Prerequisite 3 & EA Credit 4)

This credit prohibits the use of ozone-depleting refrigerants. Most buildings in the DCC will comply because they have no cooling system other than a ceiling fan and windows. Where air conditioning is used, care should be taken to specify only non ozone-depleting refrigerants. When air conditioning systems are used in the DCCTM, they are of the split-system type which consists of a wall- or ceiling-mounted air handling unit and a condenser located outside. There is no ductwork since the cool air is distributed directly from the air handling unit into the room in which it is located. The air being cooled is that which is already in the room. Fresh air is provided by leakage under and around doors and windows.

5.3.3.4 **On-Site Renewable Energy** (EA Credit 2)

This credit rewards the creation of renewable energy on the building site. Photovoltaic and wind turbine systems are the most commonly used strategies. Water turbines are another possibility for on-site energy production if the site is located adjacent to a river as the Centre ValBio is. In some areas of the more developed economies, the excess energy produced can be backfed to the electrical grid for credit or payment by the local power company.

As noted earlier, the issue of energy independence is of critical importance in the DCC where the energy grid is a lot less developed, less reliable and energy is relatively more expensive. Being a net energy producer could have a benefit for the surrounding community if energy could be made available for sale to neighbors, thus increasing the project's sustainability. A strongly related issue to consider is that of the availability of the skilled labor to install and maintain such independent energy production systems and the cost, both initial and ongoing maintenance costs.

5.3.3.5 **Measurement and Verification** (EA Credit 5)

This credit is for the installation of meters to measure energy and water use and the implementation of plan to measure and take corrective measures should energy savings not be realized. The idea of measurement is a powerful one that would also have relevance in the DCC as it would increase awareness of energy and water use and the efficacy of measures to reduce them. This raising of consciousness is very important and involves users as co-pilots of the building.

5.3.3.6 **Green Power** (EA Credit 6)

This credit intends to promote the production of renewable energy by the local electrical supplier by giving preference to renewable sources over non-renewable ones. It is not likely to find this in the DCC but it may eventually be available.

5.3.4 Materials and Resources

This credit aims to reduce waste, to encourage sustainable means of waste disposal through recycling and re-use, to encourage sustainable means of production for materials and to minimize energy used in the transport of building materials. In the more developed economies, waste is an enormous issue. 40% of waste in landfills comes from building construction and demolition.102 The poverty of the less developed countries means there is a lot less waste. A lot of needy people scavenge and scrounge through waste for anything that can be re-used or sold. The sorting and recycling of waste is a good idea, if nothing more than to assist those who make their livelihood sifting through the waste of others. Setting aside re-usable items such as bottles, cement bags, old nails to facilitate their re-use to those who could use them is helpful.

It is also helpful to make people aware of the energy embodied in a given material through its extraction and production as well as through its transport. In addition to the embodied energy, it's important to be aware of the environmental impacts of the process of extraction and production of a given building material. For example, bamboo is a highly renewable material, but if its production involves toxic chemicals being dumped untreated in streams and its use necessitates transport from the other side of the world, how sustainable is it in reality?

5.3.4.1 Storage and Collection of Recyclables (MR Prerequisite 1)

This prerequisite requires a separate room for the storage and sorting of recyclables. While space is at a premium due to its cost, it is a good idea to institutionalize the importance of recycling and build it into a building's program.

[102] USGBC. 2009. LEED Reference Guide for Green Building Design and Construction. Washington D.C.: USGBC. p. 335.

5.3.4.2 **Building Reuse** (MR Credit 1)

This credit recognizes that new building construction is an enormous consumer of energy. Reusing existing buildings also helps with continuity in a community and helps preserve existing open and arable land from development. These same issues are relevant to the DCC and probably more so. Though the cost of construction in the DCC is only 15 – 30% of that of construction in the more economically developed countries, it represents a much larger capital investment in proportion to people's personal income and to national income.[103]

Furthermore, buildings in the DCCTM, other than those built of traditional materials, are generally built of much more durable materials, such as burnt brick, solid concrete blocks and cut stone, that can withstand the ravages of time better than a lot of the materials used in the more economically developed countries. In this regard, it makes even more sense to re-use buildings in the DCCTM. The challenge, however, in the DCCTM is the lack of documentation of existing buildings, many of which are built without plans or building permits. They are often built by rule of thumb and not by calculation and corners are often cut to minimize expensive materials such as cement and steel reinforcing bars. Non-invasive structural forensic testing such as X-ray or magnetic scanning is typically not available to ascertain the presence and size of concrete reinforcing.

5.3.4.3 **Construction Waste Management** (MR Credit 2)

This is to encourage responsible and productive handling of construction site waste. This is not the same kind of an issue as was mentioned in Section 5.3.4 above since the very poverty of the DCCTM makes people much more circumspect in the handling of any waste material. As regards this point in its particulars, formal landfills with weighing facilities such as one finds in more economically developed countries are not typically found in the DCC, so it would be impossible to meet the paperwork requirements necessary for this point. The requirements

[103] Typical costs for construction in Madagascar and Tanzania vary between $250 and $500 per square meter while construction in the U.S. varies from $1,500 to $3,000 per square meter.

would need to be adapted to the existing local context to encourage separation of waste and identifying the best means of its recycling or re-use. The different nature of construction waste in the DCCTM was evident in the case studies, where care was always needed to prevent the theft of construction waste and its unnecessary production. Empty cement bags were very sought after for transport of charcoal or farm produce. Bent nails were straightened and re-sold by the piece. There was never a problem of construction debris cluttering up a site or the surrounding area.

5.3.4.4 Materials Reuse (MR Credit 3)

This criterion promotes the reuse of existing or salvaged building materials to minimize energy expended in their production and possibly in their transport as well. The issues here are similar to those of the minimization of construction waste since it is in the more economically developed countries that buildings are demolished wholesale and thrown in the landfill. In the DCCTM, any material that can possibly be re-used will be, although in a degraded state. For example, galvanized roofing sheets get re-used in self-built housing or for storage buildings after they are taken off of a building. But the nail holes are ragged and can not be successfully re-used with the original size of roofing nail and washer. The corrugations and edges of the roofing sheets are damaged typically so their strength and ability to shed water are compromised. Other parts of buildings are more easily dismantled for re-use: doors, windows, plumbing and electrical fixtures. To maximize the reuse of building materials, a new construction project as well as a demolition project can be conceived with eventual re-use of building materials in mind.

5.3.4.5 Recycled Content (MR Credit 4)

This point encourages the use of materials that contain waste materials from the production stream or material that has already been used in a finished product. This kind of effort is already readily apparent in the DCC in the ingenuity of people in making toy cars from old margarine cans, decorative beadwork from rolled up waste paper and jewelry from bottle caps. A further step will be to find ways to incorporate such waste – such as the ubiquitous thin plastic bags or the plastic water bottles – into building materials such as building blocks or pavers.

Entrepreneurial opportunities abound in this domain as long as the pricing is competitive with conventionally produced building materials.

5.3.4.6 **Regional Materials** (MR Credit 5)

This criterion promotes use of building materials that are produced within 500 miles (805 km.) of the project site in order to reduce the embodied energy in the form of transport costs and to promote the local (regional) economy. The point is achieved if at least 10% of the building materials are from within a 500 mile radius (measured in cost). This parameter is based on the case of the U.S., a large country where centers of manufacturing and harvesting are distributed over the territory of the country, so that one can generally try to privilege the most local sources to minimize energy used in transportation.

In developing countries such as Madagascar and Tanzania, there are typically only one or two main manufacturing centers and these are near to the capital or major urban center or major port. Although the countries are large – Madagascar measures approximately 350 miles (550 km.) by 1000 miles (1600 km.) and Tanzania 625 miles (1000 km.) by 720 miles (1150 km.) – a given radius may not make as much sense as simply promoting the purchase of nationally or regionally produced materials. While Madagascar is a large island, it does have Indian Ocean trading partners and trade agreements to promote economic development in that corner of the Indian Ocean. Similarly, Tanzania is part of the East African Community along with Uganda and Kenya. There are numerous efforts by the EAC to promote economic development of the region. Both Tanzania and Madagascar are also members of the Southern Africa Development Cooperation (SADC) among whose goals is the economic development and integration of the nations of the southern African region.

This component of the rating system that deals with regionally-sourced building materials should perhaps have greater emphasis in the developing country context since so much of economic development centers on this issue. The issue could be taken into consideration where the raw materials are sourced and where the transformation of the raw materials occurs since there are industries in both Tanzania and Madagascar that import raw materials for transformation into finished products. For example, in both countries, aluminum sections are imported from Europe, China and the Middle East and made into aluminum windows, doors, curtain walls and storefronts. Similarly, galvanized steel coil stock is imported and transformed into steel roofing sheets. An example of a material both sourced and transformed locally is the creation of building blocks from laterite-containing local soils on site. This is of the most benefit to sustainability of a project and to the local economy. In the Guest House and Conference Center, the roofing sheets and aluminum windows and doors were manufactured in Tanzania from raw materials imported from Europe, while the wood doors and terrazzo floors were made from materials found in Tanzania (see figure 5.3.10).

Figure 5.3.10 - Tanzania: terrazzo flooring and wood doors at the Guest House / Conference Center. Source: Fieldwork.

5.3.4.7 **Rapidly Renewable Materials** (MR Credit 6)

Rapidly renewable materials are defined by the USGBC as those that are planted and harvested in a cycle of 10 years or less. Eucalyptus and pine are two exotic species of wood that have been introduced to Madagascar and Tanzania. Eucalyptus is primarily wild and grows from the stump when it is cut down. It is a heavy wood but is serviceable for roof trusses and rafters. It can also be used for flooring. Pine has been planted for use in the construction of furniture and for ceilings in buildings. It is very light and not very strong. Bamboo is found in Madagascar and in both countries local reeds and grasses have been used for millennia for basket-weaving, clothing and for housing in the hotter coastal areas (see figure 5.3.11). Such rapidly renewable materials can be identified for the individual country and their use promoted in innovative building materials.

Figure 5.3.11 Madagascar: traditional coastal Malagasy house. Source: Fieldwork.

5.3.4.8 **Certified Wood** (MR Credit 7)

This point requires wood to be purchased from a source certified as having been harvested in a sustainable manner. Such certification does not yet exist in the context of Tanzania and Madagascar. However, there are re-forestation projects from which wood is harvested for use in construction. Such sources could be identified and listed as acceptable sources and some sort of certification could be sought that would vouch for its sourcing.

5.3.5 Interior Environmental Quality

The United States Environmental Protection Agency – as quoted in the USGBC's LEED reference guide – states that Americans spend on average 90% of their time indoors, where levels of pollutants may run two to five times – and occasionally more than 100 times – higher than outdoors. They cite similar conclusions reached by the World Health Organization (WHO) for the European context.[104] This fact makes understandable the emphasis in the LEED rating system on indoor air quality. The section on interior environmental quality assumes the type of construction where building users live in and make use of conditioned spaces and where the outside ambient temperature and humidity have to be conditioned and controlled for human habitation.

The benign climates of Madagascar and Tanzania are such that there is often not a vast difference between the indoor and outdoor temperatures. The Malagasy and the Tanzanians have always spent a great deal of time living and working out of doors and they continue to do so. As a result of this, the vast majority of buildings do not have any climate control at all apart from that available through the manipulation of doors and windows. The differences that exist at various times of the year between desirable indoor temperatures and outdoor ambient temperature can very often be minimized through passive design measures such as building orientation, roof overhangs and location of openings, or mechanically through the installation of ceiling fans.

The requirements for air changes per hour and air filtration as developed by the US-based professional society, The American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE) and referenced in the LEED criteria are only marginally relevant since doors and windows are not built to be air-tight and are often left open. Some local building practices inherited from colonial times even have permanent through-the-wall ventilation openings at the level of the ceiling to ensure continuous natural ventilation.

Some types of windows available and in common use such as jalousie type louver windows are designed to maximize air flow through the window and even in the closed position allow a great deal of air to pass through. Such jalousie windows also have greater percentage of ventilation area than sliders, for example, which typically do not have more than 50% ventilation area.

[104] USGBC. 2008. *LEED for Homes Reference Guide*. Washington D.C.: USGBC. p. 269.

5.3.5.1 **Minimum IAQ Performance** (IEQ Prerequisite 1)

This point prescribes standards for indoor air quality based on US standards. Both mechanical and naturally ventilated spaces are addressed. In the DCC, buildings are practically always naturally ventilated. The natural ventilation requirement developed by ASHRAE is that the area of operable roof or wall openings should equal or exceed 4% of the occupiable floor area. The ASHRAE standards should be reviewed for their relevancy to the DCCTM. The appropriate parts could be incorporated to provide a performance standard for natural ventilation as discussed in section 5.4.10 below.

5.3.5.2 **Environmental Tobacco Smoke Control** (IEQ Prerequisite 2)

This prerequisite prohibits tobacco smoking inside a building unless it is in a space separately ventilated from other spaces. In a naturally ventilated building, all spaces are separately ventilated because there is no central air handling equipment or ductwork connecting the rooms. It would be better to state this requirement as a simple prohibition from smoking inside the building or the provision of a separate smoking lounge away from the building’s other interior spaces.

5.3.5.3 **Outdoor Air Delivery Monitoring** (IEQ Credit 1)

This point encourages monitoring of fresh air delivery to indoor spaces to ensure healthy indoor environment. In the DCC, there is so much air moving in and out through leaky windows and doors, that the provision of fresh air inside is not too much of a concern.

5.3.5.4 **Increased Ventilation** (IEQ Credit 2)

This point rewards greater levels of ventilation for indoor air quality. As in the section above, there is plenty of natural ventilation occurring through leaky doors and windows, which is as it should be.

5.3.5.5 **Construction IAQ Management Plan** (IEQ Credit 3)

This criterion concerns the protection of absorptive building materials before they are installed and protecting components of the air handling system from contamination prior to their startup. This is not very relevant to the DCC since ducted air handling systems are rare, the air change rate is typically very high already and absorptive materials are not very much used.

5.3.5.6 **Low-Emitting Materials** (IEQ Credit 4)

The point of the low-emitting materials is to lower the quantity of indoor contaminants that are bothersome to the inhabitants of the indoor environment. This concerns adhesives, sealants, paints, coatings, flooring systems, composite wood, and agrifiber products. Because of the porosity between inside and outside in the DCCTM, the offgassing of finish materials is not an issue of critical concern. Furthermore, such products with low amounts of volatile organic compounds (VOC's) are not readily available in the DCCTM.

5.3.5.7 **Indoor Chemical and Pollutant Source Control** (IEQ Credit 5)

This point is concerned with isolating interior sources of air pollution such as where there is a concentration of photocopiers or where cleaning supplies are stored and decanted and with limiting the amount of dirt brought in on people's shoes. Most rooms in the DCCTM have windows. Care should be taken that this is still the case and that the windows are easily operable in copy rooms and storerooms. But care should be taken that, in some kind of blind imitation of a western-type skyscraper, unventilated interior spaces do not become the norm.

This point stipulates that some kind of walk-off mat or recessed grate be provided at major entries to provide a place for people to wipe their feet off. This is very useful in the DCCTM where the dry season brings so much dust, the wet season so much mud and where paved exterior surfaces are not plentiful. A provision for walk-off mats or recessed grates at entries to buildings is very useful.

5.3.5.8 Controllability of Systems: Lighting and/or Thermal Comfort (IEQ Credit 6)

This point encourages the most local control possible by individual inhabitants of the lighting and thermal comfort level of the interior spaces. Individual lighting controls are really the only way that lights are controlled in the DCCTM. Also the individual control of the windows and the ceiling fan, if available is the only way it is done. So this issue is not of much relevance to the DCCTM.

5.3.5.9 Thermal Comfort: Design (IEQ Credit 7.1)

Compliance is required for this point with a standard for environmental comfort developed by the ASHRAE. Not only would this be completely unknown in the DCCTM, it would be of little relevance since no mechanical systems typically are used in buildings as described in Section 5.3.5.1 above. The requirements related to natural ventilation would be good for reference to see how they would apply or not to the DCCTM. There may be other thermal comfort standards from more economically developed countries with climates similar to Tanzania and Madagascar that would be of more relevance, such as in Madagascar's neighboring islands of Seychelles or La Reunion, an overseas department of France.

5.3.5.10 Thermal Comfort: Verification (IEQ Credit 7.2)

This point is concerned with the thermal performance of the building over time as experienced by the users of the building. As mentioned earlier, this sort of post-occupancy evaluation is very useful in seeing how a given building is performing and what deficiencies need to be corrected or at least not repeated in a subsequent building.

5.3.5.11 Daylighting and Views (IEQ Credit 8)

Due to the intermittent availability of electricity, daylighting is simply a necessity. That fact, together with the natural ventilation of all interior spaces, is simply the way things are done in the DCCTM. These aspects thus allow virtually every space a view of the out-of-doors. It is good for a green building rating system to reward this reality so that it is recognized and valued as a positive in terms of sustainability.

5.3.6 Innovation and Regional Aspects

This final category of the LEED green building rating system accommodates sustainability strategies not addressed elsewhere in the system, gives credit for the involvement in a given project of a professional knowledgeable in the LEED rating system and identifies sustainability issues of particular importance to a specific region. This type of criterion is necessary to recognize the diverse nature of sustainability and the value of the participation in a project of an experienced and knowledgeable design professional.

One of the aspects of sustainability that LEED identifies and credits under this category is efforts at education concerning sustainability as exemplified by the building in question. This is a critical aspect of sustainability, and just as much so in the DCCTM, since it is only through the raising of consciousness that sustainability will become the normal and expected way of living. The beneficial effects of such consciousness-raising are already evident in Madagascar where there have been great efforts in the past 20 years at sensitizing the population to the flora and fauna of Madagascar, unique in the world, and the critical role they have to play in conserving it. One can see now, driving in Madagascar, signs for ecolodges and guided tours of parts of forested areas. Former loggers of endangered rosewood have been trained and work as forest guides for tourists and researchers in the Ranomafana National Park. Because of its importance to the success of sustainability, efforts at education should form part of *every* green building.

5.3.6.1 **Innovation in Design** (ID Credit 1)

This final category of the LEED green building rating system seeks to encourage innovative solutions in the direction of sustainability that are not addressed elsewhere in the rating system. This is important also to green building efforts in the DCCTM since there is much to learn from traditional building and use of materials to which the building culture there is still very close.

5.3.6.2 **Accredited Professional** (ID Credit 2)

A design professional with knowledge of green building in the DCCTM would be very useful to have on a design team, especially when consultants are involved in a project that do not have first-hand familiarity with the particular context for which they are designing. In the same way that a LEED-accredited professional can help clients and consultants understand how a project can be made sustainable in the U.S. context, a professional with training and experience in sustainable building design and construction in the DCC could have an important impact on the outcome of a building project.

5.3.6.3 **Region Specific Environmental Priority** (RB Credit 1)

Regionally specific priorities for the DCCTM would have to be researched and identified. Among them would be:

- Energy independence through renewable energies
- Water conservation and re-use
- Promotion of local industry and labor
- Security from theft
- Passive cooling and heating
- Locally and regionally important issues such as reforestation

5.4 Other Criteria Relevant to the Contexts of Tanzania and Madagascar

In the review of other green building rating systems summarized in Table 2.1 on page 50, there are a number of criteria from green building rating systems other than LEED that either do not appear in the LEED system or do not appear explicitly as separate criteria and have pertinence to the developing country context. These additional criteria help flesh out the nature of a green building rating system that would address the particular sustainability issues of the DCCTM. They are identified here below and their relevance to the DCCTM is described.

5.4.1 **Considerate Builder** (found in BREEAM, Green Star, Estidama Pearls)

This point makes explicit the roles and activities of a builder that desires to be environmentally responsible to the project and to its neighbors. Among the focus areas are: safety, noise, clean site, and environmental impact. It includes a checklist which is helpful for the builder to be able to point to specific actions taken in the direction of sustainability. This is important in that it makes of the builder an active and engaged participant and, by his/her actions, a proponent of sustainability. So often, project participants are not aware of the many dimensions of sustainability and they need to be educated.

5.4.2 **Low Polluting Maintenance Plan** (found in Estidama Pearls)

This involves, possibly as part of the User's Guide described in the following section, the delineation of a plan for the maintenance of the building describing activities that need to be done periodically along with the methods and means to undertake them that would be the most environmentally benign. For example, the type of cleaning agents to be used periodically would be specified.

5.4.3 **Building Users' Guide** (found in all rating systems except LEED)

This criterion entails the compilation of a permanent resource for the users of the building explaining the building's features and how the building should be operated and maintained including specific manufacturer's detailed information about any building systems. For institutional clients, this type of requirement is called an Operations and Maintenance (O&M) Manual, but typically does not include a narrative about the intentions for the building and its expected performance. This would be most useful so that a building's users are aware of how a building was intended to operate and makes of them informed participants. They will then be aware if the building is not functioning as intended and can try to get deficiencies in the building's operations corrected should they arise.

5.4.4 Design for Flexibility and Adaptability (found in Estidama Pearls)

This point refers to building design that attempts to leave open options for re-configuring of interior spaces, for example, and accommodates future extensions with the least trouble. Choices such as surface-mounted electrical wiring and plumbing, the use of non-load bearing interior partitions, and the use of gable instead of hipped roofs, make future changes less problematic and less expensive to undertake. This has particular relevance to the DCC where buildings are much less likely to be demolished when needs or use change as is the case in the U.S. In the DCC, where buildings are used and reused, it helps if future modifications can be foreseen and accommodated to some extent.

5.4.5 Use Less Material (found in Green Star, Green Star Australia and Estidama Pearls)

This point refers to the selection of building materials and components that both in the short and long term require less material. For example, water-free urinals use no plumbing for supply water, certain building materials such as burnt brick, stone, and stainless steel require no further finish and little to no maintenance of its finished surface. By contrast, any painted surface will need to be re-painted and will often look bad for a considerable time until it is, which could be very long in a context where budgeting for building maintenance is not the norm.

5.4.6 Security through Crime Prevention Measures (found in BREEAM)

This point refers to a UK publication by a police agency that suggests design strategies and details for the deterrence of crimes such as theft. This same idea could be adapted in the DCCTM where security issues are very important to the sustainability of any given project. The intent would be to outline strategies for making theft more difficult. It would include strategies such as maintaining sightlines to entryways in the interest of making it harder for thieves to enter. Details such as security bars at windows and locations of security lighting could be included. Acknowledging security as a major design determinant and component of sustainability facilitates its consideration early in the design process instead of the unfortunate afterthought that it most often is when the steel grates and barbed wire go up at the end of the project.

5.4.7 **Provide Outdoor Private Space** (found in Estidama Pearls)

This point recognizes that people in Abu Dhabi live outdoors to such an extent that this aspect of their lifestyle needs to be accommodated in order for a given residential building to be sustainable. If this outdoor private space is not provided, there would be something missing and the residential project would not be as successful as it could be. Similarly in the DCCTM, as noted above, people spend a great deal of their time in the outdoors owing to their traditional way of living and using space, the generally benign climate and the realities of the cost of construction. Cooking, food preparation, laundry washing and drying, hair styling and grooming, and socializing are among activities that typically occur outside. In other words, sustainability is about appropriate design as well as building technique and materials.

5.4.8 **Provide Space to Air-Dry Clothing to Conserve Energy** (found in BREEAM Gulf)

This point acknowledges that machine clothes drying uses a lot of energy and in a wasteful way given the dry and sunny climate so conducive to air-drying clothing. Making provision for this saves potentially a lot of energy. In the DCMC Guest House and Conference Center and in the Centre ValBio, in addition to an interior laundry room where the washing machines and dryers are housed, there is an open covered terrace with deep laundry sink for hand-washing (see figure 5.4.1). Clothes-drying lines are located adjacent to the covered terrace. Similarly in the two Madagascar projects, exterior clothes-washing and drying facilities are located near to the exterior cooking facilities.

Figure 5.4.1 - Madagascar and Tanzania: exterior laundry areas at Centre ValBio in Ranomafana (left) and at the Guest House / Conference Center in Dodoma (right). Source: Fieldwork.

5.4.9 **Cool Building Strategies** (found in Estidama Pearls)

This criterion supplements the intent of the LEED heat-island effect criteria in which strategies are encouraged that decrease the heat absorption of roof and surrounding project areas. This point promotes shading of the building facades by means of solar shades or vegetation in the effort to reduce cooling loads and indoor temperature. This is an appropriate strategy for the DCCTM where awnings, covered verandas, roof overhangs and plantings can reduce solar incidence on the walls (see figure 5.4.2).

Figure 5.4.2 - Madagascar: veranda roof of the Centre ValBio keeps sun and rain off the walls. Source: Fieldwork.

5.4.10 **Provide for Natural Ventilation** (found in BREEAM and Estidama Pearls)

This point promotes the accommodation of means of natural ventilation instead of or in addition to air conditioning systems. It is good to promote the accommodation of natural ventilation and the exploration of improved means to achieve it and space cooling, even if it is in addition to air conditioning systems since energy is expensive and power outages are commonplace in the DCCTM.

5.4.11 **Water Cutoff to Sanitary Fixtures** (found in BREEAM and BREEAM Gulf)

This is a simple measure to reduce water waste from malfunctioning toilets. If there is not a separate cutoff valve at each toilet, a lot of water can be wasted if one toilet malfunctions and its water supply can't be cut off. This is particularly appropriate in the DCCTM where water is also precious and resources are few for maintenance or replacement of facilities and fixtures.

5.4.12 **Durability of Exposed Building Parts – Low Maintenance** (found in BREEAM, BREEAM Gulf and Estidama Pearls)

This point addresses to need to minimize maintenance through the specification of durable building materials especially in high traffic areas that get a lot of use. This point recognizes the simple fact that sustainability is related to how long a given building or material will last in good condition. This is highly relevant to the DCCTM where the resources for construction and maintenance are so limited and provision is often not made for maintenance costs in institutional budgets.

5.4.13 **Ease of Maintenance During Life of Building** (found in BREEAM Gulf and Estidama Pearls)

This point promotes planning for the maintenance of the building throughout its life. This looks at replacement cost, repair cost, availability of spare parts and labor for any equipment in the building. This criterion would favor locally available materials for their ease of replacement and repair. This is also of great relevance to the situation of the DCCTM where resources for maintenance are so few.

5.4.14 **Management Plan to Enhance Environment** (found in BREEAM Gulf and Green Star South Africa)

This point promotes a formalizing of the planned environmental impact of a project and the means to improve the natural environment. This is a good idea to make explicit in the interest of the sustainability of the project what the impact of the construction is expected to be and how it is anticipated to be managed and any negative outcomes offset.

5.4.15 **Protect and Re-Use Topsoil on Site** (found in Green Star, Green Star South Africa & Estidama Pearls)

This point recognizes the importance of topsoil found at the project site for the future health and prosperity of the site's vegetation. This is important to safeguard also in the DCCTM.

5.5 Conclusions Regarding Green Building Rating Criteria

To summarize this review of green building rating criteria, the following LEED criteria are found to be relevant to the DCCTM:

Sustainable Sites
- Prevention of pollution from construction activity
- Preserving sites in their natural state
- Use of previously impacted site
- Build where other people already are
- Use of contaminated or otherwise disused site
- Build near to existing transport and utilities infrastructure
- Provide secure bicycle storage
- Encourage efficient and low-emitting vehicles
- Protect or restore wildlife habitat
- Maximizing open space on the site
- Stormwater runoff control
- Reduce heat-island effect on roof and site
- Retaining natural features on site

Water Efficiency
- Water use reduction and conservation
- Innovative wastewater, such as re-use greywater
- Rainwater collection

Energy and Atmosphere
- Reduction of energy use;
- On-site renewable energy;
- Measurement and verification of energy use
- Roof-mounted thermal solar hot water panels

Materials and Resources
- Storage and collection of recyclables;
- Building re-use;
- Use of regionally-available materials
- Use of rapidly-renewable materials

Indoor Environmental Quality

- Environmental tobacco smoke control;
- Walk-off mats for mud at entries;
- Windows for daylighting and views

Innovation and Regional Aspects

- Encouragement of innovative strategies
- Recognition of regionally-relevant issues

Other LEED criteria were found to be of limited relevance to the DCCTM as has been described previously in this chapter These criteria are:

Sustainable Sites

- Provide showers and lockers for bike riders;
- Limiting the number of automobile parking spaces;
- Light pollution reduction;

Water Efficiency

- Water efficient landscaping to reduce need for irrigation of lawns;

Energy and Atmosphere

- Building commissioning;
- Purchase of green power for local utility company;

Materials and Resources

- Construction waste management;
- Materials re-use;
- Recycled content building materials;
- Certified wood;

Indoor Environmental Quality

- Indoor air quality performance;
- Outdoor air delivery monitoring;
- Increased ventilation;
- Indoor air quality management plan;
- Low-emitting materials;
- Indoor chemical and pollutant source control;
- Controllability of lighting and thermal comfort;
- Thermal comfort design and verification; and

Innovation and Regional Aspects

- Involvement of LEED-accredited professional

These other criteria from the BREEAM and Estidama Pearl rating systems were found to be relevant to the DCCTM:

- Considerate builder: involvement of builder as key actor in the sustainability of a project
- Maintenance plan for users to show how the building will be low-polluting in its operation
- Provision of a building users' guide so users and visitors know what the intentions were, how they were achieved, what building performance is expected and how to verify it and remedy it if need be;
- Design for flexibility and adaptability
- Use less materials in the building, such as waterless urinals that need no supply water piping, stone foundations or walls that need no finish plaster.
- Security from theft through prevention measures
- Provision of private outdoor space for residential buildings
- Provision of outdoor space to air-dry clothing
- Use of cool building strategies such as shading devices, plants, overhangs, verandas
- Design for natural ventilation
- Provide water cutoff to individual sanitary fixtures
- Use of durable materials that require low maintenance in areas of high traffic
- Choose materials that have long life and are easy to repair and replace
- Provide management plan to enhance natural environment
- Protect and re-use topsoil disturbed at the site

In all criteria that are predicated on government-developed or other standards for compliance, each of those standards has to be reviewed to determine its relevance to the DCCTM. Since such standards have been developed for and within a more economically-developed context, there will be built-in assumptions about levels of performance achievable and the availability of financial and human resources to achieve such standards. Other standards have to do with climatic assumptions, such as the assumption that interior spaces will be heated and/or cooled. Each of the criteria has to be examined for its relevance and the standards or practices to which it refers, either explicitly or implicitly. Sometimes other similar standards exist that can be substituted, such as those from former French or British colonies with standards developed for tropical countries.

The following elements related to sustainability in the DCCTM are not mentioned or adequately emphasized in the rating systems and have significant roles in that context:

- Impact of a project on its surrounding community through job creation in the new facility or provision of some good to the community, such as education,access to clean water, or possibility of purchase of electricity;
- Poverty alleviation through construction-related employment;
- Poverty alleviation maintenance-related employment;
- Poverty alleviation through project-related development in the surrounding area;
- Building fit into its context through use of architectural elements familiar to users and neighbors;
- Orienting the building(s) to relate to its micro-climate and in relation to solar incidence of a site, and
- Building that relates to local building culture: building materials and techniques that local craftspeople will know.
- Encouragement of re-forestation as part of any project
- Importance of education of users and neighbors as a sustainability strategy

While LEED and other of the existing rating systems make a good start at defining the range of issues involved in sustainability, they do not come close enough to what sustainability is in the contexts of Tanzania and Madagascar. In fact, the use of such rating systems in the DCCTM can point people in unhelpful directions, overlooking opportunities that are present and achievable, such as those mentioned above, and spending scant resources for the purpose of gaining a point of perhaps limited relevance to their situation.

Chapter 6 Summary, Final Conclusions and Recommendations

6.1 Summary of Assumptions in Need of Reassessment

The green building rating systems are built on a number of assumptions that are valid for the developed country context for which they were created, but are markedly less valid in the developing country contexts of Tanzania and Madagascar (DCCTM). Among these are:

- Availability of an abundant and uninterrupted electric power supply
- Prolific use of electric power generally and especially for climate control
- Availability of a wide range of building materials
- A tight building envelope will reduce need for climate control and thus for electricity
- Building program activities occur inside a building's conditioned envelope
- Usefulness of commissioning a building's mechanical systems
- Availability of professional consultants to do such commissioning
- Availability of skilled labor to maintain complex building systems
- Resources to pay for ongoing maintenance of building and its systems
- Security from theft

The assumption of abundant supply and prolific use of continuous electrical power underpins most of the criteria and, in particular, those related to HVAC systems, controls and monitoring. There is, together with the energy assumption, a corollary that all interior spaces will be heated and/or cooled mechanically. However, in the developing country context of Tanzania and Madagascar, the simplicity of available building technology and systems is a good fit with the generally mild climates found there. Between the two extremes of mechanically cooled space on the one hand and mechanically heated space on the other, one finds a broad range of climatic conditions that buildings can respond to by passive means, such as orientation, vegetation, roof overhangs, and wall openings. The ubiquitous ceiling fans of Madagascar and Tanzania practically count as passive means of cooling compared to the complex HVAC systems in use in the more economically developed countries. The minimal energy consumed in such passively conditioned buildings should be credited by a rating system. The fact that a building can function well with little or no electrical power is something to note, reward and emulate.

Another assumption is that a wide range of building material choices is available. In the developing country context of Tanzania and Madagascar (DCCTM), owing to its relatively small economy, there are only limited choices in building materials. Available materials are closely related to traditional building materials, such as wood and thatch; those that are a legacy of the colonial period, such as brick, reinforced concrete, corrugated iron sheets, and roofing tiles; and those that come from a globalizing economy, such as aluminum storefront and glass curtain walls. If materials are selected outside of this relatively limited range, the cost of purchase, installation and maintenance increases astronomically.

Related to the assumptions concerning energy availability and use is that concerning the building envelope. While it is true that a tight building envelope will reduce heating and cooling load in areas of climatic extremes, it makes buildings harder to ventilate naturally in moderate climates and pushes those buildings in the direction of mechanical means of ventilation rather than natural means such as properly located openings, shading vegetation and the like. Related to this is the assumption that the majority of a building's activities occur within the building envelope. When the climate is mild and people traditionally live out of doors a good deal of the time, activities such as cooking and other food preparation, laundry, and gatherings of various kinds occur outdoors, either open to the sky, or on a veranda or other covered area, thus blurring the lines between inside and outside.

Another assumption concerns the usefulness of formal commissioning of a building's systems. When the most complicated building system is the ceiling fan or hot water heater, commissioning is not as critical to do in a formal way. Besides this aspect of usefulness, the availability of the relevant professionals to undertake the commissioning of any complex building systems is not a given in the DCCTM.

Other assumptions found underpinning LEED and other green building rating systems are that the skilled labor is available to maintain complex building systems, and that resources are available to the client to pay for ongoing maintenance of the building and its systems. The relative poverty and lack of economic development of Tanzania and Madagascar, coupled with their small economies, limit the availability of a labor pool skilled in installation and maintenance of complex building systems. Furthermore, the local institutions – public schools, for example – operate with barely enough money to exist. Teachers at times go without salary. Classrooms lack furniture and the most rudimentary learning materials. This type of institution has no capacity to employ skilled labor to regularly maintain a mechanical system. For this kind of context, a different model of what is going to be considered sustainable has to be imagined.

A final assumption that is in no way explicit, is that of state-provided security in the form of a police force, whose existence and presence acts as a deterrent to thieves. While this presence is taken for granted in more economically developed countries, its absence necessitates a design response in buildings to provide some of the needed security from theft.

6.2 Summary of Sustainability Aspects Not Addressed

Characteristics of sustainable building design and construction relevant to the contexts of Tanzania and Madagascar that are not addressed in the LEED green building rating system criteria include:

- Availability of skilled labor, importance of technology transfer, and maximizing the use of local labor;
- Addressing the alleviation of poverty;
- Maintainability within local material and labor resources;
- Durability of materials and construction;
- Adaptability and flexibility for changes to program;
- Different approach to waste and recycling because of endemic poverty;
- Response of a building to its social and cultural context;
- Use of exterior spaces and the integration of interior and exterior spaces;
- Passive means of heating, cooling and ventilating interior spaces;
- Means to ensure physical security; and
- Limiting or forbidding the use of endangered materials.

Sustainability requires local participation in a number of ways. It is desirable that the economic benefits of a given project's construction and operations be felt in the local community. If the design and building process does not involve the surrounding community, it is not likely to be cared for by them or maintained by them. Local community involvement in a project means more vested local interest in its success. Outside intervention will be expected and needed for the building operations and maintenance if neither the decision process nor the construction process involve the local community. The availability and skill level of local labor will impact the extent of community involvement in the project and thus can have an important influence on the sustainability of a given project. The issue of local labor has also to do with the concept of technology transfer – the intentional training of local labor to raise their skill level and, as a benefit to the project, to facilitate the operation, maintenance and repair of the building and its systems by means of such locally available labor.

Planning for maintenance and minimizing needed maintenance are important to achieving sustainability in the DCCTM. If the building uses materials that are not available or familiar in the local context, materials that need to be replaced frequently, or that require a lot of expensive maintenance, it is a less sustainable building in the DCCTM where maintenance is not something typically built into institutional and business budgets. It is important to stipulate whether required maintenance is expensive or not because in the DCCTM, with its endemic high unemployment, it is desirable for a building's construction and operations to provide local employment. As long as a building's required maintenance is low cost and within local means, it can be a positive because it gives the opportunity to hire local labor to perform such ongoing maintenance. In order to minimize maintenance, it is necessary to survey what building materials and systems are available or in use locally and assess their applicability to the proposed building. Maintenance concerns coupled with a restricted variety of choices due to the smaller economies of the DCCTM go a long way toward helping the designer decide what materials and systems to specify. Selected materials and systems should be familiar, or at least readily understandable by users and local labor. They should require minimal maintenance and have a long expected life span. If possible, materials should be used whose finish is already part of the material as installed. For example, burnt bricks and stone require no further finishing once installed. Prepainted galvanized roofing sheets and prefinished aluminum windows are other examples.

As mentioned above, buildings, though cheaper to build in the DCCTM in absolute terms, represent a greater capital investment, as measured against GDP and other measures of wealth and income, than in more developed economies. The idea of demolishing a well-built one-story commercial building because it no longer is needed, as happens in the U.S., would rarely occur in the DCCTM. The building in question would be put to other uses. This is also facilitated, as also mentioned above, by the fact that buildings in the DCCTM are generally built from more durable materials.

Owing to this great value that existing buildings have, there is an advantage to designing buildings to be flexible in the way they are used and adaptable to different future uses. This goal can be facilitated by installing utilities such as electricity and plumbing on the surface of walls instead of buried in the walls as is the common practice. In this way, they can be replaced, extended or repaired more easily. Another idea is to minimize interior bearing walls so that spaces can be opened up if there is a need for a larger space. Designing the building so that every space has access to natural light and ventilation is another means to ensure its flexibility and adaptability.

Poverty is another issue not addressed in the rating systems. Some aspects of LEED, such as the requirement for commissioning, assume available resources – both financial and human – that are often not available in the DCCTM. An indication of the poverty endemic in the DCCTM is the attitude to waste and recycling. Virtually everything is recycled from a construction site since all the debris has value to someone. There is a great emphasis in LEED on diverting construction waste from the landfill through recycling. By this measure, projects in the DCCTM are very green. Building projects have the potential to have substantial impact, both in the short and the long term, on poverty alleviation. Policies and strategies for job creation, and therefore fighting poverty, could figure into the rating system in an intentional and explicit way because of its importance to the goal of sustainable development in the developing country context.

A feasibility study, prior to project implementation, could identify a project's potential contribution to poverty alleviation. The construction process itself is a generator of income: in the short term, for those planning and executing the project, and in the long term, through creation of employment related to the running and routine maintenance of the facility. The short term income is not only for those working on the construction site, but those involved in the manufacture and transport of building materials, from extraction of raw materials through their conversion to finished products, and to delivery to the jobsite. For this reason, the more materials that are of local and regional extraction and manufacture, the greater the impact of the project can be on poverty alleviation. Labor-intensive construction methods are also helpful in creating local employment, and the use of building technologies that are familiar and use locally available materials is helpful in ensuring future employment in the routine maintenance of a building, and eventual replacement of building components that break or wear out.

The Portable Laboratory on Uncommon Ground (PLUG), developed by researchers and architects at Virginia Tech, presents some interesting questions about what sustainability means. The mobile field laboratory was designed to have minimal impact on a given research site. The unit is built in the U.S. of materials available there with the intention of packing it neatly into a shipping container for installation in whatever research environment needs the facility. The laudable goal is to be able to provide researchers with all the equipment that they would need at the site of their research while being able to remove the facility at the end of the research leaving no trace.[105] From the strictly environmental viewpoint, this idea works, but it has virtually no economic or social connection with its site and it does not address how the researchers eat and take care of their other bodily needs while doing their research. The broader view of sustainability as outlined in Chapter 2, Section 2.2 would require that an assessment include these other factors as well. Such an assessment would ask, among other questions: what positive impact could such a project have on its site? What kind of employment might be generated?

The LEED and other green building rating system criteria understandably emphasize physical, quantifiable aspects since their intent is to be able to objectively evaluate and compare the performance of buildings. What is not mentioned is the cultural and social aspects – which Benjamin Andriamihaja – country director of a scientific research NGO in Madagascar – underlined as the sina qua non of sustainability in the context of Madagascar. He noted that “if it is not rooted in the Malagasy cultural context, it will not be sustainable.” [106] So how does one make a proposed building rooted in the Malagasy or other cultural context? The designer can make use of building elements and materials that are recognizable and familiar to the particular

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[105]See http://www.vt.edu/spotlight/innovation/2007-01-15_structure/2007-01-15_structure.html (retrieved 24 April 2010) for information on this prefabricated modular field laboratory and its use in research in western Tanzania.
[106] Interview with in-country project director for the Centre ValBio, 2003.

cultural context. In the example of Madagascar, the use of verandas along the fronts of buildings, changes in roof pitches from veranda to main building, building materials such as burnt brick and cut stone are familiar features of building in the highlands areas.

Another aspect of a cultural connection is to root the proposed intervention in the local building culture, as defined by Howard Davis in *The Culture of Building*. Davis defines building culture as "the coordinated system of knowledge, rules, and procedures that is shared by people who participate in the building activity and that determines the form buildings and cities take."[107] Rooting a proposed building, technique or material in the local building culture would mean making use of a familiar type of labor arrangement. For example, any new technique / material would be introduced by a local master craftsman, not a foreigner. The local master craftsman, known to all, and trusted, could introduce a new sustainable technique or method with more success. In this way, the proposed technique or material is re-interpreted to fit and be part of the local context. It is by means of understanding the building cultures at work in Madagascar and Tanzania, that is, it is through the tool of the building culture that sustainability can be defined and reinforced in design and construction in the DCCTM.

Another way to address the cultural aspect is through the use of space that corresponds to the way space is used in that context. This has been mentioned above in the way that a number of everyday activities occur in the out-of-doors and the fact that interior and exterior spaces are not as strictly separated as they are of necessity in more extreme climates. An example of other uses of space particular to the contexts of Tanzania and Madagascar is the separation between food preparation space(s) and eating spaces. While in the U.S., family rooms and kitchens blend together into one space so that the cook can interact with guests, the preference in Madagascar and Tanzania is for separate spaces. Food preparation there typically involves a more comprehensive transformation of raw ingredients and, therefore, a lot of time. It often is done in the out-of-doors, as well as inside, and it is messy. Other cultural aspects with spatial implications are the importance of formal greetings, and the time and space that that requires, and the custom of providing guests with drinks and food, even if a visit is unforeseen or of short

[107] Davis, Howard. Ibid. p.3.

duration. Spaces that can serve these ceremonial and formal functions are appreciated and much used.

In the DCCTM, passive means of climate control predominate, as well they should in a mild climate. Some of these means, such as roof overhangs and natural ventilation, can be found in some of the LEED criteria. However, the passive approach that is successful in the DCCTM – building orientation and windows on opposite sides of a room – is not addressed, in favor of mechanically intensive cooling, heating and ventilating techniques.

As mentioned above, LEED and other green building rating systems assume a police presence to provide a deterrent from theft. Security is critical to the sustainability of any institution or business venture, so that people have a reasonable expectation that their possessions will not be stolen. The community is of critical importance in areas where government-provided social services, such as police, are not present, or are not effective. If there is no 911 to call, you have to enlist the aid of the surrounding community by having a recognized means of calling for help. In Tanzania, when one home is threatened by a thief, the homeowner bangs on a pan outside and shouts 'thief' and neighbors come running. In addition to the assistance of the community, a design response is needed to make access for thieves more difficult. Given enough time, thieves will always find a way in. The idea is to make the effort take enough time and be in a public enough place so that the community will notice the thieves' activities. The most common design response in the DCCTM is to add metal bars or grills to all windows and to doors. Another is to position doors and other access points such as gates in such a way that they are the most visible to the community. The need for security leads people to limit the number and size of windows which is at cross purposes with the desire and need for daylighting which seeks more and bigger window openings.

An aspect not addressed in LEED is the use of building materials in danger of being depleted. Palissandre, also known as rosewood, is a beautiful wood in Madagascar long used for fine furniture and finish carpentry. It has been harvested at an unsustainable rate for more than 20 years. Efforts have only been put in place since the 1990's to protect rosewood by limiting its harvest, but the political instability since early 2009 has given free rein to criminal groups that arrange the cutting and transport abroad of rosewood illegally logged in Madagascar's national parks.[108] Any project that uses any rosewood or similar endangered species should be deemed unsustainable until such time as a sustainably harvested source becomes available.

6.3 Elements of a Green Building Rating System for Tanzania and Madagascar

A building designed and built in developing country contexts, such as those of Madagascar and Tanzania, in order to be considered sustainable, has to respond significantly to the critical issues of sustainability in those contexts. Among these issues are environmental degradation through deforestation, overpopulation of urban areas, limited capacity of human and financial resources for maintenance, inadequate and unaffordable water and sanitation, unaffordable and nonrenewable energy sources for electricity and food preparation, endemic poverty and lack of employment opportunities. The resources for sustainable design and construction in the developing country contexts of Tanzania and Madagascar start with traditional residential construction which embodies the essence of sustainability – completely local, renewable and biodegradable. We must look around and learn from the locality by striving to use the available local technology and materials. Basic elements and strategies of sustainability are shared across economies and cultures, but there are aspects that are specific to the developing country contexts of Madagascar and Tanzania, such as the availability of labor in both countries, and the availability of stone and brick and the building culture associated with their use.

The previously cited ecolodge project in Rwanda faced challenges in applying the LEED criteria to their project, and concluded that additional criteria were needed to satisfactorily assess sustainability in the context of their project in Rwanda. They found that their efforts at reforestation in the vicinity of their project, the improvements in the local economy and in the lives of those impacted by the project, and the passive cooling achieved, were not adequately addressed by the LEED criteria.[109]

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[108] See Schuurman, Derek and Porter P. Lowry. 2009. The Madagascar Palisandre Massacre. In *Madagascar Conservation and Development*. 4:2. p. 98 for a review of the illegal logging of rosewood and its impact

[109] Percoraro, Kat. 2008. *Rwanda and LEED*. Unpublished.

Characteristics of a green building rating system adapted to the DCCTM would include:

- Emphasis on a building's independence in terms of electricity, water and sanitation;
- Independence even insofar as food production as on-site kitchen gardens should be encouraged;
- Credit for passive design strategies in response to climate such as building orientation, roof overhangs, and location of windows for natural ventilation;.
- Reference to design standards that are known to local practitioners or that at least relate to the local context; (LEED refers to US based and US relevant standards that would very often be both inaccessible and irrelevant to the DCCTM. Any referenced standards should be incorporated into the rating system document)
- Incorporation of security measures as a criterion for sustainability;
- Local sourcing criteria to refer to preference for materials sourced within national economies and regional trading blocs;
- Promotion of the use of local labor;
- Encouragement for the incorporation of a training component – technology transfer – for local labor;
- Proscription of the use of endangered materials in the building;
- Aspects of direct benefit to the community such as access to potable water;
- Natural resources accounting for existing site before and after intervention;
- Dust control measures in the dry season; and
- Education of building users in sustainability issues and strategies both in the community and as exemplified in the green building.

The existing green building rating criteria that are found to be relevant to the DCCTM should be reviewed and revised to relate more directly. An example would be the re-working of the credit related to the access to public transportation to refer to privately-owned and operated minibuses and flatbed trucks that serve as public transport.

A pressing issue often confronted is how to keep dust down in the dry season. This leads to a preference for leafy shade trees that help intercept wind-born dust, and capturing the largest quantity of rainwater to last as long as possible for irrigating the landscaping into the dry season. There are plants that thrive in the dry season, but they are not necessarily the ones that can help with the dust that is ubiquitous then. The goal is to make the rainy season spread as far as practical into the time period after the rainy season for quality of life issues: cooler microclimates around buildings for greater user comfort both indoors and outdoors – and control of dust that gets everywhere and especially into equipment such as computers. The idea should be, instead of just using drought-tolerant plants, to create an oasis through the extensive recycling of greywater and capture of stormwater runoff and the use of native shade trees. Dust-reducing strategies for the dry season should be encouraged. One idea is the use of drip irrigation technology along the top of a web of stainless steel wires at the top of a perimeter fence down which water would drip and, on its way down, would pick up wind-born dust.

Substantial credit should be given for a project that instigates or develops locally harvested and/or processed materials in lieu of normally available (and usually more environmentally destructive) building materials. More weight needs to be given to the sustainability of the proposed building within the community: how it relates to the community and what it contributes to the community.

The following strategies would be particularly useful in the DCCTM:

Integration into the natural and human environment

- Project integration (insertion) into the natural environment with minimal negative impact through climate-responsive design
- Integration of the project into the economic context – with discernable benefit to the community and explicit strategies to remain economically viable.
- Design that takes into account existing cultural patterns and behaviors and finds inspiration in local built forms, materials and techniques.
- Design that would be grounded in the local building culture of materials and methods and capabilities of locally-available labor.
- Sustainability assessment for a proposed project on a given site would address economic, environmental as well as social/cultural aspects.[110]

Ecological consciousness and sustainability

- Project design and operation that reflect consciousness of the fragility of the ecology in which it is situated and awareness of its impact upon it.
- Building materials and techniques that make use of local physical and human resources.
- Facility maintenance is minimized and undertaken through local resources to the extent possible.
- Built from renewable building materials from sustainable sources.

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[110] See Adam's discussion of Cost-Benefit Analysis (CBA), Strategic Environmental Assessment (SEA) and Social Impact Assessment (SIA). Adams, W.M. 2001. *Green Development: Environment and Sustainability in the Third World*. London: Routledge. p. 310-332. See also the Estidama Pearl green building rating system and the different assessments required at www.estidama.org.

- The operation of the facility is done in a sustainable manner maximizing local and renewable resources for energy.
- Natural resources accounting for a given site at project inception is used to evaluate what is there, to identify opportunities for amelioration and metrics to assess if and to what extent the site is in better shape at project completion. For example, planting shade trees, vegetable gardens, earthen dams/berms to hold seasonal rainwater for gradual dispersal during the dry season.
- Project includes significant education component to raise consciousness, among building users and within the community, of sustainability issues and how the building addresses them.

Sustainability of support and energy systems

- Water is collected and used with care and intentionality.
- Waste water is separated and used for gardens and landscaping.
- Trash is separated and made available to the community for recycling.
- Electricity is produced on site using renewable means.
- Vegetable gardens and other food production occurs on site.

Replicability

- Will the project or aspects of it serve as inspiration and model for other projects? To serve as a model, the strategies and materials have to be available, understandable, and affordable and to have a perceivable benefit.

Instead of developing a separate green building rating system for the developing country contexts of Tanzania and Madagascar that could be misinterpreted by their citizens – justifiably suspicious of first world intentions – as a lesser or inferior system, it would be more beneficial and useful to develop the green building rating criteria appropriate to the Tanzania and Madagascar within the framework of an established and accepted green building rating system. This separate but related rating system could be elaborated for green building in the DCCTM, and perhaps other similar developing countries, and would address the sustainability-related issues particular to their context and omit those from the rating system that do not pertain. It could be developed just as the USGBC and BRE develop modified versions of their rating systems for a particular building type, such as health care or educational facilities. In that way, comparisons between buildings will be still be possible: a high rating in the green building rating system for the developing country context would be held to be equivalent to a high rating for any other building type.

Such a rating system, modified for the developing country context, would be much easier to use since it would address issues of critical importance to sustainability in the DCCTM and give them appropriate weight. Instead of trying to contort the requirements of a green building rating system developed for an entirely different context, the system for the DCCTM would address issues of critical importance, such as energy independence, maintenance/durability, security and labor, and give appropriate weighting to issues of little relevance, such as indoor air quality.

The development of green building rating criteria appropriate for the DCCTM should be undertaken in consultation with governmental and non-governmental entities in Tanzania and Madagascar who deal with the built environment. In Tanzania, the government's Architects' and Quantity Surveyors' Registration Board, and the business group, the Architectural Association of Tanzania, could be involved both in the elaboration of such criteria for a green building rating system and in its promotion for use among the building community of Tanzania. Similarly in Madagascar, the business community's Ordre des Architectes de Madagascar and the Service de l'Architecture, de l'Urbanisme et de l'Habitat of the Ministre des Travaux Publiques could play an important role in the development and promotion of an appropriate green building rating system.

6.4 Implications for Green Building Rating Systems and Further Research

To more comprehensively address sustainability, it has to be viewed in its larger economic, social and environmental context. This stands in contrast to how sustainability is reflected in green building rating systems developed in the US and UK, in which it is treated as primarily an environmental and technical issue.

Existing green building rating systems such as USGBC's LEED in the US and BREEAM in the UK can learn from the issues of sustainability in the developing country contexts of Tanzania and Madagascar by understanding that issues of maintenance and durability of materials and systems are an integral part of the sustainability equation. Labor can also be incorporated as an issue through attention to technology transfer: the importance of training local personnel in the maintenance of building systems and materials will contribute to a project's sustainability. The incorporation of strategies to enhance the security of a building will also add to its sustainability. Finally, passive means of climate control and modulation can be more explicitly made part of rating criteria.

Further research would be useful into the manner in which cultural aspects can be incorporated into green building rating criteria in the interest of making green building rating systems respond fully to all three aspects of sustainability: environmental, economic and social/cultural. Another important subject is the identification and development of performance standards relevant to the developing country context of countries like Tanzania and Madagascar. While their building culture is rooted in their traditional and colonial heritage and colonial energy and material performance standards, these still have to be adapted to respond to the particular developing country context of climate, economy and culture.

There is also the important question of the degree to which the findings of this present research can be generalized further than the two countries that are the focus of this research: Madagascar and Tanzania. Tanzania is part of the East African Community together with Uganda and Kenya. They share a common colonial heritage and language. This is a natural opportunity for the extension of the benefits of a green building rating system to a wider geographical area. Tanzania is also part of the Southern Africa Development Conference (SADC) which began life in the era of apartheid as a unified economic force against South Africa. It comprises most all of the countries of southern Africa including Madagascar and Tanzania. There may be enough similarities between the SADC member countries to justify a unified green building rating system for joint use which would greatly increase its geographic scope. Madagascar is also part of the Indian Ocean Rim Association for Regional Cooperation (IORA-RC) with which it has shared climatic, historical and economic interests. The geographic distances between member countries may make this regional group less promising than SADC but it does offer an opportunity for shared learning and experiences on sustainability issues between tropical island nations or those tropical nations with considerable shorelines.

6.5 Conclusion

This research demonstrates how sustainability can be viewed in the contexts of Tanzania and Madagascar as a broader concept than that evidenced in the criteria of the major green building rating systems such as LEED or BREEAM. It points to the importance of process in any efforts at sustainable design. Far from being a simple one-size-fits-all checklist to review and tick off, sustainable design requires a process that looks at sustainability comprehensively, exploring each of its component dimensions to discern its fit and relevance to a given context.

The results of this research will be of assistance to various stakeholders. Malagasy and Tanzanian architects, as well as those of similar developing countries, who want to work in the direction of greater sustainability, can find here tools to explore and express what sustainable design and construction is in their context. This research will also help U.S. and other foreign architects, called upon to practice in such contexts, to better identify sustainability issues and means to their achievement that may be quite other than they expect.

This research will also help clients in Tanzania and Madagascar, and other similar developing countries, who want to better understand how their building projects can be sustainable and to identify strategies particular to their context that will propel them in that direction. The results will also be of help to those organizations that develop green building rating systems, to better understand broader issues of sustainability that find expression in contexts that may be unfamiliar to them.

This research indicates that sustainability and green building in developing countries like Madagascar and Tanzania are significantly different from that in more economically developed countries in which the major green building rating systems have been developed. For a rating system to adequately evaluate sustainability in Madagascar and Tanzania, these differences can be addressed and incorporated into a modified version of existing green building rating systems. Such a modified rating system would take into account the particularities of the cultural/social, economic and environmental characteristics of the developing country contexts of Madagascar and Tanzania and, because of its greater relevance, would be more useful and more likely to be adopted for use in those countries.

Indications from my recent and current project work in Malawi, in central southern Africa, Ghana, in West Africa, and Kenya, in East Africa, are that there are many similarities with the contexts of Madagascar and Tanzania. The extreme poverty, limited resources, similar economic, climatic and post-colonial conditions indicate preliminarily, that there is more that unites these various countries than divides them as regards the issues of sustainability. It seems possible, then, that a green building rating system could be developed that would be applicable not only to Tanzania and Madagascar, but to a number of countries with such shared characteristics. But that, as they say, will be for another day.

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