CENTER REPORT

~

Center for Environmental Policy
Department of Environmental Engineering Sciences
University of Florida

21 March 2005

Mark T. Brown, Acting Director[1]

1. Introduction and Mission

Part of the Department of Environmental Engineering Sciences, the **Center for Environmental Policy (CEP),** was created in 1991 by Howard T. Odum, Graduate Research Professor of Environmental Engineering Sciences. CEP fosters interdisciplinary graduate education, research, and advocacy in energy and environmental policy and is an outgrowth of nearly 30 years of work in developing methods of planning, designing, and quantitatively measuring sustainable patterns of human and ecological systems. The Center conducts research, sponsors conferences, and aids in teaching with short courses taught throughout the world on principles of energy systems, systems ecology, ecological economics, and ecological engineering that are the basis for sustainable environmental policy. The main contributions of the Center's scientists are new concepts for energy-based evaluation of human and environmental systems, called Emergy Synthesis, that form a quantitative basis for public policy decision-making.

The Center is a focal point on the University of Florida campus for faculty interested in local, regional, national, and global aspects of environmental policy. Faculty members from a variety of disciplines across campus are affiliated with the Center. In addition, the Center annually hosts several international researchers as visiting scholars, which adds a most important global perspective to our research, education and service components.

Our Mission

At the heart of CEP's mission is a commitment to providing a substantive and quantitative framework for shaping environmental policy and management. CEP is dedicated to conducting research, teaching, and service that address the interface of energy, ecology, and economics, and to establishing sustainable environmental policies and management frameworks. Through its communications and outreach program, the CEP provides a forum for exchange of information and increased understanding of the major environmental issues of our time.

---

[1] H.T. Odum died September 11, 2002, and Mark T. Brown was appointed acting director of the Center.

Florida Service
The Center evaluates resources for decisions by government and private agencies. Methods of energy analysis are used to anticipate future trends. The Center provides governments of Florida the institutional memory of lessons learned in the energy crises of 1970's and 1980's. Its innovations in energy evaluation give Florida an international reputation as leading the global discussion on the energy basis of the economy. Of critical importance to the State is our work in evaluating real wealth associated with resources such as phosphate ores and water.

Certificate in Environmental Policy and Management
The Center for Environmental Policy oversees the administrative aspects of the Certificate in Environmental Policy and Management (CEPM). The CEPM is a graduate level certificate that emphasizes scientific, technologic, economic, legal, political, and social dimensions of policy formation and implementation, and environmental management. The program includes courses offered by the College of Engineering, the College of Law and the Food and Resource Economics Department of the College of Agriculture. The CEPM is offered entirely online and is available to on-campus students as well. Currently there are 68 students actively pursuing this certificate and 23 have completed the coursework for the certificate. Warren Viessman coordinates the program.

2. Participants

Howard T. Odum (deceased 2002), Program Director
Mark T. Brown, Acting Program Director
Warren Viessman, Environmental Engineering Sciences. Coordinator of the Certificate in Environmental Policy and Management
Eliana Bardi, Biological Scientist
Matt Cohen, Post Doctoral Associate
Clay Montague, Environmental Engineering Sciences
Catherine O'Brien, Senior Secretary (50% FTE assigned to CEP)

University of Florida Affiliated Faculty:
The following faculty have contributed significantly over the past year and a half in developing an NSF-IGERT proposal titled "IGERT in Adaptive Management: Wise use of water wetlands and watersheds" currently pending. The Center coordinated the development of this large effort. These faculty members are committed to working with the Center in the realization of the IGERT's many goals and objects, should we receive funding.

Robert Baum (Philosophy), David Bloomquist (Civil Engineering), Mark Brenner (Geological Sciences), Jean-Claude Bonzongo (Environmental Eng. Sci.), Joseph Delfino (Environmental Eng. Sci.), Alyson Flournoy (Law), Peter Frederick (Wildlife Ecology and Cons.), Sabine Grunwald (Soil and Water Science), Dorota Haman (Ag & Bio Engineering), Richard Hamann (Law), Susan Jacobson(Wildlife Ecology and Cons.), James Jawitz (Soil and Water Science), Jack Jordan (Ag & Bio Engineering), Clyde_Kiker (Food and Resource Economics), Jonathan Martin (Geological Sciences), Joann Moss (Geography), Craig Osenberg (Zoology) Stephen Perz (Sociology), Ignacio Porzecanski (Sch. of Natural Res. and Env.), Ramesh Reddy (Soil and Water Science), Sandra

Russo (International Center), Katrina Schwartz (Political Science), Taylor Stein (Sch. of Forest Res. and Con.), Richard Stepp (Anthropology), Colette St. Mary (Zoology), Bron Taylor (Religion)

National and International Collaborators

The following individuals have been actively involved in initiatives directly related to CEP activities:

Sherry Brandt-Williams (USEPA), Vorasun Buranakarn (Chulalongkorn University, Thailand), Dan Campbell (USEPA), Dennis Collins (Univ. of Puerto Rico), Vito Comar (Universidade Estadual de Moto Grosso do Sul, Brazil), Steven Doherty (Slippery Rock University, Penn) Jean-Bernard Gay (Swiss Fed. Ins. of Tech. in Lausanne, Switzerland), Corrado Giannantoni (ENEA, Italy), Hugo Guillen (Universidad Autonoma de Chiapas, Mexico), Charles Hall (SUNY, Syracuse), Shu-Li Haung (Taiwan University, Taipei), Chung-hsin Juan (National ILAN University, Taiwan), Robert King (Austin, TX), Shengfang Lan, (Chinese Agricultural University in Guangzhou), Lotta Lagerberg (Swedish Agricultural University, Uppsala), Jay Martin (Ohio State University), Mike Murray-Hudson (HOORC, Univ. of Botswana, Maun), Per Olov Nilsson (Swedish Agricultural University, Uppsala), Elisabeth C. Odum (Gainesville), Lars Ohlander (Swedish Agricultural University, Uppsala), Enrique Ortega (UNICAMP, Brazil), Gonzague Pillet (Univ. Fribourg, Switzerland), Torbjorn_Rydberg (Swedish Agricultural University, Uppsala), Geraldo Stachetti-Rodrigues (EMBRAPA, Brazil), David Tilley (University of Maryland), Sergio Ulgiati (Italy)

3. Publications since 1999

a. Publications in refereed journals (by year)

Brown, M.T. and S. Ulgiati.1999. Emergy evaluation of natural capital and biosphere services. *AMBIO*. Vol.28 No.6, Sept. 1999.

Lagerberg, C. and M.T. Brown. 1999. Improving Agricultural Sustainability: The Case of Swedish Greenhouse Tomatoes. *The Journal of Cleaner Production* 7 pp421-434.

Odum, H.T. 1999. Limits of information and biodiversity. pp. 229-269 in *Sozialpolitik und Okologieprobleme der Zukunft*. Austrian Academy of Sciences (Centennial), Vienna, Austria.

Odum, H.T. and E.P. Odum. 2000. The energetic basis for valuation of ecosystem services. Ecosystems 3:21-23.

Odum, H.T. 2000. Emergy evaluation of an OTEC electrical power system. *Energy* 25(2000):389-393.

Yan, M.C. and H.T. Odum. 2000. Eco-economic evolution, emergy evaluation and policy options for the sustainable development of Tibet. *J. of Chinese Geography* 10(1). 27 pp.

Brown, M.T. and S. Ulgiati 2001. Emergy Measures of Carrying Capacity to Evaluate Economic Investments. *Population and Environment* Vol 22:5 pp 471-501.

Brown, M.T. and S. Ulgiati. 2001. The Role of Environmental Services in Electricity Production Processes. *Journal of Cleaner Production* 10: 321-334

Ulgiati,S. and M.T. Brown. 2001. Emergy Evaluations and Environmental Loading of Alternative Electricity Production Systems. *Journal of Cleaner Production* 10:335-348

Odum, H.T. 2002. Explanations of ecological relationships with energy systems concepts. Ecological Modeling. Vol 158 pp201-211.

Odum, H.T. and E.C. Odum. 2003. Concepts and Methods of Ecological Engineering. *Ecological Engineering*. Vol.20 pp339-361.

Brown, M.T. and C.A.S. Hall 2004. (eds). A tribute to H.T. Odum. Special Issue of *Ecological Modeling*. Vol 78:1&2, 292p

Brown, M.T. 2004. A Picture is Worth a Thousand Words: Energy Systems Language and Simulation. *Ecological Modeling* Vol 78:1&2, pp82-100

Brown, M.T. and M.B. Vivas. 2004 A Landscape Development Intensity Index. *Environmental Monitoring and Assessment.* 101: 289–309

Jorgensen, S.E., H.T. Odum, and M.T. Brown 2004. Emergy and exergy stored in genetic information. *Ecological Modeling*. Vol 78:1&2, pp11-16

Brown, M.T. and S. Ulgiati, 2004. Energy quality, emergy, and transformity: H.T. Odum's contributions to quantifying and understanding systems. *Ecological Modeling*. Vol 78;1&2, pp201-213

Brown, M.T. H.T. Odum, and S.E. Jorgensen. 2004. Energy hierarchy and transformity in the universe. *Ecological Modeling* Vol 178:172, pp17-28

2b. Other significant publications since 1999 (by year)

Odum, H.T, M.T. Brown, and S. Ulgiati. 1999. Ecosystems as Energetic Systems. in S.E. Jorgensen and F. Muller (eds) *Handbook of Ecosystem Theories*. CRC Press, New York

Ulgiati, S. and M.T. Brown. 1999. Emergy accounting of human-dominated, large scale ecosystems. In Jorgensen and Kay (eds.) *Thermodynamics and Ecology*. Elsevier.

Brown, M.T., M. Wackernagel and C.A.S. Hall. 2000. Comparative estimates of sustainability: economic resource base, ecological footprint and emergy. in C.A.S. Hall (ed). Quantifying Sustainable Development: the future of tropical economies. Academic Press. pp 695-713

Collins, D. and H.T. Odum. 2000. Calculating Transformities With An Eigenvector Method. In: Brown, M. T. (ed). Proceedings of the First Biennial Emergy Analysis Research Conference, Emergy Synthesis: Theory and Applications of the Emergy Methodology. Center for Environmental Policy, University of Florida, Gainesville, Florida, USA.

Odum, H.T. and E.C. Odum. 2000. Modeling for all scales. Academic Press, New York. 458p.

Brown, M.T and V. Buranakarn. 2001. Emergy Evaluation of Material Cycles and Recycle Options. p.139-152 In Brown, M.T. (ed). Emergy Synthesis: Theory and applications of the emergy methodology. Proceedings of a conference held at Gainesville, FL September 1999. The Center for Environmental Policy, University of Florida. Gainesville. 319 p

Bardi, E. and M.T. Brown, 2001. Emergy Evaluation of Ecosystems: a basis for environmental decision making. p. 81-98 In Brown, M.T. (ed). Emergy Synthesis: Theory and applications of the emergy methodology. Proceedings of a conference held at Gainesville, FL September 1999. The Center for Environmental Policy, University of Florida. Gainesville. 319 p

Odum, H.T. 2001. Simulating emergy and materials in hierarchical steps. pp. 119-127 in Emergy Synthesis: Theory and Applications of the Emergy Methodology, Proceedings

of the International Workshop on Emergy and Energy Quality, Gainesville, FL, Sept. 1999, ed. by M.T. Brown. Center for Environmental Policy, Univ. of Florida, Gainesville, 328 pp.

Odum, H.T. 2001. An energy hierarchy law for biogeochemical cycles. pp. 235-248 in Emergy Synthesis: Theory and Applications of the Emergy Methodology, Proceedings of the International Workshop on Emergy and Energy Quality, Gainesville, FL, Sept. 1999, ed. by M.T. Brown. Center for Environmental Policy, Univ. of Florida, Gainesville, 328 pp.

Odum, H.T. 2001. Energy hierarchy and money. pp. 139-148 in Understanding Complexity, ed. by J. Wilby and G. Ragsdell. Kluwer Plenum, NY.

Odum, H.T. 2001 Emergy Evaluation of Salmon Pen Culture. Proceedings of the International Institute of Fishery Economics (on line), 9 p.

Odum, H.T. 2001. Material circulation, energy hierarchy, and building construction. pp. 37-71 in Construction Ecology Materials as a Basis for Green Building, ed. by C.J. Kibert, J. Sendzimir, and B. Guy. Spon Publ., London, U.K.

Tilley, D.R. and M.T. Brown, 2001 Hierarchical Pattern of Energy Diversity in Ecological Economic Systems. In Ulgiati, S. (ed) Advances in Energy Studies. Exploring Supplies, Constraints, and Strategies. SGE Publisher, Padova, Italy, 2001.

Tonon, S., M.T. Brown, F. Luchi, A. Mirandola, A. Stoppato, and S. Ulgiati. 2001. Integration of Thermodynamic, Economic and Environmental Parameters for the Evaluation of Energy Systems. In Ulgiati, S. (ed) Advances in Energy Studies. Exploring Supplies, Constraints, and Strategies. SGE Publisher, Padova, Italy.

Brown, M.T. and A. Buenfil. 2002. Emergy Synthesis as a Tool for Evaluating Management Options for Fresh Water in Africa. In Conservation, Ecology, and Management of African Freshwaters, T.C. Crisman, C. Chapman, L. Chapman, and L. Kaufman, eds. Univ. of Florida Press.

Odum, H.T. 2002. Emergy accounting. Chapter in Unveiling Wealth - On Money, Quality of Life and Sustainability, ed. by P. Bartelmus. Kluwer Academic Publ.

Scatena, F.N., S.J. Doherty, H.T. Odum and P. Kharecha. 2002. An Emergy Evaluation of Puerto Rico and the Luquillo Experimental Forest. General Technical Report IITF-GTR-9. U.S. Dept. of Agriculture Forest Service, International Institute of Tropical Forestry, Rio Piedras, PR, 79 p.

Brown, M.T. 2003. Spatial and temporal simulations of emergy indices. in Brown, M.T., H.T. Odum, D. Tilley, and S. Ulgiati (eds) *Emergy Synthesis 2:* Theory and applications of the emergy methodology. Proceedings of the emergy research conference, Gainesville, FL 2001. Center for Environmental Policy, University of Florida, Gainesville.

Brown, M.T. 2003. Resource Imperialism: Emergy perspectives on sustainability, balancing the welfare of nations and international trade. In S. Ulgiati (ed) *Advances in Energy Studies.* Proceeding of the conference held in Porto Venere, Italy, October 2002. University of Siena, Italy.

Brown, M.T. and S. Ulgiati, 2004. Emergy, transformity and ecosystem health. In S.E. Jorgensen et.al. (eds) *Handbook of Ecological Indicators for Assessment of Ecosystem Health.* Elsevier. New York.

Brown, M.T. and S. Ulgiati. 2004. Emergy and environmental accounting. In C. Cleveland. (ed) *Encyclopedia of Energy*. Elsevier. New York.

c. Publications by the Center for Environmental Policy (by date)

Odum, H.T., M.T. Brown and S. Brandt-Williams. 2000. Handbook of Emergy Evaluation Folio 1: Introduction and Global Budget. Center for Environmental Policy, University of Florida, Gainesville. 16p.

Odum, H.T. 2000. Handbook of Emergy Evaluation Folio 2: Emergy of Global Processes. Center for Environmental Policy, University of Florida, Gainesville. 30p.

Brown, M.T. and E. Bardi. 2001. Handbook of Emergy Evaluation Folio 3: Emergy of Ecosystems. Center for Environmental Policy, University of Florida, Gainesville. 90p.

Brown, M.T. 2001 (ed). Emergy Synthesis: Theory and applications of the emergy methodology. Proceedings of a conference held at Gainesville, FL September 1999. The Center for Environmental Policy, University of Florida. Gainesville. 319 p.

Brandt-Williams, S. 2002. Handbook of Emergy Evaluation Folio 4: Emergy of Florida Agriculture. Center for Environmental Policy, University of Florida, Gainesville. 40p.

Giannantoni, C. 2002. The Maximum Em-Power principle as the basis for thermodynamics of quality. Center for Environmental Policy, University of Florida, Gainesville. 185p.

Kangas, R.C. 2002. Handbook of Emergy Evaluation Folio 5: Emergy of Landforms. Center for Environmental Policy, University of Florida, Gainesville. 16p.

Brown, M.T. H.T. Odum, D. Tilley and S. Ulgiati. 2003. (eds) Emergy Synthesis 2: Theory and applications of the emergy methodology. Proceedings of a conference held at Gainesville, FL September 2001. The Center for Environmental Policy, University of Florida. Gainesville. 432p.

4. Awards and Other Indicators of National/International Recognition

- NA -

5. Graduate Students Supported (by year)

Tom Abel, Ph.D. in Anthropology U of F (2000). Ecosystems, sociocultural systems, and ecological economics for understanding development: the case of ecotourism on the island of Bonaire, N.A. " with H.T. Odum as committee member aiding with methods. Tom is a faculty member at National Taipei University, Taiwan.

Cynthia Irvin, MS Env. Eng Sciences U of F (2001). "Evaluation Emergy Evaluation of a National Estuarine Research Reserve in Florida," with H.T. Odum and Clay Montague as committee Co-Chairs. Cynthia currently works for the Corps of Engineers in Jacksonville.

Charles Mann, dual degree MS in Env. Eng. Sciences and Law (2001). *An Emergy Evaluation of Everglades Restoration Alternatives*, with Mark Brown as Committee Chair. Charles is currently a practicing attorney in south Florida.

Glenn Behrend, MS in Env. Eng. Science (2002) "Carrying Capacity of the Florida Keys," with Mark Brown as Committee Chair. Glenn is currently with the Georgia Department of Natural Resources

Eliana Bardi, MS Env Eng. Sciences U of F (2002). *Emergy Evaluations of Ecosystems: A basis for Mitigation Policy* with Mark Brown as Committee Chair. Eliana is currently working at the Center for Environmental Policy

Andres Buenfil, Ph.D. Env. Eng. Sciences U of F (2002). *Emergy Evaluation of Alternate Water Supplies and Their Treatments in Florida*, with Mark Brown as Committee Chair. Andres also completed a paper on "Emergy Evaluation of Water Supplies in Southwest Africa" as a result of a summer fellowship at the International Institute of Applied Systems Analysis, Laxenburg, Austria. Andres returned to his home in Mexico where he has developed a private consulting business in Ecological Engineering.

Cecilia Ferreyra, MS in CNRE U of F (2002). *Emergy Evaluation of Argentina and the Rolling Pampas, Argentina*. with Mark Brown as Committee Chair. Cecilia is currently pursuing her Doctorate at the University of Guelph, Ontario.

Charlotte Lagerberg, Ph.D Swedish Univ. of Agricultural Sciences, Uppsala. (2002) *Emergy Evaluation of Swedish Greenhouse Agriculture,* with Mark Brown as Committee Co-Chair. Charlotte is currently faculty at Swedish Agricultural University in Southern Sweden.

Johanna Bjorklund, Ph.D. Swedish Univ. of Agricultural Sciences, Uppsala (2003). "Emergy Evaluation of Waste Technologies and Agricultural Production in Sweden" with Mark Brown as committee Co-Chair. Unknown placement.

Matt Cohen, Ph.D Env. Eng. Sciences U of F (2003). "Spatial analysis of emergy and economic variables and their relationship to soil erosion in the Lake Victoria Basin". Matt is currently an Assistant Scientist in the Soil and Water Sciences Department at U of F.

Fanny Meillaud MS Swiss Federal Institute of Technology in Lausanne, Switzerland (2003). *Emergy Evaluation of a Solar Building in Switzerland*, with Mark Brown as committee co-chair. Fanny is currently pursuing a Ph.D in Switzerland.

May Lehmensiek, MS Env. Eng Sciences U of F (2004.) *Evaluation of Tourism in the Okavango Delta in Botswana Using Environmental Accounting,* with Mark Brown as committee chair. May is currently looking for employment.

Cindy Chandool, Ph.D, SNRE U of F (2005). *Emergy and social indicators for evaluating carrying capacity in Trinidad and Tobago.* Cindy is working toward graduating in December of 2005. She will return to Trinidad upon completion.

Sharlynn Sweeney, Ph.D Env. Eng Sciences U of F (2005). *Spatial analysis of the relationship between ecological and economic variables in Thailand*

Manual Benjamin Vivas, Ph..D Env Eng. Sciences U of F (2005). S*patial analysis of landscape development intensity index.*

6. Internal and External Resources

a. Internal Resources

The Center currently receives salary support for half a Senior Secretary position (Ms Catherine O'Brien).

b. Current Funded Research

Development of Biological Indicators of Ecosystem Health. ($1,200k). Project period: 1999–2004. Project funded by the Florida Department of Environmental Protection to develop bioindicators of wetland health. A major aspect of the project is developing emergy measures of human disturbance of ecosystems. Supported students include; Charles Lane (Ph.D.), Ben Vivas (Ph.D.), Kelly Reiss (Ph.D.), Jim Surdick (Ph.D.), Mike Murray-Hudson (MS), Lisa Spurrier (MS).

An Ecosystem Approach to Restoring West African Drylands and Improving Rural Livelihoods through Agroforestry-based Land Management Interventions. ($215k). Project period: 2004 - 2005. Funded by the United Nations Environmental Program, the project will provide technical assistance and capacity building to countries of the semi-arid lowlands of West Africa to implement appropriate policies, strategies and action plans for advancing sustainable development objectives. Supported students include: Danielle King (MS), and Sharlynn Sweeney (Ph.D).

c. Proposals Submitted:

Advances in Energy Studies – Conference travel funds. NSF International programs. (2000) $25k, funded –2000-01

Mark Brown – Environmental Engineering Sciences

Development of Ecological Indicators for Gulf of Mexico Estuaries: Energy-based indicators for holistic integration of estuarine stress and response factors. USEPA STAR proposal (2001), $402,000, unfunded

David R. Tilley, University of Maryland

Mark T. Brown, University of Florida

Airborne Laser Swath Mapping for improved assessment of topography and vegetative structure in restored ecosystems across a post-mined landscape in Central Florida. A proposal to National Center for Airborne Laser Mapping. (2002). $24k, unfunded.

Matthew Cohen - Soil and water Sciences / Env. Eng. Sci.

Mark T. Brown – Environmental Engineering Sciences

Valuation of Florida's Wetland Ecosystem Services: A Comparative Analysis of Stated Preference and Energy-Based Approaches. USEPA STAR proposal (2004). $227k, unfunded.

Mark Brown, Ph.D. – Environmental Engineering Sciences

Matthew Cohen, Ph.D. – Soil and Water Sciences / Env. Eng. Sci.

Janaki Alavalapati, Ph.D. – Forest Resources and Conservation

Mark Clark, Ph.D. – Soil and Water Science

Biophysical Evaluation of Everglades Restoration Costs and Benefits Using Emergy Synthesis Techniques. US Dept of Interior-CESI proposal. (2004). $90k, unfunded

Mark Brown, Ph.D. – Environmental Engineering Sciences

Matthew Cohen, Ph.D. – Soil and water Sciences

IGERT in Adaptive Management: Water Wetlands and Watersheds. NSF – IGERT Proposal. (Submitted October 2004). $3,400k, pending.

Mark Brown - Environmental Engineering Sciences

Sandra Russo - International Center
Ramesh Reddy - Soil and Water Sciences
Richard Hamann - Center for Governmental Responsibility
Jonathan Martin - Geological Sciences

d. Proposals in Preparation

Emergy Based Network Analysis of the Okavango Delta, Botswana. NSF proposal in preparation.

Matt Cohen, U of F Soil and Water Sciences
Mark Brown, UF Environmental Engineering Sciences
Robert Ulanowicz, University of Maryland

Emergy Evaluation of the Natural Capital and Environmental Services Associated with the Land Holdings of the US Forest Service. USDA- Forest Service proposal in preparation.

Mark Brown - UF Environmental Engineering Sciences
Matt Cohen - U of F Soil and Water Sciences / Environmental Engineering Sciences

7. Other Center Activities

a. Conferences and Workshops

In the Spring of 2000 Center staff present a four day workshop on Emergy Synthesis and Systems Ecology in Cuba at the invitation of the Engineers Union of Cuba, (UNAICC) and the Instituto de Materiales y Reactivos, Universidad de La Habana. Over 100 scientists and engineers attended the conference.

The Center organizes and hosts a series of biennial conferences at the University of Florida titled "Emergy Research Conference: theory and applications of the emergy methodology". The conferences draw participants from the US, Italy, Sweden, Spain, Korea, China, Brazil, Mexico, and Venezuela among others. The third conference in the series was held in January 2004 on the campus of UF. The fourth conference is planned for January 2006. The proceedings of the conferences are published in book form as a series titled *Emergy Synthesis* edited by Mark Brown and others.

The Center co-hosts a series of biennial international conferences titled "Advances in Energy Studies". This ongoing series of conferences explores the interrelationships between energy, economy, and environment. The fourth was recently held in Brazil, while the proceeding three conferences were held in Italy. The fifth conference is scheduled for September 2006 in Italy. Proceedings of the conferences are published in book form jointly by the CEP and the Energy and Environment Research Unit, University of Siena, Italy.

Plans are currently under way to give a short course in Havana, Cuba in mid- summer of 2005 sponsored by The Engineers Union of Cuba, (UNAICC) and the Instituto de Materiales y Reactivos, Universidad de La Habana. Mark Brown, Elisabeth Odum, and Dan Campbell (USEPA) are giving the short course

The Center will give a one-week intensive workshop on Emergy Synthesis the first week of May 2005 in Florence, Italy in collaboration with Dr. Sergio Ulgiati of the Energy and Environment Research Unit, University of Siena. We have 35 registrants for the course who are coming from all over the world.

b. International Activities

In 2000, The Center arranged an informal student exchange program with the International Center for Agro-Forestry Research (ICRAF), Nairobi, Kenya.

In 2000-01 the Center provided travel funds for Mathew Cohen, graduate student in the Department of Environmental Engineering Sciences, to conduct research at the International Center for Research in Agro-Forestry (ICRAF), Nairobi, Kenya on impacts to Lake Victoria resulting from land tenure and erosion in the watershed. His research was the beginning of a continuing informal cooperative agreement for exchange of students and research activities between the Center for Environmental Policy and the ICRAF.

In 2002, the Center arranged an informal student exchange program with the Okavango Delta Research Center, Maun Botswana. Former Student Mike Murray-Hudson, now working at the research center will return to U of F for doctoral studies in 2005-06.

The Center provided travel funds for Ms. May Lehmensiek, graduate student in the Department of Environmental Engineering Sciences, in 2003 to conduct research at the Harry Oppenhiemer Okavango Research Center (HOORC) on environmental impacts of tourism in the Okavango Delta. Her research there was the beginning of a continuing informal cooperative agreement for exchange of students and research activities between the Center for Environmental Policy and the HOORC.

The Center provided travel funds for Prof.-Ing. Alberto Calvo from Cuba to attend the Advances in Energy Studies workshop in Italy in 2003.

c. International Visitors

In the fall semester 2001, the Center hosted five international exchange students as visiting scholars to learn our methods of emergy synthesis. Silvia Bargigli, Italy; Marco Raugei, Italy, Simone Tonon, Italy; and Felipe Scanavini, Brazil

The Center hosted Geraldo Stachetti Rodrigues, Director of Environmental Research for EMBRAPA (the Brazilian National Agricultural Research Institute) for a one year sabbatical (2002-2003) to study systems analysis and participate in research on environmental impact evaluation.

In the Fall 2002, the Center hosted Ms Fanny Miellaud of the Swiss Federal Institute of Technology, Geneva, Switzerland for a four month sabbatical to learn our techniques of energy analysis.Ms Meillaud, completed her thesis while at U of F titled *Emergy Evaluation of a Solar Building in Switzerland.* This was the beginning of an informal

cooperative agreement for research and education with Professor, Dr Jean-Bernard Gay, Department of Physics, Swiss Federal Institute of Technology in Lausanne, Switzerland.

In the Spring and Summer 2003, the center hosted Amaya Martinez, from the University Zaragoza, Spain as visiting scholar for 6 month period to learn our methods of emergy synthesis.

In the fall semester 2003 the Center hosted Hong-fang Lu, of the South China Institute of Botany, Guangzhou, China while on leave to study our methods of emergy synthesis.

d. International Collaborative Research Efforts

The Center has a continuing research program with Dr. Sergio Ulgiati, Department of Chemistry, University of Siena. Current research is related to measures of environmental impact of electrical production systems, funded by the ENEA (Italian Energy Agency).

The Center has a continuing joint collaborative relationship with Dr. Corrado Gionnantoni of the Italian National Energy Office (ENEA) to produce two books on thermodynamics and energy quality. The first was published at the end of 2002 and the second will be published in 2005. The Center has committed funds for the publication of both books.

We have collaborated with Jean Louis Scartezzini and Jean-Bernard Gay (Swiss Federal Institute of Technology in Lausanne, Switzerland) on a proposal to the Swiss National Science Foundation, under the NRP 54 Sustainable Development of the Built Environment Program. The proposal is titled "Ecosystemic Modelling of Urban Metabolism based on Modern Thermodynamics (Emergy Method)" and is currently pending.

e. Collaboration with Other Emergy Evaluation Initiatives

Scientists and students of the Center are collaborating with a new emergy-evaluation project of the Environmental Protection Agency Research Laboratory, Narragansett, Rhode Island, coordinated by former student Dan Campbell. The work includes evaluation of watersheds and mining in West Virginia.

We are collaborating with former Visiting Scholar, Shengfang Lan, of Chinese Agricultural University in Guangzhou, in his comparison of systems characteristics of new Chinese cities with U.S. cities.

We are collaborating with Shu-Li Haung at Taiwan University, Department of Urban and Regional Planning, on emergy measures of sustainability of cities.

We are collaborating with Dr. Geraldo Stachetti-Rodrigues, Head of Research and Development, EMBRAPA Environment, Brazil. Collaborative efforts include emergy indictors of sustainability of agriculture and technological innovations and development of spread sheets for emergy evaluation of development alternatives. Dr. Stachetti spent a sabbatical year at the Center on leave from EMBRAPA.

8. Additional Information and Future Plans

The May 2005 Emergy Short-course in Florence, Italy marks the first in a series of short-courses to be conducted by Mark Brown and Sergio Ulgiati. We anticipate at least two more in the coming year. One will be held in Brazil and a third will be held in Asia (probably mainland China). These short-courses are necessary because of the increasing number of individuals, worldwide, who are interested in learning our techniques of emergy synthesis.

January 2006. 4th Biennial Emergy Research Conference. Emergy Synthesis 4: Theory and applications of the emergy methodology. This conference will be the fourth in the series. The growth in attendance at the conference has been impressive, with a 75% growth since the first conference in 2001. We anticipate nearly 150 participants from over 10 countries at the 2006 conference.