

The Role of Institutions of Higher Education in Sustainability: The Comprehensive, Public, Land-Grant University

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***Abstract**— This paper introduces a background discussion of the importance of sustainability in the 21st century, the issues surrounding how we learn, the role of science, and the importance of interdisciplinarity with respect to ecological and socio-economic sustainability. Furthermore, background information is provided about the history and origins of the American public, land-grant university together with a discussion of a few of the opportunities and challenges that it faces with respect to its role as an engine to achieve sustainability.*

Introduction and Background

At the beginning of the 21st century, the word, sustainability, is becoming a buzz word in a variety of different arenas. Although the word is often preceded by an adjective (for example, economic, environmental, ecological, etc.), it is less common to see sustainability discussed in a more holistic way that extends beyond a certain limited frame of reference. To a growing number of people, the concept of sustainability is more complex than often assumed and recognizes the extremely complex interactions between interrelated environmental, ecological, social, political, economic, and other factors. In fact, a working definition of sustainability that appears to be gaining traction is: the process of decision-making which allows future generations at least as many natural resource options as is available to this generation, while at the same time, fostering the growth and vitality of the spectrum of human institutions that support social stability.

This approach to sustainability is arising in large part due to a variety of realizations that were all but absent for much of the late 20th century. In addition to the development of a set of scientific and technological developments that converged to bring about a new and evolving view of the relationship between the numerous facets of the natural environment and a myriad of social institutions, the moral and intellectual bankruptcy of past resource management philosophies has become evident. For many years, extreme views regarding the relationship between human and environmental interests, advocating either preservation of the environment at the expense of social development and economic progress, or

economic and commercial development with indifference to ecosystem health, dominated the discussion. This debate has been marked by each sides lack of tolerance for the other opinion. Today, the confluence of technological capabilities to collect and analyze enormous amounts of spatial and temporal data, an increasing understanding of the complex interrelationships between the myriad of physical and biological environmental systems and social institutions, and the experiences of failed paradigms concerning how people interact with the natural environment is creating a growing interested in, and potential for, the concept of the simultaneous sustainability of the natural environment and human institutions.

The complex interrelationships that exist between seemingly disparate environmental and humanistic interests are beginning to be recognized. This is evident in the way in which people learn. Recent developments in psychology have revealed how human beings receive, retain, and synthesize information into knowledge and applications. When the brain receives information that is in an isolated form and disconnected from a larger context, its significance is analogous to that of a single piece of a jigsaw puzzle. Any one piece has very little meaning in and of itself. However, when each of the individual pieces of the puzzle is seen in the context of the adjacent pieces, a picture begins to form that is recognizable and has meaning. Traditional methods of management and problem solving in natural resources have involved presenting information as individual and isolated puzzle pieces. For example, silvicultural practices designed to optimize some component of forest growth may be indifferent to wildlife, air/water quality, local societal well-being, and other

interconnected factors. As such, this decision may have negative consequences that could overwhelm any forest growth efficiency. This approach makes it difficult, if not impossible, for people to grasp the numerous components of a problem or form a solution that accounts for the integrated effects of the component variables that define the issue. Future approaches to large-scale problem solving will have to represent the salient issues in the context of other important issues and integrate them in a geospatial and temporal framework.

For virtually all of the 20th century, techniques used by state and federal agencies to make surveys and measurements of environmental parameters lacked the sensitivity to provide crucial information for local situations and often missed or placed too much emphasis on environmental anomalies. Traditional tools lacked either the precision and/or robustness to provide the information upon which optimal land-use and other decisions could be based. Furthermore, it was often the case that field measurements were used only once and lacked the interoperability that is becoming increasingly in demand. The increasingly-available geo-spatial tools (for example, GPS, GIS, remote sensing, spatial statistics, and others), especially those that deal with pixel-based methodologies, are ameliorating many of the problems that were associated with traditional measurement techniques. There is now a mechanism whereby people in the natural resource management fields, as well as a myriad of other areas, can obtain information about very small and specific geographic areas and use it in a variety of ways.

People throughout the world are realizing that in order to achieve both a healthy and vital environment for this and future generations and to create thriving and sustainable ecosystem resources-based economies and other social institutions a unified framework must be put in place that will give people of all backgrounds access to high-quality information and knowledge regarding a myriad of resources. This framework must be spatially- and temporally-explicit; at the necessary level of resolution; be sensitive to diverse needs; and have a high utility for sustainability planning and decision-making.

Unifying Information and Knowledge

If society is to be successful in accomplishing its sustainability goals, then the unification of information and knowledge across disciplines will have to occur on a scale much greater than we are experiencing presently. In addition, institutions of higher education will have to play

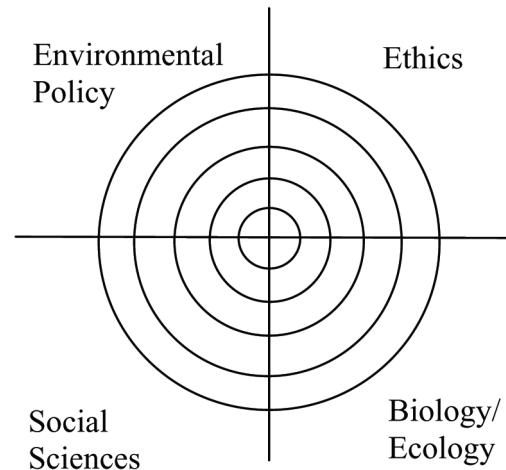


Figure 1. Conceptualization of the nature of problems and their interactions.

a leadership role. This will mean that the ways in which we teach, do research, and perform service/outreach will have to reflect the desired future outcomes.

In the much the same way that contemporary science has become increasingly fragmented, researchers in the natural resources arena have worked in intellectual isolation that separates, rather than connects, them from other fields that are impacted by their work. Much of the environmentally-related, biological science performed in the 20th century was often marked by a lack of connection to any human values or interactions. This philosophic approach to science has drifted away from that of the 17th and 18th century enlightenment thinkers, who many believe were essentially correct in their thinking. Their basic premise was that the greatest enterprise of the mind has always been and always will be the attempted linkage of the sciences and humanities. It is believed by some that the fragmentation of science that has occurred in the 20th century has caused thinkers to focus more on the discipline in which they operate (for example, the particular animal, plant, forest stand, rangeland, etc.) than on the bigger question of what are the social and ethical impacts of their work. Figure 1 is a schematic that may be useful in grasping the relationship between components of a problem. Each of the four quadrants defines a part of the contemporary academic mind. Each has its own practitioners, language, modes of analysis, and standards of validation. As the concentric rings are viewed, it becomes clear that the further a scientist is from the center (at 451 angles to the axes), the more intellectual isolation occurs. However, the vast majority of the important sustainability problems occur near the center of the figure. Here, most of the work is needed, but relatively little has been done.

The American, Land-Grant, Public University Tradition

Prior to the 19th century, American colleges and universities were private with many being religion-based. With the founding of the institution that is today the University of Virginia by Thomas Jefferson, a new tradition in American higher education was initiated. In 1862, Abraham Lincoln, who was a serious student and admirer of Jefferson, signed the Morrill Act which created the national public, land-grant university system. The signing of this legislation during intense years of the Civil War was an act of optimism that reflected Lincoln's sense of a growing and dynamic future. The land-grant university was designed to provide education to the children of all citizens in the "mechanical arts" (in other words, agriculture, engineering, etc.) and prepare the next generation of citizens with a liberal education that would facilitate the growth of a vital, democratic society. Many believe that the establishment of the land-grant university systems is the single greatest accomplishment of American education. Today, the role of the land-grant university has expanded considerably to include virtually every area of societal need, while at the same time, maintaining its role to which it was originally intended. In addition, the Historically Black Land Grant Universities created by the 1890 legislation, designed to educate the descendants of slaves, and the sea- and space-grant universities were created to fulfill additional societal needs to provide greater societal inclusiveness and address non-land-based issues.

Colorado State University, like many similar universities, not only offers programs in traditional areas, such as liberal arts, engineering, natural sciences, but recognizes its obligations to a state-wide constituency by offering a wide range of programs in agriculture, veterinary medicine and biomedical sciences, natural resources, and a variety of social and other human subject areas.

Opportunities and Challenges Facing Public Higher Educational Institutions

If sustainability in its greater holistic sense is to become a reality, it will be imperative that a major effort be developed which brings together diverse people from across the spectrum of societal institutions and across geopolitical boundaries. For any category of social institution (e.g., education, government, industry, etc.) the interactions between segments of society that contribute

to the sustainability issue will be at least as important as those within any particular institution. In the paragraphs below, the issues facing public land-grant universities will be viewed from an internal perspective.

Major public research universities are extremely complex institutions. Inherent in their structures are such things as decentralized administrative units, faculty autonomy, tenure system, disciplinary-based academic organization, affiliations with state and federal natural resource agencies, and entrepreneurial environments that represent both opportunities and challenges with respect to being positioned to address sustainability issues. Although universities and other institutions of higher education have the ability to shape the future and impact the sustainability of social and ecological resources in many ways, the following paragraphs will address a few key opportunities and challenges that exist. The paragraphs below discuss a few of the issues related to the role of land-grant, public universities in promoting sustainability.

Opportunities

When they are at their best, universities are repositories for the most intellectually-aggressive, socially-responsive, and technically-proficient individuals, who when focusing their energies and talents on important social issues, can play a significant role in ameliorating social maladies and other issues that confront society. Recent examples at Colorado State University include work on improving the lives of people with diseases such as cancer and tuberculosis, homeland security, genetically-modified mouse models, equine reproduction, social issues revolving around ethnicity, and many others. In addition, through discovery that occurs in laboratories, studios, and other intellectual campus venues, patentable products are developed capable of stimulating economic activity and advancing society. The development of health monitoring devices, synthetic human tissue, mathematical processes to facilitate secure wireless communications, and others are typical of those innovations that not only improve society, but stimulate economic activity. Finally, university faculty has the opportunity to work with students who will be the next generation of leaders. As such, they have the ability to instill certain core values in students and set them on a trajectory towards understanding the complex relationships between people and natural resources with an eye toward the responsible use and management of these resources. To impact sustainability of human and ecological resources, integrated efforts at university campuses will be necessary to infuse into society the knowledge, educated citizenry, and applications needed to address the challenges and opportunities.

Interdisciplinary programs and activity

To achieve sustainability in the 21st century, the integrated efforts of many people from diverse backgrounds, disciplines, and professional points of view will need to be assembled. To be successful people will have to understand the role of their profession and those of disparate, yet related, professions to achieve desired goals.

More progressive universities promote and encourage the initiation, growth, and vitality of programs that exploit the synergies associated with the collaboration of people from disparate, but complimentary disciplines. In the 21st century, it is becoming increasingly clear that people working at the center of traditional disciplines will not solve the most important societal problems. If the origin of the illustration in figure 1 depicts the intellectual neighborhood in which socially-meaningful solutions to sustainability and other vexing problems exist, it is very unlikely that any one person or group of disciplinarily similar individuals can have the breadth of knowledge to have a meaningful impact on such complex problems. Although no university can maintain a faculty of sufficient depth and breadth to address all socially important problems, when people working on the boundary of key disciplinary areas join forces, new intellectual areas can immerse that in time can evolve to provide new insights and perspectives. The talents of these people can be organized in a variety of ways to optimally exploit their capabilities and generate maximal synergy.

One way new fields can develop, grow, and gain recognition is by the creation of new programs that will ultimately become majors, and possibly, departments. From the work of intellectually-diverse individuals have arisen numerous new fields of endeavor. The past fifty years has been marked by the creation of many new fields that were derived from more established and traditional fields of study. Examples include: biochemistry evolving from biology and chemistry; mathematics, computer science, and electrical engineering forming computer engineering; geospatial sciences are derived from the combination of efforts from disciplines such as geography, computer science, information technology, and others; biomedical engineering developing from mechanical engineering and a variety of other biological and natural sciences; and many others. Today, these and other programs that were unheard of a generation or two ago are now ubiquitous on the national university landscape.

Although it is not difficult to find outstanding faculty, excellent facilities, and other indices of quality through the campus of many comprehensive, public, research universities; it is clear that the greatest growth will be in the areas where the institution can focus their existing strengths and exploit synergies to develop excellence in

new and exciting areas. These strengths will usually be related to faculty expertise, infrastructure, local/regional industry, societal need, and a variety of other factors. By creating incentives and mobilizing talents, administrators can serve as catalysts to focus institutional resources in directions that will produce the greatest benefits to the university and society. The distinct advantages of mobilizing and organizing institutional resources to focus on key areas with social, scientific, technological, economic, and/or cultural relevance that have the ability to add value to society are becoming clear to many. One of the opportunities and responsibilities of senior university administrators is to be vigilant in identifying where future opportunities for long-term growth and vitality exist, and distinguish them from intellectual fads that have a short shelf-life. Once identified, an effective and efficient administrative structure needs to be developed that will marshal the human, physical, and financial infrastructure necessary to be successful. Finally, as important as knowing when the propitious time to create a center or institute has arrived, it is equally important to know when a concept has out-lived its usefulness and be willing to move resources to a more profitable areas.

At universities where interdisciplinary programs are promoted and sufficient intellectual diversity exists, the potential for combining the talents of experts in geospatial sciences, biology, economics, sociology, natural resources, and many other fields to address the sustainability issue exists. By creating centers, institutes, and other administrative entities that bring attention to specific institutional strengths, universities can attract public attention and support and the financial resources necessary to achieve their goals.

Triad mission of education, research, and outreach

One of the most basic aspects of public land-grant universities is the triad mission of education, research, and outreach/service. In these three components of the modern university exists the full range of activities that relate to the discovery of knowledge, the transmission of that knowledge to the next generation of practitioners, and finally, the application of that knowledge to opportunities and challenges that face society. Of particular relevance are the relationships that exist between these three activities. In operationally complex universities, it is difficult to draw distinct lines between the various mission components. The Venn diagram in figure 2 illustrates conceptually the overlap of the educational, research, and service/outreach missions of a public, land-grant university.

Although the numerous interrelationships between the various components of the university mission can

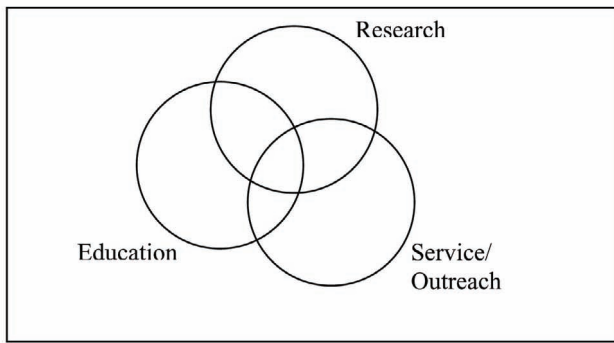


Figure 2. Venn diagram showing the interrelations between the components of the land-grant, public University's triad mission.

be variable between areas, a few examples can illustrate the concept. The research mission provides students with financial support and the opportunity to conduct basic and/or applied research under the guidance of an experienced mentor, and as such, supports the educational mission. Students provide labor, energy, a fresh point of view to enhance the research mission. Furthermore, their contributions to the undergraduate teaching activity free the time of faculty to pursue research activities and provide excellent training for the faculty of the future. There are a variety of natural connections between the outreach/service activities and the research and educational efforts of a public university. Student education is enhanced when they have the opportunity to apply their knowledge to real problems. Issues that arise in the service/ outreach enterprise for which an answer does not exist can often result in new concepts for research proposals. As such, a synergy exists between these efforts that can be applied to enhance the promotion of sustainability.

Connection to industry, government, and other stakeholders

It has become abundantly clear that a successful university takes the threads of undergraduate and graduate education, research, and service/outreach and weaves a complex fabric of programs that enriches the campus environment. At a major research university, a thriving and energetic contract and grant research enterprise will be a powerful engine to drive the growth and vitality of the entire institution. At CSU, annual contract and grant activity now exceeds \$200 million. This amount places CSU among the top three public universities that are not affiliated with medical schools in sponsored research dollar volume. The CSU indirect cost distribution model is such that slightly more than half of the captured revenues are sent to general university accounts. Although not completely obvious to the general faculty, the educational and outreach missions are enhanced

by an aggressive, successful, and growing research enterprise. The remaining indirect cost recovery is returned to the college and department of origin to support and stimulate growth of their research programs. This infusion of resources, as well as the ideas that promote the development of research proposals to address new and important issues, result from the connections that exist between universities and external stakeholders. External constituencies can take a variety of forms. However, typical types of external stakeholders include: industry (individual companies, trade associations, etc.), state and federal agencies, private foundations, NGO's, etc.

Challenges

Although public, land-grant universities are ripe with opportunities, there are also a number of challenges that they face with respect to being instruments to promote the concurrent sustainability of both socio-economic and ecological systems. In the paragraphs below, a few of these issues will be discussed.

Funding

As stated previously, universities rely on external sources of support to advance their research mission and support graduate education. For many reasons, support from external constituents is both desirable and necessary. However, it is not without some difficulties. As a receiver of support, university research priorities often reflect the funding priorities of external groups. As such, university research directions are often driven by the vicissitudes of markets, current political influences, and other idiosyncratic issues. Therefore, universities are sometimes forced to surrender their role as leaders, and accept positions of followers of societal interests.

Another funding issue relates to the cost of doing research. As science and technology are advancing at rapid rates, it is becoming increasingly difficult to develop and maintain the infrastructure necessary to perform modern research that will create the greatest social value. Issues related to buying arcane equipment needed for biological and other science/engineering research, together with creating an infrastructure conducive to storing and maintaining laboratory animals in a legally-sanctioned environment are becoming increasingly vexing.

Faculty autonomy

At American universities, faculty members are often protected by rules of tenure that have served them well over many decades. Tenure, as originally designed, was to ensure position security which would allow faculty to express opinions and forms of intellectual freedom in a way that would shelter them from academic reprisal. Today, under the blanket of tenure, faculty enjoys a great

deal of freedom to act independently. With this in mind, it is more difficult to get faculty to work in areas that they do not find interesting or appealing. When appropriate incentives are in place, faculty could be encouraged to participate in programs that could provide a wealth of collateral benefits to students, faculty, the greater university, and a variety of external constituents.

Developing faculty cooperation to promote sustainability poses some unique issues that need consideration. Because sustainability of human and ecological systems demands the talents of people from virtually every college, who practice different modes of operation in their fields and even use different technical language, getting broad-based involvement is difficult. In addition, there are many individuals on university faculties that are reluctant to interact with people whose intellectual disciplines are very different than their own. As such, getting the interdisciplinary cooperation that needed to successfully promote sustainability will be problematic.

Administrative structure

Academic programs in American universities are most often organized in departments which are administratively placed in colleges. This structure has served the academic community well for many decades and is a fundamental part of the university landscape. For all of the value that this arrangement has added to the American educational system, it is not without shortcomings that represent obstacles to cooperation between diverse individuals who have contributions to make to interdisciplinary programs in general, and sustainability efforts in particular.

Departments within colleges are often composed of like-minded and disciplinarily homogeneous professionals. This creates a focused intellectual group that tends to see issues from a singular point of view. Although there are countless advantages to such an arrangement, it does not lend itself particularly well to creating the intellectual

diversity that is needed to address many of the more complex and vexing problems associated with the sustainability of ecological and socio-economic resources. At more progressive and mature universities, administrative structures exist in which mechanisms are in place to allocate teaching credit, indirect cost recoveries, and other products of cooperation in a systematic and rational fashion. When these processes are in place, meaningful cooperation that crosses departmental and collegiate boundaries becomes relatively straight-forward, encouraged, and nurtured. For many universities which are more entrenched in traditional modes of operation, the lack of faculty incentives and other systemic obstacles create a reasonably impermeable barrier to cooperation. However, even in these environments, there exist many examples of excellent cooperative educational, research, and outreach activities. Most of these usually result from contributions of faculty time and effort beyond those expected of them in their normal work assignments. Unfortunately, when these efforts result from the generosity and professional interest of the faculty without administrative support, their probability of being successful over a long period of time decrease, and their intellectual vitality enjoy a short lifetime than might have been had with more proactive administrative assistance.

Conclusions

Universities have an enormous opportunity to develop, transmit, and apply the knowledge needed to advance the cause of sustainability in the 21st century. Their wealth of intellectual resources, contact with groups that identify issues and can utilize intellectual products, and ability to shape the minds of the next generation of professionals are only a few of the potential contributions that they can make. In addition, there are a variety of funding and structural issues that hamper universities in their efforts to be leaders in this area.