ENVIRONMENTAL COUNCIL ANNUAL REPORT STATE OF HAWAI‘I

2013

Presenting the genuine progress indicator baseline

Cover photo credit: Cristo Vlahos

Presenting the Genuine Progress Indicator Baseline Environmental Council 2013 Annual Report Summary

GPI-HI

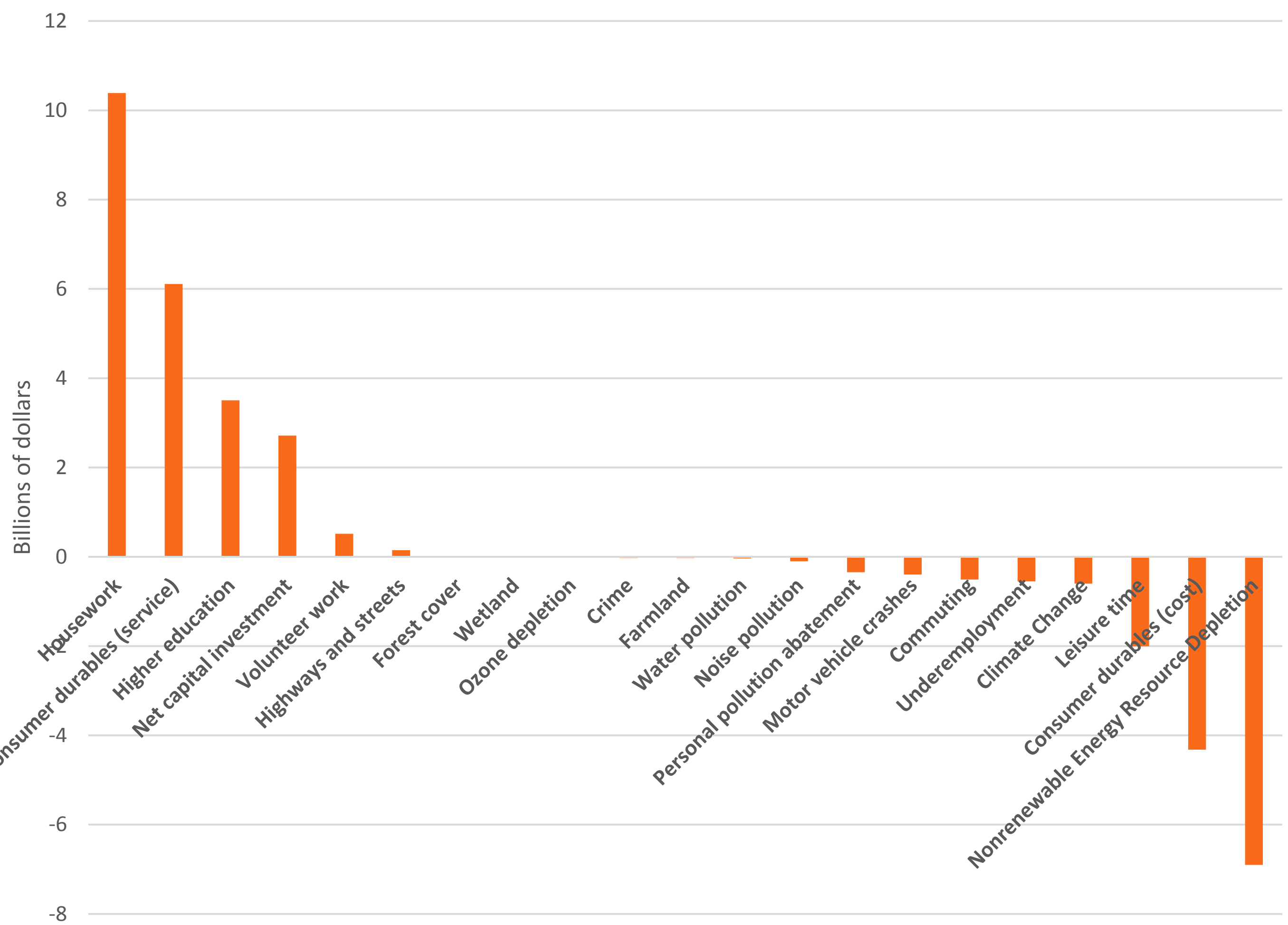
Introduction

Gross Domestic Product (GDP) accounts for changes in economic activity but falls short of capturing the related implications to society. The Genuine Progress Indicator (GPI) offers a framework to move "beyond GDP" and adjust for hidden costs and benefits of economic growth across three categories: economic, environmental, and social. The Environmental Council 2013 Annual Report, issued in February 2014, showcases the first complete calculation for Hawai'i ("GPI-HI") using the full suite of GPI indicators. **Overall, Hawai'i has made genuine progress since 1969, although there is divergence from Gross State Product (GSP). This suggests that GSP overstates the well-being of the state.**

Policy Implications

GPI aggregates economic, social, and economic changes into a single, common indicator. An aggregate number enables comparisons across seemingly incommensurate policy goals, such as forest preservation, inequality, and education. Comparing changes in the three categories can highlight trade-offs between environmental, social, and economic goals. Observing GPI trends over time can provide insight into the true progress and sustainability of the state.

GPI and GDP both start from personal consumption expenditures, but GPI then incorporates changes, both positive and negative, that are ignored by GDP. GPI features 27 indicators (7 economic, 11 environmental, and 9 social), including one environmental indicator, submerged coastal systems, uniquely developed for Hawai'i (figure below).



GPI Baseline
Environmental Council 2013 Annual Report Summary

GPI-HI

GPI uses readily available, publicly accessible data. It is measured in dollars, adjusted by adding benefits or subtracting costs for each indicator, and compared directly with GDP. GPI's real potential is its ability to tell a more complete story by tracking overall trends; the story can then be shared among policy makers, the public, and other stakeholders.

Findings

In 2005 (the most recent year with data for all indicators), *per capita* personal consumption was adjusted downward by $874 for the economic component and $6,199 for the environmental component, while it was positively adjusted by $8,558 for the social component.

- The most significant *gains* captured by GPI were a mix of economic and social indicators: the service of consumer durables, higher education, net capital investment, and volunteer work.
- The most significant *costs* span all three (environmental, economic, and social) components: the costs of non-renewable energy depletion, consumer durables, lost leisure time, climate change, and underemployment.

Conclusions and Next Steps

The GPI offers a framework for assessing the full, long-term impacts of public policy and budget decisions. The results of this study provide an opportunity for policy makers to consider a broader range of issues when making policy choices, and to make better-informed decisions. The integrated nature of the GPI could help guide budget and planning decisions.

This year's GPI exercise in Hawai'i provides the first complete baseline for the state. Hawai'i is one of a pioneering group of states using GPI to assess progress. Overall, the state is making progress per the GPI, but key adjustments highlight some key costs and gains. Additional data and research are needed to fill gaps and tailor the method to Hawai'i.

GPI could be a powerful tool for policy making in our state. We now have a central repository of preliminary data covering all the indicators. We have identified key research and data needs and are working to transform the repository into a "dashboard" friendly format that will be publicly available and automatically populated in real time as agencies report data. Through our continued efforts to reproduce the GPI every year, we hope to offer insight into the sustainability of our economy and provide policy makers with holistic information about the impacts of growth.

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This report is the result of collective efforts of many individuals. Special recognition and thank you to Dr. Regina Ostergaard-Klem of Hawai‘i Pacific University, and Dr. Kirsten Oleson from the University of Hawai‘i, as well as their team of graduate and undergraduate students, Marcus Peng of the University of Hawai‘i, and Juliann Bertone, Malin Meyer, and Emily McNintch of Hawai‘i Pacific University, for providing their technical expertise, passion, and time to continue to develop and refine the Genuine Progress Indicator for the State of Hawai‘i.

Many thanks to the Office of Environmental Quality Control, the Department of Health, the Department of Land and Natural Resources, and the Department of Business, Economic Development and Tourism for providing data. Thanks to the photographers for sharing their amazing images.

Lastly, mahalo nui loa to Governor Abercrombie for his support and broad vision for Hawai‘i.

INTRODUCTION TO THE ANNUAL REPORT

We are pleased to present the 2013 Hawai‘i State Environmental Council Annual Report, which provides a snapshot of the issues, challenges, and accomplishments of the Environmental Council (EC) and the Office of Environmental Quality Control (OEQC) in monitoring the progress of state, county, and federal agencies in achieving the state’s environmental goals and policies.

This report is provided in compliance with Chapter 341-6, Hawai‘i Revised Statutes (HRS): “The council shall monitor the progress of state, county, and federal agencies in achieving the State’s environmental goals and policies and with the assistance of the director shall make an annual report with recommendations for improvement to the governor, the legislature, and the public no later than January 31 of each year.”

The protection of our environment is critical to sustaining Hawai‘i for future generations. This report includes highlights of various initiatives supporting the environment and improving the implementation of Hawai‘i Revised Statutes 341, 343, and 344.

The subject of this year’s annual report is the Genuine Progress Indicator, continuing and expanding the introduction of it from last year’s report by introducing social and economic factors to complement the updated environmental factors from last year. We continued our work with Dr. Regina Ostergaard-Klem of Hawai‘i Pacific University and Dr. Kirsten Oleson of the University of Hawai‘i to bring their expertise and cutting-edge research to the public and policy makers in Hawai‘i.

The response from last year’s report was very positive. Our goal of introducing a standardized method for measuring the true health of the economy that measures environmental and social factors along with economic ones, has resulted in collaborative opportunities with other efforts to improve decision making using indicators and data, primarily led by the Hawai‘i Green Growth Initiative and Hawai‘i State Data Council.

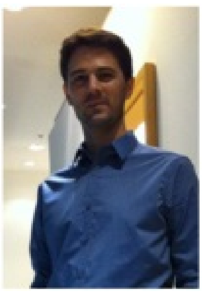
TABLE OF CONTENTS

Figures

Tables

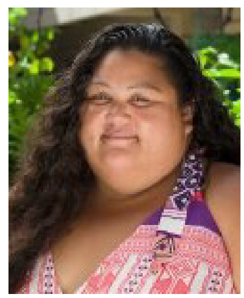
INTRODUCTION TO THE COUNCIL

The Environmental Council (EC) serves as the liaison between the Director of the Office of Environmental Quality Control and the general public on issues concerning "ecology and environmental quality." The EC consists of 14 dedicated and conscientious volunteers appointed by the Governor and confirmed by the Hawai'i State Senate. The Director of the OEQC serves as an *ex officio* member of the EC. Members of the EC represent "a broad and balanced representation of educational, business, and environmentally pertinent disciplines and professions, such as the natural and social sciences, the humanities, architecture, engineering, environmental consulting, public health, and planning; educational research institutions with environmental competence; agriculture, real estate, visitor industry, construction, media, and voluntary community and environmental groups (Chapter 341-3(c), HRS). The EC is responsible for promulgating the administrative rules for Chapter 343, HRS, codified as Hawai'i Administrative Rules (HAR) 11-200, Environmental Impact Statement Rules. The EC also reviews and provides concurrence on agency exemption lists.



Scott Glenn has served on the EC since 2011 and was elected Chair of the Council in July 2013. He is an urban planner at Cardno TEC, Inc. He received his Master's Degree in Urban & Regional Planning from the University of Hawai'i in 2009. He specializes in environmental review and climate change adaptation planning. As EC Chair, Scott seeks to help create better data and data analysis tools such as the Genuine Progress Indicator as well as to enhance the Council's role in communicating the public's concern about environmental quality to decision makers. As the Rules Committee Chair, Scott continues to lead the Council's effort to modernize the EIS administrative rules.

Charles Prentiss is an urban planner, city manager, and a retired city planner with the City and County of Honolulu. He holds degrees in economics, planning, and government management. He is a former Executive Secretary of the Honolulu City Planning Commission, a Vietnam veteran pilot, and a retired Lieutenant Colonel of the Hawai'i National Guard. Chuck is also President of Hawai'i's Thousand Friends and Chairperson of the Kailua Neighborhood Board. Chuck's professional experiences motivate him to promote environmental protection. He possesses a strong belief in the necessity for citizen participation in government. For him, "participation aids in government openness and honesty, and provides a countervailing force to special interests in government decisions. In Hawai'i, the environment is our economy." Chuck serves on the Exemption Committee and is the in-coming Chair of that committee for 2014.



Malia Akutagawa, Esquire, is an attorney and Assistant Professor of Law with both the William S. Richardson School of Law Ka Huli Ao Center for Excellence in Native Hawaiian Law and the Hawai'inuiākea School of Hawaiian Knowledge at the University of Hawai'i at Mānoa. She is part of Hui 'Āina Momona, a consortium of scholars throughout the university community charged with addressing compelling issues of indigenous Hawaiian knowledge and practices, including the legal regime and Native Hawaiian rights associated with mālama 'āina, and with focus on cross-disciplinary solutions to natural and cultural resource management, sustainability, and food security. Malia is a recent board member of Hawaiian Community Assets, a 501(c)(3) nonprofit, HUD-approved housing counseling agency and community lending institution that builds the capacity of low- and moderate-income communities to achieve and sustain economic self-sufficiency with a particular focus on Native Hawaiians. Malia is President and Founder of Sust'āinable Moloka'i, a 501(c)(3) nonprofit organization that focuses on maintaining Moloka'i's cultural legacy of 'āina momona (abundant land) while embracing modern pathways to a sustainable future. She is currently on the Information and Outreach Committee.

Mark Ambler has been a member of the EC since May 2012. Born and raised in Kailua, Hawaiʻi, he received degrees from ʻIolani High School and the University of Illinois at Urbana-Champaign. Mark's career has been devoted to pursuit of innovative and sustainable environmental engineering. He is a Professional Engineer registered in the State of Hawaiʻi and a Project Management Professional. These certifications represent a history of technical and leadership training as well as professional experience. Mark has championed implementation of sustainable concepts, such as Green Roofs and Green and Sustainable remediation in Hawaiʻi, and has had the opportunity to share those positive examples across the country.

David Atkin has been an environmental planner for more than 30 years, the last 20 of which have been in Hawaiʻi. David sees Chapter 343, HRS, process as essential to good decision making, but is concerned that "its implementation doesn't match our current circumstances." David posits that we may well be "living at the start of a new geological period, the 'Anthropocene,' marked by tremendous change wherein the consequences of past environmental practices will be increasingly evident." David served as Chair of the Exemption Committee and focused on substantive issues regarding the environment to "achieve a more responsive system." He stepped down from the EC in November 2013.

Paul Chang has forty years of experience as a carpenter in the field and as a foreman. He also has served for over ten years as a service representative for the Hawaiʻi Carpenters Union. He is familiar with board procedures and protocol from his prior experience serving as a member of the Joint Apprenticeship Training Committee and a member of the Advisory Board for the Hawaiʻi Occupational Safety and Health Division of the Department of Labor and Industrial Relations. Paul has demonstrated significant dedication to public service through his decades of service to community organizations. As a member of the EC, he seeks to examine all aspects of an issue, both positive and negative, and endeavor to find improvements. He is a member of the Legislative Committee.

Koalani Kaulukukui was raised in Puna on Hawaiʻi Island, attended Kamehameha Schools, Kapālama Campus, and received her B.A. at the University of Hawaiʻi Environmental Center. She earned a J.D. and Certificate in Environmental Law from the William S. Richardson School of Law in 2006. She has worked as an associate attorney for Earthjustice and as a policy advocate for the Office of Hawaiian Affairs. She is currently Counsel for Environmental Law and Native Rights at the Office of Hawaiian Affairs, focusing on issues like cleanup of environmental contamination at Kakaʻako Makai and ceded land revenue. As a member of the Environmental Council, Koa hopes to help shape environmental policy that ensures a robust future for our keiki without compromising the cultural and natural resources of our islands. Koa is a member of the Environmental Council's Rules Committee.

Shannon Mears, Esq., was born and raised in Burlington, Iowa, and is a proud resident of Hawaiʻi since 2001. He is a graduate of Brigham Young University - Hawaiʻi and the University of Hawaiʻi William S. Richardson School of Law. Upon arriving in Hawaiʻi, he was "blown away by the natural beauty of the land and sea and the warmth of the people, so much so that he has decided to make Hawaiʻi his home." As a member of the Council, Shannon believed it is a privilege and responsibility to first and foremost protect the environmental health of Hawaiʻi while ensuring the economic ability of Hawaiʻi's people to remain here into perpetuity. Shannon served as a member of the Rules Committee and stepped down from the EC in December 2013.

Mary Steiner has served as Chair of the Exemption Committee and then as Council Chair. Now Mary serves as Chair of the Legislative Committee. Having spent almost 20 years as CEO of The Outdoor Circle, Mary is now the policy advocate for the Hawaiian Humane Society. She also acts as the Hawaiʻi Campaign Manager for the non-profit Compassion and Choices, an organization that works to improve care and expand choice at the end of life. Mary has several goals before completing her term with the Environmental Council. These include helping OEQC to obtain proper staffing levels and funding, providing support to the Rules Committee members who are working diligently to update the rules and to demystify the environmental review process so that the grassroots, project proponents and developers alike are able to understand the procedures. Mary strongly believes that a strong economy goes hand-in-hand with a healthy environment.

Azita Quon has a broad range of architectural experience in Hawaiʻi and the Pacific Rim in the areas of master planning, design, and architecture of hospitality, and high-rise mix-use residential, educational, courthouse, and institutional buildings. She is a licensed architect and a LEED Accredited Professional with a Master's Degree in Business Administration from the University of Hawaiʻi. "As an architect, I understand the complex relationship between architecture and the natural environment. The built environment impacts how we live and the quality and well-being of our community. It is so critical that the two co-exist and integrate harmoniously. I am excited about the future of design with green initiatives and approaches to development and architecture. There is a great momentum for a green and sustainable Hawaiʻi and I am excited to be a part of it."

John Richards was born and raised on a cattle ranch on the Big Island of Hawaiʻi. He has been intimately involved with agriculture and natural resource management for most of his life. John has lived in different parts of the world for both schooling and military service, which lent him a unique perspective on sustainable land and resources use. As the sixth generation of his family in Hawaiʻi, John has very deep roots and a desire to see the islands thrive. For him, "The Council offers the opportunity to help the systems that protect the islands. A careful balance must be found to ensure business has what it needs to function well, while protecting the spirit, lands and people of Hawaiʻi. Laws and their application can either make us greater or limit our potential. The Council has the opportunity to facilitate the former." John serves on the Exemption Committee.

Iris Terashima is a licensed engineer and principal of ITES, a Honolulu-based consulting firm specializing in environmental risk management. She is a "local girl" (graduate of Waialua High School), with degrees in Chemical Engineering and Information Systems, and has worked as an environmental engineer in Hawaiʻi and the Pacific for over 20 years. She shares an enthusiasm for service on the Environmental Council and wants to do her "share and 'pull with the team' to protect Hawaiʻi's environment for future generations." Iris serves on the Information and Outreach Committee.

Glenn Teves has been a County Extension Agent with the UH College of Tropical Agriculture and Human Resources on Molokaʻi for the last 32 years, where he provides extension outreach education in agriculture and community development technical assistance to farmers and organizations. He also serves on the UH Professional Assembly Board of Directors and Molokaʻi Community Services Council. He is actively involved in agriculture, water, and land use issues on Molokaʻi, including Hawaiian and Hawaiian Home Land's issues. Glenn has served as a member of the DLNR Water Working Group and also the Maui Community Plan Advisory Committee. He is a Hawaiian Homestead farmer in Hoʻolehua and grows banana, taro, and assorted fruits and vegetables for the local market. "What makes Hawaiʻi special are its unique environment, and especially its island communities. These are inextricably connected, and we must preserve both equally. This only comes through deliberate and diligent planning."

Marjorie Ziegler joined the EC in 2011. She grew up, and still lives in Kāneʻohe, Oʻahu. She has worked in the non-profit, environmental sector for the past 30 years, including The Nature Conservancy of Hawaiʻi, Earthjustice (previously Sierra Club Legal Defense Fund), KAHEA: The Hawaiian-Environmental Alliance, and, since 2003, as Executive Director of the Conservation Council for Hawaiʻi. CCH is a membership organization established in 1950 and dedicated to protecting native Hawaiian plants, animals, and ecosystems for future generations. Marjorie brings a grassroots activist and wildlife conservation perspective to the Council.

INTRODUCTION TO THE OEQC

OEQC Staff (clockwise from top left): Herman Tuiolosega, Les Segundo, Susan Faulk, and Genevieve Hilliard

The Office of Environmental Quality Control (OEQC) was established in 1970 to stimulate, expand, and coordinate efforts to maintain the optimum quality of the state's environment. The OEQC implements Chapter 343, HRS, which governs the environmental review process. Office planners review hundreds of environmental disclosure documents and respond to thousands of inquiries each year from both the public and the private sectors. Twice a month, the OEQC publishes the Environmental Notice which announces the availability of Environmental Assessments and Environmental Impact Statements undergoing public review, as well as other local, state, and federal activities of public interest. The OEQC staff also provides support to the EC regarding amendments to the administrative rules, exemption lists, and the Council's annual report. The OEQC is attached to the Hawaiʻi Department of Health for administrative purposes.

The OEQC Director provides advice and assistance to private industry, government agencies, and community groups regarding Chapter 343, HRS. The agency is also empowered by law to conduct research, develop legislative initiatives, do public outreach, and recommend programs for the long-range implementation of environmental quality control.

This year the Council had the opportunity to work with several individuals at the OEQC. Special thanks to Gary Gill, Genevieve Salmonson, and Herman Tuiolosega for their leadership and participation in the EC.

ENVIRONMENTAL COUNCIL CHAIR REPORT

As the new Chair and on behalf of the EC, I want to extend our warmest thanks to former Chair Mary Steiner for her leadership these past three years. Thanks to her leadership, all positions on the Council were filled, we hold regular meetings, and have flourishing engagement on a number of environmental quality concerns with the public. She encouraged Council members to spearhead new initiatives, such as clearing the backlog of exemption list updates, initiating an update of the administrative rules, bringing the Council to social media, and introducing the Genuine Progress Indicator in the Annual Report. She leaves big shoes to fill – and I'm not used to heels!

This year we have a new member, Paul Chang, who brings significant public volunteer experience and an understanding of the intersection between business and the environment. I'd also like to extend our sincere thanks to David Atkin and Shannon Mears, who stepped down from the EC this year, for their dedication and commitment.

At the request of then-OEQC Acting Director Gary Gill, the newly created Information and Outreach Committee dove into the discussion on Genetically Modified Organisms (GMOs) and pesticide use, using social media and stakeholder outreach to develop a set of recommendations for the State on improving pesticide use to better protect our health and environment. The I/O Committee started our Facebook page, where we have received more than 150 comments on some of our posts!

The Exemption Committee cleared its backlog of exemption list updates and is actively contacting agencies to encourage them to modernize their lists. The Rules Committee has completed its review of public comments on its initial draft and is preparing a revised draft to the Council for its consideration.

This year's Annual Report continues the superb work of our Councilmembers, outstanding faculty, and students. Working with Dr. Regina Ostergaard-Klem from Hawai'i Pacific University and Dr. Kirsten Oleson from the University of Hawai'i has brought cutting edge research to this report and to Hawai'i. Their participation has been critical to the success of the Annual Report and the continuation of this dialogue.

We receive support from many sources. Our Deputy Attorney General, Edward Bohlen, has played a helpful role by advising us. A huge mahalo to Gary Gill and to the OEQC staff. In addition to providing administrative help, they are always available to council members for discussion and feedback. Of course, the staff also speaks to members of the public on topics concerning environmental quality.

Finally, thank you to our Council member volunteers. The EC is served by remarkable people and we are honored to have such expertise and commitment available to the public and decision makers. Our Councilmembers are professionals with significant responsibilities in our respective communities. They demonstrate on a daily basis their passion for Hawai'i so that we have a healthy environment, thriving economy, and place to live for our present and future generations.

In conclusion, this year has been an active and busy one for the EC. Each council member brings a diverse point of view, is dedicated and willing to set aside personal agendas, and is entirely committed to maintaining the integrity of the environmental review process. I want to thank each of you and tell you how much I appreciate the work you are doing.

Mahalo nui loa,
Scott Glenn, Chair

Although OEQC saw three different temporary directors in 2013, the office continued to move forward with identified core functions and planned activities. The matter of a permanent OEQC director was a recurring issue through 2013. The OEQC also lacked a permanent secretary for the first six months of 2013. By the end of the year, the OEQC was fully staffed but still short of a permanent director.

OEQC started the year with a legislative proposal to charge filing fees for environmental assessments and environmental impact statements published in The Environmental Notice. The proposal crossed over from the Senate to the House where it was tabled in the House Finance Committee.

The OEQC also continued working on its database project, which is anticipated to be completed and available for public use by the end of 2014. The completion of the database project is dependent of funding which has been requested in the State's 2014 supplemental budget request. Progress continues and the OEQC is moving forward with this effort.

The OEQC continues to support the EC by facilitating all EC meetings and interisland travel for the neighbor-island members. Finding a meeting location that met the public's expectations became challenging at times, but the OEQC converted space to provide a permanent venue for the EC meetings; so this should not be an issue anymore. The OEQC hopes to improve communications technology to assist the EC with meeting its needs. The OEQC also assisted the EC's third annual retreat and looks forward to supporting the EC with its statutory obligations.

There is still a very strong need for education outreach training with government agencies, consultants and the public, about Chapter 343, HRS, also known as the Hawai‘i Environmental Policy Act (HEPA). The OEQC conducted nine workshops to different state and county agencies who requested training, as well as to the general public. The OEQC will continue to arrange and conduct educational training.

Other routine functions staff performs include publishing The Environmental Notice, conducting project impact analysis evaluations and writing comment letters, addressing HEPA questions, and ensuring consistency of submitted studies with the statutes and rules. A total of 164 EA and EIS documents were published in 2013.

The objectives and tasks OEQC hopes to complete in 2014 includes updating the HEPA Guidebook, implementing and using the database, conducting more education outreach training, and purchasing equipment to improve OEQC and EC functions.

OEQC staff remains optimistic and looks forward to better things in 2014.

Aloha

EXEMPTION COMMITTEE REPORT

For most of 2013, there were no applications from government agencies interested in adopting new exemption lists, or amending old lists. In our view this is a lost opportunity since poll results show that many agencies still do not have adopted exemption lists, and exemption lists for other agencies date back to the 1980s. We applaud those agencies that have come before the Environmental Council to achieve updated formal clarification that routine activities with minimal adverse environmental impact are exempt from the need to prepare an Environmental Assessment or Environmental Impact Statement. This allows more of an agency's limited budget to be applied directly to its mission.

In the absence of applications for consideration, the exemption subcommittee focused its efforts this year on supporting the Rules Committee in its ongoing work updating the Chapter 341 and 343 implementation rules. Through dialogue and consensus-building, the Exemption Committee developed policy recommendations in the areas listed below. Through dialogue and consensus-building, the Exemption Committee made formal recommendations to the Rules Committee to develop and refine the following policy areas in the forthcoming rules update:

1. *Notice of Agency Exemption*, including the threshold and mechanism for notice to the public and OEQC when an agency determines its own action will be exempt; and the relationship of the public notice of an exemption determination to the challenge period to contest the agency determination of its own activity. There is presently no public vetting of exemption determinations an agency makes of its own work, because the public is not informed of these determinations as a matter of routine;
2. *Sharing Exemption Lists*, involving the ability of an agency to use, for its own purpose, exemptions previously concurred with for a different agency;
3. *Consultation for Activities not on Exemption Lists*, clarifying that on a case-by-case basis, when consultation is performed and such consultation indicates the activity merits exemption from the need to prepare an EA or EIS, the activity need not be specifically enumerated in an agency's adopted exemption list;
4. *Longevity of an Exemption Determination*, in cases where the environmental setting has changed from that initially assessed prior to initiation of the activity;
5. *Ownership of an Exemption Determination*, focusing on transferability of an exemption should property ownership change; and
6. *Content Requirements of an Exemption Determination*, clarifying the specific information to be considered in making an exemption determination.

In late 2013, the chair passed from David Atkin to Chuck Prentiss. The outgoing chair would like to thank all stakeholders for enabling this legislatively mandated process, performed by volunteers, to be successful, including clearance of an inherited backlog of applications in 6 months. The outgoing chair would also like to welcome Chuck to his new role, which truly shows Chuck’s outstanding civic commitment and dedication to the people of Hawai‘i.

David Atkin, Outgoing Chair

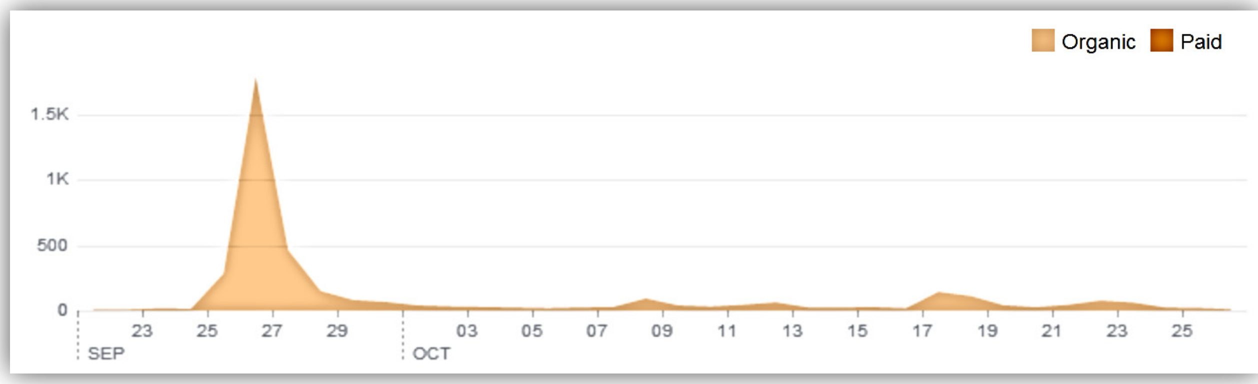
INFORMATION & OUTREACH COMMITTEE REPORT

The purpose of the Information and Outreach Committee is to communicate to the public and agencies Environmental Council issues and Hawai‘i Revised Statutes Chapter 343 requirements (excluding legislative bills, which remain in the purview of the Legislative Committee). By providing a structure for public interface, the Information and Outreach Committee is able to survey community concerns and increase outreach to the stakeholders.

The committee has increased from three members to five since 2012. This year the committee has made progress toward improving the interface to the public through the creation of a Facebook page which was made public in September. At the time of this report, there are 154 likes. The following question was posed at launch:

“Should Hawai‘i further regulate GMO above and beyond federal agencies? Explain.”

Other Facebook sites were solicited for feedback on the question and by September 26, the total organic reach (not paid) of the site exceeded 1,500 people. The question received 63 comments representing both sides of the issue, many of which guided research for recommendations on the topic.



The committee has had several meetings regarding the issue, has publicized related research, and is currently drafting recommendations for the full Environmental Council. The committee will continue to use the Facebook site as a tool to interface with the public on certain topics, post meeting notices and the Environmental Notice, and other items per the approved motion regarding site management.

RULES COMMITTEE REPORT

In 2012, the Rules Committee released its first draft of proposed changes to Hawai‘i’s EIS rules, Hawai‘i Administrative Rules (HAR) 11-200. The draft is a first step. It is the result of a year of consultation the Rules Committee and Environmental Council conducted with the public and state and county agencies.

These stakeholders identified a range of issues that have become critical in the functioning of the environmental review process. Among these issues are cultural impacts, supplemental environmental impact statements, and public participation in the process.

After the Rules Committee released the draft, stakeholders offered a range of comments on the proposed language, the reasoning for the proposed language, and alternative approaches.

The Rules Committee thanks everyone who has participated to date, sharing their mana‘o, and for their patience as well.

In 2014, the Rules Committee will continue working on revising the administrative rules. It is completing its review of the comments it received and intends to release a revised draft in summer 2014 available to the public and government agencies for review and comment.

"Our Gross National Product, now, is over $800 billion dollars a year, but that Gross National Product - if we judge the United States of America by that - that Gross National Product counts air pollution and cigarette advertising, and ambulances to clear our highways of carnage.

It counts special locks for our doors and the jails for the people who break them. It counts the destruction of the redwood and the loss of our natural wonder in chaotic sprawl. It counts napalm and counts nuclear warheads and armored cars for the police to fight the riots in our cities. It counts Whitman's rifle and Speck's knife, and the television programs which glorify violence in order to sell toys to our children.

Yet the gross national product does not allow for the health of our children, the quality of their education or the joy of their play. It does not include the beauty of our poetry or the strength of our marriages, the intelligence of our public debate or the integrity of our public officials. It measures neither our wit nor our courage, neither our wisdom nor our learning, neither our compassion nor our devotion to our country, it measures everything in short, except that which makes life worthwhile. And it can tell us everything about America except why we are proud that we are Americans.

If this is true here at home, so it is true elsewhere in world."

- Robert Kennedy, 1968

EC RECOMMENDATIONS ON THE GPI-HI

Since Robert Kennedy's powerful speech, gross domestic product (GDP) has only grown more important as the universal measuring stick for prosperity. It is an accident of history that GDP has evolved into this standard. Simon Kuznets, the originator of the GDP as a means to measure economic activity during the Great Depression, cautioned the United States (US) government that "the welfare of a nation can scarcely be inferred from a measurement of national income."

In China, for example, growth in GDP averaging around 10 percent over recent years is attributed with ending poverty for 500 million of its citizens. Yet the environmental and social consequences of such rapid economic growth are becoming more and more apparent. So much so that China's 12th Five-Year Plan (2011-2015) breaks with tradition to adopt a lower annual growth target of 7 percent and focuses less on GDP growth and more on quality of life by addressing such issues as environmental pollution and social imbalances (The World Bank Group, 2014).

Here in Hawai‘i, the forecast is that the economy (i.e., the gross state product) grew possibly 2.6% for 2013. For key indicators like population, tourism expenditures, real personal income, and jobs, these are increasing and likely to continue increasing. All signs point to yes, so it is therefore a healthy economy. We feel a collective sense of optimism that 2014 will be a good year.

Also increasing during 2013: average single-family home prices toward $800,000; environmental degradation, including one of the worst environmental disasters in Hawai‘i's history in the form of the molasses spill (Joaquin & Gutierrez, 2013); homelessness; greenhouse gas emissions; erosion of our beaches and beachfront homes; and local families in multigenerational homes or relocated to the mainland. All signs also point to these continuing to increase as well. Not only that, our system of measuring the economy's health considers the activities we undertake that both drive these trends and seek to mitigate them to be positive contributions to the economy; e.g., the BP oil spill is counted a net gain to our national economy.

For better or worse, decision makers rely on GDP and will continue to do so into the foreseeable future. In response, many societies are promoting "beyond GDP" approaches as a means of tempering it with other key economic, environmental, and social factors. In states and local governments across the US, the Genuine Progress Indicator (GPI) is gaining traction as a means to move beyond traditional GDP. Maryland has pioneered it as a practical tool for improving government decision making and operations.

The excellent work by Dr. Ostergaard-Klem and Dr. Oleson is an invaluable foundation to adapting GPI to Hawai‘i, "island-style." We hope this year's report, as a first draft of a complete GPI baseline, serves as a framework for thinking about how to fund our state and county agencies to obtain and maintain high quality data and to further Governor Abercrombie's effort to make data more accessible to the general public.

More importantly, we hope that by introducing GPI to Hawai‘i, we can stimulate and contribute to a discussion of what good governance looks like here. That factors like family time will receive as much weight as jobs when touting the health of our economy. That the government will devote as many resources to monitoring these factors and improving them as it currently does to monitoring its key GDP indicators. That agencies tasked with these missions have the expertise and resources to collect valid data consistently over time and the political and social support to take steps to improve these factors. That our GDP and GPI will converge so that we can proclaim ourselves to be a healthy society, living in a healthy environment, and creating a healthy economy.

We thank you for taking the time to consider this effort and welcome your participation.

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Dr. Regina Ostergaard-Klem is an Associate Professor of Environmental Science in the College of Natural and Computational Sciences at Hawai‘i Pacific University (HPU). She holds a Ph.D. in Systems Analysis and Economics for Public Decision Making from The Johns Hopkins University. Her graduate work was carried out in Poland as a Fulbright Fellow. After completing her Ph.D., she was a Science and Diplomacy Fellow for the American Association for the Advancement of Science in Washington, D.C. Prior to relocating to Hawai‘i, she was an environmental policy advisor at the US Agency for International Development, working on urban environmental and energy programs around the world.

At HPU, Dr. Ostergaard-Klem is program chair for both the Environmental Science/Studies program at the undergraduate level and the master's program in Global Leadership and Sustainable Development. Her teaching is concentrated in the fields of environmental and ecological economics, environmental policy, and sustainability. Her research interests are focused on alternative measures for social welfare, and the nexus between the two disciplines of ecological and environmental economics.

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Dr. Kirsten Oleson is an Assistant Professor of Ecological Economics at the University of Hawai‘i at Mānoa. She holds a Ph.D. from Stanford's Interdisciplinary Program in Environment and Resources. Prior to joining the University of Hawai‘i, she was a Fellow with Stanford's Public Policy Program, a National Science Foundation Postdoctoral Fellow studying social-ecological systems in Madagascar, and a World Bank staff member.

Natural capital, such as land, water, and biodiversity, supports human well-being, yet this crucial capital is depleted and degraded because it is generally unaccounted for in standard decision-making frameworks. Dr. Oleson's research addresses this by integrating economics and the environment along three related tracks:

- Building "green accounting" methods to improve the metrics we use to signal economic "progress." These accounting tools seek to include environmental and social changes; e.g., loss of forested land or gains in education, rather than focusing solely on the economy's productive sector. They also aim to track global impacts of consumption.
- Linking watershed-scale ecological modeling with economic models to assess the outcomes of resource development alternatives.
- Studying coastal communities' natural resource management.

INTRODUCTION TO THE GPI-HI 2013

The most commonly used measure of economic health within and across nations is gross domestic product (GDP). What started out solely as a measure of economic health in the post-Depression US, GDP has since become essentially linked with social welfare. An increase in GDP automatically implies an increase in society's well-being without accounting for many of the often negative byproducts that might result.

GDP has since become essentially linked with social welfare.

GDP is traditionally defined as the sum of all final goods and services within the borders of an economy in a certain time period (usually a year). While economic growth leads to higher GDP, it often comes at an associated cost, such as greater pollution or a longer commute time; neither are recognized nor accounted for.

GDP and its weaknesses are frequently and widely discussed among academics, policy makers, and the media, yet its use persists. The push to move "beyond GDP" has resulted in an expanding literature, more government and non-governmental initiatives, and wider media recognition. One such movement surrounds the application of the Genuine Progress Indicator (GPI).

The general idea behind the GPI started in the 1970s and was further refined into the more current model in 1995 by the think tank Redefining Progress. Although it is not meant to replace GDP, GPI is designed to offer a more holistic view by including social and environmental as well as economic factors. In fact, the GPI and GDP have the same starting point (personal consumption expenditures), but the GPI is further modified to subtract incidental costs or add unrecognized benefits not traditionally captured by GDP. Although variations exist, the most common GPI model involves two dozen or so indicators to capture economic, social, and environmental aspects.

Figure 1, **Figure 2**, and **Figure 3** show examples of conceptual models for economic, environmental, and social indicators that either increase or decrease GPI.

The GPI model has been applied across ten countries, including the US. GPI studies within the US exist at both national and sub-national (state) levels. At the state level, GPI is compared against that state's version of GDP; i.e., Gross State Product (GSP). GPI models are popping up in several US states in addition to Hawai'i, for example, Maryland (Posner, 2010; Posner & Costanza, 2011; State of Maryland, 2010), Vermont (Costanza et al., 2004), Utah (Berik & Gaddis, 2011), Minnesota (Minnesota Planning, 2009), and Colorado (Stiffler, 2014). Maryland holds a unique position as the first government-initiated GPI, with the full backing of the Governor, coverage from the press, and a complete website with interactive tools. Our current effort in Hawai'i, referred to as "GPI-HI," follows the lead of Maryland, unless otherwise specified.

Several strengths of the GPI model contribute to its relevance and potential. GPI uses readily available, publicly accessible data at the state and local level when available; otherwise, it uses proxy data at the national level scaled down accordingly.

GPI is designed to offer a more holistic view by including social and environmental as well as economic factors.

GPI is measured in dollars, making it possible for results from across the categories to be added together. Likewise, GPI and GDP can be compared directly.

GPI's real potential is in its ability to tell a more complete story, particularly in the face of often sparse or uncertain data. The story can be shared among policy makers, the public and other stakeholders.

Conceptual Models

Figure 1. Illustrating a negative adjustment to GPI to account for the cost of underemployment (ECN 5)

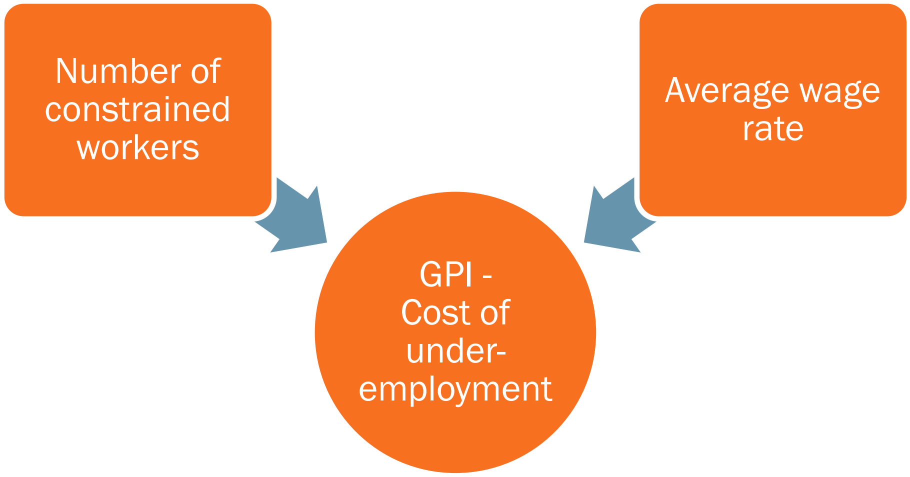


Figure 2. Illustrating a negative adjustment to GPI to account for the cost of wetland loss (ENV4)

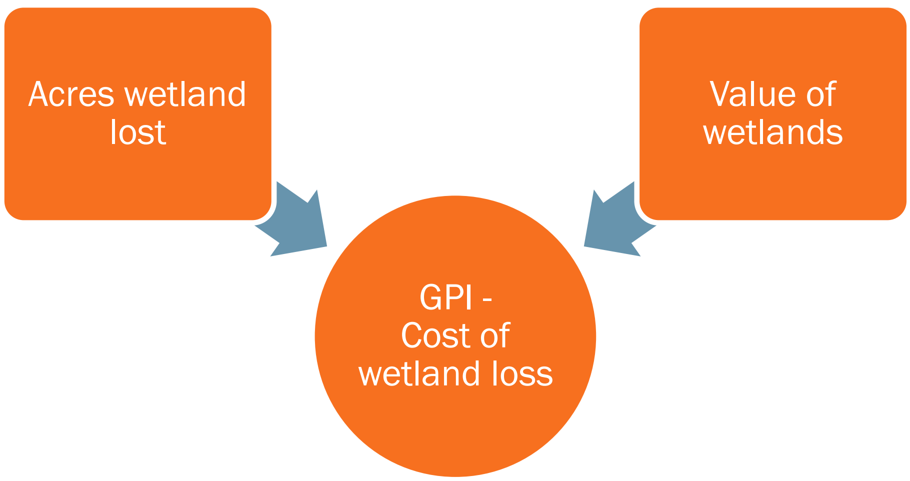
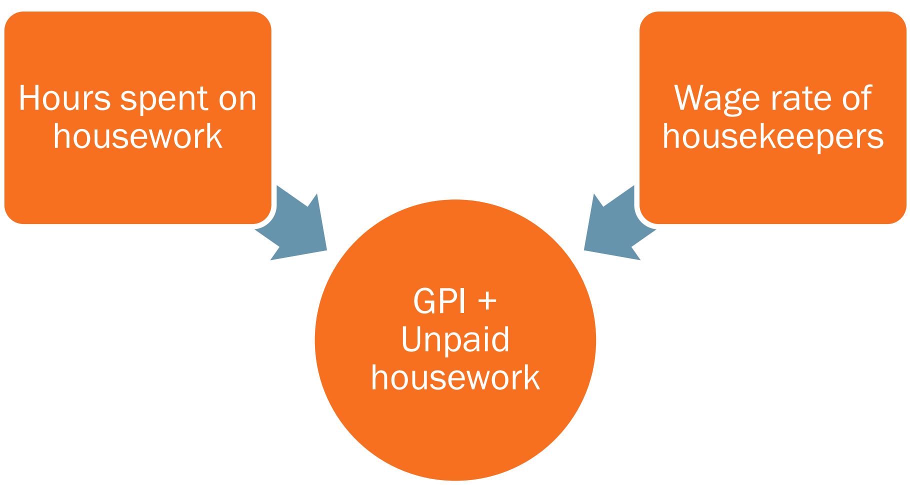


Figure 3. Illustrating a positive adjustment to GPI to account for the value of unpaid housework (SCL 1)



While the GPI model adds to the discussion of the health of our economy, it is not without shortcomings. Concerns about the lack of good data or missing data are understandable given the breadth and magnitude of the indicators in GPI. Data are gathered from multiple sources with varying degrees of certainty, and should not be used for anything but general trends. Much of the data is gathered from national sources and prorated to state and local conditions in the absence of data at the local level. We have identified local data needs and hope to address those more completely in the future. We need to strengthen the GPI-HI model to better reflect the priorities and conditions within the local context.

GPI work, including GPI-HI, is more than just the refinement of the model for the sake of an academic exercise. The faculty members of the GPI-HI team are also members of an interstate technical group poised to bring the model to the next level of sophistication (referred to as "GPI 2.0").

This report is one stop along the way for GPI-HI, having begun the journey with the technical report prepared for the 2012 EC Annual Report, for which we concentrated on only the environmental indicators. This current report builds upon the initial baseline by including for the first time for Hawaiʻi, the expanded findings for all three categories of the GPI model: economic, social, and environmental. For each indicator we include an overview of its relevance, associated trends in the US and/or Hawaiʻi, the GPI methods used, and the findings over a specified time period. All dollar values in the report are in 2000 US Dollars ("2000 USD"), unless otherwise specified. The final section of our report highlights the overall findings of GPI-HI model, as well as our recommendations for further actions and next steps. We hope that this report will spur constructive discussion and bring about greater collaboration, while contributing to the "beyond GDP" movement in both Hawaiʻi and elsewhere.

ECONOMIC INDICATORS

PERSONAL CONSUMPTION EXPENDITURES — ECN 1

Introduction to Issue

The measure of personal consumption expenditures (PCE) is the primary measure of consumer spending in the US economy. PCE refers to the sum of all spending by households on new goods and services from private businesses and government entities. Goods include both durables (such as motor vehicles or furniture) and non-durables (like clothing and footwear), while services can include health care, utilities, recreation, and unemployment insurance. Other examples range across a wide spectrum, including groceries, appliances, childcare, vacations, education, haircuts, and more (Berik & Gaddis, 2011).

PCE constitutes a major component of GDP, showing how much of the income earned by households is being spent on current consumption, as opposed to being saved (US Department of Commerce, 2009). Likewise, this measure shows the share of economic output flowing to households rather than businesses, government, or other countries. The proportion of GDP attributed to consumer spending as personal consumption expenditures is significant; over two-thirds of domestic demand (Awuku-Budu et al., 2013; McCully, 2011; State of Maryland, 2010). Hence, PCE not only provides valuable insight into consumer behavior (Awuku-Budu et al., 2013), but also is viewed as the primary engine that drives economic growth (Berik & Gaddis, 2011; US Department of Commerce, 2009). Additionally, because of a close correlation with personal income (i.e., specifically as a function of disposable personal income or "DPI"), trends in PCE can reflect trends in other aspects of consumers' economic wellbeing such as salaries and savings rates. As such, PCE estimates are an integral part of the US National Income and Product Accounts (NIPAs) tracking US economic activity.

Table 1. Real total personal income growth in Hawai‘i and the United States, 1970-2012

	Average Annual Percent Change						
	1970-2012	1970-1979	1980-1989	1990-1999	2000-2009	2010-2012	2012
Hawai‘i	3.13	4.37	3.60	1.80	3.12	1.85	1.84
United States	3.02	3.64	3.13	3.34	2.19	2.37	2.28

*Real total personal income growth determined using the Chain-Weight Implicit Price Deflator for Personal Consumption (2009=1.00).

Just as PCE is the driving component of GDP, it is also integral to the calculation of GPI. Both GDP and GPI use the measure of personal consumption as a critical starting point. Traditionally, increases in PCE are tied to a rise in GDP, accelerated economic growth, and positive contributions for a healthier economy. GPI includes PCE as a base, but unlike GDP, aims to incorporate the other impacts (whether positive or negative) generated as a result of household consumption. GPI adjusts the base using additional social and environmental measures rather than just economic measures, ultimately leading to a more accurate reflection of social welfare (Genuine Progress: Moving Beyond GDP, 2013). The structure of the GPI model, as well as the format of this report, reflects this significance; PCE is the first indicator, followed by indicators representing economic adjustments (e.g., for income inequality), contributions to social welfare (e.g., value of housework and volunteerism), depletion of social capital (such as costs of crime or lost leisure time), costs of environmental degradation and the private expenditures to defend against them, and depreciation of natural resources and stocks.

General Trends

Over the past 50 years, rising consumer demand for goods and services has been a key element of US economic growth (McCully, 2011). For the time period of 1959 to 2009, McCully (2011) notes that increases in consumer demand were supported by increases in personal income less personal current taxes (i.e., disposable personal income or DPI). For the nation, real DPI and real PCE each grew by an average annual rate of 3.4 percent from 1959 to 2009, or 2.2 percent on a per capita basis. Over the same time period, the primary composition of PCE has changed, shifting from durables to services (McCully, 2011).

While we can easily locate the trends in PCE at the national level via the Bureau of Economic Analysis (BEA) NIPA tables, it is not so easy to find the PCE trends for Hawai‘i specifically. In the past, PCE at the state level had been measured by the State of Hawai‘i. However, as of the year 2000, DBEDT switched to using Gross State Product (GSP) generated by the USBEA rather than calculate its own, so PCE is no longer calculated by the state agency on a regular basis (Hawai‘i State Department of Business Economic Development & Tourism, 2012b). BEA currently only measures PCE on a national scale, but after exploring the possibility of state-level calculations, it now has plans to release a prototype in the fall of 2014 (Awuku-Budu et al., 2013; Hawai‘i State Department of Business Economic Development & Tourism, 2012b). These state-specific statistics could be used to indicate how households fare in recessions, identify declines in consumption by category, and compare growth rates of consumer spending and disposable personal income (Awuku-Budu et al., 2013).

Historically for Hawai‘i, personal consumption has shown a relatively stable relationship with income and both tend to grow at similar rates (Hawai‘i State Department of Business Economic Development & Tourism, 2012b). Since state level personal consumption is not readily available, it is useful to instead examine the trend in total personal income growth for Hawai‘i and compare that with the US as a whole (**Table 1**) (Regional Economic Analysis Project, 2014).

Likewise, the trend in per capita personal income growth can be found for Hawai‘i and compared with the national average as in **Table 2** (Regional Economic Analysis Project, 2014). For both total and per capital personal income growth, a large boost in the growth rate took place in the 2000s, flanked on either side by a relatively low growth rate in per capita income.

GPI Approach

In the GPI model, the PCE indicator is listed first due to its significant contribution to overall GPI calculations. However, given that the BEA does not provide PCE for the states, previous GPI studies at the sub-national level calculated the statistics using a two-part calculation. First, the ratio of personal consumption to personal income is found for data at the national level and adjusted for inflation. This ratio is then applied to per capita income for the state, in order to arrive at an estimated figure for per capita PCE for that state. This method assumes that state residents spend an equivalent percentage of their income on personal consumption as the national average (Costanza et al., 2004). The per capita estimate is then multiplied by the state's population, generating a state total for PCE. The equation used to calculate PCE in previous GPI sub-national studies is as follows:

Total State PCE = (Ratio of National Personal Consumption to Personal Income adjusted to 2000 USD) x (State Personal Income Per Capita) x (State Population)

This calculation was used for GPI studies in Maryland and Vermont (Bagstad & Ceroni, 2007; State of Maryland, 2010). However, other studies took additional steps to include data more specific to their state. For example, both Ohio and Utah used the same equation above, yet made further changes to incorporate county-specific data for richer comparisons among counties within each state (Bagstad & Shammin, 2012; Berik & Gaddis, 2011). They improved estimates by using localized personal consumption data from Environmental Systems Research Institute (ESRI) to form an index comparing county spending figures to the national spending average (set at 1). By multiplying the output from the above equation by the spending index, Utah and Ohio further adjusted PCE up or down depending on the location-specific consumer data from ESRI.

Utah took yet another step and modified PCE to exclude expenditures that result in welfare loss, thus reinforcing the assumption that GPI should capture reductions in well-being resulting from increased spending and economic growth. To achieve this, all household tobacco, half of alcohol, and all junk food expenditures were deducted from PCE calculations (Berik & Gaddis, 2011). The authors suggest that these slight downward reductions could be smaller than the future health care costs associated with these goods. It is uncertain whether health-related expenditures should be deducted in future studies; also, the required healthcare data for this lacking.

Ultimately, personal consumption will be an important indicator if and when GPI patterns across different states are compared. The rates of growth can be compared between personal consumption expenditures versus negative social, economic, and environmental costs over a given time period. The discrepancies between personal consumption and the costs of economic growth can be used to explain differences in per capita GPI across geographical areas, either within studies (e.g., counties) or among studies (i.e., states) (Bagstad & Shammin, 2009).

GPI-HI Approach

For GPI-HI, we used the basic calculation stated above. We first calculated the ratio of personal consumption to personal income at the national level as found in the BEA NIPA tables and adjusted to USD in the year 2000. However, this ratio indicates the propensity to consume for the average American and assumes that the average resident of Hawai‘i will have the same willingness to consume rather than save that share of his or her income. Using Hawai‘i's personal income per capita from US

Table 2. Real per capita personal income growth in Hawai‘i and the United States, 1970-2012

	Average Annual Percent Change						
	1970-2012	1970-1979	1980-1989	1990-1999	2000-2009	2010-2012	2012
Hawai‘i	1.63	1.83	2.14	0.78	2.02	0.72	0.80
United States	1.97	2.51	2.16	2.08	1.22	1.59	1.52

*Real per capita personal income growth determined using the Chain-Weight Implicit Price Deflator for Personal Consumption (2009=1.00).

BEA, we multiplied it by the ratio indicating the national propensity to consume. That figure was then multiplied by the state population to arrive at an estimate of the total personal consumption expenditures for Hawaiʻi.

Based on our PCE estimates for years 1960 to 2012, Hawaiʻi's general trend has been upwards with an average annual growth rate of 3.39%. Our estimates are similar to the draft prototype figures calculated by BEA. The BEA estimated Hawaiʻi's 2011 PCE as $38.752 billion (US Department of Commerce, 2013a), while our calculations estimated $37.358 billion (all in 2000 USD). The monetary value of Hawaiʻi's PCE is relatively low, falling in the bottom quarter of the draft state measurements, and is less than a quarter of the national average (US Department of Commerce, 2013c).

For the year 2012 Hawaiʻi's personal consumption expenditures were valued at $37.9 billion total for the state or $27, 240 per capita (2000 USD). The average annual value in the period for which data were available (1960-2012) is estimated at $21.6 billion or $19,900 per capita (2000 USD).

Future Research

In the near future, BEA estimates of state-level PCE will be available for GPI use (the prototype will begin in the fall of 2014). There is a need to further refine the ratio of consumption to income for Hawaiʻi as opposed to a ratio based on national averages. Ideally, future calculations of PCE in Hawaiʻi would be based on local consumer spending data on durables, non-durables, and services. To acquire an even more precise personal consumption calculations, we recommend calculating PCE by county and using ESRI data to apply Hawaiʻi county spending indexes to the current equation. Other future efforts should examine trends that are unique to Hawaiʻi such as traditional or cultural influences on spending and/or savings patterns, or higher expenditures on housing or food services and accommodations.

INCOME INEQUALITY — ECN 2

Introduction to Issue

As an extension of the traditional GDP measurement, GDP per capita (i.e., annual income per person) is commonly used to track economic wellbeing. Increasing income per capita connotes an expanding economy and all the benefits that come with it. For example, the World Bank classifies member countries into low-, middle-, and high-income groups according to per capita income data; higher income characterizes a higher level of economic capacity and progress (The World Bank Group, 2013). Yet GDP per capita reports the level for the average resident (i.e., total GDP divided by the population) and assumes that the total income within a given nation is equally distributed throughout the population. Contrary to this premise, income is in fact unevenly dispersed among individuals such that the average does not capture the range of income extremes and is an unrealistic portrayal of economic expansion throughout the population. GDP per capita is the mean, representing the average citizen, while the median, illustrating the typical citizen, would be better suited to informing us about equity issues.

Income inequality refers to the differences in income among households within an economy. In some aspects, inequality might be considered a crucial part of society, functioning as a reward for individuals to work harder and be more ambitious; assuming that over time upper mobility is a plausible goal. Nevertheless, high levels of inequality are typically considered unfair to low-income citizens, often resulting in tensions between societal groups. Moreover, high inequality stifles lower-income households' opportunities for investment (e.g., lack of credit), resulting in inefficiency in the economy (Berik & Gaddis, 2011).

While several methods can be used to discern income distribution, the Gini coefficient (and its accompanying Gini index) is one of the summary measures of income inequality most commonly used by the Census Bureau. The Gini coefficient indicates how far the distribution of income deviates from an equal distribution among all residents; it is based on the proportions of total income across shares of the population (e.g., the share of total income attributed to the poorest 20% share of the population). The Gini index ranges from zero, indicating perfect equality (where everyone receives an equal share), to one, perfect inequality (where all the income is received by only one recipient) (US Census Bureau, 2012). An increase in the Gini coefficient is indicative of a growing income disparity. If the Gini index is rising along with rising GDP, poverty may or may not be improving for the majority of the population despite the increase in GDP overall.

General Trends

The United States Census Bureau provides Gini coefficients and the corresponding Gini index describing household inequality at the national level back to 1967, and at the state level back to 2000. Overall since 1967, US household income inequality has grown 18 percent. Nearly half of that growth occurred during the 1980s, but has tapered off more recently. Levels of inequality still vary across the country. For the 2010-2012 American Community Survey (ACS), the estimate of the national Gini index, averaged across the three years, was calculated as 0.4732 (US Census Bureau, 2012). Values in the 0.20s and 0.30s generally suggest low inequality.

Although the Gini coefficient for the state of Hawai‘i has steadily increased between the early 1970s to the 1990s, since 2005 the measure has only slightly fluctuated (between 0.42 and 0.43) (**Table 3**). It is generally low (i.e., low inequality) compared to other states and consistently lower than the national level (US Department of Commerce, 2012). According to the US Census Bureau’s 2012 list of Gini coefficients by state, Hawai‘i has one of the lowest values of inequality with a Gini coefficient of .4257; only Utah, Alaska, and Wyoming had lower values. The national Gini coefficient for the same year was .4757 (based on 2012 American Community Survey 1-Year Estimates). Typically, smaller populations tend to have more equitable income distributions.

GPI Approach

GPI tracks income inequality to highlight distributional effects that occur during economic expansion that GDP otherwise fails to capture when it comes to evaluating the health of the economy. GPI collects Gini coefficients because they not only provide valuable information, but also are key factors in calculating the next indicator in the GPI model: adjusted personal consumption expenditures (see the following section).

The US Census Bureau has generated Gini coefficients on the state-level annually since 2000; prior to that year, only historical data for the years 1969, 1979, 1989, and 1999 are available. To address the lack of historical data, Maryland extrapolated Gini coefficients for time periods in between the publicly available data points from 1970-1999. For the years 1960-1970, the Maryland study used the national Gini coefficient and assumed it was the same as the state-level (State of Maryland, 2010). In contrast, Berick and Gaddis (2011) relied on Nielsen and Alderson’s county-level income inequality data to calculate income inequality for Utah.

GPI-HI Approach

For the Hawai‘i GPI study, we based our income inequality indicator on the Maryland method for reporting Gini coefficients at the state-level given that county-level data (like in Utah) does not exist for Hawai‘i. The data provided by the Census Bureau for 1969, 1979, 1989, and 1999 were used to interpolate Gini coefficients for the interim years from 1970-1999. For the years 2000-2012, we used publicly available data on statewide income inequality from the US Census Bureau (i.e., the ACS).

We found that the Gini coefficient for the state of Hawai‘i showed an increasing trend and then leveled off during the time period we used. It consistently remains below the national figure.

Future Research

In future iterations of the GPI-HI, we propose that income inequality be folded into the same section as the next indicator – adjusted personal consumption – as a single indicator (see next section).

Table 3. Gini Coefficients for Hawai‘i for years 1969, 1979, 1989, 19999 (US Census Bureau) and 2000, 2005, 2010 (ACS)

Year	1969*	1979	1989	1999	2007	2009	2011	2012
Gini	.353	.390	.408	.434	.422	.425	.431	.436

* Reported as income inequality for families (not households)

Introduction to Issue

Personal consumption is the primary contributing factor in the calculation of GDP. Increases in personal consumption expenditures directly lead to increases in GDP. However, such increases in personal consumption and GDP do not guarantee that consumption is taking place equally across a population or that the associated benefits will flow to all income levels within that population. While GDP captures material welfare, it has no mechanism to track social fairness or the consumption losses that result from income inequality. GDP per capita, for example, only reflects the status of the average (mean) citizen. To counter the weaknesses in GDP, the GPI model calculates adjusted personal consumption (APC). APC is an indicator that takes into account whether increased personal consumption is being enjoyed throughout a population. The more evenly personal consumption benefits are distributed, the greater the welfare is to society as a whole, assuming that the additional benefit of a given increase in income would be greater for low- versus high-income families (Berik & Gaddis, 2011). So the previously calculated values for personal consumption expenditures are tempered by a measure of the level of income inequality among the population. This adjusted number then becomes the base upon which other indicator values are added or subtracted to calculate the final GPI (Genuine Progress: Moving Beyond GDP, 2013).

General Trends

Hawai‘i’s APC trends can be reflected in the comparison of personal consumption and income inequality (Gini coefficient) trends. In Hawai‘i, personal consumption expenditures have been trending upward as a result of a growing economy, therefore adding to social welfare. At the same time, income inequality has increased. Calculations of APC have fluctuated over the years with available data (1969-2012). Personal consumption trends have dominated, resulting in average annual growth rate of 2.31% across those years. However, it is important to note that APC has been growing slower than personal consumption expenditures showing that some benefits to growth are lost as a result of rising inequality.

GPI Approach

The GPI framework uses personal consumption expenditures as a starting point, but consequently adjusts that figure to reflect either positive or negative byproducts of economic growth. In this instance, the adjustments are made to address consumption losses due to rising income inequality; those who can no longer afford high consumption expenditures are not able to reap as many benefits from economic growth. Several GPI studies, including those of Maryland, Vermont, and Ohio, calculated APC using the following equation:

State adjusted personal consumption = (State Personal Consumption Expenditures) ÷ (State Income Distribution Index)

Each state sets its income distribution index as 1 in the year 1970, when the national Gini coefficient was the closest to zero and therefore reflected the greatest level of income equality. Although, Maryland had a lower Gini coefficient in 1968, they used the year 1970 as a base year to maintain consistency with other studies (State of Maryland, 2010).

GPI-HI Approach

To calculate APC, we used the same equation as previous GPI studies. We divided Hawai‘i’s personal consumption expenditures (ECN 1) by an income distribution index developed for Hawai‘i. When multiplied, the inequality index reduces the starting figure for personal consumption to account for the growing inequality in distribution of the benefits of economic growth. The income distribution index is the ratio of the Gini coefficient for Hawai‘i (ECN 2) for the target year divided by the Gini coefficient of the base year 1970 (such that the ratio for the base year = 1). The index uses Gini coefficients from extrapolated data for many of the years calculated. This is because Hawai‘i’s Gini coefficients are only available one year per decade prior to the year 2000.

For the year 2011, the total adjusted personal consumption for Hawai'i is valued at $30.99 billion (2000 USD). The average annual APC in the period for which data were available (1969-2011) is estimated at $20.691 billion (2000 USD). Also in 2011, PCE was adjusted downward by almost $7 billion (from $37.9 to $30.9 in 2000 USD) to compensate for income inequality for the state.

Future Research

For more precise APC values, accurate personal consumption expenditure estimates and income inequality estimates are necessary. To improve APC calculations in the future, we reemphasize including ESRI county spending index data in the calculation of personal consumption, and recommend continued annual tracking the Gini coefficient at the state level. Further refinement could also include tracking the information at the county level throughout Hawai'i, leading to better comparisons across the state.

COSTS AND SERVICES OF CONSUMER DURABLES — ECN 4

Introduction to Issue

GPI uses personal consumption expenditures (spending towards durable goods, non-durable goods, and services) as the starting point, to which a series of adjustments are then made. Two of those adjustments are related to consumer durables: the cost of consumer durables and the services of consumer durables. The cost of consumer durables refers to the annual spending on durable goods such as electronics, appliances, cars or other household goods. Yet "consumer durables" by definition are items that continue to provide service over a duration that extends beyond the initial year of purchase. The service of consumer durables is therefore an ongoing benefit, whereas the purchase is the initial cost incurred to receive the continued flow of benefits.

The service of consumer durables is therefore an ongoing benefit, whereas the purchase is the initial cost incurred to receive the continued flow of benefits.

When calculating GDP, the amount spent on a durable household good, for example a car, is only counted in the year in which it is purchased even though the good continues to provide services annually throughout its lifetime. GDP counts only the one-time expenditures increasing the stock of durables in a particular year, so the measure fails to capture the full range of benefits provided by such items. GPI is also an annual measurement, but in contrast, it includes the services that flow from that stock for the year. Because the cost of consumer durables is closely tied to their services, GPI follows a two-part process. GPI adds the estimated value of annual services, while subtracting the estimated value of the stock to avoid double counting of the services. This adjustment for services of consumer durables plays an important role in the GPI model, amounting to the third largest component of personal consumption in some applications (Talberth et al., 2007).

Spending on consumer durables is a traditional indicator of wealth; a rapid rise in spending is generally attributed to an increase in wealth. However, the costs and services of durables go hand in hand. The relationship can be used to evaluate whether the returns on that spending are positive (i.e., the value of services grows faster than total spending, as in the case of greater durability) or negative (i.e., total spending grows faster than the value of services received, as in the case of quicker obsolescence).

General Trends

National spending on consumer durables has risen steadily over the recent decades – with the exception of the year 2008-2009 when spending decreased following the financial crisis. Overall, the national level of consumer spending has increased by 142 percent from $497.10 billion in 1990 current dollars to approximately $1.20 trillion in 2012 current dollars. These data pertain to spending on durable goods as a subset of personal consumption expenditures and can be found in BEA NIPA tables (BEA NIPA Table 2.3.5).

For Hawai'i, GPI estimates for consumer durables spending increased from $2.46 billion (2000 USD) in 1990 to $5.45 billion (2000 USD) in 2012. Over the same period, the estimates of the services of consumer durables have increased from $2.90 billion (2000 USD) in 1990 to $7.88 billion in 2012 (2000 USD).

GPI Approach

State data for consumer durable spending are not readily available from BEA or other sources, so most state-level GPI studies improvise by scaling down national data accordingly. The typical approach for each year is to: 1) use national data to calculate the percentage of personal income that is spent on consumer durables; 2) scale down to state level by multiplying that percentage by the personal income figure for the state; 3) adjust current dollar figures by dividing by CPI-U for a chosen base year; and 4) arrive at a monetary value for state wide consumer durable spending for the year, that is added to the cumulative stock of durables.

This method inherently assumes that the ratio of consumer durable spending to income is the same across all states. Vermont (Costanza et al., 2004), Minnesota (Minnesota Planning, 2009) and Maryland (State of Maryland, 2010) all followed this method; Vermont and Maryland adjusted for inflation using the CPI-U with a base year of 2000. In all cases, the value for consumer durables spending is subtracted from the overall GPI, adjusting the measure downward to reflect a cost to society of acquiring the good and to avoid double counting the services provided by those durables.

The service of consumer durables is calculated by assuming an average lifetime across the various categories of household capital, i.e., the number of years over which the flow of benefits from these items occurs. Costanza et al. (2004) and the State of Maryland (2010), as examples, assumed durables would be replaced every eighth year, on average. Assuming constant wear and use over the lifetime of the items, 100 percent depreciation will occur over eight years, yielding an annual depreciation rate of 12.5 percent. According to economic theory, however, the annual services derived from this capital must incorporate not only depreciation, but also opportunity cost. The opportunity cost is the return on the money that would have been received if the consumer had chosen to save or invest the funds instead; it is represented by an average interest rate.

The GPI model adds the depreciation rate and the interest rate together and multiplies that sum against the value of the stock of durables. For example, Anielski and Rowe (1999) and Talberth et al. (2007) assumed a depreciation rate of 15 percent, with an implied product lifetime of 6.7 years; both assumed an interest rate of 7.5 percent. The services of household capital were estimated at 22.5 percent of the value of the net stock of consumer durables for that year.

GPI aims to capture the full range of benefits of consumer durables. The services provided by that capital are otherwise unrecognized by measures like GDP. GPI, therefore, considers the annual services derived from consumer durables as a positive adjustment. Ultimately, as the costs of the consumer durables are subtracted, the annual services are added to capture the ongoing benefits that stem from their use.

GPI-HI Approach

To estimate the annual cost of consumer durables, GPI-HI generally follows all state applications, but more specifically uses the same procedures as Costanza et al. (2004) and Maryland (State of Maryland, 2010). There are no existing figures for the stock of capital within the state economy, therefore it was necessary to use national data and scale down. We calculated the ratio of national spending on consumer durables to national personal income from the NIPA provided by the BEA. As per the formula below, we applied that ratio to the figures for personal income in Hawai‘i to determine spending on durables at the state level and adjusted for inflation with a base year of 2000.

Cost of Consumer Durables =
(personal income by state x *national*
percent of income spent on durables)/
CPI-U (base year 2000)

Starting with the previously calculated indicator for PCE weighted for income inequality, we subtracted the estimated cost of consumer durables to adjust the GPI downward and avoid double counting of services.

For the estimation of the services of consumer durables, we once again followed the same methods as Costanza et al. (2004) and Maryland (State of Maryland, 2010). Assuming that capital lasts eight years, the services were calculated as 20 percent of the given stock, using a 12.5 percent depreciation rate plus a 7.5 percent interest rate. The given stock was the cumulative over the previous eight years corresponding to the chosen lifespan. That product was then added to our GPI figure to represent the benefits provided through household capital.

Using the GPI-HI model, we estimated values from 1960 through 2012, showing a generally increasing trend over that time period. Results from more recent years show that the cost of consumer durables in Hawai'i increased from $3.24 billion (2000 USD) in 1990 to $4.09 billion in 2012 (2000 USD). Both consumer spending and cost of consumer durables in Hawai'i experienced a drop in the year 2008-2009 in response to the financial crisis. However, the stock of consumer durables continued to increase, as did the value of the services provided; from $2.90 billion in 1990 to $7.88 billion in 2012 (both in 2000 USD).

Future Research

Future GPI-HI studies could be customized to include more locally applicable information. For example, Bagstad and Shammin (2012) used ESRI consumer spending data on household consumer durables in Ohio counties to arrive at local estimates. State- or even county-level data to help determine the percent of personal income spent towards durables by Hawai'i residents, as well as use of the CPI-U for Honolulu (the other islands not withstanding) would be desirable for future calculations.

BEA defines consumer durables as tangible commodities that can be used repeatedly and continuously over a period of three or more years (US Department of Commerce, 2013b). Previous GPI studies did not offer much insight into choosing an average life span for the GPI calculations. Ideally, this indicator would be able to distinguish expenditures among durables with relatively shorter or longer life spans. We hope to investigate this issue in further applications of GPI-HI.

For this round of GPI-HI, we propose combining the two indicators (cost and services of consumer durables) into a single household consumption indicator for easier reference and understanding. This is similar to the format used in the Utah GPI study (Berik & Gaddis, 2011), but unlike all other GPI studies, which have kept the two separate.

COST OF UNDEREMPLOYMENT — ECN 5

Introduction to Issue

Underemployment, sometimes referred to as broader unemployment, is an alternative measure of labor underutilization that goes beyond the more commonly known official unemployment rate. The official rate refers to, as a percentage of the total workforce, the number of jobless people who are available to take a job and have actively, but unsuccessfully, sought work in the past four weeks. Underemployment is a wider measure that augments the official unemployment statistic by adding marginally attached workers (including those "discouraged" workers who have given up looking for work), involuntary part-time workers (those employed part-time who want to work full time), as well as others who do not work due to economic or family constraints (such as childcare or eldercare).

Just like underemployed individuals do not count within the traditional unemployment statistics, the related costs of unemployment suffered by those underemployed are not recorded in conventional economic measures either. The GPI model incorporates underemployment in the form of "unprovided" labor hours for which potential output per worker is unfulfilled (i.e., the opportunity cost of joblessness). This lost productivity represents a cost for the economy in general. At the individual level, there are other costs associated with being jobless such as impacts on families, loss of skills, degraded self-esteem, or worse. GPI deducts the cost of underemployment as a significant economic and social loss that should be considered by policy makers (Berik & Gaddis, 2011). Ironically enough, GPI recognizes that the inverse cost of lost leisure time (see Social Indicators) is involuntary leisure via unemployment or underemployment (Anielski & Rowe, 1999).

At the individual level, there are other costs associated with being jobless such as impacts on families, loss of skills, degraded self-esteem, or worse.

General Trends

According to the 2013 Labor Market Dynamics report from Hawai‘i's Department of Labor and Industrial Relations (DLIR), the unemployment rate in all of Hawai‘i's counties dropped in 2012; the Honolulu metropolitan statistical area posted the lowest rate. When compared with the nation, the state's unemployment rate remained relatively low, averaging 5.8 percent in 2012; only 11 other states had lower unemployment rates that year. Eight out of the top ten industries in the state posted job gains in 2012. Together the sectors showing the most increase include: leisure and hospitality; and trade, transportation, and utilities. The information industry showed the only decline in jobs (Hawai‘i State Department of Labor and Industrial Relations, 2013).

However, for a more complete picture of underutilization, it is important to look at alternative figures that go beyond the conventional measure of unemployment. The US Bureau of Labor Statistics (BLS) reports a range of measures of labor underutilization (U-1 through U-6) both nationally and by state via Local Area Unemployment Statistics. The official unemployment rate, or "U-3" is the most commonly reported statistic and represents the total unemployed as a percent of the civilian workforce. The underemployment indicator or "U-6" is the most broadly defined of these measures because it incorporates the unemployed plus marginally attached and involuntary part time workers. This indicator has been reported on a national level since 1994 and state level since 2003.

Although changes in the two indicators tend to move in the same direction, it is the comparison between U-3 and U-6 that shows slack in the labor market. For example, the official unemployment rate for the nation for November 2013 was reported from BLS as 7%. For the same time period, the total underemployed as a percent of the total population (i.e., the U-6 statistic) was reported as 13.2% (both figures are seasonally adjusted). Table 4 illustrates the gaps between the two indicators for the nation and Hawai‘i.

Underemployment can be tied to many other factors within an economy. A particular case in Hawai‘i relates to a subset of involuntary part time workers -- multiple job holders who cannot find full time work. For example, employers may hesitate to hire full time workers in order to avoid providing health care and other benefits to employees, so workers are forced to take on multiple jobs to support themselves. Multi-jobholding data are collected annually at the state level by the Current Population Survey (CPS) of the Census Bureau as well as the BLS. CPS reported data on multiple jobholders as a percentage of total employment within Hawai‘i as: 7.7 in 2009, 7.0 in 2010, 6.1 in 2011, and 6.2 in 2012 (Bureau of Labor Statistics, 2013; Campbell, 2011, 2012). The annual average multiple-jobholding rate for the United States was 5.2 percent in 2009, and held steady at 4.9 percent in 2010 through 2012 (Bureau of Labor Statistics, 2013; Campbell, 2011, 2012). Although the rate has declined for Hawai‘i, it still remains well above the national average. Moreover, although Hawai‘i's annual unemployment (U-3) and underemployment (U-6) rates are lower than the national average, the relatively higher figure for multiple job holdings indicates different conditions than might otherwise be expected by just looking at conventional unemployment numbers.

GPI Approach

For the years that BLS reported state level U-6 data, the underemployment rate is multiplied by the state's labor force to calculate the number of underemployed persons within that state. Given the lack of BLS reporting at the state level before 2003, previous GPI studies (Bagstad &

Table 4. Alternative measures of labor underutilization by state, fourth quarter of 2012 through third quarter of 2013 averages

	Measure (in percent of total workforce)					
	U-1	U-2	U-3*	U-4	U-5	U-6**
Hawai‘i	2.5	2.1	4.8	5.4	6.4	11.3
United States	4.1	4.0	7.6	8.1	9.0	14.1

* U-3 represents traditional unemployment rate.
** U-6 is the underemployment rate plus discouraged, involuntary part time and constrained workers.
Source: Table A-15 (Bureau of Labor Statistics, 2013)

Ceroni, 2007; Bagstad & Shammin, 2012; Talberth et al., 2007) instead calculated the underemployment rates using a quadratic equation developed by Costanza et al. (2004). The equation assumes that underemployment is a function of unemployment and was formulated as a regression from Schor (1992) research and BLS data. The quadratic equation to calculate the underemployment rate is as follows:

Underemployment Rate = -0.000087305 x (100 x % Unemployment)^2 + 0.969325 x (100 x Unemployment %) + 3.941336

The number of unprovided hours is not generally recorded at the state level, so GPI studies used estimates by Leete-Guy and Schor (1992), who defined "unprovided hours" as those that labor market participants indicate they would like to work, but during which they are not gainfully employed. The study found that the average "unprovided hours" per constrained worker rose from 718 per year in 1969 to 803 in 1989. GPI studies used the two data points to assume a smooth growth rate in unprovided hours per worker. Yearly figures were multiplied by the number of underemployed workers as well as an average wage rate. Most GPI studies prorated personal income data to find average hourly wages per capita.

Finally, the GPI equation used to determine the cost of underemployment is as follows:

Cost of Underemployment = (Number of Underemployed Persons, including Unemployed Persons) x (Annual Unprovided Hours per Underemployed Worker) x (Average Hourly Wage Rate)

GPI-HI Approach

Similar to other states, Hawai'i does not track the underemployment rate or unprovided hours readily. In order to calculate the cost of underemployment over the past decades, GPI-HI used the same equation stated above and used by previous GPI studies.

According to our measurements, the underemployment rate for Hawai'i from 1960 to 2012 has fluctuated, with noticeable peaks in the mid 1970's and more recently in 2009. However, the general trend for underemployment is slowly declining, showing an average decrease of .01% per year over the time period or which we had data available. Despite the decrease in underemployment rate, the monetary cost of underemployment has shown an average annual increase of 4.29 percent over the time frame we surveyed. This is likely a reflection of increases in Hawai'i's labor force and average wage rate, and shows unmet potential for increased productivity within the state.

For the year 2012, the cost of underemployment for the state of Hawai'i is valued at $926 million (2000 USD). The average annual cost of underemployment in the period for which data was available (1960-2011) is estimated at $451 million (2000 USD).

Future Research

GPI figures are calculated based on the best available estimates, including local sources if and when available and proxies otherwise. Although not a government source, Gallup has started surveying populations to identify trends in unemployment and underemployment that could provide better estimates in the long run (Brown & Marlar, 2013). Also in the future, GPI-HI could use a locally derived hourly wage rate for Hawai'i, as opposed to scaling the national personal income per year down to state level and prorating to an hourly wage. We hope to work with representatives from DLIR and other state agencies to identify Hawai'i -based sources of information on underemployment rates, unprovided hours, and wage rates.

NET CAPITAL INVESTMENT — ECN 6

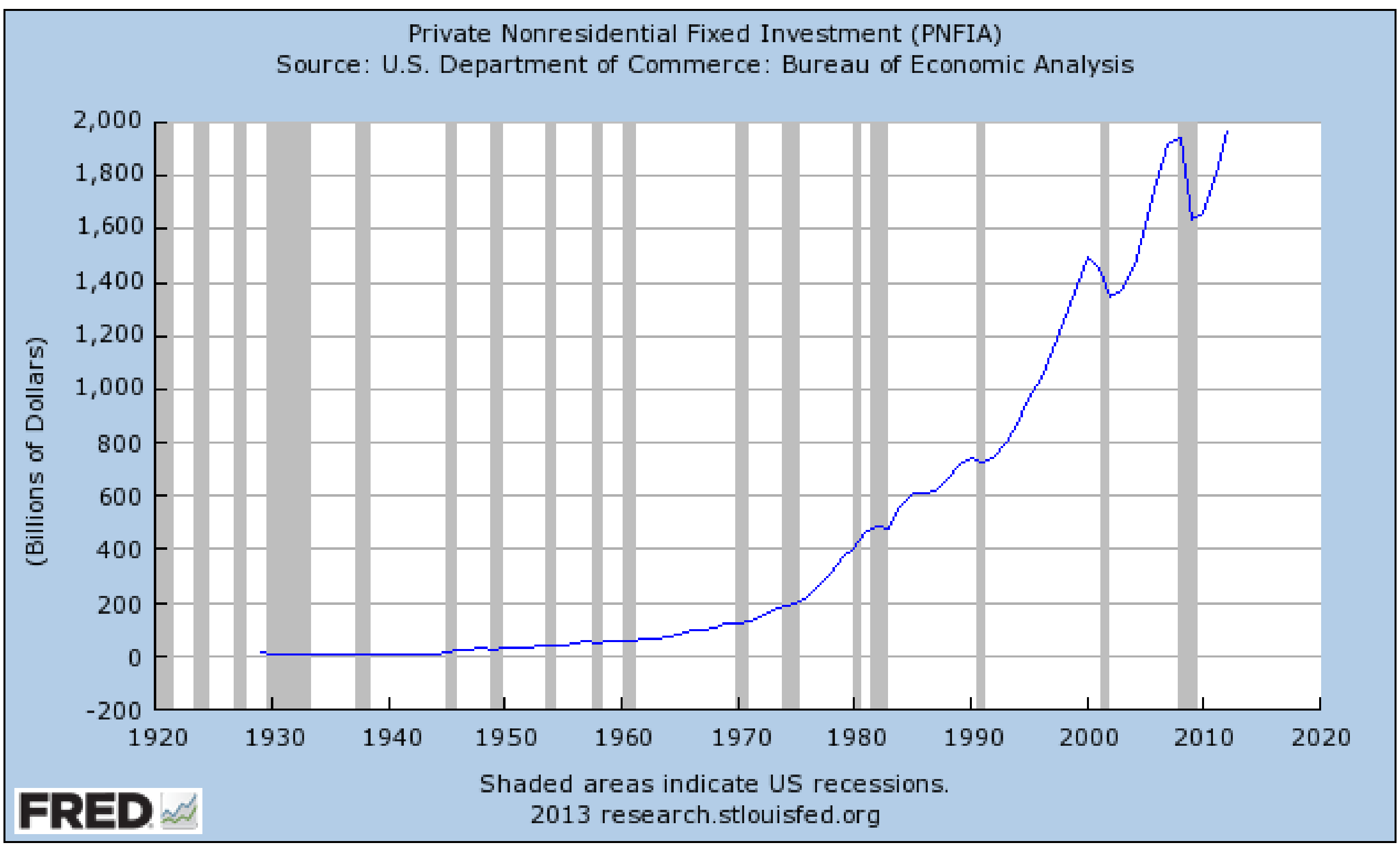
Introduction to Issue

While GDP's main focus is current consumption, the purpose behind GPI's indicator for net capital investment is to track trends in the stock of capital per worker and to take a longer-term look at productive activity within an economy. Capital is defined as private, non-residential investment and can include buildings, infrastructure, machinery, or other equipment that is used continuously in production processes for an extended period of time (US Department of Commerce, 2011). According to Talberth et al. (2007), the net capital investment indicator is one of the most important measures of economic sustainability. Long-run economic progress relies on not just replacement of existing capital as it wears out and depreciates, but also investment to grow the stock of capital available. Capital provides the necessary factors of production; further investment beyond replacement makes it possible for higher production and consequently higher consumption in future years. Therefore, net capital investment is the change in capital stock from the previous year minus the amount needed to maintain the same level of productivity, particularly if the labor force in growing. It is important to maintain capital intact, i.e., keeping the capital-labor ratio constant from one year to the next, otherwise the capital is consumed as income in the present rather than invested for the future. GPI considers a positive increment in capital stock as an addition to GPI.

General Trends

This indicator follows the general trends in investment in private, non-residential fixed assets (such as equipment and structures) used in the production of goods and services. An increase in the investments in these fixed assets signals a willingness of businesses to expand their production and serves as a barometer of confidence in, and support for, future economic growth (US Department of Commerce, 2011). Looking at BEA figures at the national level, we can observe an overall positive trend in investment levels since 1960, with many instances of double digit increases in the mid-1960s and through the 1970s. After continuing to rise on average over the 1980s and 1990s, notable declines in investment occurred in 2001-2002 and again in 2009, when the financial crisis from 2008 resulted in an even more significant decrease. The large drop in 2009 has been followed by moderate increases in the rate of growth of investment through 2012. Figure 4 illustrates the general trend (Federal Reserve Bank of St. Louis, 2013).

Figure 4. Private Nonresidential Fixed Investment



GPI Approach

Other economic indicators in the GPI model track personal consumption and the related costs and services of consumer durables, but this indicator focuses on the production side of the economy through the lens of net capital growth. The GPI calculates changes in the stock of capital year to year by adding the amount of new capital (increases in net stock of private nonresidential fixed reproducible capital) and subtracting the capital requirement, or that amount needed to maintain the same level of capital per worker (Anielski & Rowe, 1999). An increase in the capital stock available to workers is a positive adjustment in the GPI account.

Due to a lack of data for state studies, per capita national values for net capital investment were scaled down using state-specific population data (Bagstad & Ceroni, 2008; Berik & Gaddis, 2011; Costanza et al., 2004; Talberth et al., 2007). The national values came from either Anielski and Rowe (1999) or Talberth et al. (2007) and were calculated using estimates of capital stock from the BEA Survey of Current Business and labor force statistics gathered from the Bureau of Labor Statistics. The authors found the change in capital stock from the previous year and then subtracted the required capital (i.e., the capital stock in the previous year multiplied by the percent change in the labor force). A five-year rolling average of changes in labor force and capital was used to smooth out year-to-year fluctuations (Anielski & Rowe, 1999; Talberth et al., 2007).

GPI-HI Approach

Following in the footsteps of previous state GPI studies, specifically Maryland (State of Maryland, 2010), GPI-HI used the national per capita net capital investment values and scaled them down to the state-level by multiplying by the population for Hawai‘i in each year as in the following equations:

State Net Capital Investment = (National net capital investment/US population) x (state population)

Whereas,

National net capital investment = (Change in capital stock from previous year) - (capital stock in previous year x % change in labor force)

According to output from the GPI-HI model, in 2009 the state net capital investment was $1.28 billion (2000 USD) compared to $2.45 billion (2000 USD) in 2008, while national net capital investment decreased from $560 billion (2000 USD) in 2008 to $292 billion (2000 USD) in 2009. Following the drop in 2009, net capital investment at both state and national level increased in 2010, to $1.32 billion (2000 USD) for the state and $300 billion (2000 USD) for the nation. Due to a lack of data on national net capital investment, figures for 2011 and 2012 for Hawai‘i could not be calculated.

Future Research

We have found several weaknesses in the use of this indicator and in future rounds of GPI-HI we will address how or whether we can adapt it to better illustrate the environment for capital investment in Hawai‘i. For example, because of lack of state level data, net capital investment was simply scaled down from the national level values using Hawai‘i population figures for each year. This assumes that the Hawai‘i per capita figure for investment in capital stock is the same as the rest of the country. In a slightly different approach, the Minnesota GPI (Minnesota Planning, 2009) scaled down the national investment figures according to the ratio of Minnesota’s labor force to the US labor force, rather than the population as a whole; whether or not this alternative approach is better for the case of Hawai‘i is yet to be determined.

In addition to issues of data availability at the state level, we ran into difficulties reproducing and corroborating the calculation of the national figures among several of the other GPI studies. For this round, we simply used the national figures provided by Maryland (State of Maryland, 2010) through 2010, but will refine the indicator further in the next round.

If we choose to continue using this indicator in future GPI-HI exercises, we will further investigate not only the applicability, but also the consistency and quality of the national level calculations provided. The unique qualities of the economy in Hawai‘i will also be investigated further, including recent reports and activities such as the Hawai‘i Green Growth Initiative.

COST OF INLAND AND COASTAL WATER POLLUTION

ENV 1

Introduction to Issue

In traditional Hawaiian proverbs, water is life (Martin, Penn, and McCarty, 1996). This proverb captures the importance of water on our islands. Clean streams, aquifers, bays, estuaries, coasts, and the ocean provide multiple ecological goods and services, i.e., benefits to humans, free of charge. For example, streams provide us with sites for recreation, a source of drinking water, irrigation water to grow our food, and beautiful sites for contemplation or reflection. Coastal waters support fishing, tourism, surfing, swimming, and diverse and beautiful habitats. Both fresh and coastal waters underpin traditions and cultural practices of Native Hawaiians. These benefits are threatened, however, when water is polluted by excess nutrients, sediments, heavy metals, or toxins. Water pollution can lead to priceless cultural loss, costs of treating drinking water, reduced tourism, loss of recreational enjoyment, declines of fisheries, reduced property values, human health impacts, and the loss of aquatic life and habitats.

The State of Hawaiʻi contains almost 400 perennial streams, which are located on the islands of Kauaʻi, Oʻahu, Molokaʻi, Maui and Hawaiʻi where the mountains are high enough to create orographic rainfall. Hawaiʻi's geography limits stream length; the majority of streams are less than 10 miles long. Stream flow is highly influenced by rainfall, and events with high rainfall can cause stream flow to increase greatly (Hawaiʻi State Department of Land and Natural Resources, 2013). Over the past century rainfall has declined, however, and Hawaiian streams' base flow has waned, a trend which will be exacerbated with climate change (Chu, Chen, & Schroeder, 2010). Our streams host only a few fish and other aquatic species, but many are endemic (Hawaiʻi State Department of Land and Natural Resources, 2013); their survival depends on maintaining natural flows to ensure connection with the ocean.

The roughly 1,052 miles of coast in the Main Hawaiian Islands comprise innumerable beaches, cultural sites, homes, industries, marine life, and habitats (State of Hawaiʻi Office of Planning, 2013). Coasts and the resources they sustain are essential to the Hawaiian way of life and economy. Coastal and marine-related activities, including fishing, aquaculture, tourism, recreation, and shipping, support close to 15% of Hawaiʻi's non-military jobs (State of Hawaiʻi Office of Planning, 2013). One study evaluated the worth of the many amenities our coral reefs provide to be $360 million per year (Cesar & Van Beukering, 2004b). A large portion of this worth was the recreational and tourism value, which forms a cornerstone of our economy with over 8 million visitors a year spending over $14 billion (Hawaiʻi Tourism Authority, 2007).

The coasts are dynamic systems influenced by forces from both land and sea. Coastal systems are threatened by land-based pollution and impacts from climate change. Land use is shifting from agriculture to suburban and urban to support a growing population. Urbanization and agricultural production are associated with toxic effluents, including lead, zinc, copper, arsenic, cadmium, nutrients, and fecal-oral viral pathogens (Andrews & Sutherland, 2004; De Carlo, Beltran, & Tomlinson, 2004; Griffin, Donaldson, Paul, & Rose, 2003). Human activities, including pollution and fishing of important functional groups, reduce the resilience of coastal systems to climate change impacts, such as rising sea surface temperatures, acidification, and sea level rise (Hughes et al., 2003; Jokiel, 2008).

Water quality in the United States is governed by the Clean Water Act (CWA), landmark legislation for surface water quality protection across the country. The CWA makes use of regulatory and non-regulatory tools, finances wastewater treatment, and governs runoff. A more recent amendment to the CWA is the Beaches Environmental Assessment and Coastal Health (BEACH) Act of 2000 which funds beach water quality monitoring and notification at coastal and Great Lakes beach waters. Water quality standards for bacteria are formalized as part of the BEACH Act (Environmental Protection Agency, 2012a). The BEACH Act introduced

Table 5. Number of impaired perennial streams by island and number evaluated (2002, 2004, 2006, 2008/2010)

Reporting Years	1998	2002	2004	2006	2008/2010*	2012**	Total number of perennial streams
Number of impaired perennial streams	56	59	70	93	91	88	376

* The 2008/2010 report was issued in 2010, but fulfilled the reporting requirements for both 2008 and 2010.
** The 2012 report did not have any additional inland water data, repeating results from 2012; the report does not clarify why the number of impaired streams declined in 2012 despite no new data.
Source: State of Hawai‘i, 1998, 2002, 2004, 2006, 2010, 2012

additional pathogen control and reporting requirements for coastal waters.

Under section 303 of the CWA, the US Environmental Protection Agency (EPA) regulates compliance with individual state water quality standards. Standards set the quantity of allowable pollution emissions, complementing technology requirements to control wastewater discharge in other parts of the act (Environmental Protection Agency, 2013d). Where state standards are less stringent than federal standards, federal standards apply, but individual states are free to develop standards more stringent than those outlined in the CWA (Environmental Protection Agency, 2013d). In Hawai‘i, state water quality standards are set out in Hawai‘i Administrative Rules Title 11, Chapter 54 (Hawai‘i State Department of Health, 2009a). Point source wastewater discharge is governed by the permitting process as set out in Hawai‘i Administrative Rules Title 11, Chapter 55 (Hawai‘i State Department of Health, 2012c).

State governments are also required to make monitoring records and notices of pathogen exceedances available to the public. To facilitate compliance with these new standards, the US EPA provides funding for states to carry out monitoring and reporting (Environmental Protection Agency, 2012a). The CWA requires state agencies to test, compare results to standards, report, and take action to ameliorate any exceedances. Reporting is conducted on a bi-annual basis; identified polluted waters require a pollution control plan or total daily maximum loads (TMDLs). TMDLs identify the reductions necessary for the water body (i.e., stream reaches, lakes, water body segments) and outline required efforts by all levels of government (Environmental Protection Agency, 2013b).

The term “impaired” is used by the EPA to describe water bodies not achieving federal water quality standards despite efforts to reduce pollution. Impairments may be caused by exceeding TMDLs. Both bacteriological and chemical data are monitored for water bodies, with key indicators such as *Clostridium perfringens*, *Enterococcus*, pH, dissolved oxygen, and turbidity acting as proxies for pollutants. In Hawai‘i, the Department of Health (DOH), Clean Water Branch is responsible for monitoring fresh and coastal water quality and reporting findings to EPA on a biannual basis. The branch monitors pathogens, nutrients, and sediments on a complaint-driven basis. Going forward, the branch is participating in the National Rivers and Streams Assessment, which uses a probabilistic testing methodology that makes results more representative of state waters as a whole (Environmental Protection Agency, 2013c).

General Trends

Hawai‘i’s streams are increasingly impaired. The DOH 2012 Integrated Report contains a total of 225 marine segments and 88 stream segments that were impaired (Hawai‘i State Department of Health, 2012a), compared with 204 marine and 91 stream segments for 2010 (Hawai‘i State Department of Health, 2010). In 2012, 23.4% of the State of Hawai‘i’s perennial streams were deemed impaired. **Table 5** below depicts the decrease in water quality in streams tested by CWB and reported to EPA. It is important to note that the year of the report does not necessary reflect the year when the stream was actually impaired. In many cases, reports use old data from previous reports. For instance, no new data was included for the 2012 report, but impaired stream segment listings decreased slightly from the 2008/2010 report, apparently due to shifting the reporting timeframe slightly. The reports do not contain information on sampling dates and DOH has not made available data on the number of stream segments sampled each year.

The number of impaired coastal waters is also on the rise. **Table 6** depicts data from the DOH Clean Water Branch.

GPI Approach

The pollution of water through excess nutrients, sediments, heavy metals, or toxins results in a variety of costs, including clean-up, increased treatment costs, decreased amenities, and lost revenue. The cost of water pollution can be evaluated in various ways, however each must begin with an assessment of water quality. As each state is required to submit an annual list to the EPA identifying waters that are not achieving water quality standards, the GPI approach merely extends this requirement of the Clean Water Act by adding a monetary value (Berik & Gaddis, 2011; Posner, 2010).

The value of clean fresh water stems from beneficial uses, which generally include drinking water, recreation, aquatic uses, and agriculture. We follow Maryland's methodology for assigning a monetary value for water pollution, which updated previous state-level studies and values from national GPI studies. Following Costanza et al. (2004) and Maryland Department of Natural Resources, Maryland determined the value of clean water to be $130 per person per year (in 2000 USD), or $676.5 million per year for the entire state. The annual cost of water pollution was calculated as the value of clean water for the population multiplied by the percentage of waterways that were degraded. Notably, the national GPI studies included erosion damage, but Maryland omitted it as damage was difficult to determine at a state level.

The value of clean coastal waters is not included in the other state GPI studies.

GPI-HI Approach

Freshwater

As mandated by the EPA, Hawai‘i records impaired streams and coastal waters for the state. Currently, these data are available as "number" of water bodies, which we can convert to a percentage of total streams or coastal waters for the GPI. However, for the future it may be a more accurate replication of the Maryland study to include distance (i.e., miles) of the waterway or area (i.e., square miles) of the water body when calculating the percent of impairment.

For GPI-HI's calculation of the value of fresh water, we followed Maryland's example by using a value of $130 per capita (in 2000 USD) and the following equation adjusted for Hawai‘i to calculate water pollution costs for each year of data available:

> *Cost of water pollution = (State population) x ($130 per capita) x (% degraded streams)*

For the year 2012, the cost of water pollution for the state of Hawai‘i is valued at $42 million (2000 USD)(Figure 5). The average annual cost (from 1999 to 2012) is estimated at $34 million (2000 USD). The total cost over this period was $512 million.

Future Research

For future GPI studies, we need better data on stream impairment. At the very least, we need data on the number of sampled sites each year and the portion deemed impaired. Further, the value assigned to clean fresh water has to be validated for the Hawaiian context. As Hawai‘i is a top tourist destination with rich tradition and culture, more current local valuation studies need to be done to ascertain appropriate values for clean water. A higher estimate of the value of local water would incorporate Hawai‘i's unique tropical environment, isolation, and dependence on clean fresh water. It should be further noted that the current methodology substitutes the *percentage of streams impaired = impaired streams / total streams sampled* for *percentage of streams impaired = impaired streams / total streams,* as sampling information was not available in time for this report. Further, the number of impaired streams may be an underestimate as testing of streams is conducted on a complaint-driven basis.

Table 6. Number of impaired coastal waters by island and number assessed (2008/2010, 2012)

Reporting Years	2008/2010	2012
Number of impaired coastal waters	204	225

Source: State of Hawai‘i, 2010, 2012

Coastal water

Future GPI studies will include the value of coastal water quality. Using impairment and water quality event data combined with the economic value of lost recreational opportunity, we can derive the damage costs of coastal pollution. We have data on impairment and water quality events, but no valuation studies. A current project evaluates the economic losses from beach closures due to water quality events. This planned study draws on several cases exploring the value of beaches elsewhere in the US (Dixon et al., 2012; Huang et al., 2007; Lew & Larson, 2005, 2008; Oh et al., 2008; Shivlani et al., 2003; Whitehead et al., 2008), and one study valued Hawaiian residents' willingness to pay for bch use (Moncur, 1975).

COST OF AIR POLLUTION — ENV 2

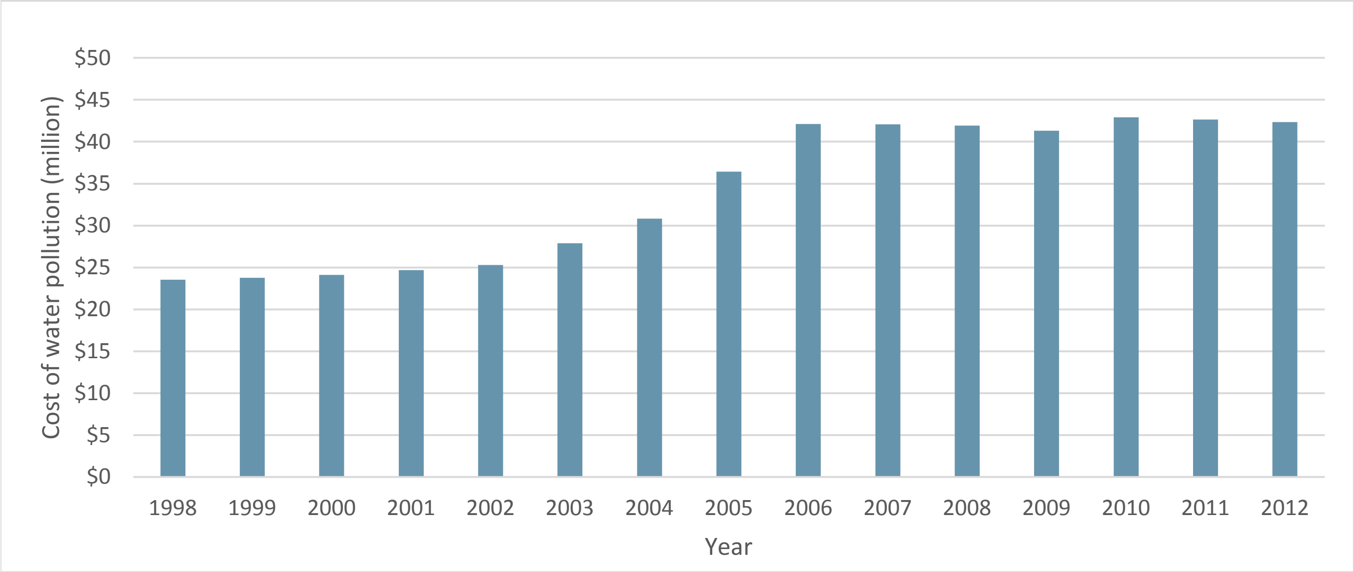
Introduction to Issue

Clean ambient air is essential to the health, productivity, and quality of life. State and federal agencies have a role in protecting citizens from harm. The harmful impacts of air pollution vary depending upon the pollutant itself and the exposure to it. Among the critical pollutants are ground level ozone (a key component of smog), sulfur dioxide, particulate matter (both coarse and fine), and carbon monoxide. Generally, exposure to elevated levels of these pollutants can be linked to irritation of the respiratory system, reduction in lung function, increased heart disease, or aggravation of asthma or other chronic lung diseases. While it is important to consider health effects on the general population, sensitive subpopulations such as children, asthmatics, and the elderly are even more susceptible to air pollution.

Air pollution impacts not only human health, but also the health of ecosystems and the services they provide. Pollutants in ambient air can lead to environmental impacts such as degraded visibility or damage to buildings, animals, crops, and vegetation. These secondary impacts make the role of state and federal agencies even more critical.

The Clean Air Act (CAA) requires states to design a network of stations to routinely monitor and detect pollutants dispersed or suspended in the air. Agencies are then responsible for comparing those detected levels to acceptable standards set at the national and/or state regulatory level. These National Ambient Air Quality Standards (NAAQS) were designed to limit the exposure of the public to six criteria air pollutants: particulate matter (both PM_{10} and $PM_{2.5}$); ground level ozone; sulfur

Figure 5. Cost of water pollution from impaired streams in Hawai'i (1998–2012) (2000 USD); years 1999-2001, 2003, 2005, 2007-2009 are interpolated



dioxide; nitrogen oxides; carbon monoxide; and lead. The standards are designed primarily to protect public health, including sensitive subpopulations. If the level of a pollutant exceeds that specified in the NAAQS, then the state is said to be in nonattainment for that pollutant for that particular time period.

General Trends

In Hawaiʻi, the DOH Clean Air Branch is responsible for monitoring the ambient air for certain pollutants to ensure that air quality standards set by EPA and the state are met. These pollutants include airborne particulates (PM_{10} and $PM_{2.5}$); sulfur dioxide; nitrogen dioxide; ozone; lead; carbon monoxide; and hydrogen sulfide. The DOH maintains twelve (formerly thirteen) air monitoring stations across four islands (Oʻahu, Maui, Hawaiʻi, and Kauaʻi) to track how ambient conditions are impacted by both anthropogenic and natural sources of air pollution. Six special purpose monitoring stations are situated on the Island of Hawaiʻi to check impacts on air quality from Kilauea Volcano as well as geothermal energy production. Oʻahu has the largest population and highest levels of industrial, commercial and transportation activities that are tracked by four (previously five) urban monitoring stations on that island. Maui's single station monitors sugar cane burning, while Kauaʻi's new and only station was established especially to monitor potential impacts from cruise ships. Of the total monitoring stations, the majority screen for $PM_{2.5}$ and/or SO_2; no single monitoring station measures all criteria air pollutants (DOH, 2012).

Hawaiʻi is widely recognized for its high quality of ambient air, even while trends in many other states continue to show problems with $PM_{2.5}$ and ground-level ozone, particularly when accompanied by increases in urbanization. According to the American Lung Association (2012) annual State of the Air, Honolulu ranks first in cleanest metropolitan areas for ground level ozone, and eighth overall when including short- and long-term measures of particulates. Honolulu consistently ranks high on EPA's Air Quality Index and Air Pollution Index as reported on the AIRNow website, a consortium of federal, state and local agencies providing national air quality information to the public (AIRNow, 2012). With the exception of stations in communities in proximity to Kilauea, monitoring of ambient air conditions by DOH consistently show air quality conditions that are well below the standards prescribed by NAAQS (Hawaiʻi State Department of Health, 2012d, 2012e).

Yet Hawaiʻi is also unique from other states due to the recent and continued natural and uncontrollable emissions from Kilauea Volcano on the Island of Hawaiʻi. Volcanic activity increased considerably in March 2008 due to a new opening of the Halemaʻumaʻu Vent, leading to increased sulfur dioxide and fine particulate matter emissions on the Big Island. The resulting vog (i.e., volcanic smog) occurs when volcanic gases and particles combine with air and sunlight to produce atmospheric haze. Although naturally occurring, vog impacts human health just as the related anthropogenic pollutants do. Readings from monitoring stations in proximity of the volcanic emissions frequently exceed the NAAQS levels for sulfur dioxide and occasionally exceed the NAAQS for fine particulate matter (State of Hawaiʻi Environmental Health Administration, 2012).

When subtracting out the number of exceedances due to volcanic activity from the overall results of monitoring for the state, Hawaiʻi was in attainment of all NAAQS for 2011. Given that volcanic activity is an act of nature, it is considered an exceptional event by the EPA, thus related exceedances are excluded from the determination of attainment or nonattainment. State officials (in conjunction with other federal agencies) continue to assess the ongoing vog and sulfur dioxide issues and provide up to date information and guidance to citizens via real-time, 15-minute SO_2 levels and corresponding advisories (online at www.hiso2index.info).

GPI Approach

Within the GPI framework, the air pollution indicator relies on monitoring of ambient air to identify harmful levels of contaminants in the air, either gaseous or particulate matter. Air pollution is an externality, or byproduct, of economic activity with costs for society, but these costs are not captured by GDP.

Past GPI studies have taken a variety of approaches for this indicator. Some GPI models such as Anielski and Rowe (1999) and Costanza et al. (2004) incorporated cost figures for damage to forests, farmland, and urban environments. This approach builds upon an earlier (Freeman, 1982) cost-benefit analysis of the national cost of air pollution in 1970 disaggregated across those three sectors. In Utah, Berik and Gaddis (2011) took a different approach, using county and state level emissions of specific air pollutants multiplied by the per ton cost of emissions taken from a study by Muller and Mendelsohn (2009) to estimate total damages due to air pollution.

Maryland GPI modified these earlier studies to scale down to sub-national level by using the ratio of state to national figures for forest, farmland, and population and designating that amount as the 1970 baseline year. Additionally, Maryland researchers created an air quality index related to ambient ground-level ozone values to track changes in pollution damage, since high levels of that pollutant remain an ongoing problem for the state. Maryland looks at the trends in ozone days and incorporates the number of days over the 8-hour limit for ozone per year relative to the previous year to scale the costs accordingly. The general equation used by the Maryland study is as follows:

Cost of air pollution = (cost of air pollution scaled to Maryland) + (costs of ground level ozone)

GPI-HI Approach

On the surface, the costs of air pollution for the State of Hawai‘i appear to be minimal relative to other states. While air pollution does result from economic activities as well as natural phenomena, we do not generally suffer the effects because the prevailing trade winds tend to carry air pollutants away from our land and people. In addition, unlike the contiguous states, our geographical location means we are not subjected to interstate transboundary air pollution. While the damages from vog may be significant and may constrain economic growth in some areas, vog is not a byproduct of human economic activity, and are therefore those damages are not captured in GPI.

So for the baseline GPI-HI, we contemplated using only that portion of Maryland’s equation that is based on the earlier work of Freeman (1982), eliminating the portion related to ground level ozone as this is not a problem in Hawai‘i. This would be achieved by multiplying the national estimates of air pollution damages to agriculture, forests, and urban environments by the corresponding Hawai‘i figures for acres of farmland, acres of forest, and state population. After analyzing Freeman’s estimates and Maryland’s approach further, however, we identified several weaknesses (e.g., not including health costs within the calculation) and its implementation (e.g., errors in calculations) and were dissuaded from using it. Furthermore, since the typical impacts of air pollution on farmland, forests, and the population may not apply to Hawai‘i due to its unique geographical location and wind patterns, this calculation is not necessarily a good proxy for the GPI-HI baseline. Therefore, we have chosen not to include air pollution costs in the baseline calculation for GPI-HI.

Future Research

Researchers will need to focus on a few key aspects of air pollution in future GPI-HI efforts. We anticipate that the health costs will be one of the topics of discussion for the GPI 2.0 technical working group as a possible amendment to the GPI model. The issue of transboundary pollution will also be addressed. For example, even though the prevailing trade winds carry our air pollutants away, damages from those pollutants will eventually be felt somewhere else, yet the ultimate impacts remain accounted. In terms of data, the number of sites monitoring ambient air quality in the state is limited. As urbanization increases, its associated drawbacks, such as increased traffic congestion and air pollution, might not be adequately accounted for with current monitoring efforts.

Introduction to Issue

Loud, intrusive noises are pervasive in our surroundings, particularly in urban areas, such that they are considered a form of pollution. Noise pollution is regulated under the Clean Air Act (CAA) and the Noise Control Act of 1972, although primary responsibility for addressing noise issues takes place at the state and local government levels. According to EPA, noise pollution has adverse effects on the lives of millions of citizens, and can impact both enjoyment and health. Direct links between noise and human health can be found in a range of impacts including stress-related illnesses due to sleep disruption, lost productivity, or hearing loss. Research shows that exposure to high levels of noise at a constant rate can cause particularly adverse health effects (Environmental Protection Agency, 2012c).

General Trends

Exposure to noise pollution in Hawai‘i is driven by our growing urban population. While in 1960 only three-fourths of the population (total 1960 population = 642 thousand) lived in an urban setting, in 2012 92% of the population did (total 2012 population = 1.4 million) (Hawai‘i State Department of Business, Economic Development, & Tourism, 2012c). As a result, increasingly more people are living closer together in active, urban environments. Associated construction, motor vehicle traffic, higher density housing, and other factors contribute to the noise pollution levels.

Exposure to noise pollution in Hawai‘i is driven by our growing urban population.

In Hawai‘i, the community noise program resides in the DOH Indoor and Radiological Health Branch. Responsibilities include enforcement of maximum permissible sound levels for stationary noise sources and issuance of permits for agricultural, construction, and industrial activities (Hawai‘i State Department of Health, 2011).

GPI Approach

Under the GPI approach, noise pollution is a cost to be subtracted from GSP because it disrupts the quality of life primarily for those residing in areas of increased urbanization. Past GPI studies worked with the 1972 estimate by the World Health Organization (WHO) that damage caused by noise pollution in the US was $4 billion (1972 USD) (Congressional Quarterly, 1972 as cited by Talberth et al. (2007)). The GPI studies used

Figure 6. Growth of urban population in Hawai‘i as percent of total population, 1960-2012

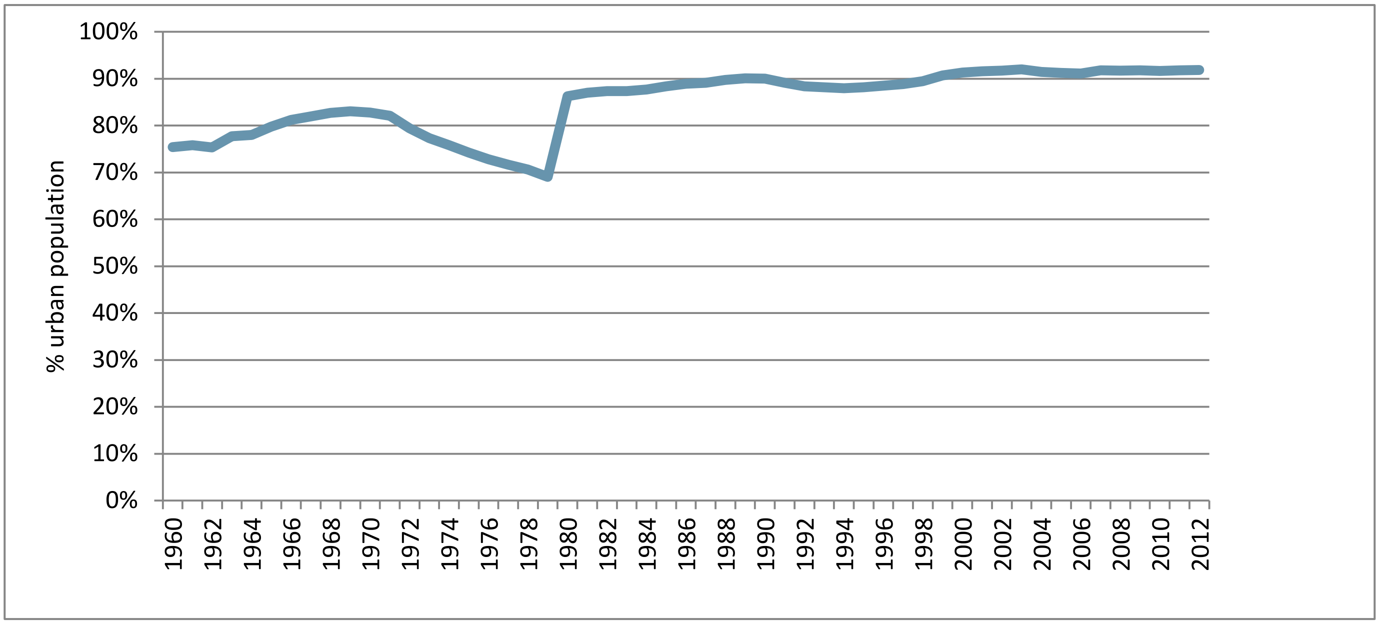
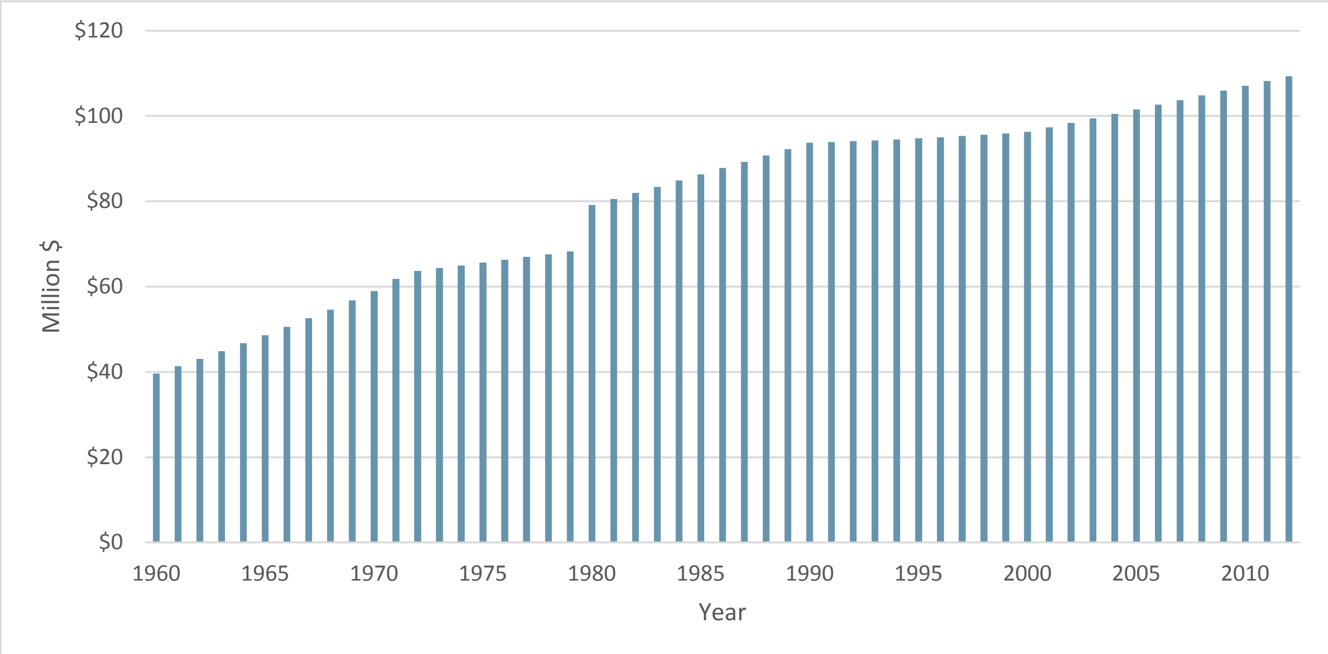


Figure 7. Cost of noise pollution in Hawai'i 1960-2012 (millions year 2000 USD)



this base figure and assumed that the national cost of noise pollution increased by 1% per year from 1973 onward and 3% a year prior to 1974 (Anielski & Rowe, 1999; Bagstad & Ceroni, 2007; Bagstad & Shammin, 2012; Costanza et al., 2004; Posner, 2010) (the difference in rates is due to assumptions about rates of industrialization, levels of noise, and abatement). The Maryland sub-national study assumed that the cost of noise pollution is tied to the level of urbanization. Therefore, the national level damage estimates from the previous national GPI studies were scaled down to the state level by comparing Maryland's urban population with the national urban population. The equation they used was:

Cost of noise pollution = National cost of air pollution from WHO study x (state urban population/US urban population)

GPI-HI Approach

To calculate the GPI-HI baseline for noise pollution we followed Maryland's example, adapting it to the urban population in Hawai'i. First, we found the general trends of urbanization as shown in Figure 6.

Then, we scaled down the national costs of noise pollution by the ratio of Hawai'i urban to national urban population. We made the final calculations based on the equation above.

For the year 2012, the cost of noise pollution for the state of Hawai'i is valued at $109.3 million (2000 USD). The average annual cost in the period 2001 to 2012 is estimated at $103.2 million (2000 USD), and the total $1.24 billion (2000 USD) (Figure 7).

Future Research

All previous GPI studies acknowledged the need for better characterization of noise pollution for future GPI estimates. Some of the assumptions and problems with the approach include the reliance on an outdated study for the cost estimate, which may not capture all the factors of noise pollution. Since the 1972 WHO study, research has come out enumerating the multiple detrimental effects of noise exposure, including health care costs and lower work productivity. Posner (2010) suggests an alternative approach to capture noise pollution costs based on abatement costs. A technical working group of GPI experts will revisit the noise pollution metric.

Introduction to Issue

Wetlands provide a host of valuable services (Brauman, Daily, Duarte, & Mooney, 2007; Woodward & Wui, 2001; Zedler & K ercher, 2005) water quality, groundwater recharge, flood control, biodiversity, cultural resources, recreation and pure aesthetic inspiration. They filter pollution, waste, and sedimentation from water, purifying it as the water travels through the wetland. Wetlands act as a shock absorber during periods of excessive rains or tidal fluctuations and provide abundant recreational activities such as fishing, hunting, bird watching, as well as a place of intrinsic aesthetic beauty (Brander, Florax, & Vermaat, 2006). They also provide critical habitat and breeding grounds for many species of flora and fauna. In Hawaiʻi, many of these species are threatened or endangered native species, and some are only found on the Hawaiian islands, such as the *alae keʻokeʻo* (Hawaiian coot), *ʻalae ʻula* (common moorhen) and the *aeʻo* (black-necked stilt). Hawaiians first settled around the coastal and wetland areas, and the wonders of the wetlands have been incorporated into Hawaiian history, cultural identity, and spirituality.

The major threats to wetlands in Hawaiʻi are invasive species, pollution, development, and climate change.

Wetlands are categorized based on the percentage of herbaceous vegetation, trees and shrubs, and water salinity (National Oceanic and Atmospheric Administration, 2013). The most common types of wetlands found in Hawaiʻi are riverine wetlands, palustrine wetlands (such as bogs), estuarine wetlands, and marine wetlands. A portion of these wetlands host healthy, native vegetation, but invasive, exotic vegetation, including mangroves, are displacing the rare and endangered native species and traditional land uses such as fishponds that are important to Hawaiian culture (Allen, 1998). The major threats to wetlands in Hawaiʻi are invasive species, pollution, development, and climate change.

Wetlands are protected under Sections 401 and 404 of the CWA from point and non-point source pollution (Environmental Law Institute, 2008; Environmental Protection Agency, 2013a). Section 401 governs state water quality certifications and Section 403 the disposal of dredging and fill materials. The CWA mandates compliance with applicable state laws, in Hawaiʻi's case, the Hawaiʻi Water Code. This governs wetlands in the state including coastal wetlands, elevated wetlands, and low wetlands. At the state level, the DLNR and DOH share responsibility for the protection and restoration of Hawaiʻi's wetlands. The DOH Clean Water Branch administers the state's Section 401 water quality certifications. Within DLNR, the Division of Forestry and Wildlife manages wetlands to help native species recovery and habitat restoration. The DLNR Division of Aquatic Resources oversees aquatic ecosystems and resources. DLNR also works with wetland management partnerships, which comprise many private and public entities including local organizations, cultural groups, schools, and community members.

General Trends

Robust evidence to evaluate trends in wetland area is difficult to obtain. Large tracts of wetlands have been lost to agricultural conversion and, later, urban development. The percentage loss is difficult to discern, as each study and dataset defines wetlands slightly differently. One study cites evidence of a 12% overall loss and a 30% loss in lowland wetlands from a historical baseline of 59,000 acres (Environmental Law Institute, 2008). According to the US National Oceanic and Atmospheric Administration (NOAA) Coastal Change Atlas Project (C-CAP) data, however, over 120,000 acres of wetlands currently exist in Hawaiʻi (National Oceanic and Atmospheric Administration, 2013), while the USGS GAP analysis reports only 4,000 acres (Gon et al., 2006).

Data to analyze current wetland area are incomplete. While the state provides data on the area within diverse land districts (agricultural, urban, rural, and conservation), we cannot easily disaggregate conservation lands into its constituent components (e.g., forests, wetlands, and grasslands). Two major sources of remotely sensed spatial data exist for the state: the US Geological Survey (USGS) GAP analysis and C-CAP. The USGS GAP analysis (Gon et al., 2006) provides 590 classes of detailed land cover and land use classes for only one year (reported as 2001, with data collected 1999-2001), and is thus not useful for our purposes.

The C-CAP land cover analysis currently contains three years of data: 1992, 2001, and 2005 (National Oceanic and Atmospheric Administration, 2013). A fourth year (2013) is forthcoming, and a previous time series (2000/2001) has been removed from the official site. C-CAP's regional land cover data split land cover/use into 29 classes. In theory, the C-CAP data provide a time series, however, there is variable coverage across the main Hawaiian Islands in the earlier dataset; 1992 includes all islands except Maui county, while the 2001 and 2005 data cover all islands.

In addition to any decrease in area, the quality of the wetlands is also of concern, as the quality will affect the services provided. A detailed analysis in 2006 revealed that of the remaining wetlands, only 2,652 acres were considered under "effective conservation"; i.e., both actively protected and adequately managed, including the control of exotic/invasive species (Gon et al., 2006). At least half of all wild species in Hawai'i today are non-indigenous, highlighting the issue of alien species and the threats they represent to the island ecosystem. The vast majority of alien species that arrived in Hawai'i can be attributed to human activity, introduced intentionally or unintentionally. Alien species destroy native habitat, compromise ecological processes, and reduce the value of associated ecosystem services (Kaiser et al., 2002; Kaiser & Roumasset, 2002).

GPI Approach

The goal of the GPI is to recognize the value on the non-market benefits of environmental goods and services provided by ecosystems. For this indicator, the GPI attempts to put a value on wetland's contribution to clean water, biodiversity, and recreation, as well as its cultural and aesthetic benefits, by attributing a monetary value for each acre restored or lost. The GPI component for wetlands is calculated as:

Value of net wetlands change =
(change in the number of acres) x
(estimated wetland value per acre)

Previous GPI studies calculated the cost of net change in wetlands as total wetlands lost multiplied by the estimated wetland value per hectare; calculations are based on the earlier work of Costanza et al. (2004). Maryland (State of Maryland, 2010) used a wetland value of $1973 (in 2000 USD) per acre per year beginning in 1950, increasing by 2% annually to reflect the fact that they are becoming scarcer. Ohio used an estimate of $396 per acre per year for losses from settlement to 1940, $1973 per acre per year from 1940 to 1950, and in some counties where wetlands were particularly scarce due to population and urban sprawl, they increased the value 2% per year in subsequent years (Bagstad & Shammin, 2012).

Taking a different approach to natural capital, Utah assessed the total value of all wetlands (and other ecosystems), i.e., they evaluated the total flow of ecosystem services from the entire existing stock or area of wetlands, rather than calculating the damages from the loss in wetlands over time (Berik & Gaddis, 2011). They used a value of $22,453 per acre (in 2000 USD), a value extracted from Dodds et al. (2008).

GPI-HI Approach

To develop a baseline for GPI-HI, we looked for both wetlands inventory data and available related valuation studies. To get a sense of wetlands loss, we evaluated several sources of remote sensing data including LANDFIRE (Department of the Interior, 2013), the USGS GAP analysis (Gon et al., 2006), the Hawai'i Statewide Assessment of Forest Conditions and Resource Strategy (Hawai'i State Department of Land and Natural Resources, 2010), and NOAA C-CAP (National Oceanic and Atmospheric Administration, 2013). We interpolated a 4-year trend from the C-CAP data, as 2001 and 2005 had complete coverage of the islands (**Figure 8**). We see a slight upward trend, but this should not be over-interpreted, as it represents a change of less than 54 acres total (13 acres a year), and could be an artifact of different processing of the remote sensing data.

No studies of the economic value of wetlands have been conducted for Hawai'i. We therefore use the same valuation as Maryland. For this round of GPI we decided not to use Utah's stock method (but see future research below).

The 54 acre gain in wetland area between 2001 and 2005 is valued at $305 thousand (2000 USD), an average annual benefit of $76 thousand (2000 USD) (

Figure 9**).**

Future Research

The C-CAP spatial data show a slight increase in wetlands. Given development pressures in Hawai‘i, a growth in wetlands is counterintuitive. Additional verification of the data is warranted.

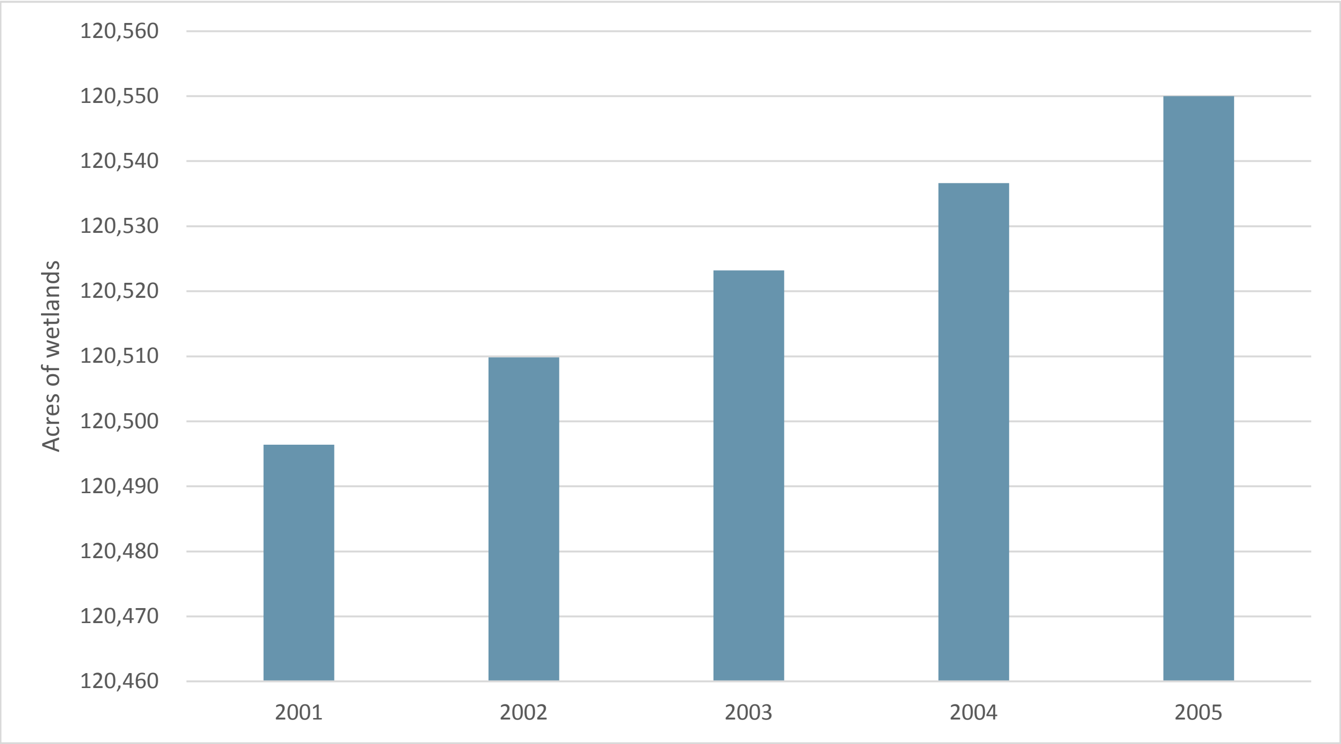
In future efforts to refine the GPI in Hawai‘i, we will need local valuations that capture the range of values flowing from our wetlands, including groundwater recharge, flood protection, habitat, and, if possible, cultural value. To date, there are no valuation studies of wetlands for Hawai‘i, other islands, or similarly isolated sites. These valuations would ideally recognize the uniqueness of Hawai‘i’s biodiversity along with factors that lead to declines in the functionality and quality of the wetlands, such as exotic species invasion. In the technical working group, we are discussing the best way to represent the value of nature in GPI, using the Utah case as an example of a potential alternate approach.

COST OF NET FARMLAND CHANGE — ENV 5

Introduction to Issue

Situated more than 2500 miles away from the agricultural and food production centers of the continental United States, change in agricultural production capability is exceptionally important to Hawai‘i (Leung & Loke, 2002, 2005, 2008). Often-cited estimates of the portion of food imported illustrate Hawai‘i’s current dependence on food imports. According to the state Environmental Council Annual Report from 2008 (State of Hawai‘i, 2008), 90% of beef, 67% of fresh vegetables, and 65% of fresh fruits come from elsewhere, while Leung and Loke estimate that 85

Figure 8. Acres of wetlands interpolated between 2001 and 2005, showing a slight upward trend

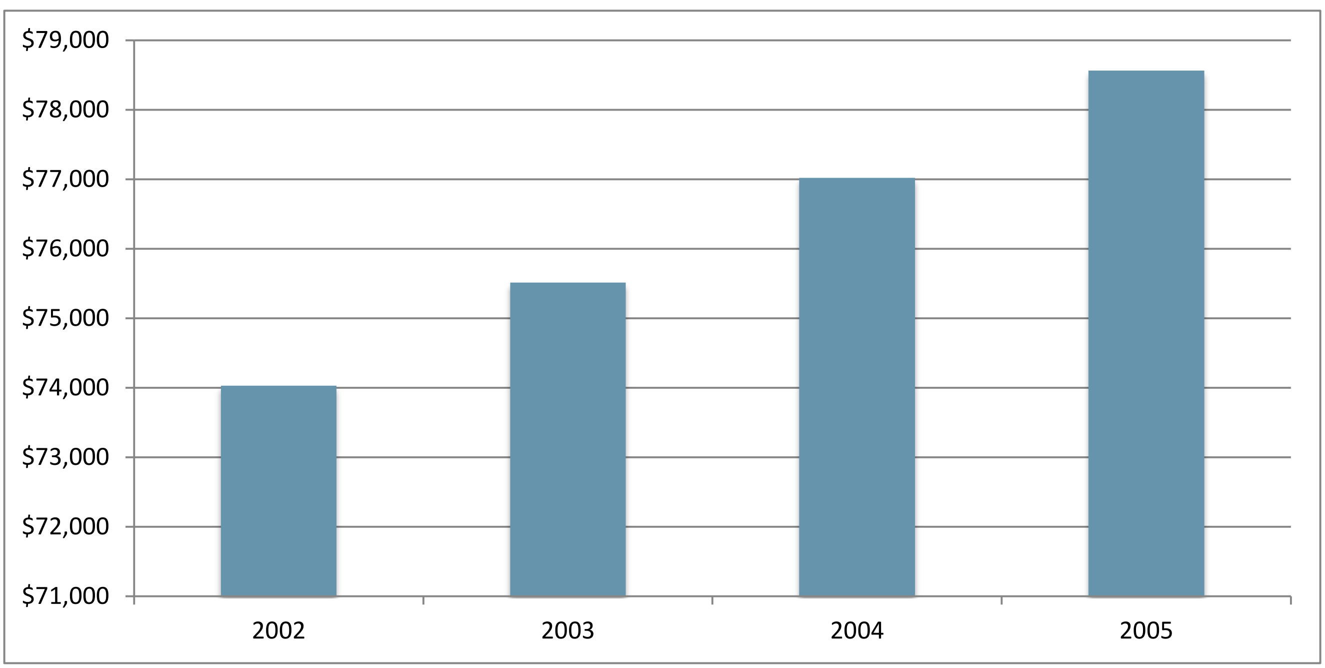


Source: C-CAP data (available for 2001 and 2005).

to 90 percent of all food consumed here is produced outside Hawai‘i (Page, Bony, & Schewel, 2007). Our food imports result in significant transportation costs and associated carbon dioxide emissions, while impacting the quality and quantity of the available food products.

Over the past 150 years, Hawaiian agriculture has undergone major changes. Once consisting of sweet potatoes, taro, and yams to support local consumption, agriculture in Hawai‘i became an important sector of the economy in the 1900s when plantations began production of export-based cash crops such as sugar and pineapples (Page et al., 2007). In the past few decades, however, competition from developing countries, changing market preferences, and the price of land and water caused cash crop production to decline, and the amount of harvested land fell precipitously (Burnett, 2012). Hawai‘i's agricultural sector currently represents a small portion of the overall economy (just above 1 percent of GSP and 1 percent of total employment) (Leung & Loke, 2008). Despite the recent decline in agricultural value, expenditures, and employment, new agricultural sectors have emerged, including genetically modified seed corn, which is planted on a small fraction of agricultural land, but contributes a third of Hawai‘i's agricultural output (Burnett, 2012; Hawai‘i State Department of Business, Economic Development, & Tourism, 2012c). In addition, former plantation agriculture is being replaced by small farms producing more diversified agricultural products increasingly destined for the local market, including vegetables, fruits, flowers, and biofuels (Burnett, 2012). Diversification is not only partially filling the economic void left by the collapse of cash crops and plantations, it is also beginning to reduce Hawai‘i's reliance on imported produce, confirming progress towards achieving our economic goal under the Hawai‘i 2050 Sustainability Plan to "increase production and consumption of local foods and products" (Hawai‘i 2050 Sustainability Task Force, 2007), as well as the state's Comprehensive Economic Development Strategy (State of Hawai‘i Office of Planning, 2012a, 2012b) and the Governor's New Day Plan (State of Hawai‘i, 2010), all of which call for increased food and energy self-sufficiency.

Figure 9. Benefit of net wetland change for years with data



Former plantation agriculture is being replaced by small farms producing more diversified agricultural products increasingly destined for the local market

Land use in Hawai‘i is strictly regulated, based on strong local values of the importance of land. Stewardship of the land is central to Hawaiian values and identity, so much so that the state's motto is "Ua Mau Ke Ea O Ka ‘Āina I Ka Pono" – which translates as "The Life of the Land is Perpetuated in Righteousness." Private land ownership was introduced in the post-colonial period, but the government regulates allowable land use by designating districts. Chapter 205 of the Hawai‘i Revised Statutes (HRS) prescribes the role of the Hawai‘i Land Use Commission, a public decision making body that designates land as one of four districts (urban, rural, conservation, and agricultural), as well as issues rules and regulations governing the use of land.

Of the 4.1 million acres of land in Hawai‘i, only 200,000 acres are urban/rural, nearly 2 million are designated conservation, and 1.9 million acres are agricultural (Hawai‘i State Department of Business, Economic Development, & Tourism, 2012c).

Agricultural districts, which can be used for a diversity of activities ranging from farming to ranching to wind energy to agricultural tourism, are further broken down into highly productive and less productive classes. The former, called "important agricultural lands," are protected by Act 183, passed in 2005. The apparent abundance of land districted as agricultural is somewhat misleading, however, as only 1.1 million acres of the 1.9 million acres districted were actually "land in farms" (per the US Department of Agriculture [USDA] definition, which counts all land that was part of a farm that had at least $1000 in annual sales) and only 103,000 acres were "harvested cropland" (as defined by the USDA) in 2007, the latest year data are available (US Department of Agriculture, 2009).

A loss in agricultural area results in costs to society in several ways. A loss in farmland implies a loss of the productive capacity of the land, restricting the ability to grow food locally now and into the future, regardless of whether that produce is intended for local consumption (to offset the cost of importing food) or for sale outside of the state. It increases the vulnerability to supply chain disruptions. Agricultural jobs are lost as the sector contracts (the loss of which are captured in traditional GSP and the personal consumption indicator of GPI), and a way of life is lost. Moreover, agricultural lands provide environmental services, such as water filtration and aesthetic beauty. Agricultural lands are also a cultural asset, a source of pride in deep-rooted traditions, creating strong community bonds in addition to the intrinsic value of open land, a refuge from the urban centers. Therefore, the loss of agricultural lands and the agricultural way of life has broader impacts on social well-being, which is not captured by the changes in agricultural production alone or GSP.

General Trends

According to the Hawai‘i State Department of Business, Economic Development, and Tourism (2012c), acreage designated for agriculture is declining in Hawai‘i. In 1964, 2.1 million acres were designated agriculture land, whereas only 1.9 million exist now. The state lost 5,500 acres of agricultural land since 2003, 1,350 acres of which were converted in 2012 alone (**Figure 10**). This land was taken out of agricultural designation for development to urban/rural uses, and thus largely losing the future option to use the land for agriculture.

In terms of land in farms, as defined and reported by USDA, the state saw a similar trend (**Figure 10**), dropping from 2.4 million acres of farmland in 1964 to 1.1 million acres in 2007 (the last year a census of agriculture was completed). As mentioned above, only a small portion of the land in farms is used for growing crops; most is used as pasture land or is fallow.

Despite this decline in agricultural land, the last four decades saw positive changes. The number of farms climbed from a low of 3,800 in 1974 to 7,500 in 2007, and the value of crops and livestock production actually increased from $103 million a year in 1958 to $680 million in 2011 (Hawai‘i State Department of Business, Economic Development, & Tourism, 2012c). While individual farm size is smaller (an average of 149 acres in 2007 down from 461 in 1978), between 2002 and 2007 the number of family farms increased from 4,629 to 6,363. Data suggest that smaller farms supported local markets, while the largest farms were responsible for most of the exports to the mainland and international markets (Burnett, 2012). Burnett (2012) showed an increasing local market for local goods that paralleled a decline in state exports.

GPI Approach

The Maryland, Ohio, and Vermont GPI studies used USDA National Agricultural Statistics Service (NASS) census data to arrive at the total farmland. They used the USDA's definition of farmland, which considers land to be farmland if it is part of a farming operation that sells at least $1,000 worth of goods a year. Maryland excluded the portion of this farmland that is forested and used for grazing, however, to avoid double counting with its GPI forest indicator.

Maryland chose to value agricultural lands using the estimate from the 1998 GPI study (Anielski & Rowe, 1999), which fixed the productive value of an acre at $372, which Maryland then converted to year 2000 dollars, resulting in a value of $404. Notably, this value captures the productivity of farmland only, but not the other services it provides. Maryland adjusted this productivity estimate to $1,131 based on the observation that Maryland's agricultural productivity per acre was 2.8 times higher than the national average (State of Maryland, 2010). The following equation illustrates the generic approach taken:

Cost of net farmland change =
(number of acres farmland lost) x
(estimated productivity)

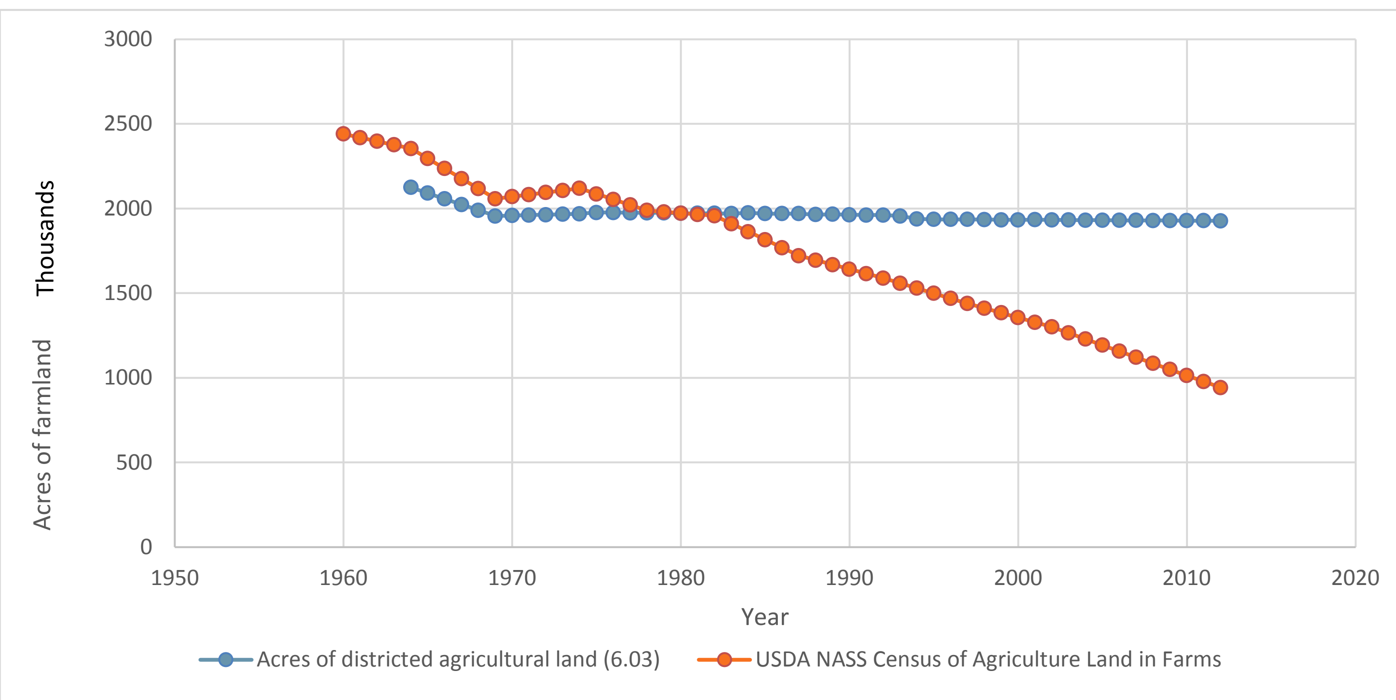
Other studies (e.g., Talberth et al., 2007) used much higher values to capture the broader benefits of agricultural land, but Maryland was skeptical of the methods used by the underlying study, which was done in 1992 on the value of horse pastureland in Kentucky. In a different approach, Utah used the market value of preserving agricultural lands through conservation easements based on the argument that this represents the option value of the land, and arrived at values between $578 - $66,935 (2000 USD), depending on the county (Berik & Gaddis, 2011).

GPI-HI Approach

In the case of Hawai‘i, we also use the USDA NASS data on farmland.

For the GPI-HI, we chose to be conservative and use the

Figure 10. Trends in agricultural land and actual farmland area



Source: DBEDT, 2012 Table 6.03 "Estimated acreage of land in farms 1964 to 2012"; USDA NASS, 2009).

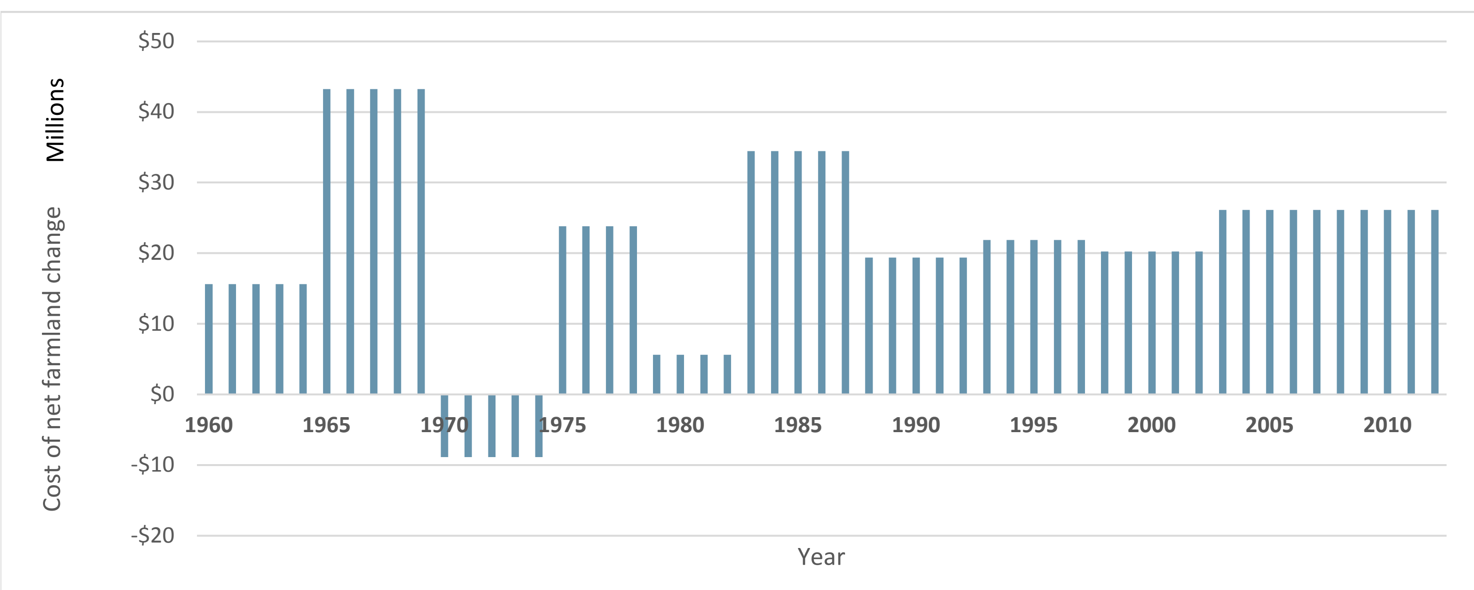
1998 GPI study value of $404 per acre, adjusted to Hawai‘i's productivity, which is 1.8 times the national average. This multiplier was calculated using a 5-year (USDA census years 1987, 1992, 1997, 2002, 2007) average of the ratio of reported dollars of sales from agriculture over the area in farms, as reported in the USDA NASS Censuses.

For the baseline GPI-HI over the time frame for which data were available, we estimated an average annual cost of $21 million dollars (2000 USD). For the time period from 1960 to 2012, the estimated cost of farmland loss is $1.1 billion (2000 USD) (Figure 11).

Future Research

Future GPI exercises for Hawai‘i will refine both the estimated farmland area and farmland value per acre. We could use the land districted as agriculture rather than farmland area, as its conversion represents a loss of the option to farm, although some experts believe that this would be misleading as the agriculture district was historically used as the "other" category (i.e., not urban or conservation). Alternatively, we could tap into emerging remotely sensed land use data to refine the estimate of actual productive farmland. In terms of the value we apply, the baseline number of $404 per acre is an artifact of a weakly substantiated study published in 1998. For a number of reasons, it is likely not reflective of the average value of farmland in Hawai‘i. We continue to use it for the simple reasons that we do not have a better estimate of the average value of agricultural land, and using it makes our outputs comparable to other states. The first step is to get a better estimate of the productive value of Hawaiian farmland. One recent study averages land rental rates over a 25 year period, finding a range between $25 (pasture) - $642 (vegetables) per acre per year (Goldstein et al., 2012). These specific values could be combined with more detailed information about the area under each type of agricultural use. However, it is important to note that this annual productive value of the land represents only a fraction of the true value of agricultural landscapes, which, as we have mentioned, provide multiple benefits beyond food production. We need valuations of these other ecosystem services to fully capture the loss to society of agricultural land conversion.

Figure 11. Cost of net farmland change (1960-2012) (millions of dollars per year in 2000 USD)



Introduction to Issue

Hawai‘i’s forests are vital to the islands’ cultural heritage, freshwater supply, economy, carbon footprint and biodiversity. The upland forest is the realm of the gods, or *wao akua*, and are valued as an essential cultural resource. The forest protects key areas that recharge streams and aquifers, which are the sole providers of freshwater to the islands. The forests’ role for water supply has been recognized for a long time, and is referenced in traditional proverbs: *Hahai no ka ua i ka ululā‘au* translates to “the rain follows the forest.” Without the forests, water would quickly run off the land into the ocean. The forest canopy increases the water supply by as much as 30% by extracting water from clouds and fog and allowing rainfall to fall gently to the absorbent ground (Hawai‘i State Department of Land and Natural Resources, 2011). Forest vegetation protects the soil and reduces sediment in runoff that would otherwise damage our beaches and coral reefs, key economic assets. Our forests sequester around 51.3 megatons of CO_2 (Hawai‘i State Department of Land and Natural Resources, 2011). Finally, Hawai‘i is home to nearly 400 threatened or endangered plants and animal species, a large majority of which rely on a healthy forest ecosystem for food, shelter, and other ecosystem services to survive natural disturbances and a changing climate (Hawai‘i State Department of Land and Natural Resources, 2011).

A number of plans and policies focus on the importance of Hawaiian forests for water in particular and set out to increase the area under protection, which is currently only 10% (Hawai‘i State Department of Land and Natural Resources, 2012). The Governor’s New Day Plan (State of Hawai‘i, 2010) recognizes the need to be stewards of natural resources in order to protect their important role for the economy, survival, and general quality of life. With this plan, the Governor reinvigorated the role of the Department of Land and Natural Resources in ensuring that upland watersheds were protected. In response, DLNR generated “The rain follows the forest: A plan to replenish Hawai‘i’s source of water” (Hawai‘i State Department of Land and Natural Resources, 2011), which identifies priority watersheds and sets out needed actions and projects to protect key watersheds and water sources. At the time of publication of DLNR’s plan, only 10% of the priority watersheds were protected; the plan sets out the goal to double this in 10 years. Implementation of this initiative began in 2011 once Act 106, SLH 2012 was enacted, and despite underfunding, DLNR has fenced an additional 5,600 acres and maintained thousands of priority areas (Hawai‘i State Department of Land and Natural Resources, 2012).

General Trends

The past 250 years have witnessed a drastic decline in forest cover in Hawai‘i. Bennett and Friday (2010) estimated pre-settlement forested area covered 95% of the land (around 3.9 million acres). The biggest changes in forested area came after European contact in 1778, with the establishment of large-scale agriculture and cattle ranches, followed by urban development (Bennett & Friday, 2010). According to the most recent GAP analysis, only 35% of the islands are currently forested (Gon et al., 2006); according to NOAA’s C-CAP estimates, only 29% is forested (National Oceanic and Atmospheric Administration, 2013).

Many ecosystem goods and services are provided by forests, including groundwater recharge, flood control, water purification, opportunities for recreation, aesthetics, climate control, and habitat provision.

Forest cover loss is not the only concern. Invasive species overrun at least 36% of the forests, crowding out native species (Gon et al., 2006). Alien species are in direct competition with native flora, do not meet the habitat requirements of native fauna, and alter basic ecological functions. Such is the case with forests infested with strawberry guava (*waiawī*), which evapotranspire 27-53% more water than native forests, resulting in less groundwater recharge (Cook & Stephens, 2008). This is a prime example of invasive species diminishing the ecosystem services provided by forests.

Many ecosystem goods and services are provided by forests, including groundwater recharge, flood control, water purification, opportunities for recreation, aesthetics, climate control, and habitat provision. The loss or degradation of these goods and services disturbs our economy, quality of life, and even survival. While the benefits forests provide are generally recognized, the value of these benefits can be hard to capture as they are goods and services that are not traded in any market. Nature provides the services free of charge, so our traditional means of assigning an economic value by looking at the market prices is unavailable to us. A specialty within the field of environmental economics focuses on assigning prices to these non-market goods and services.

One local case study explored the value of Oʻahu's 97,000 acre Koʻolau conservation district's contribution to groundwater recharge, finding the service to be worth a (net present value) of $4.6 – $8.5 billion (Kaiser et al., 2002; Kaiser & Roumasset, 2002). This value derives from the avoided cost of replacing the ecosystem service with engineering solutions (in this case desalinated water). The increased evapotranspiration of strawberry guava invasion (assumed 31%) resulted in a total loss between $1.42-$2.63 billion from decreased groundwater recharge (Kaiser & Roumasset, 2002). The authors found a combined value for all quantifiable market and non-market benefits in this important conservation district between $7.4 and $14 billion, which equates to an annual benefit of approximately $1,690 per acre (Kaiser et al., 2002). This study validates the importance of dedicating management resources to protecting these valuable resources.

GPI Approach

GPI puts a monetary value on the market and non-market contributions of forests, recognizing that forests provide many ecosystem services supporting our economy, quality of life, and survival. The value assigned to forests attempts to capture the "total economic value" of the forest, similar to the study above, in order to capture the loss to society of deforestation (or the gain from afforestation in some cases). The GPI component for forests is calculated as: *The value of net forest change = (change in number of acres) x (estimated forest value per acre)*.

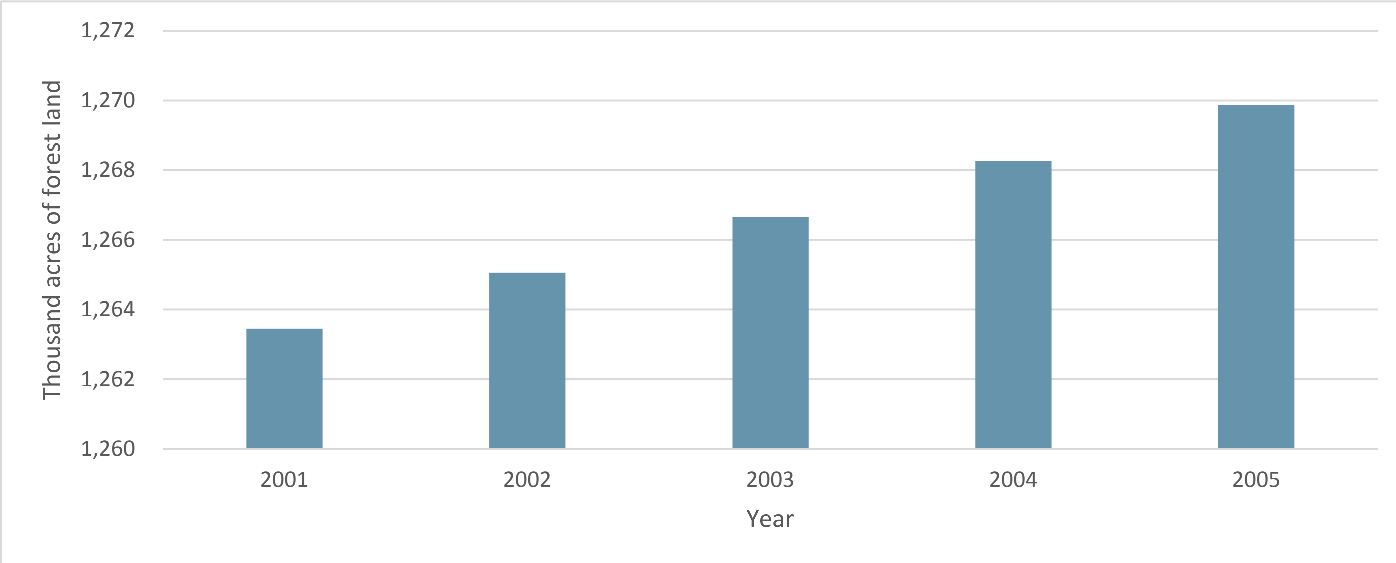
A range of data sources for forest area and estimates of values emerges from an examination of previous GPI studies. Focusing on the values, Ohio's figure of $481 per acre is based on the 2004 Costanza et al. (2004) study, while Maryland estimated their forest cover value at $318.50 per acre. Utah used $875 (2000 USD) per acre, based on a study by Dodds et al. (2008). As noted in the Koʻolau case study cited above, in one area of Hawaiʻi, our forests are worth $1,690 per acre.

It is important to note that Utah again took a completely different route for forests, similar to how they valued wetlands. Utah assessed the total value of the resource, considering it a stock (an asset) that produces an annual flow of benefits that increases or decreases depending upon the stock's size. This can be contrasted to the traditional GPI approach that deducts the loss of benefits from an annual decrease in the area (or adds the gain in benefits from an increase in area).

GPI-HI Approach

As discussed in the wetland indicator (ENV 4), a number of datasets exist that estimate different land covers and land uses in a spatially explicit manner. The USGS GAP analysis (Gon et al., 2006) covers only one year (data were collected between 1999-2001, but reported as 2001), so we cannot use it to track trends in forest area (see http://gapanalysis.usgs.gov/data/). NOAA's Coastal Change Analysis Program's (C-CAP) (National Oceanic and Atmospheric Administration, 2013) regional land cover data, on the other hand, are available for Hawaiʻi for 1992 (partial coverage), 2000/2001 (which has since been removed from the website), 2001 (all islands), and 2005 (all islands), with 2013 forthcoming (see http://www.csc.noaa.gov/digitalcoast/data/ccapregional). Similar to GAP data, C-CAP data is classified into land cover categories, but far fewer (29 as opposed to 590). We interpolate a four-year period using NOAA C-CAP data from 2001 (1.263 million acres) and 2005 (1.270 million acres). The other year of partial C-CAP data (1992) was excluded. (The area of forest from C-CAP does not match the GAP estimates cited above due to differences in classification.) The slight upward trend (representing a gain of 6,400 acres in four years) (**Figure 12**) should not be over-interpreted, as it may be an artifact of the spatial data processing.

Figure 12. Acres of forested land interpolated between 2001 and 2005 showing a slight upward trend



While the Koʻolau region is not representative of all Hawaiʻi's forests, we prefer to use the local valuation study to assign a value to our forests: $1,690 per acre. This is likely an overestimate, as the value is driven by the groundwater recharge and aesthetics benefits, the level of which are a function of the use by residents of densely populated Oʻahu. That said, it is more representative of the value of our biodiverse forests and their critical role in water recharge than a value transferred from Utah or Maryland. We use this value for all years (2000-2005). We follow previous studies, so we do not increase the value over time to account for increasing scarcity, as we did for wetlands; this is a topic we should revisit in the future.

For the GPI-HI baseline we used the following equation:

The cost (or benefit) of net forest change = (number of acres lost or gained) x ($1,690/acre in year 2000 USD)

The gain of 6,400 acres of forest between 2001 and 2005 represents gains of $11 million (2000 USD). The average annual benefit in the period for which data was available (from 2001 to 2005) is estimated at $2.7 million per year (2000 USD).

Future Research

Similar to the estimates of wetland area, the C-CAP spatial data show an increase in forests. Given development pressures in Hawaiʻi, a growth in forests is counterintuitive. Additional verification of the data is warranted.

We suggest refining and adapting the Kaiser and Roumasset (2002) valuation so that it is generalizable for all islands. A first step would be to adjust the value assigned to an area of forest for the population size gaining benefits. Obviously, urban Oʻahu's forests would carry a relatively high value reflecting the high demand from its population. Furthermore, not all forests are equally valuable, and it would be useful to apply values specific to different categories of forests (e.g., old and new growth, invaded or native) reported by C-CAP.

Introduction to Issue

Scientists have come to the conclusion that the Earth's climate has been warming, and that this warming trend has increased and will continue to do so as a result of human activities that have exponentially increased the amount of certain atmospheric gases (Stocker, Dahe, & Plattner, 2013). While not the most potent, carbon dioxide traps more of the sun's energy radiating back into space than the other gases, effectively acting like a greenhouse. These greenhouse gases (GHGs), including carbon dioxide, methane, and nitrous oxide, warm the atmosphere sufficiently for life to flourish, but as the concentrations of these greenhouse gases continue to increase the temperature of the Earth's atmosphere and oceans will also continue to rise, changing global climate patterns.

The changing climate system can drive more frequent and intense storms, alter precipitation patterns, and bring about extreme temperature variation (Parry, Canziani, Palutikof, Linden, & Hanson, 2007). While no single event can be attributed to climate change, in the wake of hurricane Sandy and typhoon Haiyan, ice storms in Dallas, Texas, and record tornado seasons in Oklahoma, to name just a few examples from 2013, people are increasingly paying attention to extreme and anomalous weather events. These physical impacts cause changes in terrestrial, aquatic, and marine systems, affecting non-human biological systems (Parry et al., 2007). While the impacts on humans is harder to determine due to human adaptation and the fact that climate change is just one of many forces impacting human well-being, human health, forestry, and agricultural systems have been affected (Parry et al., 2007).

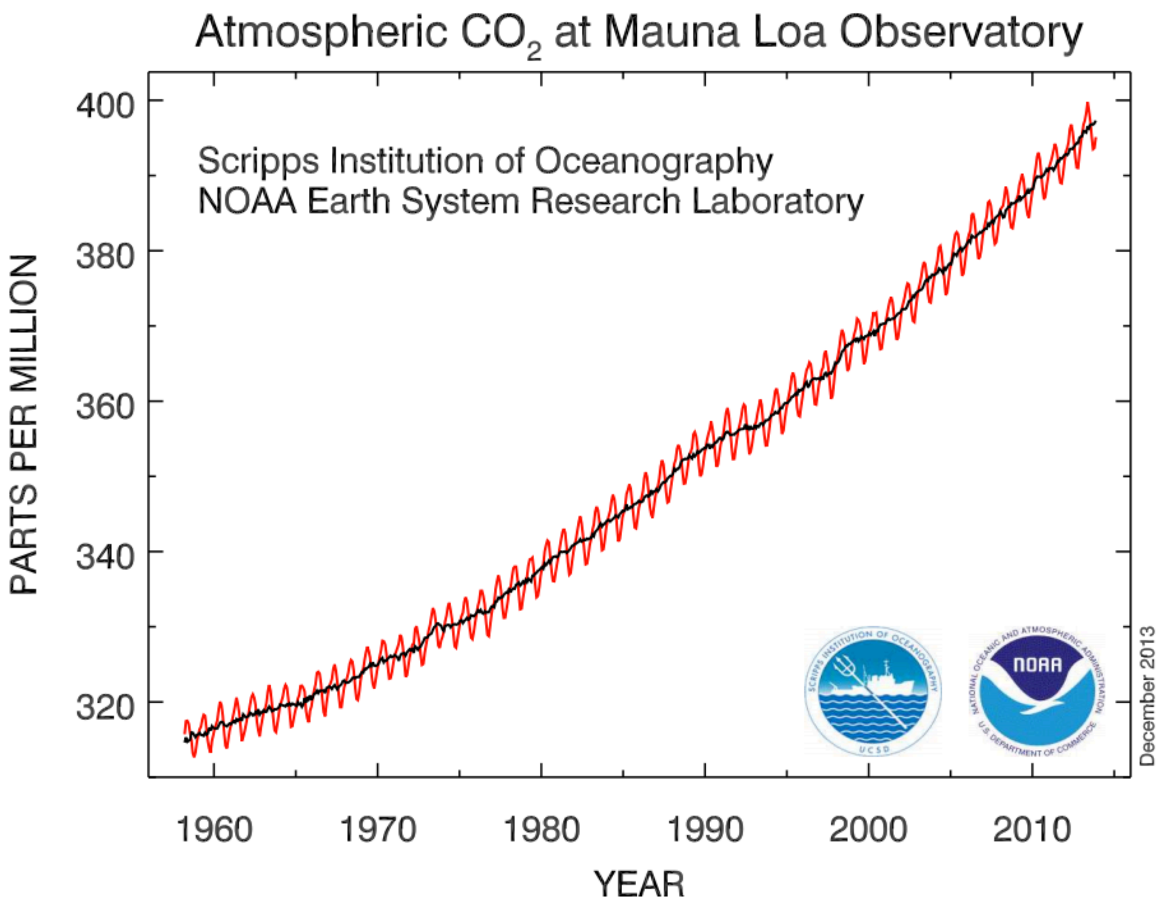
One recent study anticipating a shift in climate from historical patterns within the very foreseeable future expects that Hawai‘i could feel these effects sooner than other areas due to its location in the tropics (Mora et al., 2013). This is worrisome because, as an island state, Hawai‘i is very vulnerable to the effects of climate change. Water resources will be altered due to changed precipitation, sea level rise, and higher temperatures driving increased evapotranspiration. Health risks due to heat stress are very likely to increase with increasing temperatures. Aquatic ecosystems, especially coral reefs, will likely be degraded by increased water temperatures and ocean acidity. Biodiversity of plants and animals associated with Hawai‘i's delicate ecosystems is likely to decline. Sea-level rise is very likely to continue at an even faster rate, inundating wetlands and coastal communities, and escalating damages from storm surges.

Climate change adaptation planning in Hawai‘i officially began with Act 20 (State of Hawai‘i, 2009), which created a task force to deal with climate change mitigation, but the task force never convened due in part to a lack of funding (State of Hawai‘i Office of Planning, 2012a). To fill the void, DBEDT's Office of Planning used its authority under the Coastal Zone Management Act to lead an effort to develop an adaptation plan. Act 286 (State of Hawai‘i, 2012) is an amendment to the state's Planning Act, and was codified in HRS §226-109 (State of Hawai‘i, 2012a) outlining the state's adaptation policy. Currently, the Ocean Resources Management Plan serves as the main vehicle for adaptation action. Turning to emissions, Hawai‘i was just the second state in the nation to enact GHG emissions regulations. Climate change mitigation is covered by Act 234 (State of Hawai‘i, 2007), which established the state's policy framework to address greenhouse gas emissions, namely to achieve reductions in GHG emissions to 1990 levels by 2020. The Department of Health is responsible for its implementation.

General Trends

Greenhouse gas emissions are globally distributed. Emissions from one place contribute to damages suffered across the globe. Most measurements are generally done in remote locations such as Mauna Loa, HI, which has one of the longest records of direct measurements of atmospheric carbon dioxide (CO_2). The measurements of CO_2 at Mauna Loa Observatory have shown a steadily increasing trend since the 1960s (**Figure 13**).

Figure 13. Global CO2 concentration, 1955-2013



Source: Keeling, 2013; Tans, 2013

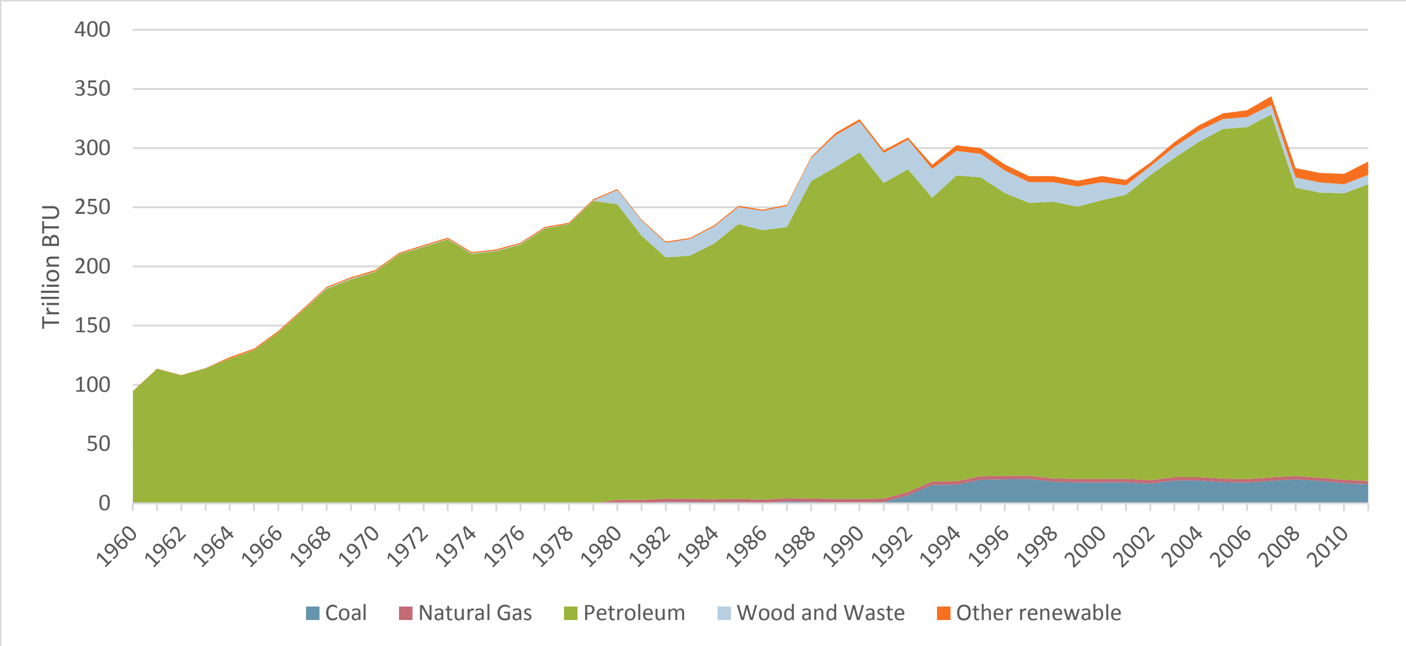
Although a global problem, climate change can be addressed locally by focusing on local consumption. Human activities, intensified by industry, are the main culprit of increased GHGs. Emissions associated with energy consumption are particularly significant, and can serve as a proxy for costs of climate change that are missed by standard accounting (State of Maryland, 2012). EPA reports that Hawai‘i's transportation (including aviation) (54%) and electricity (36%) sectors are the major contributors to the state's greenhouse gas emissions. Energy consumption in Hawai‘i has tripled from 1960 levels, while the composition of energy sources contributing to emissions has remained virtually unchanged (**Figure 14**).

Petroleum makes up the vast majority of energy currently consumed in Hawai‘i (**Figure 15**). Hawai‘i has a renewable energy portfolio mandate, requiring utilities to produce 10% of net electricity sales with renewables by December 31, 2010; 15% of its net electricity sales by December 31, 2015; 25% of its net electricity sales by December 31, 2020; and 40% of its net electricity sales by December 31, 2030 (Environmental Protection Agency, 2012b; US Department of Energy, 2009). It should be noted that some renewable sources are still carbon-intensive and contribute substantively to climate change

GPI Approach

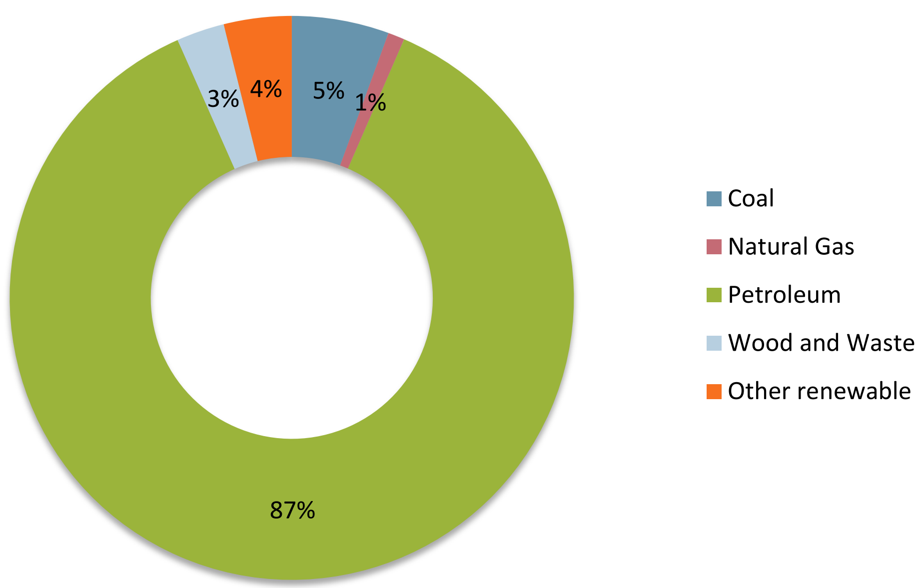
The most common approach used in the GPI studies to-date to determine the cost of climate change is to evaluate CO_2 emissions from the consumption of different forms of energy across the various sectors of the economy, and to assign those a value representative of their projected damages. Notably, this method focuses on the value of damages that the state's emissions will cause, regardless of where those damages will occur. (This can be contrasted to a "damages suffered"

Figure 14. Energy consumption in Hawai'i showing an upward trend in overall BTUs



A small amount of biomass (wood and waste) and other renewables emerge along the top of the graph. Greenhouse gas emissions in the GPI are based on this consumption.
Source: EIA, 2012

Figure 15. Energy production in 2011 (as a percentage of BTU)



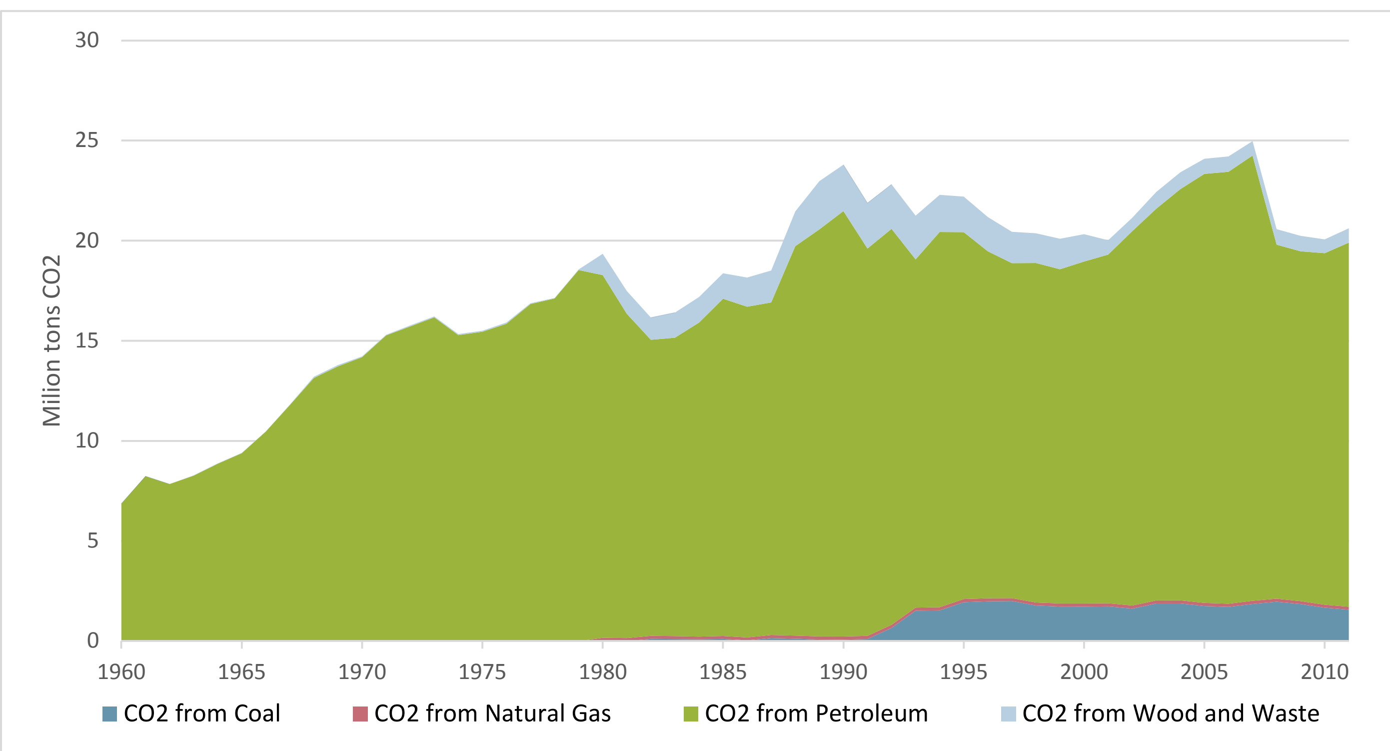
approach, which accounts for the cost of climate change impacts to a state's assets.) In Hawai'i, the transportation of energy presents a unique cost, as petroleum is shipped into the state.

Focusing on consumption of petroleum, coal, natural gas, and wood and waste, Maryland applied the average carbon intensities per British Thermal Unit (BTU) of their four main types of fuel consumed (coal, petroleum, wood, waste, and natural gas); these intensities were reported by the US Energy Information Administration (EIA) State Energy Data System (US Energy Information Administration, 2012b). Although this is only an approximation, it provides a relatively accurate and reasonably simple methodology for calculating emissions and extrapolating back to the study's baseline year of 1960. These values were then further converted to metric tons of emissions (we use tons and metric tons interchangeably throughout this section, in all cases we mean metric ton, or 1000 kg). **Figure 16** shows the trends in Hawai'i carbon dioxide emissions.

Maryland based their estimate of the total damage that each ton of emitted CO_2 will cause on a method set out in Talberth et al. (2007). This method effectively assumed that CO_2 emitted any time before 1964 caused no damage because the assimilative capacity of the atmosphere had not been reached. From 1964 onwards, however, the estimated damage caused per ton of emitted carbon rose year by year as the atmosphere became increasingly polluted. Their damage estimate increased along a linear trend from 1960, based on two data points: $0 in 1960, and $89.57 per metric ton CO_2 (2000 USD) in 2004. Though the 2004 figure incorrectly interprets a meta-analysis by Tol (2005) (see below), the damage value is meant to include a wide array of modeled impacts, from coastal property destruction to agricultural production to loss of human life, that will continuously increase as climate change impacts worsen. Maryland followed Talberth et al. (2007), extrapolating the linear trend to the future. To calculate the annual cost of damages associated with carbon dioxide emissions, then, each year's CO_2 emissions from energy consumption were multiplied by that year's cost per ton of CO_2.

Unfortunately, Talberth et al. (2007) and in turn Maryland, misinterpreted the baseline study they relied upon for the 2004 figure (Tol, 2005) as reporting the cost of carbon in "dollars per metric ton CO_2" and not as

Figure 16. CO2 emissions from various fuel sources in Hawai'i, 1960-2011



"dollars per metric ton C," which is correct. This makes a big difference: $89.57 per metric ton C is equivalent to $24.43 per metric ton CO_2. Tol's published study reviewed dozens of estimates to come up with a median cost of $14 per metric ton C and a mean cost of $93 per metric ton C (Tol, 2005). Talberth et al. (2007) used Tol's mean of $93, adjusted it to year 2000 dollars under the assumption that Tol's estimate was for the year of his publication's submission (2004) to get the $89.57 value, but incorrectly interpreted the figure as per metric ton CO_2 rather than per metric ton C. (Tol provided no baseline year for his values, but Talberth reasonably assumed it to be 2004, the year the study was initially published. Talberth does not specify the deflator used to convert to year 2000 USD.)

GPI-HI Approach

To determine the cost of climate change damages caused by emissions in the State of Hawai'i, we used Energy Information Administration data on amount of coal, natural gas, petroleum, and wood and waste consumed (reported in billion BTUs), converted these to tons CO_2 emissions based on carbon equivalence rates reported by the State Energy System Database (US Energy Information Administration, 2012b), then valued each emitted ton by Tol's cost per ton CO_2. We used energy consumption data from the EIA State Energy System Database for petroleum, coal, natural gas, and solid waste from 1960 through 2012, with 2013 data forthcoming in 2014.

We applied Tol's mean value of $93 per ton C (2004 USD), translated into year 2000 USD ($89.57), then converted to $25.4 per ton CO_2. Similar to the other studies, we interpolate a linear trend between 1963 ($0 damages) and 2004 ($25.4 per ton CO_2), then extrapolate that trend through 2011, the latest year with data.

For the year 2011, the cost of climate change for the state of Hawai'i is valued at $589.5 million (2000 USD). Over the past decade (2002-2011), the total cost of climate change from Hawaiian emissions was $5.7 billion (2000 USD), with an average of $573 million per year.

Future Research

Future GPI calculations should revisit the carbon damage estimate, as the social cost of carbon has been an active area of research since Tol's (2005) study. The social cost of carbon estimates depend on the integrated assessment model used to estimate future impacts and damages, and the discount rate applied (see, for example, Interagency Working Group on Social Cost of Carbon (United States Government, 2010) which illustrates this variability). Moreover, the growth of damage costs is unlikely to be linear, as we have assumed.

An altogether alternative approach would be to look at consumer spending data to assign a carbon intensity (defined as pounds of carbon emitted per dollar spent) as described in Shammin and Bullard (2009). Consumption categories in the analysis could then be far more detailed, such as in Utah's GPI study (Berik & Gaddis, 2011), which included things like food, dwellings (owned and rented), electricity, phone, housekeeping, air travel, healthcare, entertainment, education, and insurance.

COST OF CLIMATE CHANGE — ENV 8

Introduction to Issue

The stratospheric ozone layer naturally shields the earth from harmful levels of the sun's ultraviolet (UV) rays. Yet decades of emissions of chlorine compounds, such as chlorofluorocarbon (CFCs), have led to a 50-75% depletion of total ozone, resulting in a significant "ozone hole" at the stratospheric level. The ozone hole has steadily grown in size (up to 27 million sq. km.) and duration of existence (from August through early December) over the past two decades (National Oceanic and Atmospheric Administration Climate Prediction Center, 2011). Furthermore, in addition to the hole that regularly appears over Antarctica, in 2011 for the first time in observational record, another hole was detected over the Arctic (Manney et al., 2011).

Without a naturally functioning ozone layer, increasingly harmful levels of UV radiation reach the ground. Greater exposure to UV leads to a variety of health and environmental problems such as (Environmental Protection Agency, 2011): increased rates of skin cancer and cataracts (Environmental

Protection Agency, 2010a); decreased plant and crop growth (Fiscus & Booker, 1995); and reductions in phytoplankton production from higher UVB exposure in marine ecosystems (Smith et al., 1992).

General Trends

Since 1987, the Montreal Protocol (ratified by 197 countries), enabled the reductions of over 98% of all global production and consumption of controlled ozone-depleting substances (primarily CFCs). Under the Protocol, the global phase-out of CFCs was achieved by 2010. According to the United Nations Environment Program (UNEP), global observations detect that atmospheric levels of key ozone depleting substances are decreasing, such that the ozone layer should return to pre-1980 levels by 2050 to 2075 (United Nations Environment Program, 2012).

GPI Approach

The overall approach to calculating the annual cost of degradation of the ozone layer follows the method set out by the Utah team (Berik & Gaddis, 2011). Global CFC emissions levels have been dropping since the enactment of the Montreal Protocol in 1989. These authors set US national ozone emissions as one-third of global emissions based on historical levels, extrapolated from 2003 (the last year with data), then scaled emissions to the state using population. They then assigned a cost of $49,669 per metric ton to account for the damages that a ton of CFC emissions caused or will cause to human health and the environment (Talberth et al., 2007). Talberth et al. claim that UV damages associated with CFCs have a profound and potentially catastrophic effect to justify their cost estimate, although no studies are cited to back this up (Talberth et al., 2007).

Cost of ozone depletion (1960–2004) = (tons of emissions of CFCs at national level) x (state population / national population) x ($49,669 (2000 USD) per ton CFC)

GPI-HI Approach

For Hawai‘i, we mainly followed Utah’s lead, extrapolating US share of global emissions in ozone depleting chemicals through 2004 (after which they become negligible), multiplying this by the ratio of Hawai‘i’s population to the national population, then evaluating the cost by multiplying this by the estimate of damage per ton of CFC as described above.

The cost of ozone depletion for the state of Hawai‘i was highest in 1988, reflecting a peak in national ozone emissions; damages that year cost an estimated $113 million (2000 USD). The average annual cost (from 1960 to 2012) was $39.2 million (2000 USD).

COST OF NON-RENEWABLE ENERGY RESOURCE DEPLETION — ENV 9

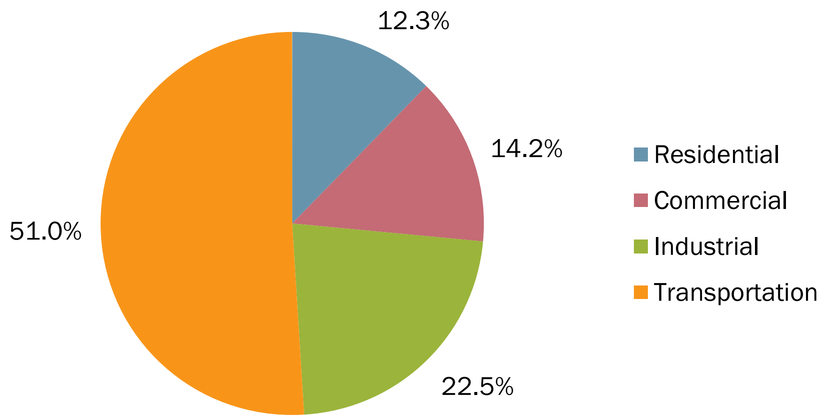
Introduction to Issue

Nonrenewable resource depletion is the extraction of fossil fuels and other finite energy sources. At one time, these resources seemed infinite, and, as accessibility to these resources increased, so did society’s dependence upon them. However, by continuously extracting these resources we are depleting limited stocks, negatively impacting local environments through destructive extraction processes, and taking away choices and opportunities for future generations to use these resources.

This indicator focuses on the depletion of fossil fuels as a proxy for all non-renewable resources as they are one of the most heavily exploited. Fossil fuels are but one example of non-renewable resources that we are exploiting, others include minerals, fossil groundwater, and metals. As we are forced to face the ever-increasing needs for energy and tighter environmental constraints, we will need to find renewable energy sources to meet this continuous demand.

The issue of non-renewable resource depletion is distinct from that of climate change. It so happens that our use of fossil fuels (a non-renewable resource) causes global climate change (a global environmental impact). However, this externality is considered under a separate GPI indicator that quantifies the damages of a warming climate. Of course, the issues are inextricably linked: policies aimed at mitigating climate emissions typically

Figure 17. Hawai‘i Energy Consumption by End-Use Sector, 2011



focus on switching from fossil fuels to renewable sources, and policies aimed at reducing reliance on non-renewable fossil fuels have the co-benefit of reducing greenhouse gas emissions.

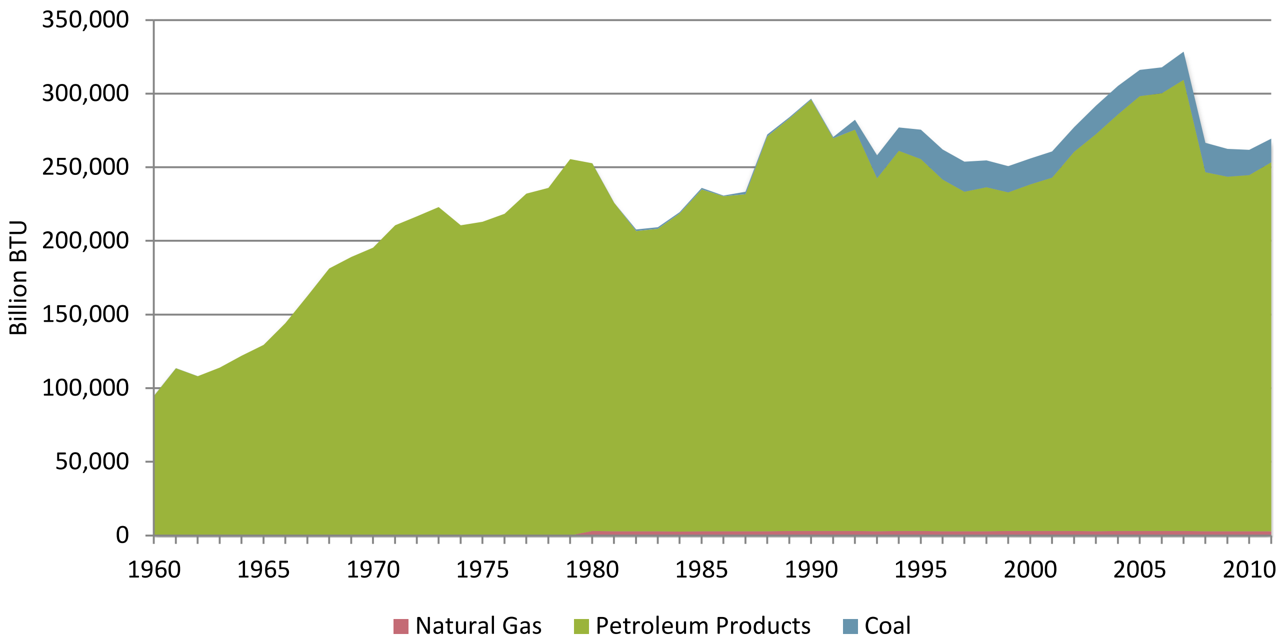
General Trends

According to the Energy Information Agency's state profile for Hawai‘i (US Energy Information Administration, 2012b), in 2010 Hawai‘i had the third lowest per capita energy use in the US, which they attribute to our mild tropical climate. Not surprisingly, due to our isolation and concentration of military operations, the transportation sector drives our overall energy demand (**Figure 17**). Despite operating the largest commercial waste-fueled electricity generator in the world, power plants fueled on imported petroleum supply more than three-fourths of Hawai‘i electricity (**Figure 18**). As a result, we have the highest electricity prices in the nation. Hawai‘i imports 94% of its energy, and is currently the most oil dependent state in the US with nearly full dependence on fossil fuel imports to meet its energy needs. Not only is this costly both economically and environmentally, it increases Hawai‘i's vulnerability to political, environmental, and economic shocks.

Hawai‘i need not be so reliant on imported fossil fuels, as we have enough potential capacity for renewable energy production to meet our energy demands. According to a National Renewable Energy Laboratory study by Arent et al. (2009), the state generates 2,414 MW, 83% of which using fuel oil, but has 2,133 MW of new renewable potential and an additional 2,000 MW of rooftop PV system potential. Already, the state ranks among the top ten solar-producing states and produces energy from other renewable sources such as hydroelectricity, geothermal, landfill gas, and other biomass. Hawai‘i is also one of eight states with geothermal power generation and ranks third in terms of energy generated (US Energy Information Administration, 2012b). Hawai‘i also has great potential for increased energy efficiency. This could be achieved by retrofitting, as well as construction of "net-zero energy" buildings that produce as much energy as they use each year.

Recognizing this, in 2010 Governor Neil Abercrombie launched the “New Day in Hawai‘i Plan” (State of Hawai‘i, 2010), which aimed to enhance Hawai‘i's energy policies and bolster the state's economy by investing in renewable energies. His initiative built on the 2008 partnership between the US Department of Energy and the state of Hawai‘i to launch the Hawai‘i Clean Energy Initiative (Hawai‘i Clean Energy Initiative, 2010). As a key component to achieving Hawai‘i's 70% clean energy goal by 2030 set by HCEI, DBEDT's State Energy Office is working to design policies that support energy-efficiency efforts, renewable energy development, and transportation objectives. Furthermore, Hawai‘i created financial programs that help reduce the costs for implementing energy efficiency measures, such as installing solar water heaters and upgrades to energy efficient appliances. These financial programs include

Figure 18. Hawai'i's non-renewable energy consumption by source (in billions of BTUs)



Petroleum dominates consumption, with a small amount of coal and even smaller amount of natural gas penetrating the market in recent years. Source: US EIA, 2012.

subsidies, grants, loans, rebates, and financial incentives. These programs are offered through a partnership between DBEDT's State Energy Office and the federal government (Hawai'i State Department of Business, Economic Development, & Tourism, 2013).

GPI Approach

In order to calculate the environmental and social cost of non-renewable energy resource depletion, GPI multiplies annual energy consumption by the cost of replacing that energy with alternate, renewable sources.

Most states used energy consumption data from the EIA, converting to barrel equivalent (for the electrical sector) or kilowatt-hours (for all other uses) using conversion rates from EIA. The states differed in what renewables they use to replace fossil fuels, however. Ohio and Vermont followed previous GPI studies that measure the cost of replacing petroleum with ethanol. Their methodology followed valuation studies by Anielski and Rowe (1999), which estimated the cost of replacing fossil fuels with ethanol to be $109.17 per barrel equivalent (2000 dollars). Maryland (2012) replaced fossil fuels in the electricity sector with a 50/50 mix of wind and solar energy, estimated to cost $0.0875 per kilowatt-hour based on Makhijani (2007), and biofuels for all other uses (transportation, industry, etc.), at $116 per barrel equivalent. (Makhijani assumes that wind cost $0.04-$0.06 per kilowatt-hour depending upon the site, and solar at $0.12 per kilowatt hour.) Maryland used the following equation:

Cost of non-renewable energy resource depletion = (energy consumption) x (costs of replacement through alternative sources (e.g., biofuels, wind, solar))

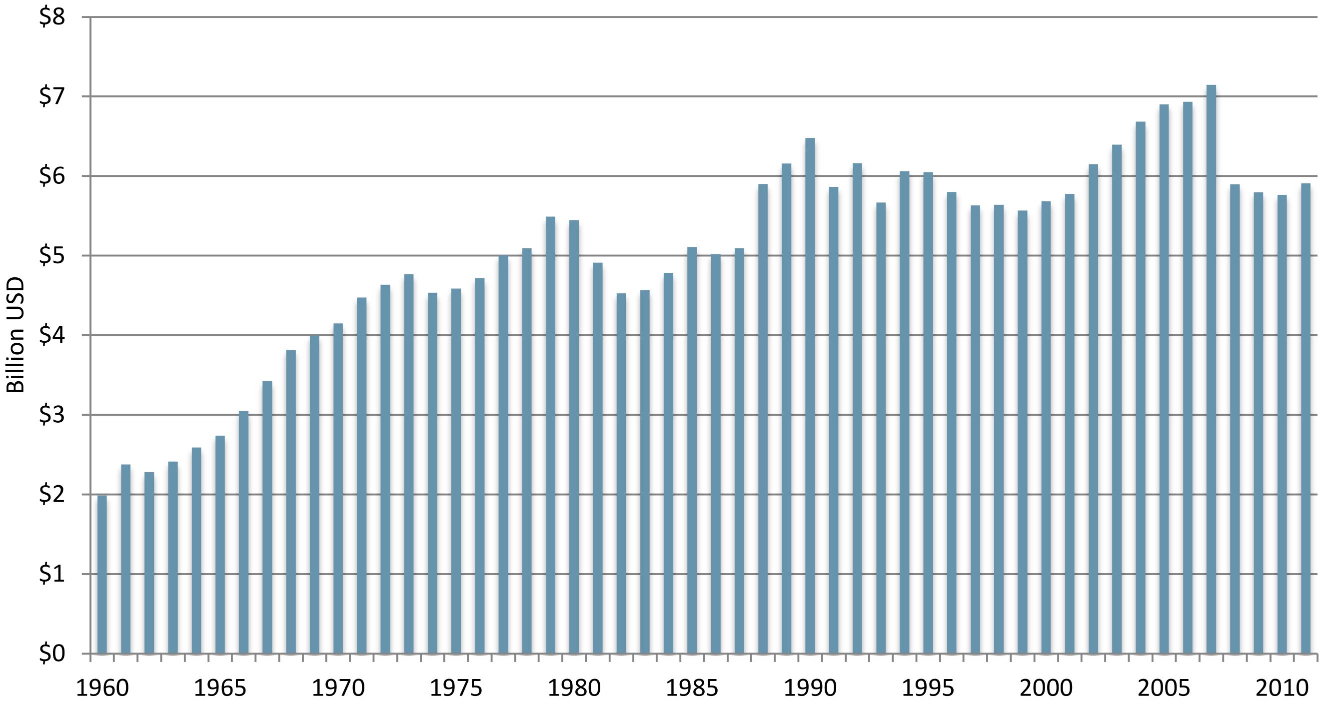
GPI-HI Approach

Energy consumption and production at the state level is closely monitored and the data is compiled and made publicly available annually from the EIA as well as DBEDT. The cost of non-renewable energy resource depletion for the state of Hawai'i can be calculated as:

Cost of non-renewable energy resource depletion = replacement costs in electrical sector + replacement costs outside electrical sector

We use the same assumptions as Maryland for the replacement mix and costs.

Figure 19. Cost of non-renewable energy resource depletion in billion 2000 USD, showing a general upward trend over the past 50 years (1960-2011)



For the year 2011, the cost of non-renewable energy resource depletion for the state of Hawai‘i is valued at $5.9 billion (2000 USD). The average annual cost in the period 2000-2011 was 6.3 billion, and the total cost for that period was $69.4 billion (2000 USD) (Figure 19).

Future Research

GPI calculates the cost of replacing fossil fuels with alternative energy. Right now, we use the same mix as other states, but in the future, all of Hawai‘i's many forms of alternative power generation should be used to calculate the cost of replacing non-renewable energy sources. For instance, further research into the cost of replacement through geothermal and wave energy should be considered.

COST OF PERSONAL POLLUTION ABATEMENT ENV 10

Introduction to Issue

All households take on certain "defensive" expenditures to protect family members or the community from risks; air purifiers, bottled water, or noise insulations are examples. Moreover, these expenditures compensate for the negative impacts of pollution but do not necessarily improve environmental quality. Ironically, even though associated with negative impacts, such defensive expenditures are captured as positive additions to GDP or GSP. The GPI model sets out to account for household costs associated with reducing air, solid waste and wastewater pollution risks and deduct this total spending from GDP or GSP accordingly. GPI studies typically use the associated costs of emission controls on vehicles, waste disposal, and sewer/septic systems.

Air Pollution Household Abatement

GPI looks at the impacts of personal vehicles on air quality and the associated defensive expenditures of catalytic converters. Catalytic converters convert toxic carbon monoxide, unburned hydrocarbons, and nitrogen oxides into less harmful exhaust and are installed in new cars.

General Trends

State transportation data can be used to aggregate defensive expenditures related to personal vehicle use across all households in the state. For Hawai‘i, the number of passenger vehicle registrations can be found in the State of Hawai‘i Data Book (Hawai‘i State Department of Business, Economic Development, & Tourism, 2012c). Although the number of passenger vehicle registrations statewide is variable from year to year, the overall number has increased by 36% for 2000 to 2012.

GPI Approach

In previous GPI applications, the costs of air pollution abatement were calculated using national or state figures for the number of new passenger vehicles, multiplied by a cost (in 2000 USD) of $100 for a catalytic converter (following Costanza et al (2004)) plus $8.50 for air filters for each new vehicle (as in Bagstad and Ceroni (2007)). The costs for catalytic converters were added after 1977 since they were not widely used prior to that time (State of Maryland, 2010). Catalytic converters are just one of multiple technologies to reduce or avoid pollution, so serves as a lower bound for defensive expenditures.

To identify the number of new passenger vehicles in the state, the Maryland GPI team first looked at the change in the stock of registered vehicles from the previous year. Additionally, the team assumed that given a 13-year lifespan on average of a personal vehicle, 7.69% of the stock of registered vehicles will be retired and consequently replaced each year by transferring the registration (State of Maryland, 2010). These new vehicle figures were multiplied by the costs of catalytic converters and air filters as noted above. The Utah GPI study estimated figures for abatement of auto emissions by linking new car registrations with catalytic converter expenses. In addition, this study matched vehicle miles traveled with air filter costs, assuming replacement every 20,000 miles on average (Berik & Gaddis, 2011).

GPI-HI Approach

For the baseline GPI in Hawai‘i, we followed Maryland’s example of using the increase in the stock of personal vehicle registrations plus an estimate of the number of retired vehicles; this is assuming that retired vehicles will be replaced by new ones and the existing registration will transfer. We also assumed the same costs for equipment (catalytic converter + air filter) used in the Maryland GPI model. We used the following equation (also based on the Maryland GPI model and in year 2000 USD):

Cost of personal pollution abatement for air pollution = number of new personal vehicles x ($100 for catalytic converter per vehicle + $8.50 for air filter per vehicle)

Data were collected on number of vehicles through 2012 and costs were estimated for the years 1977 to 2012. The average annual cost associated with personal pollution abatement for air was $11.3 million (2000 USD) over that time period. After a slight decrease in years 2008 and 2009 due to fewer car registrations, the figure reached $21.2 million in 2012.

Future Research

Besides verifying the number of new vehicles and updating the costs of catalytic converters, future GPI-HI efforts will expand on the Maryland model to consider the cost of air filters as a function of vehicle miles traveled, disaggregated for personal vehicles. Future GPI-HI tasks will also update the costs for vehicle equipment based on local prices.

Solid Waste Household Abatement

Municipal solid waste (MSW) is a byproduct of our everyday life, generated by every household. As generally defined, MSW includes durable and nondurable goods, containers and packaging, paper, food wastes and green wastes generated by households that may be disposed in municipal landfills. MSW in this definition does not include commercial, construction and demolition, or industrial waste. The costs of waste disposal are borne by households (via service fees and/or assessed taxes), regardless of whether the trash is landfilled, incinerated, or recycled.

General Trends

Waste management is a unique and particularly important issue in Hawai‘i. Given the economic importance of the tourism industry in the islands, waste management is critical for maintaining aesthetically pleasing landscapes as well as disposing of the additional waste that is generated by visitors. Yet the options for proper disposal of MSW are significantly constrained by the state's limited land area and remote location.

In Hawaiʻi, the responsibility for MSW management and residential curbside recycling rests at the city and county levels on each island in the state. Each county has developed its own integrated solid waste management plan outlining collection, diversion, and disposal options ranging from landfilling, to recycling, to composting, to incineration. At the state level, the DOH Office of Solid Waste Management provides statewide guidance, mandates, and funding mechanisms to the county level and regulates landfills and incinerators.

The overall objective, at both the city/county and state level, is to achieve higher rates of recycling and reuse. This diversion reduces the volume of waste sent to landfills, incinerators, or waste-to-energy activities. Honolulu City and County, for example, is working to increase its material recycling rate to more than 40% of MSW, compared to current recycling rates ranging from 33.7% in 2007 to 38.7% in 2011 (City and County of Honolulu, 2012a). An island-wide curbside recycling program for mixed recyclables and green waste was implemented on Oʻahu in 2010, and although still new, it contributed to reducing the amount of MSW going to the landfill by a full 6% in fiscal year 2011 (City and County of Honolulu, 2012a). However, constraints on increasing the diversion rate include the size of the on-island market for recyclables and the cost of shipping to other markets (Hawaiʻi State Department of Health, 2009b).

Although each county has a solid waste management plan, Honolulu City and County has the largest volume of MSW to manage, given that approximately 70% of the state's population lives on Oʻahu. The elements of Oʻahu's integrated solid waste management plan are illustrated in the graph below (see www.opala.org for more details) and includes: general materials recycling; H-POWER waste to energy incineration; and landfilling of MSW and incinerator ash at Waimānalo Gulch Sanitary Landfill. A plan to ship MSW off-island was never implemented and that waste was later incinerated.

In 2011 on Oʻahu, 26.6% of MSW was sent to the Waimānalo Gulch Sanitary Landfill (City and County of Honolulu, 2012a). This landfill received an extension to its original closure date and continues to accept waste while the City and County are exploring other potential landfill sites. In the same year, 34.7% of MSW collected was diverted from the landfill and processed by the H-POWER Waste-to-Energy Facility (City and County of Honolulu 2012a). The incineration of MSW typically generates 5% of the island's electrical power (Gessel & Langham, 2009). Diversion from the landfill will increase even more once the project to expand capacity at H-POWER by 300,000 tons per year is completed (estimated startup was at the end of 2012). Future plans also include a new composting facility to process sewage sludge, green waste, and food waste. According to the City and County of Honolulu (2012a), the new facility is expected to increase recycling of sewage sludge by an additional 15,000 tons and food waste by an additional 10,000 tons.

GPI Approach

Previous GPI studies used per capita solid waste generation and associated costs of disposal to estimate yet another household defensive expenditure. These prior studies examined national trends in per capita solid waste generation, generally based on an EPA calculation of a national average of approximately 4.5 pounds/person/day in 2010 (Environmental Protection Agency, 2010). In the cases of absent data at the state level, the Maryland GPI study scaled down national per capita figures according to the ratio of state to national population data (State of Maryland, 2010). Maryland follows Costanza et al. (2004) by using a cost of $100/ton (in 2000 USD) to dispose of household municipal solid waste; this figure was based on a 1997 study for EPA.

GPI-HI Approach

For the Hawaiʻi case, figures for per capita solid waste generation were found in three different studies. First, a report for EPA Region 9 estimated a figure of 1.39 tons/person/year averaged across all islands, translating into 7.62 pounds/person/day (Kaufman & Themelis, 2008). An Integrated Solid Waste Management Plan update for the City and County of Honolulu (2008) estimated 1.87 tons/person/year on Oʻahu, which translates into 10.25 pounds/person/day. The DOH Environmental Health Administration estimated 9.2 pounds/person/day statewide in 2008. All three figures are high compared to the 4.5 pounds/person/day cited by the EPA. However, a direct comparison cannot be made since the national level calculation excludes some materials that are included in the city's tonnage, such as sludge and small amounts of construction and demolition debris (City and County of Honolulu, 2008).

For the baseline study for Hawai'i GPI we used the lowest of the three figures for Hawai'i, 7.62 lbs/person/day or 1.39 tons/person/year, to estimate a lower bound for this indicator in 2008. We utilized the same figure for household costs as Maryland's study, resulting in the following equation:

> *Cost of personal pollution abatement for solid waste = Hawai'i state population x 1.39 tons/person/year x $100/ton (in 2000 USD)*

Calculations for solid waste pollution abatement were performed over the time period of 1960 to 2012. The average annual cost was estimated at $144 million (2000 USD) over that time period. The figure for 2012 was $194 million (2000 USD).

Future Research

Future work on GPI in Hawai'i will focus on: clarifying the figure for pounds/person/day across the islands given the de facto population (i.e., including visitors). More importantly, we will refine the net costs of disposal per household, taking into account current assessed tax rates, variation in cost for disposal methods other than landfilling, and any by-product revenues from recycling or reuse.

Wastewater Household Abatement

Wastewater (sewage) is generated from daily activities in households using sinks, toilets, showers, washing machines and dishwashers. Wastewater must be treated before it is released back into the environment to reduce both human health and ecological risks from pathogens, excessive nutrients, and other contaminants. For those households connected to the municipal sewer system, the wastewater flows to a centralized wastewater treatment plant (WWTP) and is subsequently treated and discharged or reused. Other households without connections utilize septic or cesspool systems (also known as individual wastewater systems) to collect and dispose of wastewater.

General Trends

DOH regulates both WWTPs and individual wastewater systems for the state. While each relevant city and/or county agency operates WWTPs for its urban and suburban customers, those homeowners in rural locations typically must assume the responsibility of wastewater management.

In 2008, 152 million gallons per day (MGD) of wastewater (including both household and industrial) were treated statewide: 72% treated in the City and County of Honolulu, 17% in Maui County, 6% in Hawai'i County, and 5% in Kaua'i County (Center on the Family, 2009). To accommodate for the largest portion of the state's population and resulting wastewater, the City and County of Honolulu operates nine WWTPs and receives between 100 and 110 million gallons of wastewater daily, through a system of 2,100 miles of pipelines and 70 pump stations (City and County of Honolulu, 2012c).

In the state of Hawai'i, the volume of total wastewater treated has decreased from 150 MGD in 2006 to 141 MGD in 2011 (Hawai'i State Department of Business, Economic Development, & Tourism, 2008). DOH also tracks the percentage of wastewater reused, refers to the proportion of wastewater that is treated to an appropriate level and then used for irrigation. In 2011, the percentage reused was reported as 13.93%; DOH would like to increase this rate upwards toward 20% by 2015 (Hawai'i State Department of Business, Economic Development, & Tourism, 2008).

GPI Approach

In previous GPI studies, the cost of household abatement for wastewater was calculated using the ratio of households with sewer/septic connections to the total number of housing units multiplied by costs associated with each type of system. Most of these GPI studies used data from the US Census Bureau to estimate the percent coverage by state. Household abatement costs are related to either city and county sewage fees or fees for periodic maintenance of septic systems. Due to variation in sewer rates across the state, Maryland chose a conservative estimate of $4 per 1000 gallons and 91,250 gallons per household per year or 250 gallons per household per day (State of Maryland, 2010). For onsite treatment, the Vermont (Costanza et al., 2004) and Maryland (State of

Maryland, 2010) studies assumed new septic systems cost $4000 (in 2000 USD). Costanza et al. (2004) estimated cleaning costs for septic systems at $200 (in 2000 USD). Maryland further assumed that based on a cleaning interval of five years, one fifth of households with septic systems would incur cleaning costs each year.

GPI-HI Approach

The figures for the proportions of Hawaiian households with and without sewer connections vary across sources of information and therefore remain unclear. The US Census Bureau gathered historical data on the number of household sewer connections in each state from 1940 through 1990. The figures for 1990 show that 80.2% of households in Hawai‘i were connected to sewers, 18.7% utilized septic systems, and 1% used other (US Census Bureau, 1990). Yet the Clean Watershed Needs Surveys conducted by EPA in 2004 and again in 2008 found that the percent of Hawai‘i residents served by WWTPs were 61.9% and 60% respectively (Environmental Protection Agency, 2004, 2008). The remaining households used individual treatment systems for wastewater. A 1999 survey by DOH found that approximately 19% of the households in the state relied upon onsite wastewater treatment (Hawai‘i State Department of Business, Economic Development, & Tourism, 2008).

In Hawai‘i, residential sewer rates are calculated according to a base charge to cover operation and maintenance costs of the WWTP and a sewer usage charge that varies according to the volume of water used by the household. The rates vary across the different counties, with O‘ahu having the highest. On O‘ahu, for example, the base charge for sewage is $63.23 per unit per month for single family/duplex residences or $43.47 per unit per month for multiple units. On top of the base charge, the sewer usage charge is the cost to collect and treat an average of 80% of the volume of water used by the household and the monthly single family/duplex usage charge on O‘ahu is $3.77 per 1000 gallons (City and County of Honolulu, 2008). The City and County of Honolulu also provides cesspool services to households not connected to the municipal system at the request of the customer. The city pumps cesspools at a rate of $132.90 per load or fraction thereof (City and County of Honolulu, 2012b).

For the baseline GPI-HI, we followed the lead of previous GPI studies, using US Census Bureau figures for percent household connections (approximately 80%). Likewise, we used the following equation (based on Maryland), retaining the same cost figures but adapting the model for the number of households in Hawai‘i:

Costs of personal pollution abatement for wastewater = (number of households with sewer connections) x ($ typical sewer fees per year) + (number of households with septic systems) x 1/5 x ($ for pumping)

Values related to wastewater abatement were calculated from 1961 to 2012. The average annual cost of wastewater abatement was estimated at $115 million (2000 USD). The value in 2012 was $159 million (2000 USD).

Future Research

Future GPI efforts will aim to find a more recent figure for the proportion of households with sewer connections, as well as refine the costs to better reflect what typical households in Hawai‘i pay for this defensive expenditure.

For the year 2012, the cost of personal pollution abatement for the state of Hawai‘i is valued at $374 million (2000 USD). The average annual cost in the period for which data was available (from 1990 to 2012) is estimated at $328 million (2000 USD).

SUBMERGED COASTAL SYSTEMS ENV 11

Introduction to Issue

Coral reefs are one of the most diverse, rich, and productive ecosystems on Earth, providing critical habitat for a diversity of marine life (Bishop et al., 2011; Needham, 2010). They also provide important benefits to the people of Hawai‘i. Our reefs sustain fisheries important for food security and cultural practices, dissipate wave energy that has the potential to damage coastal property and threaten human life, and offer opportunities for recreation, aesthetic enjoyment, and spiritual contemplation (Barbier et al., 2011; Cesar & Van Beukering, 2004a, 2004b). High quality reefs increase property values of nearby residential, rental, and lodging properties. Reefs produce sand, which in turn creates beaches; our beautiful beaches draw more than 11 million visitors annually. Reefs generate significant research activity, which also brings in millions of dollars each year in research funds spent in the state. According to one study that estimated the composite value of all ecosystem services, or benefits, that coral reefs provide to society, the 410 thousand acres of coral reef ecosystems in the main Hawaiian Islands contribute $360 million annually to the state economy, constituting an estimated overall asset value of approximately $10 billion (Cesar et al., 2002).

Coral reefs fall under the jurisdiction of the state as they are within three nautical miles of shore, but regulation and administration are complex, involving multiple state and federal agencies. In 1998, a Presidential Executive Order established the Coral Reef Task Force to preserve and protect reefs. The enactment of the Coral Reef Conservation Act in 2000 enlisted NOAA to govern management and conservation of coral reef ecosystems across the United States. The Coral Reef Conservation Act initiated a national program that includes the National Coral Reef Action Plan to Conserve Coral Reefs, the Coral Reef Conservation Program, and the Coral Reef Conservation Fund (Barbier et al., 2011). The Magnuson-Stevens Act mandates regulation of fishing activities to minimize impact on Essential Fish Habitats from 0-200 nm, thus coral reefs fall under its jurisdiction (Pomeroy et al., 2007). Lastly, the Endangered Species Act (1973), whose aim is to protect living organisms from going extinct, has recently been used as a mechanism to protect corals (Fabricius, 2005). The agencies charged with managing Hawai‘i’s coral reefs are the Coral Reef Conservation Program at the federal level and the DLNR Division of Aquatic Resources at the state level. A multi-stakeholder group including federal and state agencies, academic researchers, experts, and non-governmental organizations, produced the Hawai‘i Coral Reef Strategy in 2010 to address Hawai‘i-specific coral reef issues, setting the overarching coral reef management goals, priorities, objectives, and conservation actions.

General Trends

Despite their biological, economic, and social importance, these systems are under serious threat from increasing anthropogenic activities including fishing, tourism, coastal development, species introduction, and climate change (Jokiel, 2008). Human activities threaten the continued provision of these benefits directly from overuse from tourism, fishing, and recreation (Cesar & Van Beukering, 2004a) and indirectly from climate change and nutrient pollution (Needham, 2010). Land-based development increases pollution delivered to the reef, recreational overuse can cause physical destruction, fishing alters the ecological balance, invasive species outcompete natives, and climate change is predicted to exacerbate those stressors (Fabricius, 2005, 2011; Hughes et al., 2003; Jackson et al., 2001). There is already evidence of alarming declines in coral reef coverage in Hawai‘i, especially in areas with high human populations and heavy sedimentation (Jokiel et al., 2004). In Maunalua Bay, O‘ahu, for example, the volume and residence time of polluted waters and sediments have increased because of human activity, leading to the collapse of the coral population throughout the area (Wolanski et al., 2009).

Data on nearshore habitats generally and coral reefs in particular are collected by Federal and state agencies, as well as research organizations. Ideally, the GPI would include any change in coral across the state. Only one source has statewide coverage. NOAA’s Center for Coastal Monitoring and Assessment Shallow-Water Benthic Habitats of the Main Hawaiian Islands Shallow-Water Benthic Habitats of the Main Hawaiian Islands mapped the state’s coral reefs using remote sensing in 2003 and 2007. The resulting Shallow-Water Benthic Habitats of the Main Hawaiian Islands datasets are the most spatially extensive data set, but only 2007 has complete coverage (some areas are missing due to obstructions from clouds, etc.), the 2003 coverage is limited. No future datasets are slated.

Many other individual sites are monitored and assessed on a regular basis. The Hawai‘i Institute of Marine Biology's Coral Reef Assessment and Monitoring Program (CRAMP) has 60 permanent stations across the Hawaiian islands that have been surveyed at least twice over a four year period since 1999 (Jokiel et al., 2004), including the Nā Pali Coast, Hanalei, and Po‘ipū on

Kauaʻi; West Oʻahu, Waikīkī, Kāneʻohe Bay, Hanauma Bay, and Pūpūkea on Oʻahu; South Molokaʻi; West Maui, Māʻalaea Harbor on Maui; Kahoʻolawe; Kona Coast, Kawaihae Harbor, and Hilo Bay on Hawaiʻi (Coral Reef Assessment and Monitoring Program, 2010, 2012). NOAA's Pacific Island Fisheries Science Center's Coral Reef Ecology Division has data from benthic towed-diver surveys, Rapid Ecological Assessments, benthic line-point intercept surveys, and permanent transects around the main Hawaiian Islands.

GPI Approach

Coastal systems are not currently included in the GPI. Coastal systems, and coral reefs in particular, present a unique asset of particular value for the state of Hawaiʻi. The notion of including coral reefs as another "land" type in GPI is supported by the traditional Hawaiian land management concepts of *ahupua*ʻ*a*, according to which entire watersheds including submerged reefs were considered as one single management area (Smith & Pai 1992). Similar to how the application of the GPI in Utah included an additional grasslands indicator unique to the region (Berik & Gaddis, 2011), this assessment will account for the change in coral reef cover to tailor the indicator to Hawaiʻi.

In adapting the GPI to Hawaiʻi, the goal is to capture the value of coral reefs in the state, recognizing that coral reefs are, of course, but one important marine habitat.

GPI-HI Approach

In adapting the GPI to Hawaiʻi, the goal is to capture the value of coral reefs in the state, recognizing that coral reefs are, of course, but one important marine habitat. A GPI should consider the cost to society of net coral reef cover change. Ideally, the GPI would monitor the gains and losses in coral area cover as well as the health and quality of the reefs, which determine the type and level of ecosystem services provided. Together with local valuation studies that attempt to measure the reefs' value to society, it is then possible to construct the value of coral reefs as a GPI component. Initially, the focus can be placed on just the area of coral cover change, regardless of habitat health and quality.

Similar to how GPI arrived at component scores for change in land cover, the cost of change in coral cover could initially be estimated by:

> *The cost of net coral cover change = (number of acres change) x (estimated coral value per acre)*

Future Research

To calculate the economic value of coral reef change, we require multi-year estimates of coral cover. It may be possible to wait until NOAA's Center for Coastal Monitoring and Assessment emit another statewide dataset, but the data's relatively infrequent publication limits the real-time assessment power of the GPI. Another possibility to have spatially extensive time series coral cover data would be for a researcher to create new benthic habitat maps from new statewide World View 2 imagery. Finally, we could turn to proxies, tracking changes in coral cover in selected NOAA or CRAMP monitoring sites.

A statewide value of coral per acre can be derived from Cesar and van Beukering (2004) estimate of approximately $360 million/year for 410 thousand acres of coral reef ecosystems. Future studies can refine this estimate with a richer and more expansive spatial dataset, expanding on Cesar and van Beukering's ecological-economic model that links ecological indicators with the value of ecosystem services. Continued monitoring and economic valuation efforts are necessary for making a more complete assessment of coral reefs in the state, particularly regarding the cover and condition of the entirety of coral reefs. A statewide ecological-economic model needs to be built that links coral reef area and conditions with ecosystem service flows and values in a spatially explicit manner.

VALUE OF HOUSEWORK

SCL 1

Introduction to Issue

The value of housework is the estimated contribution of unpaid goods and services provided by households to the national or state economy. Examples of housework include among other activities, raising children, preparing meals for household members, maintaining an adequate living area, and providing for family members who are sick or aging. The opportunity costs of time spent engaged in household work are not captured by GSP or GDP because no monetary payment is exchanged. Yet if someone outside the household is hired to provide these same services, then that cost is recognized by GSP/GDP. Unpaid housework activities are undoubtedly essential to the functioning of an economy, so the GPI is adjusted upwards to reflect unpaid labor not captured in the more traditional measures.

General Trends

Since 2003, the BLS has used ongoing surveys to collect information on how Americans spend their time on work, household chores, child care, recreation and other activities through the American Time Use Survey (ATUS). Although less than a decade old, the data collection better illustrates trends in workforce composition, the roles of men and women in the workforce, as well as the impacts that employment has on households. According to the ATUS for the period 2006-2010, on an average day, 84 percent of women and 67 percent of men engaged in household activities such as housework, cooking, lawn care, or financial and other household management. On average, women spent 2.6 hours, while men spent 2.1 hours on those activities (Bureau of Labor Statistics, 2011a).

Unfortunately, data comparable to that from ATUS is not available at the state level, however the issues are still relevant to our state and economy. For example, Hawai‘i’s Department of Health currently is absorbing costs associated with the value of housework via their home and community services programs. The services are provided to needy members of the public free of charge, and include but are not limited to adult day care, chore services, personal care and assisted transportation (Hawai‘i State Department of Health, 2012b). For those not receiving government assistance to meet these needs, someone is still doing the work and spending the time necessary to complete the tasks, most likely family members who are not necessarily remunerated. The time and effort that could be spent otherwise engaged in other productive activities or even at leisure result in opportunity costs that are not captured in the Hawai‘i’s GSP accounting system.

According to a report released by the US Census Bureau, nine percent of households in Hawai‘i are multigenerational, the highest percentage in the nation. Multigenerational households are defined as homes containing three or more parent-child generations. Nationally, the number increased to 5.1 million in 2010, up from 3.9 million in 2000, potentially contributing significantly to the value of housework. The roles of grandparents and additional in-home family members provide the services of housework without impacting the current economic valuations of GSP and GDP (Engle, 2012).

The roles of grandparents and additional in-home family members provide the services of housework without impacting the current economic valuations of GSP

GPI Approach

The GPI model uses a replacement cost method to assign value to household work; the wage rates to hire workers outside of the household to perform the household tasks is applied to the amount of time spent on those tasks within the average household. Krantz-Kent (2009) gives an example of the choice between unclogging one’s kitchen drain or hiring a plumber to provide the service. In addition to being un-paid, an activity fits within the definition if a readily available market substitute exists and the tasks are done for one's own household (Krantz-Kent, 2009).

Past national GPI studies have used national household work estimates by gender and employment status provided by Eisner (1989) and the ATUS starting in 2003. Time-use data are instrumental in quantifying the economic contributions of unpaid household labor. Results from the 2003–2007 ATUS were tabulated to show the time individuals spent doing unpaid household work and is the first step in attempting to quantify the labor time resources involved in household production.

The small sample size for each state in the ATUS prevents obtaining annual estimates of household labor hours per state, which are differentiated by both employment status (i.e., employed, unemployed, or out of the labor force) and gender (Krantz-Kent, 2009). This caused past GPI studies to use national data scaled to the state in which the labor force is being analyzed.

GPI-HI Approach

Hawai'i's GPI approach for the valuation of housework follows the examples of past GPI initiatives. To find the total number of housework hours in Hawai'i per year, we accessed ATUS national data and summed the average hours per day spent on household activities plus caring for others in household by the population aged 15 and older. These data were only available from 2003 (when the ATUS started) through 2011. We used trend analysis of the existing ATUS data to back cast for the years 2000 through 2002 in order to complement the available time series of data of average hourly wage rates for housekeepers in Hawai'i. For the years 2000 through 2011, we multiplied the hours by the wage rate of housekeepers in Hawai'i (in 2000 USD). The wage rate of housekeepers was retrieved from the 2012 State of Hawai'i Data Book and based on data from the Hawai'i Employers Council (Hawai'i State Department of Business Economic Development & Tourism, 2012c).

For GPI-HI, we calculated the value of housework for the years 2000 to 2011 and found that this category contributes significantly to the GPI. The annual values ranged from $9.89 billion in 2000 to $11.07 billion in 2011, and the average annual value of housework across the time period was $10.43 billion (2000 USD).

Future Research

Unlike the Maryland GPI that incorporated data from two earlier time use studies done by University of Maryland, we did not find similar information for Hawai'i, and at this time we did not feel comfortable filling in past data gaps. These calculations would be more robust if the hours spent on childcare and housework were specific to Hawai'i. Likewise, local data for housekeeper wages would be ideal, but are not available prior to 2000. Our future GPI-HI efforts will concentrate on identifying information that will enrich our calculations for both past and future trends in housework.

COST OF FAMILY CHANGES — SCL 2

Introduction to Issue

Much of the focus of the social and economic indicators in the GPI model is on households; from personal consumption expenditures, to the cost of durable household goods, to the value of unpaid housework. This indicator focuses more specifically on the family dynamics that occur within households.

Both internal and external factors impact the quality of life of family members in a household. In the past, the GPI model aimed to capture such details via the Cost of Family Changes indicator. Prior GPI models assumed that the family bonds that enable more resilient and healthy households and national well-being begin to break down due to lack of time spent with spouse, children, and extended families, possibly leading to divorce (Anielski & Rowe, 1999). When couples divorce, GDP captures the direct expenditures on lawyers' fees, counseling, and establishing separate households, but does not include the indirect costs of time lost due to the stress that results when relationships dissolve or the impacts on children involved (Anielski & Rowe, 1999).

General Trends

In Hawai‘i, ‘ohana (families) play an extremely important role in shaping the lives of individuals, communities, society and the economy. Families support schools, religious institutions and recreational councils while also contributing to the success of the majority of small businesses through the state. Yet previous GPI studies throughout the nation have shown that families are changing due to the two primary challenges of high divorce rates and the cost of television watching in families (State of Maryland, 2010).

GPI Approach

GPI studies at the national level have used two proxies to gauge the cost of family changes: divorce rates and TV viewing rates (Anielski & Rowe, 1999; Costanza et al., 2004; Talberth et al., 2007). The studies used the following equations (in 2000 USD):

Cost of family changes = (Costs of Divorce) + (Cost of Television Viewing) where:

Cost of Divorce = (Number of Children Affected by Divorces x $13,380) + (Number of Divorces x $8,999)

Cost of Television Viewing= (Hours Spent Watching Television in Households with Children) x $0.54.

The number of family divorces per year per state can be found via US Census data or the US Center for Disease Control (CDC) National Center for Health Statistics, although data availability varies by state. Anielski and Rowe (1999) assumed a cost per child affected by divorce of $13,380 in 2000 dollars, but did not include public costs of divorce. Scafidi (2008) created national and statewide estimates for the cost of divorce by measuring the costs to the legal system and government expenditures.

In past GPI studies, US household television viewing data were gathered from two primary sources. A value of 7 hours and 35 minutes per day for 2000 was adopted by the Vermont GPI study (Costanza et al., 2004), drawing this number from Nielsen Media Research data at five-year intervals. This value is not specific to television viewing in any particular state.

GPI-HI Approach

For multiple reasons, we chose not to calculate for the cost of family changes in Hawai‘i for this round of GPI-HI. First, we found the data reported on divorce rates were sporadic and contradictory. According to a report from the National Center for Family and Marriage Research, in 2011 the divorce rate in the US was 19.4, or roughly 19 per 1,000 marriages ended in divorce in 2011 (Cruz, 2013). In Hawai‘i in 2011, that figure was 12.78 divorces per 1,000 marriages, the lowest divorce rate in the nation (Cruz, 2013). However, the Hawai‘i state divorce rate for 2011 was not available as reported by The CDC National Center for Health Statistics reports divorce rates by state, but a figure is not available for 2011; for those years in which data were available, the rates were significantly lower than those reported by Cruz (2013), ranging from 3.7 to 4.6 per 1000 marriages (Center for Disease Control, 2011a).

We are also dissatisfied with the lack of information on direct and indirect costs of divorce in Hawai‘i. Those provided by past GPI studies were ambiguous and did not offer a clear direction to choose. With regard to the cost of divorce, Talberth et al., (2007) state that the costs assigned to divorce ($5000 per divorce) and child affected ($7,500) are arbitrary. The use of arbitrary numbers is problematic (Minnesota Planning, 2009).

The cost of children watching TV is even more questionable in our opinion. We question whether hours of TV watched per day for a household is an acceptable indicator of family breakdown. Since these data apply to all people watching TV, not exclusively children, the cost is inaccurate (Minnesota Planning, 2009). We are concerned that TV watching, which is categorized as leisure in the ATUS, has the potential to be double counted. Moreover, Talberth et al. (2007) arbitrarily assigned 30 cents per hour for the social cost of children watching TV.

Future Research

Although we agree that changes to families can have ramifications on household productivity, expenditures, and other behaviors, we feel that this indicator is not justified for our current GPI-HI efforts. We plan to explore this issue further with the GPI technical working group.

Introduction to Issue

Crime thrusts negative social and economic impacts on individuals and households within each state. Crime statistics generally include both violent crimes and property damages. These include but are not limited to murder, rape, robbery, assault, burglary, larceny-theft, motor vehicle-theft and arson. Ironically, current economic measures such as GSP assume that the costs to deal with criminal actions are positive additions to the economy. When residents need to replace stolen goods, purchase security devices, or incur legal fees, these actions stimulate GSP. The GPI approach attempts to highlight these personal expenditures as negatives rather than positives in the economic system (Maryland, 2010). Crime also results in psychological costs, but because such impacts are less tangible, they are also more difficult to quantify. GPI addresses these costs by incorporating pain and suffering into the figures.

General Trends

National crime rates continue to decrease overall (Federal Bureau of Investigation, 2011); that trend is continuing in Hawai‘i as well. Despite slight upticks in 2010 to 2011 in Hawai‘i, between 2000 and 2011 crime rates generally have been on a steady trend downward. This trend includes all major crimes in the state; murder, rape, robbery, assault, burglary, larceny-theft, motor vehicle-theft and arson (Hawai‘i State Department of the Attorney General, 2012). Nevertheless, the impacts of those crimes occurring are still not captured within GSP.

GPI Approach

Generally, GPI studies focus on the impacts of crime to individuals and households, assuming that other costs, such as incarceration, are borne by the government. Past GPI studies have estimated the cost of crime to victims using out-of-pocket expenditures and/or the value of stolen property. Maryland's approach to incorporating crime into GPI is based on the associated costs of quality of life impacts and property losses. The costs are taken from research by the National Institute of Justice at the US Department of Justice on victim costs and consequences. Maryland used this information, matched with local crime rates, to estimate how much crime costs the state (State of Maryland, 2010). This includes tangible costs such as property loses, productivity loses, medical bills as well as intangibles costs such as pain and suffering. Similarly, Utah measured the cost of crime based on statewide data and available estimates of incurred costs. The cost of murder was estimated based on traffic fatalities used in the motor vehicle crash indicator. The cost of rape was based on a study done by Miller, Cohen, and Wiersema (1996). The cost of property crimes was based on the average costs of goods stolen or damaged.

While the value of stolen property and direct out-of-pocket expenses are obvious costs of crime, other GPI studies included a second indirect element: defensive expenditures. These are indirect expenses incurred to prevent or avoid the impact of crime, such as locks, burglar alarms, security devices, and security services, which GDP and GSP track as positive contributions to the economy. Defensive expenditures are relevant under the assumption that people would not otherwise purchase these items if crime or lack of security were not problems. Utah, Vermont and Ohio used ESRI data to track consumer spending on defensive expenditures at the city, county, and state level; Maryland did not.

GPI-HI Approach

The Hawai‘i GPI approach models Maryland's methods of calculation. To calculate and account for the welfare of crime victims through trauma, fear, and physical damages, the US Department of Justice's estimates of damages were used. Each specific type of crime was multiplied by a set amount or "Victim Costs and Consequences" from the US Department of Justice, calculated for both quality of life effects and property losses (Miller et al., 1996). The costs range from larceny thefts (approximately $320 per incident in 2000 USD) to murder (approximately $2.3 million in 2000 USD). The number of crimes in Hawai‘i was collected from the Uniform Crime Reporting Data of the State of Hawai‘i (http://ag.hawaii.gov/cpja/rs/cih/) and were available from the year 1975 onward.

Ideally tangible, intangible, and defensive expenditures should be included in this measurement; but this method of calculation does have limitations. The data used via

The National Institute of Justice to calculate total costs per crime do include both tangible and intangible costs, but are not completely comprehensive of all impacts a crime has on the economic system. For example, figures capture victim-related costs, but not the economic or social costs borne by the criminal once he/she enters the criminal justice system.

Cost of Crime = (Number of each Crime) x (Victim Cost Estimate for each Crime)

In the year 2000, the total cost of crime was $21 million (2000 USD). The average cost of accidents over the years for which data are available (1975 to 2011) is $24.9 million (2000 USD). Across that time frame, the year with the highest cost of crime is 1988 at $38 million and the lowest was in 1975 with $12 million (2000 USD). The figure for the most recent year (2011) is $21 million (2000 USD).

Future Research

Due to a lack of available data on preventative measures, such as the spending of money on locks, alarm systems and security, we did not include defensive expenditures in the calculated cost for GPI-HI. In the future, we would like to follow the attempts of Utah and others to incorporate consumer spending into the calculations.

VALUE OF VOLUNTEER WORK — SCL 4

Introduction to Issue

Volunteering is a form of unpaid labor in which citizens use their valuable time growing and supporting their local communities. Yet, this important labor source is not accounted for in GDP. Volunteers perform services that can fill gaps in services that are provided through the market. Simultaneously, volunteer labor builds relationships in communities that foster better community development. GPI estimates the impact and value of volunteering through an estimate of its monetary value.

General Trends

According to the Corporation for National and Community Service, in 2011 national volunteer rates reached their highest levels in 5 years. 64.3 million Americans volunteered a total of almost 8 billion hours, an estimated economic value of roughly $171 billion (Federal Agency for Service and Volunteering, 2012). Nationally, Hawai‘i is ranked 49th among the 50 states and Washington DC with an average of 30.8 volunteer hours per resident. The majority of people in Hawai‘i spend volunteer hours in the educational (29.1%), religious (22.7%) and social service (16.1%) areas. The volunteer rate in Hawai‘i has not changed significantly in the last ten years; between 2002 and 2012 the percentage of those volunteering stayed between 21 and 28 percent (Federal Agency for Service and Volunteering, 2012).

GPI Approach

Past GPI studies done in Maryland and Utah have used the information via the Corporation for National and Community Service to find the value of volunteer work in their respective states (State of Maryland, 2010). Using this information on the hours spent volunteering per state and the state volunteer value in dollars per hour, they calculated a monetary value for volunteering per state.

GPI-HI Approach

To measure the value of volunteering in Hawai‘i, the estimated monetary value per hour of volunteer work was multiplied by the number of hours spent per year. The number of total volunteer hours in the state of Hawai‘i was found via the Federal Agency for Service and Volunteering website. The hourly volunteer wage rate has been valued by the Federal Agency for Service and Volunteering. Starting with the 2011 amount of $18.14, the dollar amount was deflated for 2002 onward from 2000 USD (Federal Agency for Service and Volunteering, 2012).

Value of Volunteer work = (Total Volunteer Hours per Year) x (Value per Volunteer Hour)

Across the time period for which data exist (2002 to 2011), the average annual volunteer hours per resident was 37 hours, ranging between 31 and 41

hours across those years. The average value of volunteerism over that time period was $588 million (2000 USD). The year with the highest value of volunteerism was 2010 at approximately $704 million.

Future Research

In the future, we recommend extending the data back to the year 2000 to be consistent with the other indicators.

COST OF LOST LEISURE TIME

SCL 5

Introduction to Issue

As defined by the US Bureau of Labor Statistics (2011a), leisure time is when people are engaged in some sort of leisure or recreation activity, such as: watching TV or reading; using the computer for personal interest; relaxing or thinking; socializing and communicating; playing games; attending arts or cultural events; or enjoying nature. In a report for National Bureau of Economic Research (NBER), Aguiar and Hurst (2009) define leisure as that time spent other than engaging in market production (work), home production (cooking, cleaning, shopping, and so on), or child care.

Increased GDP is traditionally considered a positive marker of economic progress. GDP per capita can be viewed as a rough indicator of a nation's economic well-being, and GDP per hour worked can provide a general picture of a country's productivity (Bureau of Labor Statistics, 2011a). Yet leisure time is considered a "non-productive activity," and therefore is not captured in traditional measures like GDP. Time spent toward market activities might increase GDP, but the opportunity cost of allocating more time to market work is having less time available for non-market activities, including leisure (Anguiar & Hurst, 2009).

We are continually faced with the challenge of how to strike a balance between productivity and leisure, for both contribute positively to our quality of life.

We are continually faced with the challenge of how to strike a balance between productivity and leisure, for both contribute positively to our quality of life. Past GPI studies define leisure as free time away from the responsibilities and duties typically associated with work. This time away from work or commitments can be spent in many ways including with family, in relaxation, or outdoors (State of Maryland, 2010). Physical activity during leisure time, for example, can help control weight, reduce the risk of heart disease and some cancers, strengthen bones and muscles, and improve mental health (Center for Disease Control, 2011b).

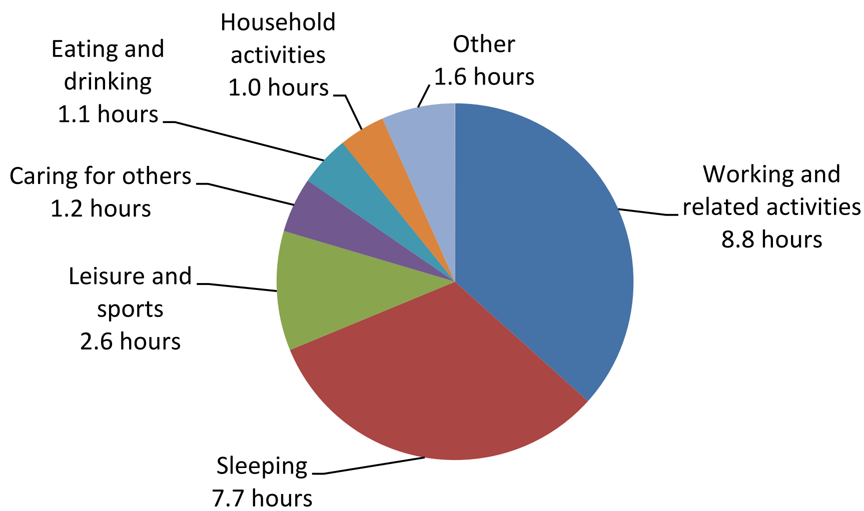
Leisure time is positive, but only up to a point, after which forced leisure, as in the case of workers who want to work more but cannot find employment, becomes a negative impact on society; the associated cost is captured by GPI via a separate indicator for underemployment.

GPI includes the loss of leisure time as one of the costs of economic growth; an expense that individuals and households pay to in order achieve increased economic activity by working more hours. As Talberth et al. (2007) suggest, a more accurate measure of genuine progress and well-being would consider the loss of leisure that went along with increased output, so accounting for the nation's or state's well-being ought to include the value of leisure time lost or gained.

General Trends

Through the ATUS, the BLS uses detailed time diaries to estimate time spent by Americans on different activities throughout the day. Two charts from Bureau of Labor Statistics (2011b) are relevant: time use on an average work day (**Figure 20**); and leisure time on an average day (**Figure 21**). **Figure 20** refers to workers from ages 25 to 54 years with children while **Figure 21** includes all persons of ages 15 years and older. Of course, data vary according to age, marital status, education, etc. For example, employed adults living in households with no children under the age of 18 engaged in leisure activities for 4.5 hours per day, nearly an hour more than employed adults living with a child under age six (Bureau of Labor Statistics, 2011a).

Figure 20. Time use on an average work day



Note: Data include employed persons on days they worked, ages 25 to 54, who lived in households with children under 18. Data include non-holiday weekdays and are annual averages for 2012. Data include related travel for each activity.
Source: US Bureau of Labor Statistics, American Time Use Survey

With the exception of the year 2000, data from BLS show a gradual decrease from 1,829 hours worked per employed person per year in 1979 to 1,758 hours in 2011. The average annual rate of change in the number of hours worked per employed person in the US from 1979 to 2011 is -0.1 percent (Bureau of Labor Statistics, 2012). Yet controversy exists within the literature over how to best interpret the work and leisure data and whether the average work hours are indeed increasing (Hout & Hanley, 2003).

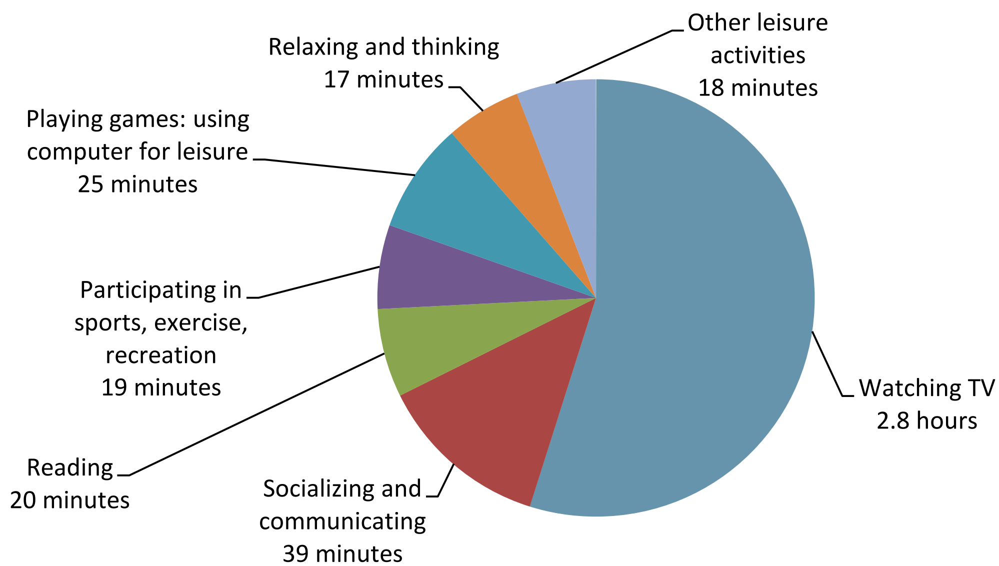
Leete-Guy and Schor (1992) are notable among researchers who have come to the opposite conclusion, which they refer to as the "Great American Time Squeeze." They analyzed both paid market hours and hours of unpaid household work (e.g., home repair, child care, shopping, cleaning, and so on) in which fully employed Americans engaged from 1969 to 1989. Based on their calculations, the annual total hours of work (the sum of work on the job and around the house) of unconstrained American workers have risen by approximately 140 hours; these "overworked" Americans have added more than an additional three weeks' worth of work per year. By excluding those workers who are "constrained" i.e., those who desire to work more but are not able to find work, the data provide strong support for their time-squeeze hypothesis (Leete-Guy & Schor, 1992). The researchers also note that the increase is paid work was unaccompanied by a decline in unpaid household-related work hours, thus leading to a significant loss of leisure (Leete-Guy & Schor, 1992).

GPI Approach

While there continues to be debate over how to best interpret work hour data, GPI studies to date have assumed that annual work hours for fully employed workers in the US are increasing, leaving less discretionary time available for workers to devote to leisure or other activities. The assumption is based primarily on the work of Schor (1992) and Leete-Guy and Schor (1992) but also assumes s public perception that individuals need to commit to ever increasing work hours (State of Maryland, 2010). Increasing work hours results in a deficit of time for not only housework or volunteering (captured elsewhere in the GPI model), but also leisure. GPI tries to capture this impact by subtracting increased work hours as lost leisure.

For the GPI model, three pieces of data were required as inputs to the calculations: employment levels within the state or nation; the average amount of time dedicated to market and non-market work activities per worker; and the average wage rate.

Figure 21. Leisure time on an average day



Note: Data include all persons age 15 and over. Data include all days of the week and are annual averages for 2012.
Source: US Bureau of Labor Statistics, American Time Use Survey

Employment level refers to the number of unconstrained workers in the labor force, or the total labor force excluding the unemployed and underemployed. These figures are available at the national and state level through the Bureau of Labor Statistics (Bureau of Labor Statistics, 2011a, 2011b). National figures for the average amount of time dedicated to market and non-market work activities by unconstrained workers come from Leete-Guy and Schor (1992) for the years 1969, 1973, and 1989; interpolation and extrapolation were used to fill in the missing years. Their results showed 1969 as the year when workers had the greatest amount of leisure time on average, with workers enjoying the extended benefits of increased automation and productivity and the mandated 40-hour workweek coming out of the post-war economy. In the GPI model, 1969 was chosen as the base year, against which the work hours from every other year are compared. The difference from the base year represents the amount of leisure time lost. Finally, a geographically appropriate average wage rate is used to give a monetary value to the lost leisure time.

GPI-HI Approach

Hawai‘i’s GPI approach for the cost of leisure time follows the examples of past GPI initiatives: lost leisure time multiplied by average wage rate. Likewise we were interested in the portion of the work force that is fully employed (neither part time nor underemployed) and subject to “overwork.” While the estimates of lost hours of leisure were based on national figures, data specific to Hawai‘i include the average annual wage rate and the underemployment rates for the state, both from the DBEDT Data Book (Hawai‘i State Department of Business, Economic Development, & Tourism, 2012c.

The cost of lost leisure in Hawai‘i for the year 2000 was $1.62 billion (2000 USD). The annual cost of lost leisure increased from 1969-2012 with an average cost of $1.13 billion over that time period (2000 USD).

The unconstrained workforce in Hawai‘i was estimated using 1 minus the state underemployment rate (which can be found as U-6 in BLS’s alternative measures of labor underutilization), then multiplied by the total work force. We followed the lead of Talberth et al., (2007) and Maryland (State of Maryland, 2010), choosing 1969 as the base year. We then calculated the difference of each year relative to 1969.

For this round of GPI-HI, we followed Maryland’s (State of Maryland, 2010) approach to interpolating annual work hours for years in which gaps existed. In Maryland’s model, the assumed rates of growth in annual work hours prior to 2003 are based on Mishel, Bernstein, and Allegretto (2007), while in later years the assumed rates are based on ATUS data from 2003 to 2010. In future GPI-HI efforts, we will reevaluate what rates of change would be more appropriate for the Hawaiʻi context, given that we were not able to replicate Maryland's rates from the existing data and that new ATUS data are now available through 2012.

Future Research

The use of national data for the average annual work hours masks any difference in the quantity or quality of leisure time in Hawaiʻi versus the nation. The Aloha state is famous for providing exceptional options for leisure and recreation, so future GPI-HI efforts should better reflect the role leisure plays for Hawaiʻi's residents.

VALUE OF HIGHER EDUCATION — SCL 6

Introduction to Issue

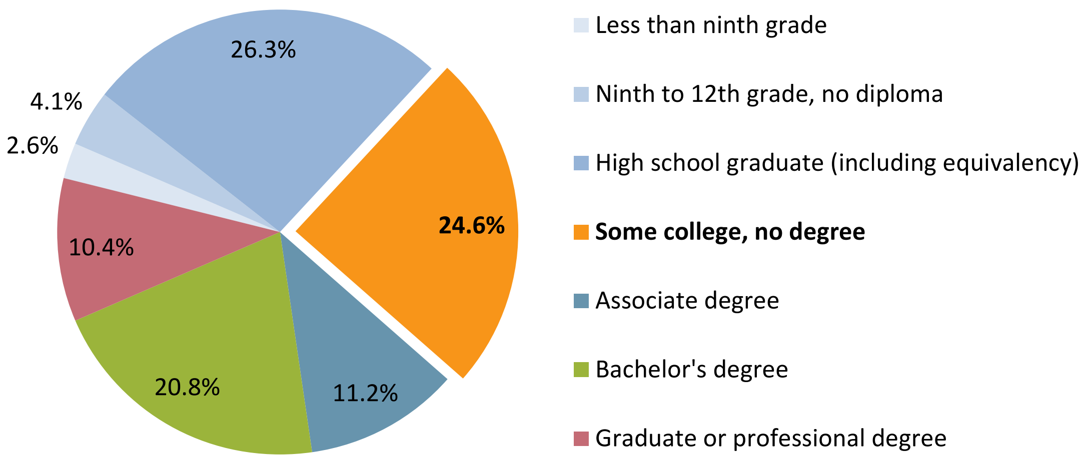
Attainment of higher education, or non-compulsory education that is received beyond the high school level, leads to many economic and social benefits. Higher education includes college, university, community college, and graduate or doctoral education. According to Hill, Hoffman, and Rex (2005), the average annual earnings of individuals with a bachelor's degree exceed the earnings of high school graduates by over 75 percent. Greater educational attainment is linked to enhanced worker productivity, leading to higher output for the economy and associated social benefits of such. Non-monetary societal benefits, such as lower crime rates or higher civic participation, are noted within populations with higher educational attainment (Hill et al., 2005). Higher education can be part of a GPI approach because it assists in creating more productive members of a state's workforce (State of Maryland, 2010).

General Trends

According to 2008 Census data, in Hawaiʻi 42 percent of the state's nearly 690,000 working-age adults (25-64 years old) holds at least a two-year degree (**Figure 22**). Although attainment rates in Hawaiʻi are above an average for the nation of 38 percent, the chart below shows the overarching issue of those who have started degrees but not completed; this is an estimated 25 percent of the adult population (Lumina Foundation for Education, 2012).

It appears that students achieving a higher education and who choose to stay within the state will continue to

Figure 22. Levels of education for Hawaiʻi residents, ages 25-64



Source: US Census Bureau, 2008 American Community Survey derive associated benefits into the future. A Georgetown University study estimates that between 2008 and 2018, new jobs in Hawaiʻi requiring postsecondary education and training will grow by 21,000 while jobs for high school graduates and dropouts will grow by 9,000 (Carnevale et al., 2010). Furthermore, in 2018 an estimated 65 percent of all jobs in Hawaiʻi (451,000 jobs) will require some postsecondary training beyond high school (Carnevale et al., 2010).

GPI Approach

Past GPI studies have approached this topic in a variety of ways based on differing assumptions about the role of higher education in the GPI model. While the national GPI study by Talberth et al., (2007) and the state GPI project for Maryland (State of Maryland, 2010) do include this indicator, the Ohio (Bagstad & Shammin, 2012), Vermont (Costanza et al., 2004), and Utah (Berik & Gaddis, 2011) studies do not.

GPI studies that do include the value of higher education assume an amount of additional income flowing to degree holders on top of the broader economic gains within the economy. Other GPI studies choose not to include higher education specifically, countering that associated benefits are captured by way of other GPI indicators such as increased personal consumption expenditures (ECN 1). Bagstad and Shammin (2012) note that higher education benefits are also potentially captured through volunteer work and crime rates as a function of either higher or lower educational attainment.

For those studies that use the indicator, higher education data were found via periodic census data. For those years in which national census data were not available, Maryland's GPI scaled down according to population ratio of state versus national (State of Maryland, 2010). Then, a value of $16,000 per graduate in 2000 USD was applied, following Talberth et al. (2007) and as estimated from Hill et al. (2005).

GPI-HI Approach

To calculate the value of higher education in Hawaiʻi, we used US census data that were available for the years of 1990, 2000, 2006-2009. For the purposes of this report, interpolation was used for all other years not available after 1990. To determine the social benefits of higher education in Hawaiʻi, the value of $16,000 in 2000 USD was applied to each graduate as per Maryland (State of Maryland, 2010) and Talberth et al. (2007).

First we located the percentage of individuals who are 25 years and older and hold a bachelor's degree or higher as reported periodically in the US Census data. We took this information from Table 2-33 reporting educational attainment by state (US Census Bureau, 2013) however it was only available for 1990, 2000, 2006-2009 (US Census Bureau, 2013) and we interpolated to fill data gaps.

Value of higher education = (Hawaiʻi Residents 25 years or older with a bachelor's degree) x by $16,000

In the year 2000, the total value of higher education was $3.32 billion (2000 USD). The average value of higher education over the years for which data are available (1990 to 2009) is $3.19 billion (2000 USD). Across that time frame, the year with the highest value is 2009 at $4.12 billion (2000 USD) and the lowest in $2.58 billion in 1990 showing the steady increase of the value of higher education.

Future Research

Future efforts will concentrate on finding local values for the social benefits of higher education in Hawaiʻi rather than using the default from other GPI studies. We will further explore not only the underlying assumptions for this indicator, but also the flow of graduates to or from the mainland, and deliberate whether this indicator should remain in the GPI-HI.

Introduction to Issue

One way or another, we are all impacted by commuting; even if we work at home, we are doing our best to avoid time spent on congested roads. Our employment, residential, and transportation choices influence our commuting patterns and vice versa.

Whether we drive ourselves, drive with others, or take public transit, we incur direct costs from commuting. Direct costs could include maintenance of our cars or fares for the public bus. These costs tend to be undesirable, but nevertheless raise personal consumption expenditures (PCE); increased PCE is considered positive under measures like GDP. We incur indirect costs as well. Commuting is one more activity to fit into our busy schedules in addition to work, family, household chores, and leisure. GDP does not account for the opportunity cost of time for commuting; time that could otherwise be freed up to spend sleeping, with family, at leisure, or at work (Talberth et al., 2007). As with other indicators within the framework, GPI corrects for these shortcomings of GDP accounting by subtracting the cost of commuting.

General Trends

US government reports using census data from the US Census Bureau and more recently, the American Community Survey (ACS), show very distinct patterns of commuting in terms of travel time and mode of transportation. McKenzie and Rapino (2011) used census data from 1980 to 2009 to track an increase in the mean travel time in the US. Nationally, the mean travel time for workers was just under 22 minutes in 1980, but increased between 1980 and 2000 to about 25 minutes, where it remained in 2009 (McKenzie & Rapino, 2011). The national average commute time in 2011 was 25.5 minutes (McKenzie, 2013).

Census data show a long-standing and overwhelming dominance of the private automobile among travel modes in the US. According to McKenzie and Rapino (2011), the number of workers who commuted by private automobile rose between 1960 and 2009, from about 41 million to about 120 million (**Figure 23**). In 2011, according to national figures from the ACS, 79.9 percent of workers not working at home drove to work alone, 10.1 percent car-pooled, and 5.3 percent took public transit (McKenzie, 2013).

GPI Approach

This GPI indicator calculates both the direct and indirect expenses of commuting. The direct, or out-of-pocket, expenses relate to the money spent to operate a vehicle or for fare on a bus or other public transportation. The indirect costs are associated with loss of time while commuting, time that could have been spent on other, more enjoyable or productive activities (Talberth et al., 2007). The sum of the costs is then subtracted from the GPI to reflect a loss to society.

Past GPI studies have used a range of variables to calculate direct costs such as: non-commercial vehicle miles, cost of user-operated transport (i.e., cars); cost of depreciation of privately owned cars; the portion of passenger miles used for commuting; or the price of purchased local transportation. For state GPI studies, limited data similar to the national level were readily available. Minnesota, for example, used motor vehicle registrations for a proxy for user-operated transport and public bus registrations as a substitute for purchased local transportation (Minnesota Planning, 2009).

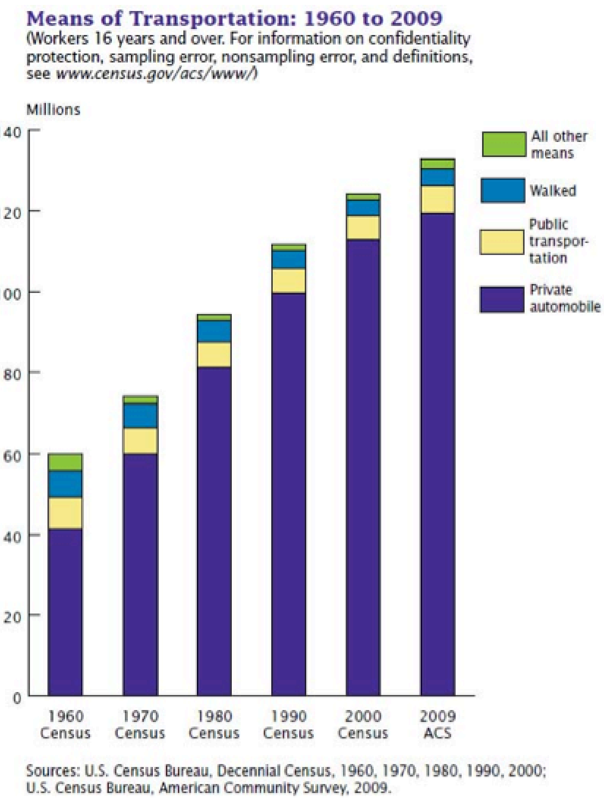
The indirect costs are associated with loss of time while commuting, time that could have been spent on other, more enjoyable or productive activities

Generally for GPI studies, the indirect costs of commuting (i.e., the value of the time lost) are calculated using the total number of people employed each year, the estimated annual number of hours per worker spent commuting, and a constant wage or value for their time (Talberth et al., 2007).

GPI-HI Approach

For the cost of commuting in Hawai‘i, we have chosen to follow the general approach of past GPI studies, with some exceptions and modifications. In line with all the other GPI studies, we estimate the total cost of commuting as the sum of direct and indirect costs. Direct costs relate to the cost of user-operated vehicles for commuting, both single occupancy vehicles and car pools, as well as the cost of public transit. Indirect costs refer to the value of time lost when commuting.

Figure 23. Means of Transportation: 1960 to 2009



We calculated the direct cost of commuting by user-operated vehicle using the following equation:

1. *Direct costs of commuting by car = (number of workers commuting by single occupancy vehicle + 50% of the number of workers carpooling) x 30% of total VMT x cost per mile for vehicle use*

Starting in 2005, the ACS provides information on commuting patterns by state, including the breakdown of workers 16 years and older across different modes of transportation. According to the ACS five year estimate from 2008 to 2012 for Hawaiʻi, for example, 66.2 percent drove alone, 15 percent car pooled, 6.3 percent used public transit, 4.7 percent walked, 3.2 percent used other means and 4.7 percent worked at home (US Census Bureau, 2013). To get a rough estimate of the number of cars used for commuting, we followed other GPI studies that used the percentage of the workers who are single drivers plus one-half of the percentage of workers who car pool (Berik & Gaddis, 2011; State of Maryland, 2010).

The National Household Transportation Survey tracks non-commercial vehicle miles traveled (VMT) for commuting as opposed to other uses such as errands or recreational travel. The national average for the proportion of the total VMT attributed to commuting from 1969 to 2009 is an estimated 29.7 percent (Santos et al., 2011). We used this information to reconfirm the figure of 30 percent proposed by Anielski and Rowe (1999) and used by other GPI studies.

Following the Utah GPI (Berik & Gaddis, 2011), we assumed a cost per mile for privately owned vehicle use from year to year based on the US General Services Administration (GSA) schedule. The GSA sets the government mileage reimbursement rate to cover costs associated with gas, insurance, and expenses associated with wear and tear (General Services Administration, 2013).

The direct cost of commuting by public transit is calculated using the following equation:

2. *Direct cost of commuting by public transit = number of workers taking the bus x average fare per trip x number of trips (assuming round trip each day and 250 work days per year)*

Other GPI studies have used transit agency passenger revenue data from agency reports to estimate per capita consumer expenditures on public transit fares (Berik & Gaddis, 2011). We took a little different approach, given that the public transit system in Hawaiʻi is currently limited to a single transit system, TheBus. We gathered one-way cash bus fares across the time period from 1971 to 2012 (Hawaiʻi State Department of Business, Economic Development, & Tourism, 2012a) and doubled it to represent round trip commutes. We also assumed from others (Bagstad & Ceroni, 2007; Berik & Gaddis, 2011; State of Maryland, 2010) that 250 work-days are the basis for yearly commutes.

The indirect costs of commuting come into play as well, but are typically a bit more difficult to capture and quantify. We used the following equation:

3. *Indirect cost of commuting representing lost time = average commuting time (across driving and public transit) x 2 (for round trip) x adjusted local wage rate*

The average commuting time for the state of Hawai‘i was taken from ACS tables for 2005 through 2012 and Census reports for 2000 and 1990; we interpolated figures for years in between. We converted the figures to total hours per year, applied that across the number of commuters each year, and multiplied by a local annual wage rate to represent the value of lost time. In their national GPI study, Anielski and Rowe (1999) noted that because some people regard commuting as part leisure rather than all nuisance, they lowered the value of lost time per hour from \$11.20 to \$8.72 (about 77 percent). Other GPI studies follow suit using an adjustment of 72 percent (Bagstad & Shammin, 2009; Berik & Gaddis, 2011; State of Maryland, 2010; Talberth et al., 2007). Therefore, we have chosen to adjust the average hourly wage for the state of Hawai‘i retrieved from the DBEDT Data Book (Hawai‘i State Department of Business, Economic Development, & Tourism, 2012c) by 72 percent.

Although providing a rough figure for indirect costs, this method does not reflect the benefits derived from using public transportation for commuting as opposed to driving personal vehicles. Commuting by public transit, even if the commute is longer, may improve quality of life because the commuting time is more leisurely and has less impact on the environment (Costanza et al., 2004).

This first round of GPI-HI found an average annual total cost of commuting of \$518 million (in 2000 USD) across the time frame from 2000 to 2012. The costs ranged from \$389 million in 2000 to \$641 million in 2012 (all in 2000 USD). Direct costs for driving (alone plus in carpools) accounted for over 90 percent of the total average annual costs of commuting; direct costs of public transit constituted about 6 percent and indirect costs of lost time made up just over 1 percent.

Future Research

Like all GPI-HI indicators, future calculations should strive for data more specific to Hawai‘i. For example, it would be advantageous to find the average commute in miles rather than use an assumed 30% of total vehicle miles traveled in the state. More generally, it would be helpful to differentiate commuting patterns both on and among the different islands. The anticipated movement of new developments to Leeward and Central O‘ahu might change the commuting patterns on O‘ahu, so the GPI could be used to capture these changes.

GPI studies infer a relationship between commute time and distance, yet changes in travel time can be a function of increased congestion or shifts between transportation modes, not just increased distance to work. Because we live on an island, commuting costs are less about distance and more about congestion. According to INRIX (2014) and Schrank et al. (2012) in 2012 Honolulu ranked the second worst city for traffic congestion, and has experienced a 4 percent increase in congestion in 2013. This congestion is measured by the Travel Time Index as the ratio of travel time in the peak period to travel time in free-flow (Schrank et al., 2012).

The annual DBEDT Data Books already include information on the impacts of commuting based on research from TTI. For example, in the most recent DBEDT Data Book (Hawai‘i State Department of Business, Economic Development, & Tourism, 2012c), Table 18.19 captured measures such as annual excess fuel consumed; annual delay; and congestion cost. These performance measures are similar, yet different, from the approach taken by the GPI model, but could play a critical role in future GPI-HI efforts. Future GPI studies should utilize this factor to indicate the “quality” of the commute, not just the “quantity” or length.

Future GPI-HI efforts should support Department of Transportation and reinforce the objectives of state-led programs like the Hawai‘i Clean Energy Initiative or other city/county initiatives such as Honolulu Clean Cities. One lesson learned from this exercise is to ensure that data collection systems are in place for future needs, particularly once the Honolulu county light rail system nears completion.

Introduction to Issue

Automobiles are a way of life in the US and in Hawai‘i. In Hawai‘i, the number of cars nearly match the population, (Nakaso, 2007). Motor vehicle crashes create multiple economic implications. Costs can include property damage, lost earnings, lost household production, medical costs, emergency services, travel delay, vocational rehabilitation, workplace costs, and legal expenses (State of Maryland, 2010). Standard economic measuring systems do not account for motor vehicle crashes as costs; in fact, the side effects could be misconstrued as a positive economic gain. Accordingly, GPI deducts these costs since accidents are a side effect of operating motor vehicles that damages well-being (Berik & Gaddis, 2011).

General Trends

The costs of motor vehicle crashes are substantial both throughout the US and in Hawai‘i. According to the CDC (2006), over 30,000 people are killed in motor vehicle crashes in the United States each year. In 2005, this amounted to a staggering $41 billion in medical and work loss. In 2005, when the population was 1.3 million, Hawai‘i totaled $124 million in costs associated with motor vehicle crashes (Center for Disease Control, 2006). Trends in traffic accidents, injuries and deaths have been decreasing since 2005, yet are still a significant source of economic loss for the state (Hawai‘i State Department of Business, Economic Development, & Tourism, 2012c).

Based on data from the National Highway Traffic Safety Administration (NHTSA), in 2010 the median number of deaths from car accidents per 100,000 population was 11.62 across the US. The same statistic for the state of Hawai‘i was 8.28 deaths per 100,000, or 28.7% lower than the median across all states (National Highway Transportation and Safety Administration, 2012).

GPI Approach

The methodology used in the previous studies of Maryland and Utah characterizes the costs as injury, death, and property damage. The associated values per accident come from the National Safety Council (NSC) Injury Facts (National Safety Council, 2004). The NSC calculates a cost of $1,024,000 per death, $36,000 per injury, and $6,400 per accident involving only property damage (all in 2000 USD). These values were also used in the GPI studies for Vermont and Ohio (Bagstad & Shammin, 2012; Costanza et al., 2004). The studies used the following equation:

> *The Cost of Motor Vehicle Crashes = [(Number of Deaths from Motor Vehicle Crashes) x $1,024,000] + [(Number of Injuries from Motor Vehicle Crashes) x $36,000] + [(Property Damage Accidents) x $6,400] in 2000 USD*

GPI-HI Approach

Hawai‘i’s GPI approach for the cost of motor vehicle crashes follows the examples of past GPI initiatives in Maryland, Ohio, Vermont, and Utah. However, due to data gaps in number of accidents only incurring property damage, we could not incorporate those costs within our calculations at this time, similar to Talberth et al. (2007). If those data are made available in the future, we can include those easily and use the value of $6,400 estimated damages.

The data on total fatalities and injuries in Hawai‘i were retrieved from table 18.20 in the 2012 State of Hawai‘i Data Book and is based on data from the Fatality Analysis Reporting System published by the NHTSA (Hawai‘i State Department of Business, Economic Development, & Tourism, 2012c). These data were available for the years of 1995-2011. However, effective June 20, 1995, the data include only accidents with damage of $3,000 or more or causing injury or death.

> *Cost of automobile crashes = [(Number of Deaths from Motor Vehicle Crashes) x $1,024,000] + [(Number of Injuries from Motor Vehicle Crashes) x $36,000] in 2000 USD*

In the year 2000, the total cost of motor vehicle accidents (fatalities and injuries) was $521 million (2000 USD). The average cost of accidents over the years for which data are available (1995 to 2011) is

$421 million (2000 USD). Across that time frame, the year with the highest cost of accidents is 1995 at $670 million (2000 USD), with a general downward trend since then. The figure for the most recent year (2011) is $185 million (2000 USD).

Future Research

To better localize the calculation for Hawai'i, we will look for better estimates of the costs of accidents from insurance claims and accident reports specific to Hawai'i. In the short term, we will use more up-to-date data published in NSC's Injury Facts. We will also further investigate the total number accidents with property damage only with the Hawai'i State Department of Transportation. It might be interesting to explore any correlations in trends between VMT and the accident rates to paint a better picture of vehicle safety in Hawai'i.

SERVICES OF STREETS AND HIGHWAYS — SCL 9

Introduction

Transportation heavily influences the economy and our quality of life. Roads are the networks that link people, goods, and services. Streets and highways enable the movement of industrial, recreational, emergency and utility vehicles as well as bicyclists and pedestrians (State of Maryland, 2010). Well-maintained roadways contribute to both production and productivity within an economy; their maintenance is key to a well-functioning state. Yet the services they provide are not captured by GSP or GDP. Just like consumer durables provide ongoing services beyond the initial purchase, streets and highways provide ongoing services beyond the initial cost to construct them.

General Trends

O'ahu is home to one of the most expensive interstates ever built, H-3. The final cost was $80 million per mile and a staggering $1.3 billion when completed (Yuen, 1997). According to DBEDT (Hawai'i State Department of Business, Economic Development, & Tourism, 2012c), the number of miles of highways and streets rose slightly as the state of Hawai'i continues to develop (from 4,217 miles in 1998 to 4,416 miles in 2012 or about a 5 percent increase). Whether new or existing, the stock of roads has potential for providing better and more equally distributed services, such as encouraging alternative transportation, adding more bike lanes, etc.

GPI Approach

The Department of Transportation Federal Highway Administration reports every five years on the net stock, or collection, of federal, state, and local roads (US Department of Transportation, 2012). On an annual basis, the BEA calculates the value of the stock of the collection of streets and highways across the nation, although it does not do so for individual states (US Department of Commerce, 2010; US Department of Commerce, 2013b).

The annual value of services of highways and streets is converted from the BEA figures of the net stock of federal, state, and local government streets by adjusting for depreciation and opportunity costs (similarly to the services of consumer durables). This annual flow of services from streets and highways is estimated as 10 percent of the total stock (assuming 2.5 percent for depreciation plus 7.5 percent for average interest rates). Furthermore, other GPI studies assumed that 25 percent of all vehicle miles are for commuting, as a defensive expenditure, which leaves 75 percent as net benefits. Their GPI calculation therefore assumes the net service value of streets and highways is 75 percent of 10 percent, or 7.5 percent of net stock (State of Maryland, 2010).

GPI-HI Approach

Hawai'i's GPI approach for the services of highways and streets follows the examples of past GPI initiatives. The total length of paved highways and streets in Hawai'i was retrieved from table 18.02 in the 2012 State of Hawai'i Data Book (Hawai'i State Department of Business, Economic Development, & Tourism, 2012c). The figures are based on data from the Department of Transportation's Highway Division. When available, we used data for actual miles of roadway in Hawai'i to find the ratio of Hawai'i roads to the national total; those data from 1998 to 2012 were readily available from DBEDT Data Book over various years. Prior to 1998, we used an assumed ratio of Hawai'i to US road miles of 0.108 percent based on the trends in the available data. We know that this ratio may change once we acquire data from earlier years in the state.

In either case, we next multiplied the ratio of state to national miles by the value of the national stock of streets and highways published by BEA for those years. The data were found in under Government Fixed Assets for Highways and Streets from Table 11 Current-Cost Net Stock of Government Fixed Assets (US Department of Transportation, 2012).

To arrive at an annual value for non-commuting services provided by the streets and highways in Hawai‘i, we adopted the same adjustment factor from past GPI studies. The adjustment factor assumes a depreciation rate of 2.5 percent, a 7.5 percent interest rate, and the percentage of vehicle miles used for everything except commuting as 75 percent.

For the years 1960 to 2012, the annual average value of services provided by highways and streets in Hawai‘i was $101.71 million (2000 USD). For the years for which we have actual data on the miles of streets in Hawai‘i, from 1998 to 2012, the average annual value of the services provided by those streets was $151.25 million (2000 USD). The value of services of streets and highways in the year 2000 for GPI-HI was calculated as $107.64 million (in 2000 USD).

Future Research

In terms of data, there are two factors that could be improved upon in future GPI-HI efforts. Data for actual miles of roads in Hawai‘i would be preferable to using the ratio of Hawai‘i miles to national miles, particularly since Hawai‘i constitutes such a small percentage of roads across the nation. In addition, we will look more closely at the adjustment factor for determining the percentage of vehicle miles attributed to commuting to bring this in line with other indicators such as the cost of commuting (which assumes a rate of 30 percent of vehicle miles traveled for that purpose).

Also, we will look at other transportation networks (air, sea) that provide service to us, but are not included in streets and highways. Our island setting is unique in that most of our goods come from the mainland or elsewhere via air and sea, as opposed to interstate highways as on the mainland. We can examine further whether that would be an appropriate addition to the GPI framework.

CONCLUSIONS

This is the second exercise to calculate Hawai‘i's GPI. The goal of this year's report was to expand the scope of the GPI from last year's focus on environmental indicators to its full suite of economic and social indicators. Hawai‘i's GPI builds on and adapts a template from Maryland, featuring 27 indicators (7 economic, 11 environmental, and 9 social), including one environmental indicator, submerged systems, that is unique to Hawai‘i.

Similar to last year, the purpose of doing a GPI exercise for the state is to provide a policy-relevant tool. This report demonstrates how GPI can support more holistic policy-making by highlighting the important though "hidden" economic, social, and environmental changes that occur alongside economic development.

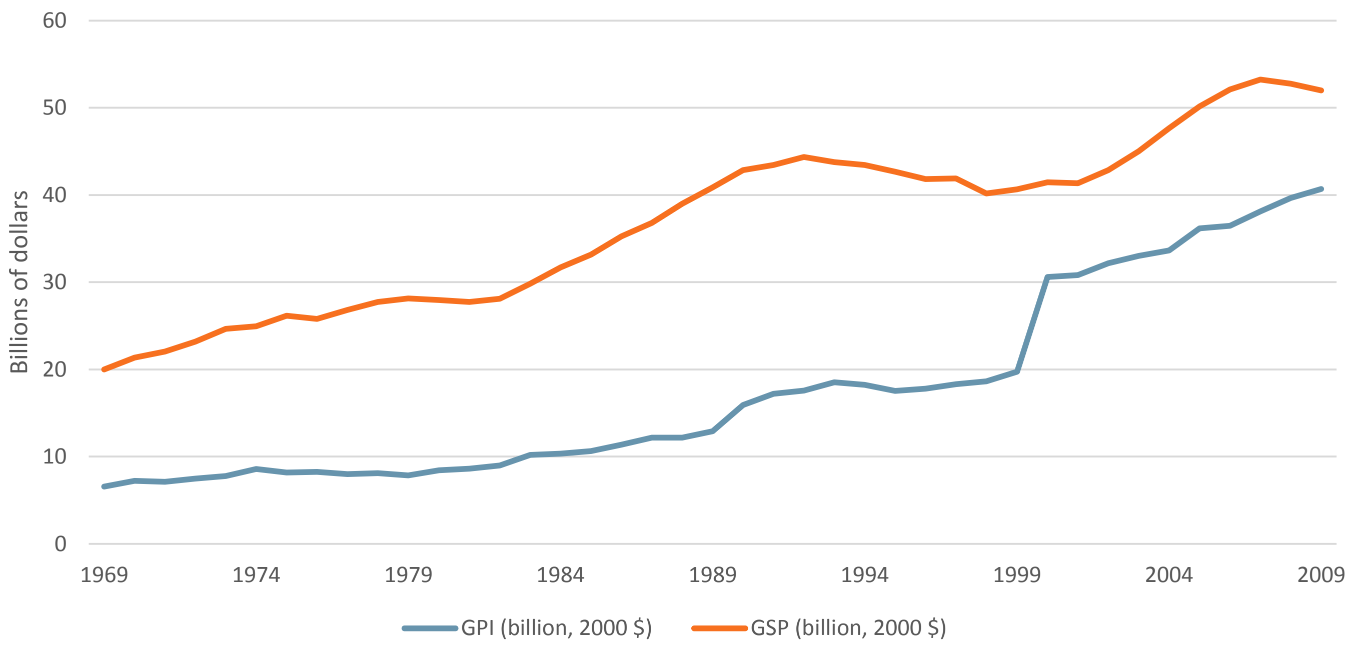
Finally, we now have a central repository of data covering all the indicators, and are working to move the repository into a "dashboard" format that will be publically available and automatically populated in real time as agencies report data. We also identified key research and data needs.

HIGHLIGHTS OF THE HAWAI‘I GPI STUDY

Overall

Hawai‘i has made genuine progress since 1969 (the earliest year for which we have most data), although there is divergence from GSP (**Figure 24**). This suggests that GSP overstates the wellbeing of the state. GPI and GSP start from the same basic figure – personal consumption expenditures – but GPI then incorporates changes, both positive and negative, that are ignored by GSP. The figure below illustrates this discrepancy.

Figure 24. Hawai‘i's GPI and GSP (1969-2009)

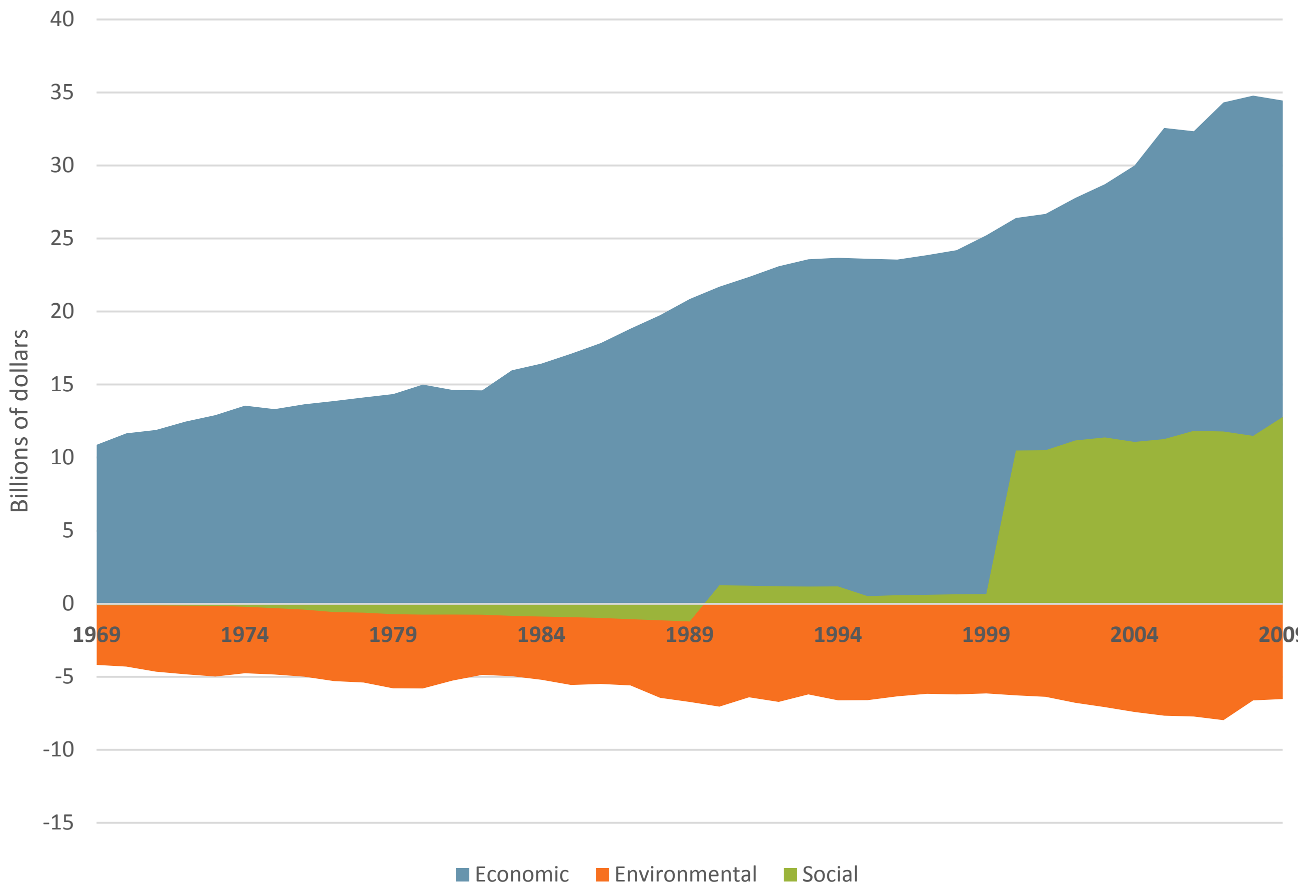


Note that the value of housework data were only available after 2000, explaining the steep increase in GPI.

It is important to note that the GPI figures in this section plot an aggregate of the data we have on-hand. We chose the period 1969-2009 based on the fact that most data are available for that period. Where possible, we interpolated (or extrapolated when required) between available data. Nonetheless, in most years, one or more individual indicators are missing, and an abrupt change is apparent in 2000, when the value of housework data became available.

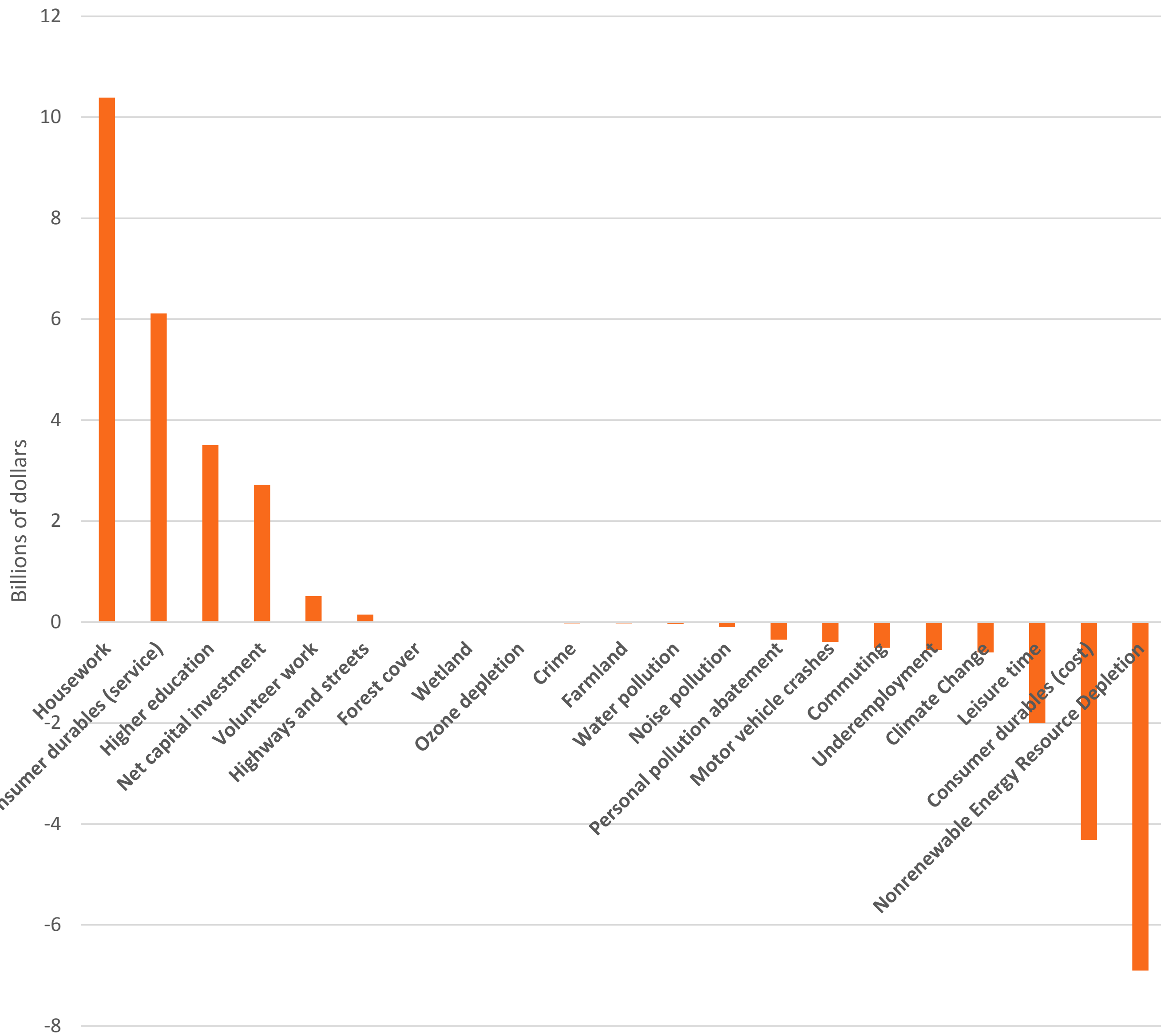
In general, the rising GPI was driven by positive trends in economic components, but these were partially offset by declines in environmental components, while social indicators have remained steadily positive over the past 30 years (**Figure 25**). Again, the abrupt increase in the social component was due to the value of housework dataset, which was only available from 2000.

Figure 25. Components of GPI (economic, environmental, and social) (1969-2009)



The most significant gains captured in GPI that drive the discrepancy from GSP in Hawai‘i were a mix of economic and social indicators: consumer durables (the service component), higher education, net capital investment, and volunteer work, while the most significant costs span all three (environmental, economic, and social) components: the cost of non-renewable energy depletion, consumer durables (the cost component), lost leisure time, cost of climate change, and underemployment (**Figure 26**). In 2005, the per capita adjustments to personal consumption were $-874 for the economic component, $-6,199 for the environmental component, and $8,558 for the social component.

Figure 26. Adjustments included in GPI for 2005, sorted by indicator



Economic

Personal consumption expenditures (PCE) is the main contributor in the calculation of GDP; an increasing PCE drives economic growth and results in higher GDP – how's that for progress? GPI, like GDP, also uses PCE as its starting point, but the GPI model puts a twist on the use of this economic indicator by adjusting for the byproducts of economic growth. PCE is the platform upon which all other negative and positive adjustments are made. Our GPI results in this category show that regardless of PCE increases across the years for Hawaiʻi, negative impacts such as increasing income inequality or underemployment accompany the increases, so adjustments are made downward. For example, in 2011, PCE was adjusted downward by almost $7 billion (from $37.9 to $30.9 in 2000 USD) to compensate for income inequality for the state. Likewise, by acknowledging the services of consumer durables, GPI reflects true positive results that were not normally captured in GSP. In 2012, the service of consumer durables was estimated $7.88 billion and outweighed the cost of consumer durables in the same year of $4.09 billion (2000 USD) to be a net positive adjustment to GPI.

Environmental

Hawai‘i is highly dependent on its natural resource base for its economy and overall wellbeing. Our provisional calculations reveal that economic development, which is what is reflected in GSP, has come at an overall cost of environmental depletion and degradation. The environmental costs of economic development totaled $-7.75 billion in 2004.

These costs are driven by the cost of non-renewable energy resource depletion, climate change, personal pollution abatement, and noise and water pollution.

Social

This category of social indicators illustrates the overwhelming importance of households in figuring the genuine progress of society. Our findings across the social indicators highlight some significant contributions (both positive and negative) that are not being accounted for in GDP/GSP. The most significant, of course, are loss of leisure time, followed by unpaid value of housework. The cost associated with lost leisure topped $2.36 billion (2000 USD) in 2012; the value of unpaid housework totaled $11.07 billion in 2011 (2000 USD). Both of these categories clearly point out the associated sacrifices that households must make (in terms of more hours of housework and fewer hours of leisure) in the name of economic productivity. The ATUS offers extremely helpful data for analysis of how Americans spend their days; however that dataset is relatively new and the sample size of years is still small. It nevertheless provides a solid source of information now and an even richer one later. As for positive adjustments, higher education figured prominently in terms of value, reaching $4.12 billion (2000 USD) in 2009.

Differences with Last Year’s Report

Last year was the first introduction of GPI to Hawai‘i. The 2012 report solely concentrated on the environmental indicators. There are some differences in this year’s environmental section. In some cases, we used new or updated data sources, for instance for forests and wetlands. In other cases, we corrected minor errata or altered assumptions. These changes are noted in each indicator’s write-up.

POLICY RELEVANCE

Implications for Hawai‘i’s Progress

GPI is an exercise to aggregate economic, social, and economic changes into a single, common indicator that reflects social progress. An aggregate number can be powerful, enabling comparison across seemingly incommensurate policy goals, such as forest preservation, inequality, and education. Comparing changes in the three categories can highlight trade-offs between environmental, social, and economic goals. Observing GPI trends over time can provide insight into the true progress and sustainability of the state.

This study shows that Hawai‘i’s GPI diverges from GSP, reinforcing the call for more holistic indicators of progress. GSP overestimates the state’s progress because it focuses exclusively on a handful of economic aspects of the economy, but does not incorporate key social, economic, and environmental changes that come about from economic development.

The GPI offers a framework for assessing the full, long-term impacts of public policy and budget decisions. The results of this study provide an opportunity for policy makers to consider a broad range of issues when making policy choices, and to make more informed decisions. The integrated nature of the GPI could help guide budget and planning decisions. In other states, decision-makers have used GPI to analyze trade-offs in well-being outcomes posed by alternative resource allocations and policies. It also could help focus policy attention to the most important factors, or ones with worrisome trends. For instance, the fact that Hawai‘i’s GPI is being reduced by costs related to non-renewable energy consumption, consumer durables, and the loss of leisure time implies that policy attention could focus in on mitigating these costs. Alternatively, policy could focus on reinforcing gains from education and investment.

Integration with Other Hawai‘i Indicator and Sustainability Initiatives

GPI fits well within a number of on-going sustainability efforts in Hawai‘i, including initiatives to develop meaningful indicators. One such effort, the Hawai‘i Green Growth Initiative, is a working group formed by leaders of business, academia, and civil society to support sustainability goals set out in both the Hawai‘i 2050 Sustainability Plan and New Day Hawai‘i. One of the activities of this group is to develop a set of comprehensive indicators to track progress in the state; the GPI is included.

In-depth information on additional social indicators can be found in the University of Hawai‘i at Mānoa Center on the Family's data portal and Quality of Life in Hawai‘i reports (latest version 2009) (http://uhfamily.hawaii.edu/index.aspx). Similarly, the University of Hawai‘i's Economic Research Organization compiles relevant data and produces occasional reports covering sustainability topics, including one on the importance of natural resources and ecosystem services for food security, and ecosystem health (http://www.uhero.hawaii.edu/88/sustainability).

NEXT STEPS

Ownership of the GPI Exercise

The GPI accounts can help keep track of progress at the state, county, or island level. Part of the attraction of the GPI is that it calls upon data that are already collected and reported by public agencies. The natural home for the GPI effort would be in the state government, perhaps coordinated by the Office of Planning or State Data Council. The coordinating agency could seek out important, undiscovered data repositories and facilitate data sharing across agencies. Moreover, as the indicator is intended to guide policy, housing the GPI effort in government could ensure its use as a policy tool.

Updating the GPI Method

The main critiques of GPI surround the choice of indicators (i.e., why these and not others?) and the valuation methods used to assign a monetary cost of benefit. Further, as with any indicator, there are a number of arguable assumptions embedded in the method. While the current consensus is that GPI is a useful indicator of economic welfare, there is an active research agenda tackling these critiques, strengthening the assumptions, and improving the GPI. The authors of this study are playing an active role in this effort.

Part of the discussion revolves around the "localization vs. standardization" issue. Should the GPI method (and calculations) be immutable, or should the local context dictate the indicators and values assigned. Localizing implies GPIs cannot be compared across context, but standardization may attenuate the policy relevance. The debate continues, but many states are considering reporting a "standard" GPI alongside a "local" one. Here in Hawai‘i, we are developing amendments to capture things important for Hawai‘i. The initial amendments to our "island style" GPI included in this report are the two additional environmental indicators – submerged systems and coastal water quality – and more local flavor is expected in the coming years, including water scarcity and invasive species.

Other points of discussion include the challenges of applying GPI at a local scale. GPI was designed for national level assessments, where aggregate datasets exist for long periods of time. Our problems with data availability (see below) mirror those that other states have faced. Data collection and management are expensive, and thus data availability can be difficult at sub-national scales. For some of the indicators, downscaling is accomplished by taking national level studies and scaling it by population, which undeniably diminishes accuracy. Another issue related to scale revolves around transboundary costs and benefits. Consumption in Hawai‘i relies upon production in other states (and nations), which undeniably impacts their natural resource base. The GPI does not currently capture this (or other spatial, transboundary issues).

Data and Research Needs

Table 7 provides a summary of the figures used to assign monetary value to the economic, environmental, and social indicators and the studies from which these values are taken. In addition, **Table 7** summarizes the needs for future research across all three categories of indicators as identified in the current study. **Table 8** shows our initial assessment of the quality and comprehensiveness of the biophysical data used for the environmental indicators, plus sources (either current or future). The information in both tables will be useful to target data collection and generation efforts for future improvements to GPI-HI.

Particularly for the environmental indicators, we were limited by data comprehensiveness and quality. The GPI calculation for each environmental indicator requires two elements: a biophysical change and an economic valuation of that change. In some cases, we have both, and in some cases, neither. For the biophysical data, we made do with what we had, but as **Table 8** summarizes, better data are almost universally needed. Ideally, we would have annual, statistically robust biophysical data. This is unlikely given the budgetary constraints, but this report highlights the need to prioritize data collection and/or quality assurance for the indicators with poor data.

The social and economic indicators are also limited to an extent by data availability and completeness. Instead of quantifying biophysical changes in the environment, these indicators focus on how changes in time use (labor, leisure, commuting), safety (crime, automobile accidents), or services (consumer durables, streets and highways) impact individuals, households, and larger populations. The economic valuation is pulled in through wage rates, costs per accident, and depreciation of capital stock. Although we use proxies for some factors and scale down national data for others, ideally we want to incorporate locally based variables

Using the GPI to Analyze and Guide Policy

In other states, the GPI has been used as a policy tool. For example, in Maryland, the GPI has been used to help shape policies related to smart growth, land use planning, green energy, and green jobs. A ripe area of future collaborative research surrounds the use of GPI to guide policy in Hawai‘i.

A goal for next year is to use the GPI to assess policies on a pilot basis.

Table 7. Summary of values assigned and valuation sources for current GPI-HI as well as future research needs

	Indicator	Value assigned (2000 USD unless noted)	Source	Future Research Needs
Economic Indicators				
ECN1	Personal consumption expenditures	National values from BEA NIPA tables	US Dept of Commerce (2013a)	PCE by state/county; ESRI data to apply county-level spending
ECN2	Income inequality	N/A	N/A	Continued annual tracking of the Gini coefficient at the state level
ECN3	Adjusted personal consumption	PCE adjusted by Gini coefficient	US Census Bureau (2012)	ESRI county spending index data
ECN4	Consumer durables	National values from BEA NIPA tables	US Dept of Commerce (2013a)	ESRI consumer spending data on household consumer durables
ECN5	Underemployment	Prorated HI:US personal income data	US Dept of Commerce (2013a)	Locally derived hourly wage rate for Hawaiʻi
ECN6	Net capital investment	Per capita national net capital investment	Anielski & Rowe (1999); Talberth et al. (2007)	State level data on net capital investment
Environmental Indicators				
ENV1	Inland and coastal water pollution	$130 per person	Derived from Freeman, 1982; as per Costanza et al, 2004, Bagstad and Ceroni, 2007, and Posner 2010	Valuation study on stream water quality; valuation study on coastal water quality
ENV2	Air pollution	N/A	N/A	N/A
ENV3	Noise pollution	Total damages were $14.62 billion globally in 1972	Derived from WHO study, reported in Talberth (2007) and Bagstad and Ceroni (2007)	Update to WHO study
ENV4	Wetland change	$1,973/acre in 1950, rising 2% per year	Bagstad and Ceroni (2007)	Valuation study on total economic value of wetlands
ENV5	Farmland change	$730/acre	Based on HI:US ratio of agricultural productivity as reported by USDA NASS	Valuation study on total economic value of farmland (including ecosystem services and more nuanced production)
ENV6	Forest change	$1,690/acre	Kaiser et al (2002)	A usable baseline study exists, but needs to be transferred to other forests
ENV7	Climate change	$89.57/tonne carbon in 2004, interpolated linearly to $0 in 1962; extrapolated at same rate	Tol (2005)	Updated social cost of carbon
ENV8	Ozone depletion	$49,669/tonne	Talberth et al (2007)	N/A
ENV9	Non-renewable energy resource consumption	Replacement cost electrical sector: $0.0875/kilowatt/hr Replacement cost outside electrical sector: $116/barrel equivalent	US EIA (2012b); DBEDT Data Book (2012c)	Refined cost of renewables

	Indicator	Value assigned (2000 USD unless noted)	Source	Future Research Needs
ENV10	Personal pollution abatement	$100 catalytic converter + $8.50 air filter	Costanza et al. (2004); Bagstad & Ceroni (2007)	Better technology proxy/price for catalytic converters
		$0.004/gallon sewer; $200/septic system (maintenance); $4,000/septic system (install)	City & County Honolulu (2008; 2012b)	More accurate figure on percent coverage for sewers vs. septic
		$100/ton solid waste (disposal)	Costanza et al. (2004)	Figures for pound/per/day and cost per ton of solid waste disposal for Hawaiʻi
ENV11	Submerged coastal systems	N/A	N/A	A usable study exists, but fisheries need to be added
Social Indicators				
SCL1	Housework	Average annual housekeeper's wage in HI	DBEDT Data Book (2012c)	Hawaiʻi specific information on hours spent particularly on childcare and housework
SCL2	Family changes	N/A	N/A	Reevaluate and redefine proxies used for family breakdown
SCL3	Crime	Ranges from $320 per larceny theft to $2.3M per murder	Miller et al., (1996)	Local data on defensive expenditures for locks, security alarms, etc.
SCL4	Volunteer work	$18.14 (2011 USD) value per volunteer hour	Federal Agency for Service and Volunteering (2012)	Local volunteer rates prior to 2000
SCL5	Lost leisure time	Average annual wage rate for HI	DBEDT Data Book (2012c)	Local versus national leisure rates
SCL6	Higher education	$16,000 per graduate per year	Hill et al. (2005)	Local value of the social benefits of higher education
SCL7	Commuting	GSA mileage; TheBus fares; average wage rate for HI	GSA (2013); DBEDT Data Book (2012a); DBEDT Data Book (2012c)	Congestion data to reflect quality of commute not just length
SCL8	Motor vehicle accidents	$1.02M per death; $36,000 per injury; $6,400 per property damage only	NSC Injury Facts (2004)	Costs of accidents from insurance claims and accident reports specific to Hawaiʻi; updated NSC data; trends between the vehicle miles traveled (VMT) and the accident rate
SCL9	Services of streets and highways	BEA value of national stock of roads x HI:US ratio of roads	US Dept of Commerce (2010, 2013b)	Local value of roads; refine percentage of VMT for non-commuting; consider other transport systems

Table 8. Status of local economic valuation studies

	Indicator	Data needed	Comprehensiveness (time and space)	Quality	Data source (potential/current)
ENV1	Water pollution	Stream water quality	Poor	Poor	DOH
		Coastal water quality	Moderate	Moderate	DOH
ENV2	Air pollution	N/A	N/A	N/A	N/A
ENV3	Noise pollution	Population	Good	Good	DBEDT
ENV4	Ozone	N/A	N/A	N/A	N/A
ENV5	Wetland	Area change	Poor	Poor	NOAA USGS
ENV6	Farmland	Area change	Good	Moderate	USDA
ENV7	Forest	Area change	Poor	Moderate	NOAA USGS
ENV8	Climate change	Greenhouse gas emissions	Good	Good	DBEDT
ENV9	Non-renewable energy consumption	Energy consumption	Good	Good	EIA
ENV10	Personal pollution abatement	Defensive expenditures	Good	Moderate	National studies
ENV11	Submerged coastal systems	Area change	Poor	Good	NOAA

ACRONYMS AND ABBREVIATIONS

ACS	American Community Survey
APC	adjusted personal consumption
ATUS	American Time Use Survey
BEA	US Bureau of Economic Analysis
BEACH	Beaches Environmental Assessment and Coastal Health
BLS	US Bureau of Labor Statistics
BTU	British Thermal Unit
C-CAP	Coastal Change Atlas Project
CAA	Clean Air Act
CDC	US Center for Disease Control
CPS	Current Population Survey
CO_2	carbon dioxide
CWA	Clean Water Act
DBEDT	Hawai‘i State Department of Business, Economic Development, and Tourism
DLIR	Hawai‘i State Department of Labor and Industrial Relations
DLNR	Hawai‘i State Department of Land and Natural Resources
DOH	Hawai‘i State Department of Health
DPI	disposable personal income
ECN	economic (indicator)
EIA	US Energy Information Administration
ENV	environmental (indicator)
EPA	US Environmental Protection Agency
ESRI	Environmental Systems Research Institute
GHG	greenhouse gases
GPI	Genuine Progress Indicator
GSA	US General Services Administration
GSP	Gross State Product
HCEI	Hawai‘i Clean Energy Initiative
HEPA	Hawai‘i Environmental Policy Act
HRS	Hawai‘i Revised Statutes
MGD	million gallons per day
MSW	municipal solid waste
NASS	National Agricultural Statistics Service
NAAQS	National Ambient Air Quality Standards
NHTSA	National Highway Traffic Safety Administration
NIPA	National Income and Product Accounts
NOAA	US National Oceanic and Atmospheric Administration
NSC	National Safety Council
PCE	personal consumption expenditure
SCL	social (indicator)
TMDL	total daily maximum loads
UH	University of Hawai‘i
US	United States
USD	US dollars
USDA	US Department of Agriculture
USGS	US Geological Survey
VMT	vehicle miles traveled
WHO	World Health Organization
WWTP	wastewater treatment plant

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