Hawai‘i 2050

Building A Shared Future

ISSUE BOOK

Ua mau ke ea o ka ‘āina i ka pono

“The life of the land is perpetuated in righteousness.”

2050

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Aloha Mai Kākou

Hawai'i 2050

Hawai'i's future is truly in *our* hands. We can chart a course for a preferred future, or let the winds of change determine our destination. As an island society, we must develop and perhaps invent the tools and infrastructure to shape our destiny, but it will take individual and community action and political will. We must be focused and disciplined, as well as creative, imaginative and visionary in our approach.

Creating the Hawai'i 2050 Sustainability Plan is an opportune time for our community to engage in meaningful dialogue about Hawai'i's future. Recognizing the dynamic changes that Hawai'i has undergone in the last fifty years, planning for the long term will require uninhibited, futuristic thinking. What kind of economy do we want in fifty years? How self-sufficient do we want to become in growing our own food? Will we provide self-sufficient energy resources to meet our population needs? How do we preserve our land and water for future generations? How do we care for our children and our elders?

The Hawai'i 2050 SustainabilityTask Force was established in 2005 to address these issues and to develop a long-range plan to realize our hopes for a sustainable Hawai'i. Public dialogue has directed this effort, and will continue in the months ahead, as we engage citizens, businesses, labor organizations, and community groups alike on all islands. The Task Force is moving ahead to determine what plans, strategies, and accountability indicators will best mark progress toward achieving a sustainable Hawai'i.

The Task Force will deliver its sustainability plan recommendations to the 2008 Hawai'i State Legislature for deliberation. Upon its approval the plan will be our path and guide-way for years to come. The Task Force is working to assure that the plan will reflect a shared community vision, recognizing that achieving sustainability will require our courage, hope, imagination, and willingness to work together.

This book contains thoughtful papers and research background on various issue areas which the Task Force identified as important for Hawai'i's sustainable future. Scholars at the University of Hawai'i provide you with information and ideas as we begin the serious deliberations for the future of our state.

It is our hope that in the chapters which follow, you will find the reasons for our work, and a fact-based foundation for public discourse about our future. Please join us in creating a better Hawai'i.

The Honorable Russell S. Kokubun
Hawai'i State Senator
Chair, Hawai'i 2050 Sustainability Task Force

A Special Mahalo!

Having sound and reliable information on the key components of sustainability is crucial to the development of the Hawai‘i 2050 Sustainability Plan. In order to ensure that the dialogue about Hawai‘i’s future is reasoned and productive, it was essential to provide a team of researchers and scholars who are knowledgeable about key areas relating to Hawaii’s sustainable future.

Special thanks to the University of Hawai‘i College of Social Sciences Public Policy Center for coordinating the research efforts. Scholars within the various disciplines at the University of Hawai‘i at Mānoa campus were tapped to share their expertise and perspectives on Hawai‘i’s current status and its future. The issue briefs presented are reflective of the broad depth and understanding of Hawai‘i’s top scholars at the University of Hawai‘i.

Dr. Sharon Miyashiro, principal investigator of the H2050 Research Team, is to be commended for her leadership and tenacity for completing this monumental task. Her patience and dedication in coordinating this large-scale research project is sincerely appreciated.

Thank you also to Miles Hakoda for his artistic graphic talents; Paul “Doc” Berry for his commentary and insights on sustainability; Jim Hollyer for obtaining the data and information to support the project; Dr. Kem Lowry for his guidance and insight on using research for community decision-making; and Professor Gerald Kato for his editing assistance. Finally, thank you to the Hawai‘i Institute for Public Affairs, consultants to the Hawai‘i 2050 Sustainability Task Force, for their skill and expertise in policy development and technical support of the Hawai‘i 2050 Sustainability Task Force.

building a shared future Hawai'i 2050

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Ua mau ke ea o ka ʻāina i ka pono

"The life of the land is perpetuated in righteousness."

King Kamehameha III

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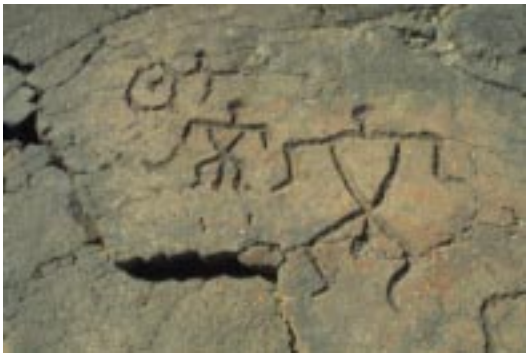
About This Book

In 1987, the World Commission on Environment and Development first spoke of *sustainability*, calling on humanity's ability to make development sustainable "to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs."



At its core, sustainability is simply the desire to keep things going, to continue to have what we have — something humans have sought for millennia.

Five years later, a United Nations conference refined the concept to include "a balancing or integration of environmental, social, and economic issues." Experts note its similarity to the "seventh generation" philosophy of the Native American Iroquois Confederacy, which mandated that chiefs always consider the effects of their actions on their descendants seven generations into the future. History tells us the stories of those who did; and of those who vanished because they did not.

In 1959, the Hawai'i State Legislature, adopted a resolution declaring Hawai'i as "The Aloha State." The resolution expressed some key principles for a sustainable community — taking care of our places and people so that all residents can lead meaningful and quality lives within a healthy environment and strong economy.

At its core, sustainability is simply the desire to keep things going, to continue to have what we have — something humans have sought for millennia. Yet, to ensure that sustainable future for generations yet unborn requires more of each of us: we must decide and act responsibly for today and for generations yet to come.

Because the task has become more urgent, we have now set out to identify ways to incorporate sustainable practices in our personal, household, and collective lives. Hawai'i now looks seriously at sustainability because disturbing trends and serious problems seem to be arriving at a speed that threatens to overwhelm us. A growing population is consuming more land, homes are becoming more expensive, and traffic is horrendous. We are urged to conserve water and electricity to avoid shortages and blackouts. Rising food and energy prices remind us about how much our island state depends on external sources for nearly all of our food and energy.

We are mindful that forces beyond our control will shape the future of our small islands: major influences such as energy prices, global climate change, regional economic upheavals, and terrorism, to name a few. Our challenge is to anticipate the local effects of global and regional changes, to identify our vulnerabilities, and to build greater resilience in our economy, our infrastructure, our networks of social services, and our collective ability to respond to trends and events that we now can only barely perceive.

This report is part of the new effort to respond to these challenges. It is intended as an introduction to some of the key issues surrounding sustainability in Hawai'i. Experts studying social trends, water, energy, economy, and our

environment tell us that we need to change our direction. They show us where an aging population, a faltering educational system, a degrading environment, and a reliance on a visitor-driven economy appear to be leading us. In the chapters ahead, they provide the background, the current situation, and some of our possibilities and choices. They suggest avenues for planning: *aloha 'aina* and land use planning as well as education, improving our self-sufficiency, protecting our environment, growing a healthy, diversified economy, and creating a society with effective safety nets.

If you will read all of the papers — not as separate issues, but as interconnected pieces of a puzzle — the larger picture of our sustainability needs will become clear. We all need to understand the issues we face if we hope to clarify our values and priorities, if we are to make choices individually and as a community that effectively address these problems. While none of us can see the future in 2050, we can identify those quality of life factors — those conditions that we want sustained through 2050 and for the seventh generation forward.

We all need to understand the issues we face if we hope to clarify our values and priorities, if we are to make choices individually and as a community that effectively address these problems.

We invite you to read these chapters, to consider the vision they offer of current and future conditions, and to reflect on your image of Hawai'i's futures and the paths we need to take to create our preferred future.

We are confident that our community — with its sense of stewardship for this land, its strong values of family and community, its appreciation of our diverse cultures, and its resilience in dealing with risks and adversities — will meet the challenges ahead and take seriously this opportunity to work together for a sustainable future for our Hawai'i.

Each of us can act today to protect the qualities that make us choose Hawai'i as our home: to ensure our families and neighbors have enough food and shelter; and to plan together for future generations so they may enjoy the quality life we all desire for ourselves.

Hawai'i's future depends on all of us taking the time to plan and to act now. It will take moving beyond personal concerns to assure that we meet our collective needs not only for today, but also for tomorrow. More, it will require personal and political will, and we hope that this book inspires both.

Please visit the Hawai'i 2050 Sustainability Task Force's website at: www.hawaii2050.org to obtain more information on the issues covered as well as share your comments on these issues and the developing Hawai'i 2050 Sustainability Plan. You can also find out about upcoming Hawai'i 2050 events, review Hawai'i 2050 meeting minutes, and learn more about other sustainability efforts and activities in Hawai'i and beyond.

The ʻāina is the land and natural resources of *Hawaiʻi Pae ʻāina* or the Hawaiian archipelago.

Aloha ʻĀina

By Davianna Pōmaikaiʻi McGregor

Aloha ʻāina is at the core of sustainability for Hawaiʻi.

The *ʻāina* is the land and natural resources of *Hawaiʻi Pae ʻāina* or the Hawaiian archipelago. The ʻāina is the foundation of traditional Native Hawaiian cultural and spiritual custom, belief, and practice. As reflected in Hawaiian legends, place names and songs, the land and all of nature are alive, respected, treasured, praised and honored. Throughout the islands, many Native Hawaiian *ʻohana* in rural communities continue to practice subsistence cultivation, gathering, fishing, and hunting as part of their livelihood. Rural Hawaiians conduct subsistence activities in accordance with cultural and spiritual values and responsibilities taught to them by ancestors who nurtured both physical and spiritual relationships with their ancestral lands.

The land is not viewed as a commodity; it is the foundation of their cultural and spiritual identity as Hawaiians.

***Davianna Pōmaikaʻi McGregor**, PhD, Historian of Hawaiʻi and the Pacific, Department of Ethnic Studies, College of Social Sciences, University of Hawaiʻi at Mānoa.*

ʻĀina is *ʻone hānau*, sands of birth, and *kula iwi*, resting place of ancestral bones. The land has provided for generations of Native Hawaiians and will provide for those yet to come.

Cultural and spiritual foundation

At the core of traditional Native Hawaiian spirituality is the belief that the land lives as do the *ʻuhane*, or spirits of family ancestors who cared for the ancestral lands in their lifetimes. In communities where Native Hawaiians live on and work the land, they become knowledgeable of the life of the land. In daily activities, they develop a partnership with the land so they know when to plant, fish, or heal the mind and body according to the ever-changing weather, seasons and moons. Native Hawaiian subsistence practitioners speak of their cultural and spiritual relationship to the lands of their ancestors, and their commitment to take care of it and protect it for future generations.

Hawaiians acknowledge the *ʻaumakua* and *akua*, the ancestral spirits and gods of special areas. They even make offerings to them. They learn the many personalities of the land — its form, character and resources — and name its features as they do their own children. The land is not viewed as a commodity; it is the foundation of their cultural and spiritual identity as Hawaiians. They trace their lineage to the lands in the region as being originally settled by their ancestors. The land is a part of their ʻohana and they care for it, as they care for the other living members of their families.

Principles of Hawaiian stewardship of the ʻāina

There are five basic principles of Hawaiian stewardship and use of natural and cultural resources, which are relevant to sustaining the natural resources of *Ka Pae Āina Hawaiʻi*. These principles identify the principal elements which must be protected in order to sustain the well-being of the ʻāina.

Ahupua'a management: First, the ahupua'a is the basic unit of Hawaiian cultural resource management. An ahupua'a runs from the sea to the mountains and contains a sea fishery and beach, a stretch of kula or open cultivable land, and the forest higher up. In "Na Hana A Ka Po'e Kahiko: The Works of the People of Old," Samuel Kamakau provides a vivid description of how Hawaiians recognized the various zones within an ahupua'a:

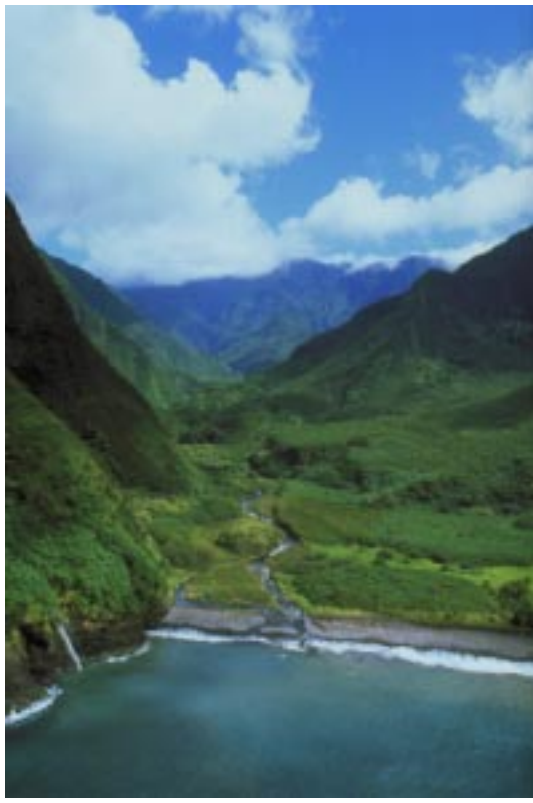
> *Here are some names for [the zones] of the mountains — the mauna or kuahiwi . . . the part directly in back and in front of the summit proper is called the kuamauna, mountaintop; below the kuamauna is the kuahea, and makai of the kuahea is the kuahiwi proper. This is where small trees begin to grow; it is the wao nahele. Makai of this region the trees are tall, and this is the wao lipo. Makai of the wao lipo is the wao 'eiwa, and makai of the wao ma'ukele. Makai of the wao ma'ukele is the wao akua, and makai of there the wao kanaka, the area that people cultivate. Makai of the wao kanaka is the 'ama'u, fern belt, and makai of the 'ama'u the 'apa'a, grasslands . . . Makai of the 'apa'a are the pahe'e [pili grass] and 'ilima growths and makai of them the kula, open country, and the 'apoho hollows near to the habitations of men. Then comes the kahakai, coast, the Kahaone, sandy beach, and the kalawa, the curve of the seashore -- right down to the 'ae kai, the water's edge. That is the way ka po'e kahiko named the land from mountain peak to sea. (Kamakau, 1976).*

Sustainable resource management needs to assess the condition of natural resources within each ahupua'a — mauka to makai and into the ocean — in order to derive a plan to sustain the resources of an entire island.

Land, air, water, ocean: Second, the natural elements — land, air, water, and ocean — are interconnected and interdependent. This excerpt of a chant by Ku-a-Paka'a in "The Wind Gourd of La'amaomao," collected, edited, and expanded by Moses K. Nakuina, reflects the Hawaiian knowledge of the dynamic interplay of the natural elements of rain and wind upon the landscape which, in turn, has an impact upon the ocean.

> *The rain falls,*
>
> *The dripping, clinging rain of Hanakahi [Hilo];*
>
> *The rain clears and it is calm,*
>
> *The sand is muddy and brown,*
>
> *The leaves fall here and there,*
>
> *Leleiwi stands alone in the sea (Nakuina, 1990)*

From the ocean rise clouds, which drench the land with rain and recharge the island's water table or flow across the landscape as streams or rivers. Streams, rivers and springs ultimately flow back to the beaches and into the ocean. Cultural land use management must take all aspects of the natural environment



An ahupua'a runs from the sea to the mountains and contains a sea fishery and beach, a stretch of kula or open cultivable land, and the forest higher up.

into account. The atmosphere where clouds form is an integral link in the cycle of life. *Hoʻailona*, or prophetic natural signs and omens, appear in the atmosphere and help guide and validate Hawaiian practices. Hawaiians consider the land and ocean to be integrally united, and that these land sections also include the shoreline, as well as inshore and offshore ocean areas such as fishponds, reefs, channels, and deep sea fishing grounds. Coastal shrines called fishing *koʻa* were constructed and maintained as markers for the offshore fishing grounds which were part of that ahupuaʻa.

The wealth of the land is based upon the amount of freshwater available upon it.

Wai or freshwater: A third important principle of Native Hawaiian stewardship is that — of all the natural elements — freshwater is the most important for life and needs to be considered in every aspect of land use and planning. The Hawaiian word for freshwater is *wai* and the Hawaiian word for wealth is *waiwai*, indicating that water is the source of well-being and wealth. The wealth of the land is based upon the amount of freshwater available upon it. At the core of developing a plan to sustain life on our Hawaiian islands must be a water-resources management plan that will allow development only of the amount of water estimated to equal the sustainable annual yield island-by-island. Any use of water beyond the annual sustainable yield should be developed from the desalination of ocean water.

Acknowledgment of ancestral knowledge: A fourth important principle is the acknowledgment that Hawaiian ancestors studied the land and the natural elements and became very familiar with its features and assets. Ancestral knowledge of the land was recorded and passed down through place names, chants and legends which name the winds, rains, and features of a particular district. Hawaiians applied their expert knowledge of the natural environment in constructing their homes, temples, cultivation complexes and irrigation networks. Hawaiian place names, chants, and legends inform Hawaiians and others who know the traditions of the cultural and natural resources of a particular district. Insights about the natural and cultural resources inform those who use the land about how to locate and construct structures and infrastructure so as to have the least negative impact upon the land. This ancestral knowledge about the land and its resources is reinforced through continued subsistence practices.

In planning for the land, ancestral knowledge about the land and its natural resources should be gathered and, where the community is willing, mapped in order to allow for sustainable use of its resources. Planning should also provide for continued subsistence activities by the community of cultural practitioners.

Mālama ʻāina and Lōkāhi: A fifth principle recognizes that an inherent aspect of Hawaiian stewardship and use of cultural and natural resources are the practices of *aloha ʻāina* and *mālama ʻāina*, or respect and conservation of the land, to ensure the sustainability of natural resources for present and future generations. These rules of behavior are tied to cultural beliefs and values regarding respect of the ʻāina, the virtue of sharing and not taking too much, and a holistic perspective of organisms and ecosystems that emphasizes balance and coexistence.

The Hawaiian outlook which shapes these customs and practices is *lōkāhi*, or maintaining spiritual, cultural and natural balance with the elemental life forces

of nature. Hawaiian families who rely upon subsistence for a primary part of their diet respect and care for their surrounding natural resources. They only use and take what is needed to allow the natural resources to reproduce. They share what is gathered with family and neighbors. Through understanding the life cycle of the various natural resources — how changes in the moon phase and the wet and dry seasons affect the abundance and distribution of the resources — the subsistence practitioners are able to plan and adjust their activities and keep the resources healthy. Such knowledge has been passed down from generation to generation through working side-by-side with *kūpuna*, or elders.

Throughout the islands of Hawai'i, subsistence livelihoods (and well-being) thrive in particular rural communities.

Throughout the islands of Hawai'i, subsistence livelihoods (and well-being) thrive in particular rural communities. Surrounding these communities are pristine and abundant natural resources in the ocean, the streams, and the forest. This is largely due to the continued practices of *aloha 'āina/kai* (cherish the land and ocean) and *mālama 'āina/kai* (care for the land and ocean). These rural communities were bypassed by mainstream economic, political, and social development. Hawaiians living in these communities continued, as their ancestors before them, to practice subsistence cultivation, gathering, fishing and hunting for survival. Thus, we find in these areas that the natural resources sustained a subsistence lifestyle — and a subsistence lifestyle, in return, sustained the natural resources.

Taken together, these principles provide an excellent foundation for the stewardship of the Hawaiian Islands as a whole.

Community mapping to mālama ʻāina

In planning for the sustainability of our islands, the identification of key cultural and natural resources can play an important role in their protection and conservation. Community mapping of the identified resources can provide an instrument to scope cultural and natural resources reserve areas. Communities that are willing to participate in such a process can also be asked to manage this information or entrust the information to an appropriate and trusted entity.

A cultural landscape can be looked at in two zones: the core area and the broader traditional cultural practices area. The core area includes land used for residences and cultivation. The broader traditional cultural practices area usually coincides with the traditional ahupua'a and *moku*, or overall region. It includes all of the zones needed to gather, hunt, and fish for subsistence, cultural, and religious purposes. In many cases, the areas utilized by ʻohana for gathering, hunting, and fishing may have extended beyond the ahupua'a where they reside into other areas of their moku. One must rely upon the ʻohana of the area who are subsistence practitioners to describe the boundaries of the traditional cultural practices area.

Cultural landscape components

A cultural landscape is composed of physical elements which manifest human use of the land through time. The components of a Hawaiian cultural landscape include: (a) areas of taro cultivation; (b) other areas of cultivation; (c) circulation

networks; (d) buildings, structures, facilities, and objects; (e) clusters; (f) internal boundaries; (g) an irrigation ditch system, including roads and tunnels; (h) archaeological and historic sites; (i) open areas; (j) small-scale elements; (k) viewing points; and (l) cultural resources and use areas.

The last component, cultural resources and use areas, include:

Wahi Pana: These are sacred sites such as heiau, shrines, burial caves and graves as well as geographic features associated with deities and significant natural, cultural, spiritual or historical phenomena or events. Edward Kanahele offered the following description of wahi pana in the introduction to "Ancient Sites of O'ahu: A Guide to Hawaiian Archaeological Places of Interest" by Van James:

> *The gods and their disciples specified places that were sacred. The inventory of sacred places in Hawai'i includes the dwelling places of the gods, the dwelling places of venerable disciples, temples, and shrines, as well as selected observation points, cliffs, mounds, mountains, weather phenomena, forests, and volcanoes.*

Streams and springs: These waters are important as habitats for native species of marine life, for taro cultivation, and for domestic uses.

Shorelines, reefs, nearshore and offshore ocean: These areas are important for gathering of foods, medicine and for conducting cultural and spiritual customs.

Forests: Forests are important for hunting pigs and other animals; for gathering plants used for medicine, foods, ceremonial adornment, ritual offerings; and for the conduct of spiritual customs.

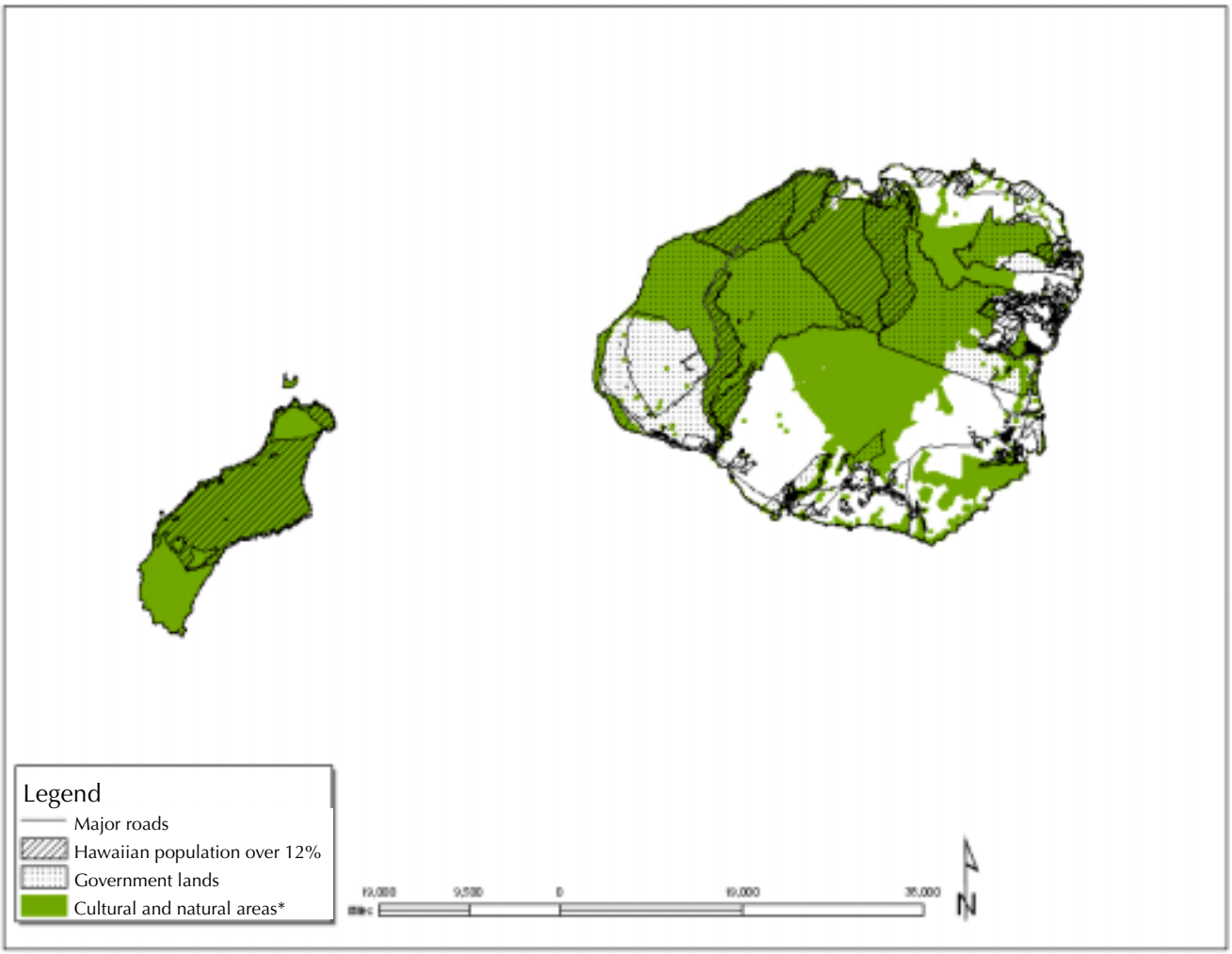
Domains of 'aumakua or ancestral deities: Particular natural and cultural areas are important as traditional domains of 'aumakua or ancestral spirits and deities, where Hawaiians renew their ties to ancestors through experiencing natural phenomena and witnessing *ho'ailona*, or natural signs.

Trails and dirt roads: Trails and dirt roads are indispensable to afford access to the cultural resources and use areas, both mauka to forests and streams and makai to streams and the ocean.

Island cultural and natural resources maps

In 1996, as part of an integrated resources planning process, the cultural and natural resources of the islands served by Hawaiian Electric Company were mapped to depict the impact of electrical generation on Native Hawaiian cultural customs and practices. Geographic information system (GIS) layers using 1990 data were designed to identify regional locations of natural and cultural resources which were important to Native Hawaiians. These maps, with the addition of similar GIS mapping for the island of Kaua'i, which is served by another utility company, are shared as an example of how cultural and natural resources can be identified and rendered through a GIS mapping methodology and how technology can be used to identify and support the precious resources

Figure 1. Cultural Map of Kauaʻi and Niʻihau



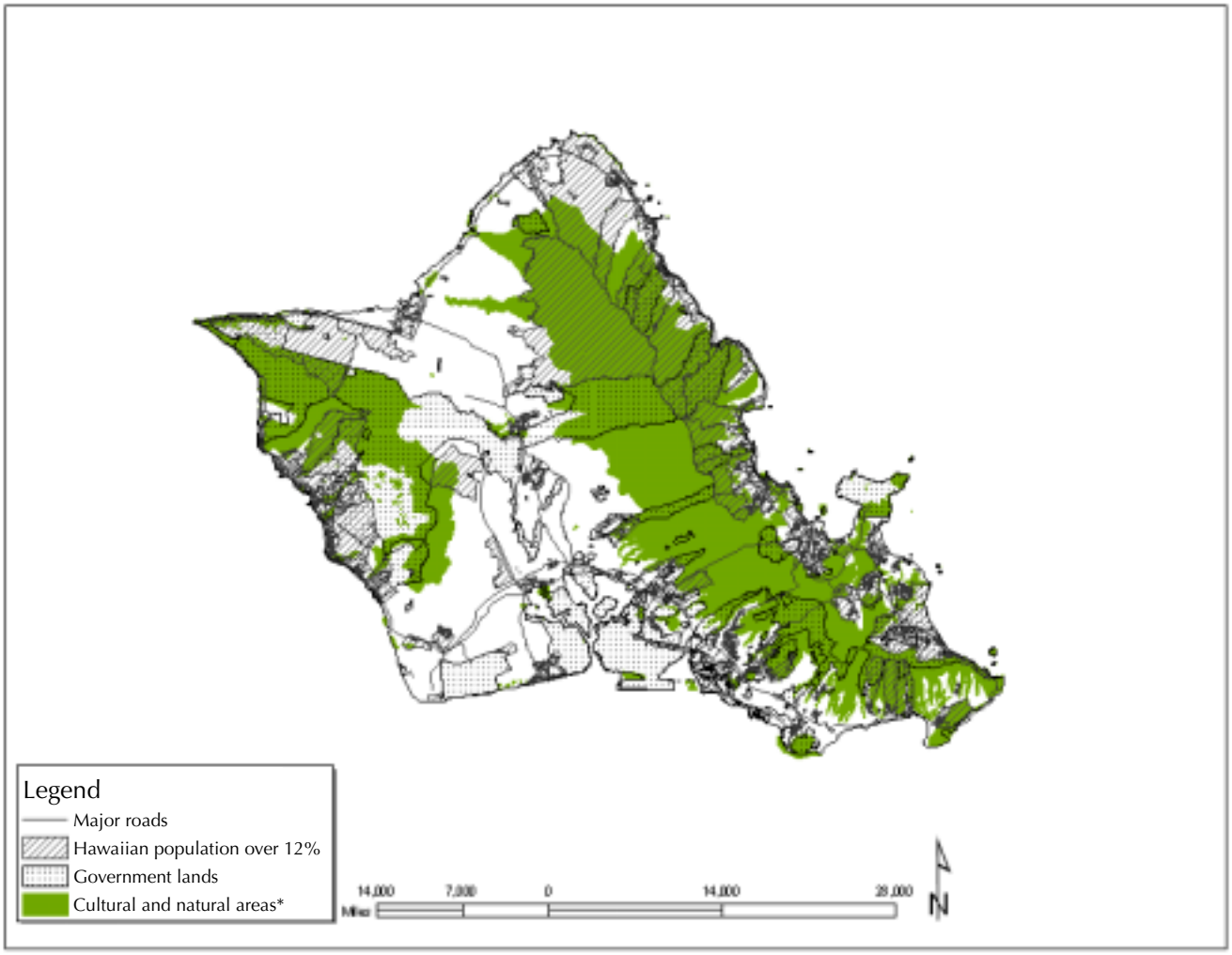
Sources: Department of Business, Economic Development and Tourism; Office of Hawaiian Affairs; The Nature Conservancy; US Census Bureau; CANDO (1990).
* Includes known historic sites, conservation zones, and areas with rare and endangered species.

on all our islands that are so important to the well-being of Native Hawaiians and to all for whom Hawaiʻi is a homeland. (Figures 1–4)

In developing the maps, an underlying assumption was that there are seven important indicators of Native Hawaiian well-being that should be rendered through the mapping process. These indicators and how they were mapped are described below.

Family and community: Are rendered in a map layer which shows the Hawaiian population ratio in each census block across each island. An underlying assumption is that population distribution will reveal aggregates of extended families and areas where Hawaiian households are concentrated and comprise communities.

Figure 2. Cultural Map of O'ahu

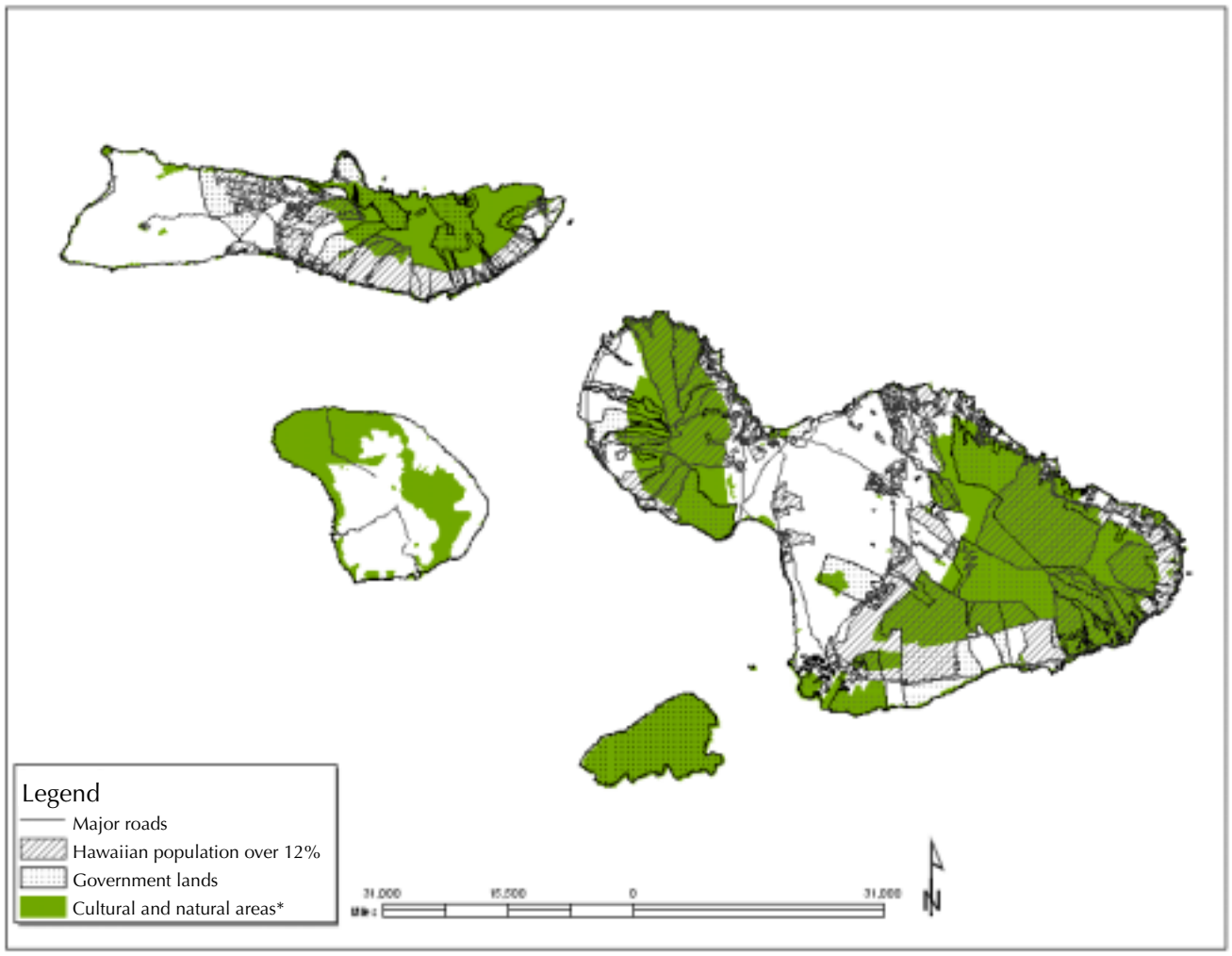


Sources: Department of Business, Economic Development and Tourism; Office of Hawaiian Affairs; The Nature Conservancy; US Census Bureau; CANDO (1990).
* Includes known historic sites, conservation zones, and areas with rare and endangered species.

Subsistence, cultural, and religious beliefs, customs, and practice in relation to natural and cultural resources: Are rendered through the map layer showing known historic sites, state conservation zones, and habitats of rare and endangered species. The underlying assumption is that subsistence, cultural and religious practices rely upon and are carried out in areas where the natural and cultural resources are abundant and of good quality.

Hawaiian lands and community economy: Are rendered in the map layer which shows government lands. The government lands are inclusive of Hawaiian Home lands, state lands and federal lands. Most of these lands were originally the Crown and Government lands of the Kingdom of Hawai'i and are today called the ceded public lands. The Native Hawaiian people consider these their national lands and seek to reestablish sovereign control over them. In addition to being sensitive to development, these areas are encumbered by

Figure 3. Cultural Map of Maui, Molokaʻi, Lanaʻi, and Kahoʻolawe

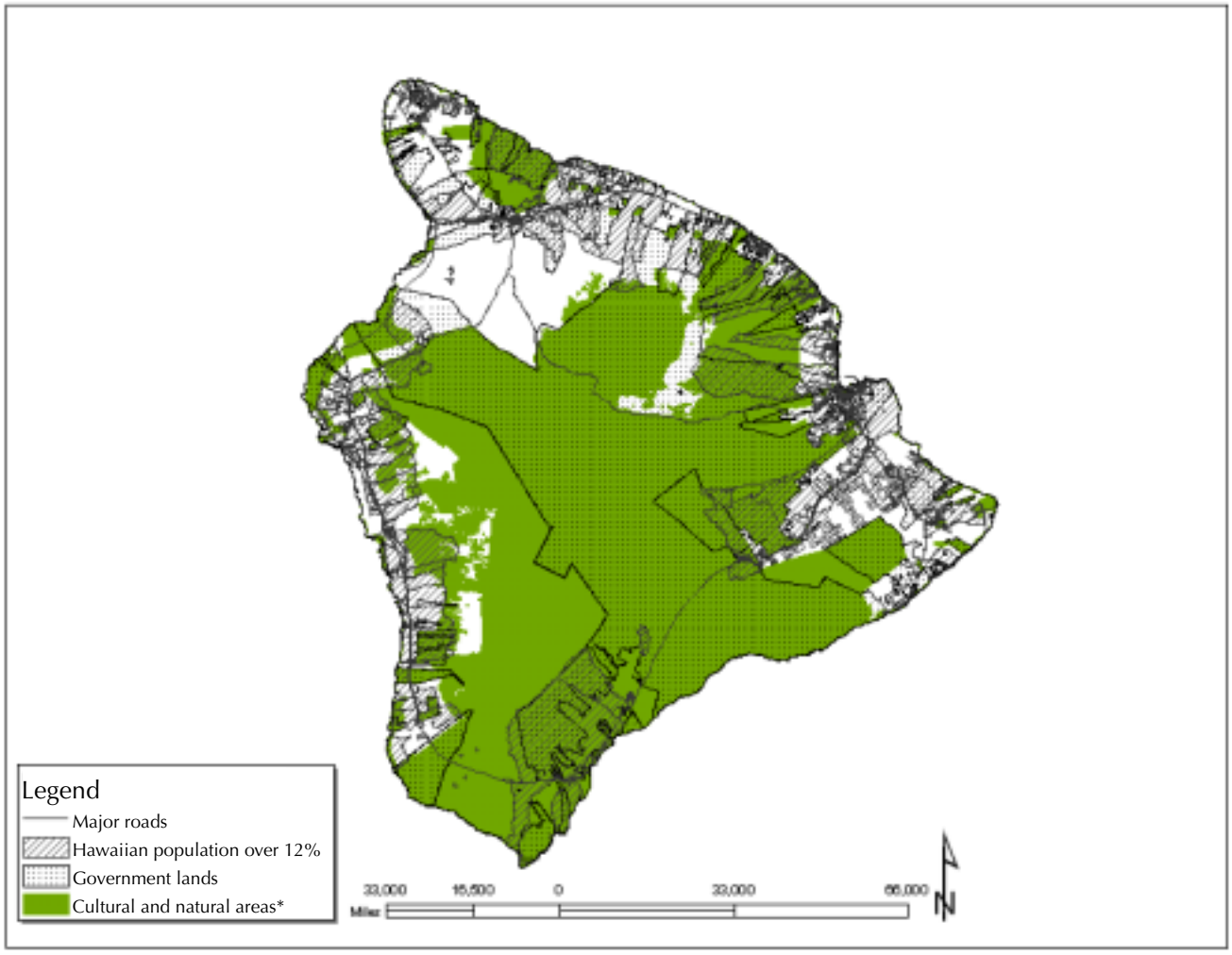


Sources: Department of Business, Economic Development and Tourism; Office of Hawaiian Affairs; The Nature Conservancy; US Census Bureau; CANDO (1990).
* Includes known historic sites, conservation zones, and areas with rare and endangered species.

Table 1. Indicators and Map Elements of Native Hawaiian Well-being

Well-being indicators	Map element indicators
Family and community	Hawaiian population ratio
Subsistence, cultural and religious customs and practices	Known historic sites State conservation zones Habitats of rare and endangered species
Hawaiian lands	Government lands
Human well-being and spirituality	Cultural/natural area layers
Hawaiian rights	Simplified overlay of all layers

Figure 4. Cultural Map of Hawai'i



Sources: Department of Business, Economic Development and Tourism; Office of Hawaiian Affairs; The Nature Conservancy; US Census Bureau; CANDO (1990).
* Includes known historic sites, conservation zones, and areas with rare and endangered species.

Hawaiian claims and have implications for management, lease, arrangements, permits, and revenues. These areas have multiple layers of management jurisdiction which make the process for attaining use permits more complicated and involved.

Human well-being and spirituality: Are not explicitly rendered in a specific map layer. Rather, they are depicted in the overlay map of all the layers. An underlying assumption is that mental, physical, and spiritual health is related to cultural integrity and dependent upon pristine environments. Well-being is grounded in the extent to which communities are able to carry out ways of life related to the ʻāina and maintain a strong environmental kinship.

Hawaiian rights: Are not explicitly rendered in a specific map layer. An underlying assumption is that Hawaiian rights are carried out in areas where the

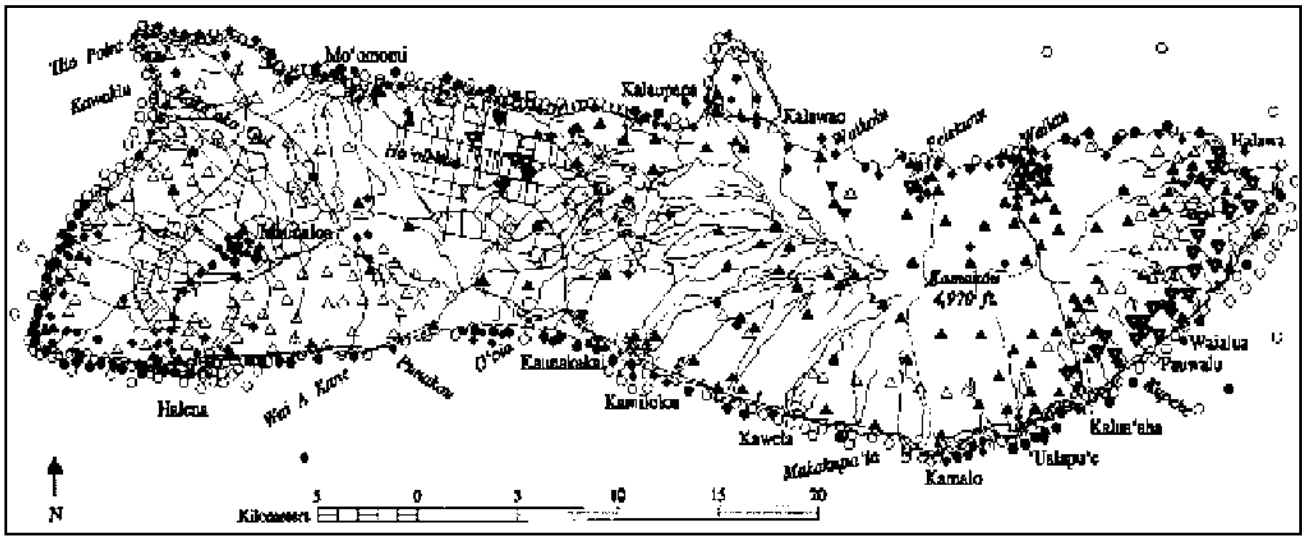
cultural and natural resources are available and where Hawaiian lands are situated. Implicitly, therefore, Hawaiian rights are reflected in the overlay maps indicating the location of cultural and natural resources, and the Hawaiian lands now under the state and federal governments.

Community mapping: An example

Another in-depth example of community mapping is the map of subsistence activities on Molokaʻi (Matsuoka, et al, 1994). (Figure 5)

As part of the Governor's Molokaʻi Subsistence Task Force study, cultural practitioners on Molokaʻi were asked to mark sites where they engage in subsistence fishing, gathering, hunting, and farming using paste-on dots on a U.S.Geological Survey topographical map. This level of community mapping of resources demonstrates that the community can use these maps to assess the potential impacts of proposed projects. It is interesting to note, for example, that this map reveals significant cultural resources and activities in Kaluakoʻi West Molokaʻi that is not apparent in the GIS map of the cultural and natural resources.

Figure 5. Community Map of Molokaʻi's Subsistence Activities



Subsistence Sites

- Fishing
- Gardening
- Hunting
- Future sites to access and/or protect
- Ocean gathering
- Raising animals
- Forests and stream gathering
- Streams
- Roads and trails

Source: Molokaʻi Subsistence Task Force Report (1994).

Toward 2050: Mālama and aloha ʻāina

All of the people who live on the islands today enjoy the rich cultural and natural resources which make Hawaiʻi a special place to live, a sensibility born from the persistence of Hawaiian ʻohana values and practices. As we move through the 21st century, it will become increasingly important for everyone to recognize and appreciate the value of and begin to adopt Hawaiian principles of stewardship of the ʻāina through public policies, community plans, and collective and individual actions. It is the responsibility of everyone who enjoys living in Hawaiʻi to protect the precious resources of the islands, especially in the face of competing interests and rapid changes locally, nationally, and globally.

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We sustain ourselves when we sustain who we are.

Quality of Life

By Susan Chandler, Noreen Mokuau and Sylvia Yuen

Three days before President Eisenhower signed the Admission Act in 1959, Herbert K.H. Lee stood before a festive crowd gathered outside Iolani Palace to celebrate Hawai'i's pending statehood. Lee, president of the Territorial Senate, proudly described a resolution he drafted proclaiming the islands "The Aloha State," a designation he credited to the Reverand Abraham K. Akaka, minister of the nearby Kawaihao Church. "Hawai'i's opportunity is to transmit the message of aloha across the world," Lee declared. "It is most fitting that our new state be called 'The Aloha State.' People for hundreds of years will thank us."

Maintaining and improving conditions so people can lead healthy, meaningful, and high-quality lives is a function of a sustainable community.

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Lee was speaking decades before sustainability was even a formal idea. Maintaining and improving conditions so people can lead healthy, meaningful, and high-quality lives is a function of a sustainable community. A successful community, however, is more than the sum of its measurable economic indicators. It is also a repository and perpetuator of cherished values, of deeply shared beliefs that shape the way individuals interact with each other and the greater world, and help define a people's sense of decency, purpose and self — the type of worldview that in Hawai'i is uniquely and concisely expressed in *aloha.*

Paul "Doc" Berry (1993), a former Punahou teacher and early sustainability proponent, identified many central values which capture the inner landscapes of our people, the fear, hopelessness, joy and general confidence we feel in our lives. Whether *aloha* endures for hundreds of years more is unknowable, but it has withstood the dramatic changes seen in the decades since statehood, and trivialization by marketers who recognized the commercial worth of the word. It should be considered not only a prism through which other quality of life issues are viewed, but also as an essential component of a quality life itself. We sustain ourselves when we sustain who we are.

The spirit of sustainability

If sustainability is a goal, then Hawai'i residents would be well-served with *aloha* as a central value, and its complementary aspects. *Aloha* is fundamental to the Native Hawaiian host culture and connotes a positive regard in all relationships. It places importance on several principles, including the centrality of spirituality; the honoring of people, places and things; and the acknowledgment that we must be responsible stewards for the benefit of future generations.

In practice, the resulting sensibility is frequently associated with the ease Hawai'i's diverse cultures show living with each other. The Hawai'i State Data Book breaks down the population into an international roster of 28 separate racial and ethnic categories. The islands have a higher percentage of Native Hawaiians and other Pacific Islanders (22.1 percent), Asians (57.5 percent) and persons identified as Mixed Race (20.1 percent) than any other state in the nation. Yet — unlike cities such as Los Angeles, where races have settled into separate enclaves — Hawai'i's people live seamlessly with one another, each for the most part respecting the equality of the other's culture.

The blending is fostered by values commonly shared among cultures that, much like *aloha*, give emphasis to the centrality and importance of family, the interdependence of people within their communities, the need for ecology, and a belief in a higher spiritual power.

Values of the Native Hawaiian host culture

- The centrality of spirituality
- The honoring of people, places and things
- Sustaining Hawai'i for future generations

In traditional Japanese culture, for instance, *ikigai* (well-being) places an individual's purpose in the context of commitment to a group: A healthy person is connected to, and interdependent with, family members, coworkers and others, and is responsible for protecting and promoting the collective welfare. Among Filipinos, *pakikipagkapwa-tao* (concern for the dignity and welfare of others) is at the heart of many cultural traditions. In particular, it is expressed through the honor and respect bestowed on parents and older relatives, the care provided children, and the sacrifices willingly made for the family. Many Native Hawaiians view *'ohana* (family) as a commitment reaching beyond an immediate and extended family, into the wider community and environment. Reciprocity and interdependence are evident in the practice of *hanai* (informal adoption) and *'ohua* (foster parenting), under which a network of people, kin and non-kin, care for vulnerable members of society, especially young children.

Social scientists have coined their own phrase for such an outlook: the ecological perspective. It sees continuously interacting systems that move outward in widening circles from the home, to school and work, into neighborhoods and communities, and finally to the all-encompassing sociopolitical and economic frameworks. It is a rose by another name, though, and the message is the same: We are all linked, and must understand the worthiness of choosing to act in ways that benefit the greater good.

We are all linked, and must understand the worthiness of choosing to act in ways that benefit the greater good.

Three issues

Of course, it is not as simple as that, and Hawai'i is witnessing problematic trends like every other community as it looks toward 2050. The challenges are many, but three that could severely affect Hawai'i's quality of life are highlighted: wealth distribution, health and education.

Wealth distribution: One need look no further than the current immigration debate to understand that the image of America as a land of opportunity, where honest work yields success, is still a potent draw. But the image is being tested by the reality of a growing inequality in the nation between those at the top and bottom of the economic ladder. In short, the rich are getting richer, and the poor are lagging behind.

Income and wealth are more inequitably distributed in the U.S. now than at any other time in the past half-century. Congressional Budget Office data indicate the mean after-tax income of the top one percent of the population grew by 129 percent between 1979 and 2003, while that of the poorest fifth of Americans went up by just four percent. Executive suites are prospering: In 1965, the average CEO earned 24 times more than the average worker. In 2003, the CEO was earning 185 times as much.

Hawai'i has not been immune from the growing disparity. The top 20 percentile group in terms of income holds 60 percent of the state's income, and household median income charts from the 1990 and 2000 U.S. Census show the rich-poor gap is widening. Even though Hawai'i has had extremely low unemployment rates the last several years — in fact, the lowest in the nation since 2004 — take-

"Imagine… three overlapping circles: one representing environmental needs; one representing economics needs; one representing community social needs. The area where the circles overlap is the area of sustainability; the areas of livability – the areas where all the threads of the quality of life come together… We must recognize these three circles are not separate, unrelated entities."

Former Oregon Governor
John Kitzhaber (2002)

home pay hasn't been enough to keep up with the price of paradise. Of the 25 most common jobs in Hawaii — which employ 40% of the state's workforce — only two jobs pay enough to minimally support a family with one breadwinner and two children.

One manifestation is the growing number of people unable to find affordable housing, as the cost of buying or renting homes and condominiums throughout the state has soared, and more upscale houses and retail developments are built. The number of homeless people rose by an estimated 39 percent from 1999 to 2003. For many, it was not for lack of trying: Over one-quarter of Hawai'i's homeless adults receiving emergency and transitional shelter services reported being employed either full- or part-time. But the prices were stacked against them.

Generally, increased inequality of wealth results in a larger underclass that tends to be poorly educated, less able to be self-sufficient and likely to stress a community and its resources. A widening gulf between the rich, poor and middle-class can threaten the stability and well-being of society, and breed pessimism about the future.

Health and health care: Health is more than the absence of disease. Rather, it reflects the cumulative status of a person's physical, mental, social, environment and spiritual well-being. In many important measures, Hawai'i stands favorably compared to the rest of the nation. People essentially live longer here than anywhere else in the country. Fewer die from the two leading causes of death, heart disease and cancer. Hypertension and behavioral risk factors, like drug use and obesity, are climbing. But improving trends continue to be seen in life expectancy, death from disease, and smoking. (Table 1.)

Table 1. Health Trends in Hawai'i

Positive Trends	Negative Trends
Life Expectancy	Hypertension
Coronary Heart Disease	High Cholesterol
Lung Cancer Mortality	Diabetes
AIDS Incidence	Adult Drug Use Ages 26+
Adult Cigarette Smoking	Youth Drug Use
Youth Cigarette Smoking	Obesity

Source: *Health Trends in Hawai'i* 2006 (7th ed.). (2006). Honolulu, HI: HMSA Foundation

Ironically, the positives foreshadow the potential problems. From 1980 to 2000, Hawai'i's population grew by 26 percent. But the relative number of people aged 60 or more jumped by 82 percent, while the percentage increase of those 85 or older skyrocketed by 216 percent. The population is aging, with the attendant disabilities, chronic conditions and demands on healthcare resources. Hospitals, care homes and other facilities, as well as social service providers, will be called upon to deliver more intensive and frequent care. However, new medicines and technological advances mean seniors will remain healthier and independent longer, providing a tremendous resource to the community.

Other issues bear watching. Consistent differences among ethnic minorities in disease, birth and death rates, and risk factors suggest disparities in health status and care. The neighbor islands tend to have a higher proportion of older adults, but are underserved by mental, dental and primary-care health professionals.

Kaua'i, Maui, Moloka'i and Hawai'i islands, and the O'ahu communities of Kalihi-Palama, Waikiki and Waimanalo, are federally designated Medically Under-Served Population sites, characterized by a shortage of services and a population blocked from getting them due to cultural and linguistic barriers, or a lack of money or health insurance. The lack of services for those most in need results in a cycle of negative consequences, as poor health compromises the pursuit of happiness, limits employment opportunities, and interferes with education

Education: Education brings many rewards associated with an improved quality of life: greater financial security and upward mobility, good physical and mental health, positive social relationships and overall life satisfaction. The past decade has seen some positive trends in Hawai'i. Over four-fifths of those aged 25 or more has completed high school, with 26 percent going on to finish at least four years of college. The robust completion rates partly may arise from a public higher education system that charges relatively low tuition, combined with one of the highest percentages of students with the financial means to attend private schools (15 percent). Asians had among the highest college enrollment and completion rates, reflecting national patterns.

Hawai'i's children need to have a solid educational foundation to give them footing in a rapidly evolving world that is increasingly technology-based and globally competitive.

These highlights are offset by continuing difficulties in upgrading quality. In 2004, only 38 percent of public school students met state proficiency standards in reading; the figure was even more troubling —18 percent — for math scores. Students with special needs and limited English skills tend to score lower on tests, and some children enter school already behind. The assessments of teachers is that the vast majority of incoming public kindergartners are "not ready to learn." On the neighbor islands, distance-learning technology has been useful, but administrators still confront aging school facilities, an uneven distribution of resources to rural areas, and problems recruiting and retaining teachers. And at the university's Manoa campus, Native Hawaiian students have among the lowest graduation rates.

Hawai'i's children need to have a solid educational foundation to give them footing in a rapidly evolving world that is increasingly technology-based and globally competitive. Education also can be directed toward meeting existing and anticipated workforce demands. The State Department of Industrial and Labor Relations reported a strong and growing need for nurses, teachers and educational administrators and, in particular, home healthcare providers. While education is not synonymous with job training, it can be focused to help alleviate immediate needs while providing the skills and mental agility to meet future ones.

Toward 2050

Hawai'i has much in its favor as it debates sustainability. It strongly values family and has the nation's highest percentage of multigenerational households. Hawai'i is known for its respect for and appreciation of diverse cultures. It is generous, with nine out of 10 donating to charity. And while many struggle economically, most are optimistic that life will get better. This reflects a capacity to adapt to many challenges in the face of risks and adversities. Overall, it is a picture of a people bonded in mutual care, respect and hope, augmented by the strong sense of identification that comes from living in an island state—a resilient people capable of meeting the challenges of the future.

The quality of life in the years ahead will depend on the choices made today.

The quality of life in the years ahead will depend on the choices made today. We can choose to be a state where jobs, productivity, wages and educational achievement continue to grow, and disparities are reduced. We can choose to cut pollution, waste, poverty, and discrimination. We can choose to protect the ocean and island ecosystem. Or we can choose not to. That sustainability is being discussed at all is a very promising sign. And we also might be encouraged by the fact that Hawai'i already has made one clearly correct choice: The main contenders in 1959 to "The Aloha State" were "Hawai'i, the Sugar State" and "The Pineapple State," representing industries that have since left the islands for cheaper labor overseas. Aloha, meanwhile, remains and guides. Whether it does until 2050 — or for hundreds of years more — is up to us.

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Our standard of living depends not just on the built environment, but also on natural capital.

Economy

By Byron Gangnes, Kimberly Burnett, Sang-Hyop Lee and James Roumasset

In the mid-1960s, Indonesia's economy was in shambles, people were starving and the political climate was volatile. A new administration instituted changes that encouraged foreign investment and exports. By one traditional measure, they appeared to work splendidly. During the 1970s and early 1980s, Indonesia's gross domestic product (GDP) per person grew 6 percent annually. But the robust growth came at a cost, perhaps not as readily noted, in the form of a significant depletion of the country's vast natural resources. This cost — estimated at 4.5 percent of GDP — was not taken into account in the conventional growth measure.

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Natural capital refers to natural resources (like water, land, minerals and fish) and the ecosystems that maintain a stable climate, and clean water and air.

The Indonesian model has been labeled a "cake-eating" economy since having the resources was secondary to eating them to finance material gain — an obviously unsustainable development path. To this day, deforestation for timber, mining and agriculture continues to make Indonesia an environmental red zone. It is also illustrative of developing principles of economic thought relevant for Hawai'i as it considers sustainability, principles that look not just at our dollar earnings today, but also how current economic decisions affect the future. This type of thinking recognizes that the value of green is greater than simply being the color of our currency. We discuss these issues first, before examining economic challenges specific to Hawai'i.

It's the "environomy"

Our standard of living depends not just on the built environment, but also on natural capital. Natural capital refers to natural resources (like water, land, minerals and fish) and the ecosystems that maintain a stable climate, and clean water and air. There is no understating its importance: Natural capital is essential to sustain all forms of life and — unlike produced capital, such as buildings and machines — a significant portion is irreplaceable once it has been used. It is the coin of sustainability, and for sustainable development to occur, the efficient and equitable use of natural capital is required.

There has been an evolution in thinking about how best to use this coinage sustainably.

One criteria for sustainable resource use is known today as *strong sustainability*. Its prevailing rule is resources should not be used faster than they can be renewed naturally — for example, we should not harvest more trees than will grow back, and we should not catch more fish than are born and survive each year. It has an instinctive appeal, but carries the problematic suggestion that nonrenewable resources such as oil should never be used. A looser interpreta-

tion, requiring the total value of natural resources to remain the same, has been rejected as unreasonable since it might doom some societies to perpetual poverty. If developed countries had not been able to exploit their natural capital in the early stages of development, they would not have been able to become the thriving economies they are today.

A group of distinguished Stanford University economists and ecologists has shown recently that sustaining human welfare requires "genuine savings" not to be negative (Arrow et al., 2004). Genuine savings is an indicator developed by the World Bank that measures the true rate of savings in an economy, taking into account investments in human capital, depletion of natural resources, and damage from pollution. The requirement that genuine savings not fall below zero is known as *weak sustainability*.

Both strong and weak sustainability are of limited value, though, because they only prescribe what *not* to do. Subsequent research addressing this shortcoming has led to the establishment of the three principles of *positive sustainability*: interdependency, dynamic efficiency and intergenerational equity (Roumasset and Endress, 2006). In brief:

- Interdependency requires consideration of the "environomy," a hybrid term that places the economy inside the environment, allowing the performance of the entire system to be analyzed. Taking this approach forces us to realize that population pressure, poverty and environmental degradation are a linked whole, and attempts to pursue development through just one, or even two, of the components could produce unintended consequences.

- Dynamic efficiency requires that a resource be used in a way that brings the maximum benefit over time. For instance, not using oil today is beneficial because it will be available for use tomorrow. However, never using oil will provide no benefit at all, so the question becomes one of determining the amount that should be pumped each year to get the most benefit from the entire stock.

- Intergenerational equity mandates that one generation not be given preference over another. We should not deplete resources and irreversibly harm the environment if that prevents future generations from being at least as well off as we. At the same time, we should not make inordinate sacrifices that impoverish us relative to rich future generations.

By exercising the principles of sustainability, we take into account the welfare of today's residents as well as our children and grandchildren.

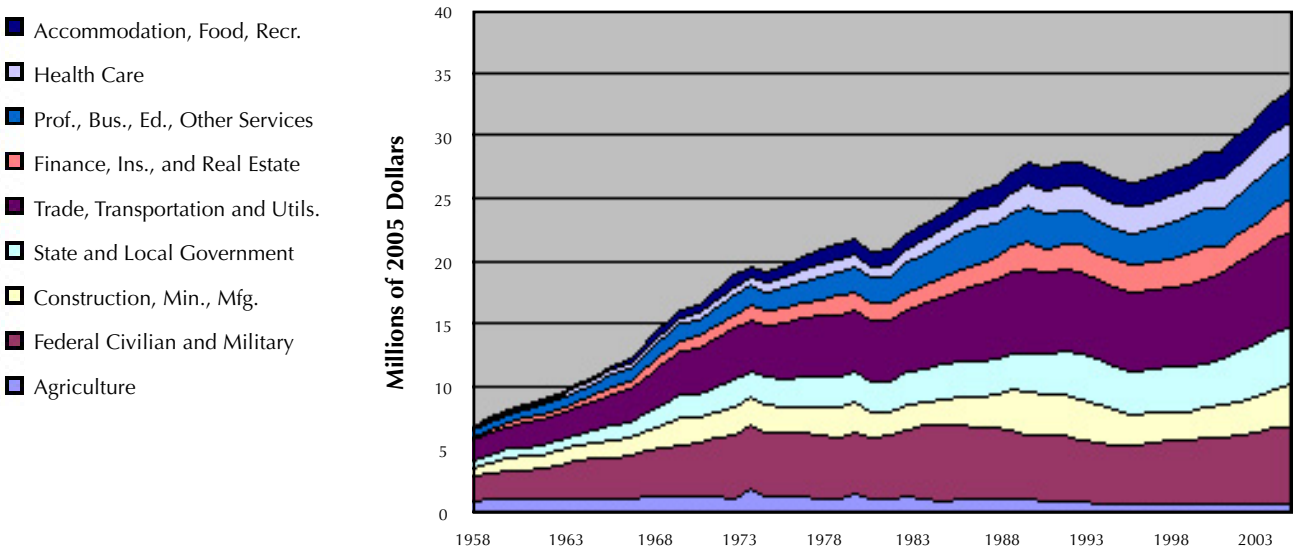
As we look at Hawai'i's economic past and specific economic issues, it might be useful to apply these principles in a broad context, such as energy alternatives. Sustainability does not imply a rush to photovoltaics and other renewable resources; throwing billions of dollars into renewable resources through subsidies and similar policies may violate dynamic efficiency. By the same reasoning, moratoriums on growth generally are ill-advised. A primary goal is to not waste scarce resources, including monetary resources, which might be needed for more urgent environmental problems. At the same time, interdependency requires that energy policies cannot be considered separately from questions of economic performance and culture, such as the impact on tourism or needy residents. And by exercising the principles of sustainability, we take into account the welfare of today's residents as well as our children and grandchildren.

Hawai‘i’s evolving economy

Longtime residents on all islands can recall when a drive outside of town often included miles of passing through a corridor of tall, green sugar cane. Now they are just as likely to be speeding past a big-box mall or subdivision. That snapshot reflects the considerable changes Hawai‘i’s economic structure has gone through in the past 50 years, evidenced by the shifts in primary sources of income earned by island residents (Figure 1)

In the late 1950s, federal military and civilian spending comprised the single largest chunk of the Hawai‘i economy, over one-quarter of all payroll income. Income from agricultural workers represented more than 12 percent, with the industry playing a major support role in the trade, transportation and utilities sectors. By contrast, tourism was in its infancy and represented just over 2 percent of all income.

Figure 1. Hawai‘i Real Income by Industry (1958–2005)



Source: U.S. Bureau of Economic Analysis, deflated by UHERO using the Honolulu Consumer Price Index.

Statehood, jet travel and mass-marketing — combined with cheaper farm costs overseas — switched that around. Income from workers today in tourism accommodations, food services and other allied areas accounts for 10 percent of all earned income. Add to that paychecks in areas indirectly connected to tourism, and the sector represents nearly 20 percent of all economic activity and more than a quarter of state tax revenue. Agricultural income, in the meantime, has dwindled to less than two percent.

With the trappings of tourism so constantly apparent, from the King Kamehameha landmark signs to the tour buses maneuvering through the streets, some may be surprised the industry accounts for just a fifth of the Hawai‘i economy. This partly reflects the large role federal, state and local governments continue to play here, combining to provide a third of all payroll income. But it also highlights an underappreciated reality: A large part of the local economy

serves the needs of residents, through home construction, retail trade, finance and other areas. From an economic standpoint, tourism is not the only game in town.

Construction remains an area of rapid income growth, with notable gains in recent years also in fields such as nursing, management and administrative services. This parallels to some extent an evolution in the overall U.S. economy, with Americans spending a much larger share of income for services, particularly for healthcare, but also for restaurant meals and the like. This has begun to add better-paying jobs outside of tourism, in a naturally occurring, if gradual, economic diversification.

One area that has received special public attention is the high-tech industry, which nonetheless remains a very small part of the Hawai'i economy. According to state figures, there were fewer than 14,000 technology-sector jobs in 2005, or about 2.2 percent of the workforce, a figure that has not budged since 2001 (DBEDT, 2005). While the jobs pay an average 65 percent higher wages than typical private-sector employment, a significant number are in communications and computer services, areas which may not be as desirable for future growth as research-and-development. Other measures also raise concern about Hawai'i's high-tech progress. For example, Hawai'i ranks 48th among the fifty states and the District of Columbia in the number of patents awarded per resident. The industry clearly has a long way to go before becoming a significant factor in the local economy.

From an economic standpoint, tourism is not the only game in town.

Hawai'i's poor performance

Luxury condominiums, four-star restaurants and high-end fashion boutiques all have become regular components of Hawai'i, but their emergence does not correspond with a windfall in income for the average worker. Economic measures show the state's economy has lagged behind the continental U.S. for the past several decades. Since 1970, inflation-adjusted income for residents has grown a cumulative 44 percent, while workers countrywide have seen their paychecks rise by 68 percent. In more than half the major industries, wages in Hawai'i now are lower than those nationally, even before we account for the higher cost of living here, a situation that exacerbates problems like housing affordability.

The economic underperformance can only partly be attributed to Hawai'i's acknowledged vulnerability to events outside our borders. For instance, weak tourism and the bursting of the Japanese real-estate bubble precipitated the stagnant 1990s, during which income for residents actually dropped for much of the period. This was a confined episode, though, and does not explain why the state has fallen behind the nation in every decade since 1970, with the exception of the current period. Some of the poor performance can be attributed to the industrial structure of the Hawai'i economy, which historically has specialized in lower-paying sectors such as agriculture, transportation and trade. But even in emerging job areas like professional and technical services, which have shown encouraging signs of development here, real-wage growth has been weaker than in the rest of the U.S., preventing these areas from achieving their full promise.

Hawai'i's poor income growth is fundamentally linked to the sub-par job skills of its residents. Just as satisfactory economic growth depends on maintaining produced and natural capital, so too must there be a nurturing of human capital — the knowledge, experience and skills workers bring to their employment. Inadequate educational achievement may well be the biggest impediment to advancing human capital in the islands.

An example can be found in a 2006 report by the Hawai'i Jobs Initiative, a collaboration of state, business and labor organizations focusing on the construction industry. It says a large percentage of applicants for apprenticeship programs were rejected because they could not pass an entry test, with particular difficulties seen in basic math skills (Hawai'i Jobs Initiative, 2006). Of those who make the grade, more than half leave after a few weeks or months, mostly because they find they are not suited for the work.

The low acceptance and high dropout rates implicate gaps between the educational system and workforce demands, further displayed by the difficulties in finding enough qualified residents to fill vacant positions in other fields, like nursing and teaching. Attracting skilled immigrants can help, but many are discouraged by the high cost of living in Hawai'i and the poor reputation of its public-education system. As the population ages, the skilled-worker shortage will be felt even more sharply.

Hawai'i's Educational Attainment Ranks High…

Percentage of residents completing	National ranking
High school or more	18
Bachelor's degree or more	13

…But Student Achievement is Low

Average scores of eigth-grade public school students	National ranking
Math	48
Science	43
Reading	51

Source: US Census Bureau, 2000 Census; 2005 National Assessment of Educational Progress (8th Grade)

Three issues

As Hawai'i residents look toward a sustainable future, their list of hopes is much the same as it is now: better job opportunities, improved education, more affordable housing, adequate healthcare facilities. They would like to see greater economic diversity and self-sufficiency, and worry about the impact of growth on the quality of their lives. These feelings exist against a shifting backdrop. The tourism industry has matured and no longer will be a major growth center for Hawai'i. Less-skilled workers likely will fall further behind those equipped for an increasingly knowledge-based economy. And population growth will place new demands on natural capital and the environment.

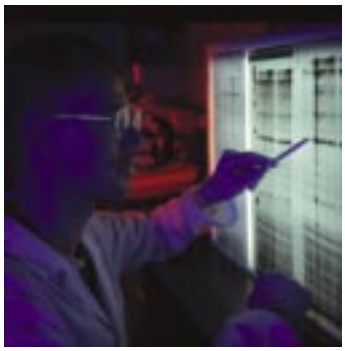
How can policymakers best support a healthy environomy for Hawai'i's future, one that promotes a stronger economic base while ensuring optimal use of natural capital? We address three issues.

Increasing economic opportunity: To attract better-paying jobs to the state, it is tempting to try to buy them. That essentially is what Hawai'i has done with its generous tax credits for high-tech investment. But there is no clear evidence the credits were effective in increasing high-tech jobs here, echoing ample evidence from other states that showed targeted tax incentives are of limited use in promoting growth — assuming, of course, that government officials had chosen one of the winning industries to begin with (See Tax Review Commission, 2006).

Economists generally agree it is more important to establish sound economic fundamentals, such as moderate and predictable taxes, efficient regulation, and a high-quality workforce. Hawai'i's general excise tax, for example, is considered relatively efficient since it covers a broad range of goods and services at a fairly low rate, spreading the burden evenly so individual employment and spending decisions are not distorted.

The overriding need, though, is for better results from Hawai'i's educational and job-training systems in meeting current and future workforce demands. Quality education is crucial for workers to build a satisfactory lifestyle, and for the state to attract its share of the best and the brightest. Higher education is important in advancing research and creating a new generation of teachers, among other purposes. Community colleges and vocational programs also play a key role by training students in technical skills. To address this issue, we need a public commitment underwriting a program to align the goals of these institutions with anticipated future job requirements.

Improving access to material needs: Even with our best efforts, the evolution of Hawai'i's economy will be slow, and its natural attractions virtually ensure tourism will continue to be a leading economic driver. Limited capacity for wage growth in such sectors means a considerable number of families will have only modest incomes at their disposal. Economic and social policy must continue to work on meeting basic needs through, for example, the employer-based health system which, although gaps remain, is providing better care than is available in many other states.



Higher education is important in advancing research and creating a new generation of teachers, among other purposes.

Housing affordability problems will not go away for reasons most residents are familiar with: Hawai'i is a desirable place to live, land is limited, and construction costs are high (Figure 2). Government can help by streamlining as much as possible the approval and permitting process, subject to environmental goals. Rent or price caps should be avoided since they are likely to lead to housing shortages, and public management of low-income housing often is inefficient. Instead, housing vouchers could help reduce costs for poorer residents. In the end, though, the single best way to reduce affordability problems is to build a workforce with the human capital necessary to command higher incomes.

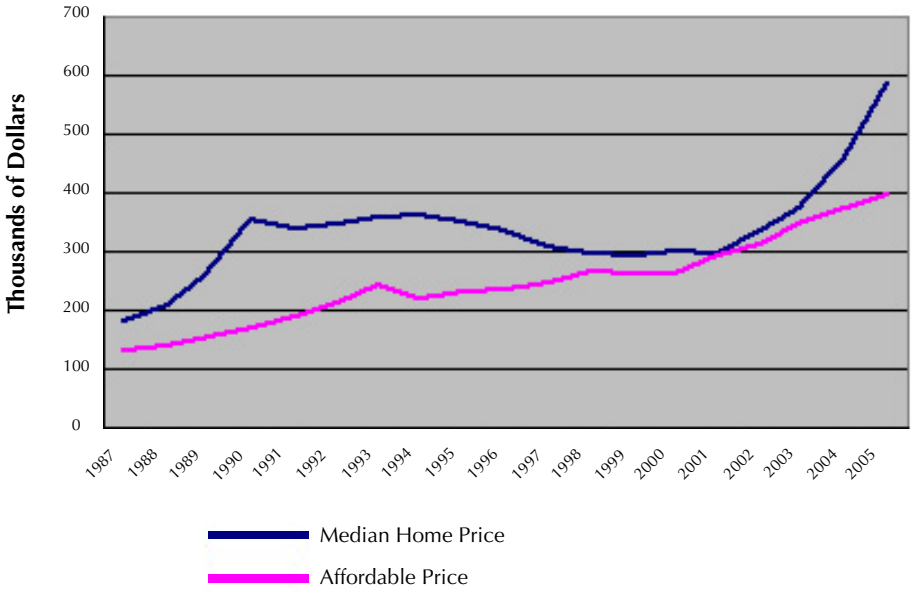
Vulnerability and self-sufficiency: Hawai'i has one of the nation's most open economies, which makes us hypersensitive to events elsewhere in the world. Economic diversification will reduce this vulnerability, but only very gradually. A quicker sort of diversification could take place within the tourism industry, which likely will expand promotion beyond the U.S. and Japan, as China and other emerging Asian countries begin to send more visitors to Hawai'i.

Many advocates of environmental sustainability argue for increased self-sufficiency, as a check against food and energy insecurity during natural disasters, or because they sense trade prices do not adequately reflect true costs to the environment. But because of Hawai'i's natural endowments, our state likely enjoys a comparative advantage in its current trade structure, in which we sell the coveted Hawai'i tourism experience in exchange for goods and services that are cheaper to produce elsewhere. A sudden retreat from the global economy would almost certainly reduce our standard of living.

Toward 2050

The thorniest issues in planning for sustainability will arise when resource needs collide. Solving the affordable-housing dilemma may require cutting into our shrinking inventory of open lands. Requiring use of renewable energy may lead to higher bills than with fossil fuels. It is all part of the balancing act that takes place within the environomy, as human wants and needs share the arena with

Figure 2. Honolulu Home Prices Compared to the "Affordable" Price



Source: Prudential Locations, Inc.
Note: The affordable price, calculated by UHERO, is a counterfactual maximum price for a median income household, given interest rates and conventional mortgage terms.

Sustainability is a young concept, and to do this well, we need to measure the actual economic worth of the environment, and the costs and depreciation arising from depleting resource stocks.

principles and values, within the context of our limited and diminishing natural capital.

Sustainability is a young concept, and to do this well, we need to measure the actual economic worth of the environment, and the costs and depreciation arising from depleting resource stocks. Economists have developed advanced techniques for valuing natural-resource assets and services that can be used in cost-benefit analyses for individual projects. One such effort underway in Hawai'i is attempting to assess the market value of tropical forests that reduce watershed runoff in the Ko'olau Mountain Conservation District and aid in recharging the Pearl Harbor aquifer. Along these lines, and to get a more complete picture of "environomic" performance, we believe Gross State Product accounts should be expanded to include the value and depreciation of natural capital, as well as the costs of air and water pollution.

In discussions of sustainability, there sometimes is excessive focus on tradeoffs, as various elements seem to be in competition. There is a suggestion that something must get short-ended, or that everything must be compromised a bit. But solutions sometimes can be found that benefit both the environment and material gain, in a win-win scenario aimed into the future. It certainly is an ideal to be sought. Perhaps the important message is to stay open to possibilities, now that the decision to embark on the sustainability path has been made.

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In discussions of sustainability, there sometimes is excessive focus on tradeoffs, as various elements seem to be in competition.

Population size and structure impact on schools, the job market, medical services and other components of society.

Population

By Yean-Ju Lee

Thoughts and feelings about population growth in Hawai'i are for most people a matter of experience rather than statistics. Homes seem less private as new ones suddenly spring-up next door. Gridlock appears inevitable as the morning commute stretches on and on. Lines at supermarket check-out counters backup into the aisles. And, that relaxing day at the beach on the weekend to get away from it all? A wonderful idea … if you can find the parking.

Projections about future population involve many assumptions about the future course of demographic, social and economic processes.

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The questions that naturally might arise are: How many people can fit on the islands? How many people *should* we fit for an ideal lifestyle? It is understandable that people would seek an absolute number — an ideal count beyond which it would be unwise to tread. But that does not take into account the nature and dynamics of population studies and forecasting.

Population size and structure impact on schools, the job market, medical services and other components of society. And, as a result, they affect our overall well-being — the ultimate measure of sustainability. Well-being, however, is not determined by the size or structure of a population alone — it also must be seen in the context of the infrastructure established to support the population, in a cause-and-effect relationship that is mutual and continuously evolving. Thus, projections about future population involve many assumptions about the future course of demographic, social and economic processes.

With that in mind, we look at the most recent state projection, revised to reflect changing county trends (Table 1).

Table 1. Resident Population by County (1990–2030)

Year	State Total	Hawai'i County	Honolulu County	Kaua'i County	Maui County
1990	1,113,491	121,572	838,534	51,676	101,709
1995	1,196,854	140,492	881,399	57,068	117,895
2000	1,211,537	148,677	876,156	58,463	128,241
2005	1,275,194	167,293	905,266	62,640	139,884
2010	1,346,600	186,780	938,215	67,126	154,479
2015	1,418,650	206,267	970,854	71,583	169,946
2020	1,489,550	226,065	1,001,357	76,049	186,079
2025	1,560,400	246,227	1,030,858	80,640	202,675
2030	1,630,450	266,427	1,059,362	85,358	219,302

Source: Department of Business, Economic Development, and Tourism (2004)

The state's population is projected to increase modestly at an annual growth rate of about one percent annually, tapering off after 2020.

A number of assumptions are made in reaching this projection. Fertility rates by age group and the number of births will increase slightly each year (from 15,500 to 18,400). Death rates by age group will decline — meaning people will be living longer — but the overall number of deaths will increase annually (from 10,500 to 15,600) as the population ages and the elderly comprise a larger share of the whole. The number of people migrating into the state each year will stay at current levels (8,550 to 9,950), and the size of military-related residents is set at 85,850.

All these assumptions are based on a belief that the state economy will show modest but steady growth. If this changes, the actual population that arises also could fluctuate. For example, largely due to a poor economy, the annual population growth rate in the late 1990s was less than half a percent, as people moving out of the state exceeded those coming in.

Honolulu will see its share of the state's population decline further. From 2001 to 2005, the annual growth rates by island were Hawai'i County (2.5 percent, primarily due to migration from other islands or states), Maui (1.8 percent), Kaua'i (1.4 percent) and Honolulu (0.6 percent). Accordingly, Honolulu's share decreased from 75.3 percent to 71 percent between 1990 and 2005, and the trend is projected to continue, although at an increasingly slower pace.

Since birth and death conditions are similar across the state, the relative size of the counties is largely dependent on migration. The shifts have been paralleled by a construction boom from 2000 to 2005 when the number of housing units statewide grew by 6.6 percent. The unit increases by island were Hawai'i (14.9 percent), Maui (10.2 percent), Kaua'i (8.4 percent) and Honolulu (4.2 percent).

Most social systems, for instance, are geared more toward certain age groups over others: the educational system toward the young, and medical services toward the elderly, are two such examples.

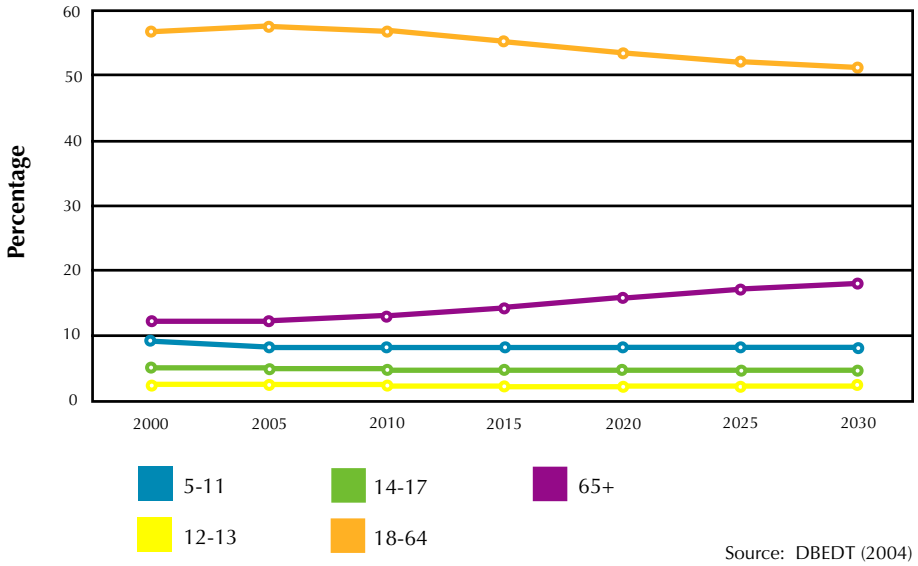
Trends in age structure

Total population size is a number that has instinctive appeal, and is easy to grasp. For planning purposes, though, trends in the structure of the population — its composition by age, sex and other characteristics — may be of greater use. Most social systems, for instance, are geared more toward certain age groups over others: the educational system toward the young, and medical services toward the elderly, are two such examples.

The projection foresees a continuation of a trend in Hawai'i that already has been widely noted: As mortality keeps declining, *the population is aging*. The proportion of people (including military-related) age 65 or more is increasing, while the proportion of those 18 to 64 is decreasing (Figure 1).

Some indications of this trend can be seen in 2005 statistics that rank Hawai'i with the other states and Washington, D.C. In Hawai'i, 13.6 percent of the population is age 65 or older (7th in the nation), and 1.8 percent is age 85 or more (2nd). The median age is 38.5 years (12th). However, in the old age dependency ratio — the elderly population per 100 working-age people — Hawai'i's ranks 15th, suggesting a relatively large work force.

Figure 1. Trend in Age Distribution, State of Hawai'i (2000–2030)



Source: DBEDT (2004)

These rankings are expected to remain stable in coming years. Among the many social and economic implications of an aging population is a rise in overall disability, since the disability rate is much higher among elderly members of the population.

Major characteristics

The American Community Survey is a U.S. Census Bureau program designed to give ongoing, up-to-date statistical profiles of communities rather than issuing such information once every 10 years when the census is conducted. The survey has been conducted for Honolulu County since 1996, and was expanded to include Hawai'i and Maui counties in 2005 (still excluding Kaua'i County). It does not include people living in group quarters like school dormitories, prisons, nursing homes and hospitals. The following highlights based on the 2005 survey report those characteristics most distinctive from the US national averages (U.S. Census Bureau, 2006).

Family structure: Households in Hawai'i are characterized by a relatively large percentage of married couples and larger families as compared to the other states and the District of Columbia.

The average household size is 2.88 (3rd highest in the nation). Families with married couples comprise 53 percent of all households (4th in the nation). At least one elderly person lives in 29 percent of the households (2nd). And at least one child under 18 years of age lives in 35 percent of them (11th). This is so even though fertility rates here are about average (26th).

In short, households in Hawai'i are more likely to be multigenerational families than in the rest of the nation. Yet the state ranks near the bottom (50th) when it comes to grandparents as caregivers for their grandchildren living with them (27 percent in Hawai'i, compared to 43 percent nationally). This suggests that it is

more common for elderly people in Hawai'i to live in multigenerational homes. The household structure may be responsible for the relatively favorable economic status of the elderly and child populations in Hawai'i. Only 13 percent of children younger than 18 live below the poverty level (44th in the nation) and only 9 percent of the elderly do so (26th).

Race and ethnicity: Asians comprise the largest segment of the population (42 percent), followed by White (25 percent), and Native Hawaiian or Other Pacific Islander (9 percent). Another 21 percent identify themselves as being of two or more races.

Migration: As fertility and mortality rates are low and stable in Hawai'i and across the county, migration is the most significant factor affecting population redistribution.

Hawai'i is experiencing a major turnaround in this area. In the 1990s, international and domestic in- and out-migration added up to a net loss in population. Now, Hawai'i is experiencing a reversal of that trend mainly due to the growing number of people moving here from other countries.

From 2000 to 2005, the rate of net international in-migration averaged 4.6 percent annually.

From 2000 to 2005, the rate of net international in-migration averaged 4.6 percent annually. Honolulu County led the way (with a 5.1 percent annual average), followed by Maui (4.4 percent) and Hawai'i counties (3.1 percent). In contrast, domestic migration accounted for about a 2 percent drop in the state's population each year, an average that fell into the negative column because of the number of people leaving Honolulu County. Honolulu had an average annual rate of net domestic out-migration of 6.3 percent. Hawai'i and Maui counties, on the other hand, saw more people arriving than leaving due to domestic migration. The average annual rate of domestic in-migration was 13.6 percent for Hawai'i County, and five percent for Maui County.

The high rate of international migration, and the influx of foreign-born residents is reflected in English proficiency figures. Statewide, about one in six people (17 percent) are foreign-born with the majority from Asia. Maui has the highest proportion of foreign-born residents (19 percent) followed closely by Honolulu (18 percent). The survey reports that about a quarter of the State's residents speak a language other than English at home, and more than one in 10 speak English less than "very well."

Disability status: Disability rates by age group in Hawai'i are among the lowest in the nation: four percent for those ages 5-20 (51st in the nation), 10 percent for ages 21-64 (45th), and 36 percent for those 65 and older (45th). Native Hawaiians and other Pacific Islanders have the highest rates of disability, and higher among those 65 or older (45%).

An optimal population?

In his 2005 book "Population: An Introduction to Concepts and Issues," John R. Weeks defines carrying capacity as "the size of population that could theoretically be maintained indefinitely at a given level of living with a given type of

economic system." Demographers use the term but, in reality, that does not mean there exists an optimal level of population that maximizes human welfare.

First, "carrying capacity" is a theoretical concept, and, cannot be calculated exactly. An economic system is constantly transforming and has too many components for all their interactions to be considered in assessing their outcomes. This is especially so in the contemporary context of a local economy embedded in the national and global economies.

Second, the definition is based on a perspective that postulates population growth as detrimental to the economy or there exists a limit to the Earth's capacity to support people. But other perspectives, especially from economists, postulate modest population growth as a prerequisite to economic growth or, at the very least, that the two are compatible (Becker, 2006). In fact, this can be seen in the parallel patterns of greater population and economic growth seen in Hawai'i and Maui counties when compared to Honolulu.

Third, the role of intervening factors — notably technology and social infrastructure — is critical. Historically, for example, the technological advances of the agricultural and industrial revolutions were responses to population growth, much as the green revolution has emerged in modern times. Social infrastructure may play an even more important role than technology in assessing capacity. In particular, the huge inequalities seen today in the distribution of resources among various peoples worldwide may have greater impacts on the sustainability of quality of life (Population Reference Bureau, 2006). For instance, the population density in Africa is much lower than in Europe, but that says little about the standards of living in the two continents.

Toward 2050

Social infrastructure may play an even more important role than technology in assessing capacity.

As citizens look toward 2050, two things should be kept in mind when considering population-related policies. First, childbearing and migration — the drivers of population change in Hawai'i — are, in principle, matters of individual choice. And any policies influencing those demographic behaviors are choices of certain values over others, and should be based on a general consensus among residents with accurate data. Hawai'i, to date, has attracted more international immigrants, has lost more of its younger residents to the mainland U.S., and continues to have a growing elderly population. These trends will impact on how we, as a community, can live together in sharing the limited resources and in collectively addressing the diverse needs of our residents.

And, particularly important for social planning purposes, planners and policymakers should consider the changing age structure that may be more relevant than changes in total population size as they impact on the generation and use of resources for sustaining the quality of life for residents and future populations.

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Hawai‘i’s remote location in the Pacific Ocean makes it among the most oceanic of land areas in the world, with climate and weather primarily influenced by the surrounding ocean.

Environmental Quality

By Carl I. Evensen and Katherine A.D. Chaston

Native Hawaiian tradition tells of Hawai'i Loa, a voyager from another land who steered his canoe in the direction of Iao, the Eastern Star, and discovered the island that would bear his name. He was a distinguished man, according to "Voyaging Chiefs of Hawai'i," noted for fishing excursions that could last a year "during which he would roam about the ocean in his big canoe (wa'a), called also an 'island' (moku) . . ." (Kamakau & Kepelina, 1995).

The island as a voyaging canoe is a metaphor that arises readily in Hawai'i and one that is apt when discussing environmental quality.

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The island as a voyaging canoe is a metaphor that arises readily in Hawai'i and one that is apt when discussing environmental quality. We live in a small area within a vast ocean, using limited resources that are interdependent and often irreplaceable. An underlying theme that we should not forget, particularly in this age of iPods™, cyberspace, and other forms of technological disconnection is this: Like crew members are part of their vessel, we are part of the natural world around us. We depend on our ecosystem to provide food, clean water and air, space for living, and beauty; its health affects our health. We must recognize and embrace our place in this scheme.

There is a tendency, too, for people to think human needs ultimately are incompatible with a healthy environment and that productivity and resource use inevitably must lead to degradation. Indeed, the history of exploitation in Hawai'i and worldwide would support this view. Now, more than ever, we need to acknowledge that a healthy environment is essential for long-term human well-being. We must give full weight to the importance of *ecosystem services* which are the benefits people obtain from ecosystems. The Millennium Ecosystem Assessment program, initiated by the United Nations in 2001, described these services: "*provisioning services* such as food and water; *regulating services* such as regulation of floods, drought, land degradation and disease; *supporting services* such as soil formation and nutrient recycling; and *cultural services* such as recreational, spiritual, religious and other nonmaterial benefits." (Millennium Ecosystem Assessment, 2005)

A wise crew maintains the integrity of its canoe after setting out to sea. It is in this spirit that environmental quality can best be explored.

The physical and biological environment

Hawai'i consists of eight major islands, with 99 percent of the total land area, and 124 small islands, reefs and shoals (Juvik & Juvik, 1998). It stretches 1,580 miles, from the island of Hawai'i in the southeast to Midway in the northwest. The state has a tropical climate strongly influenced by northeast trade winds, complex topography, and elevations ranging from sea level to 14,000 feet.

Hawai'i's remote location in the Pacific Ocean makes it among the most oceanic of land areas in the world, with climate and weather primarily influenced by the surrounding ocean. Much of the rainfall occurs when the trade winds release

Hawai'i's ecosystems have been greatly modified by humans, although remnants of native ecosystems and many native species remain.

moisture upon reaching steep mountain slopes, making the windward (east and north) sides of the islands the wettest. Climate, soils and vegetation are characterized by large differences over short distances. It is not unusual to see annual rainfall vary by 150 inches within a distance of 10 miles.

Most watersheds are small. Streams are short in length, with peak flows that are brief and intense. Older islands like Kaua'i and O'ahu have many perennial streams — streams that always have water except during extreme drought — while younger islands like Maui and Hawai'i have fewer streams because their terrains are more permeable.

The plants and animals of Hawai'i arrived over thousands of years on the winds, or floating on ocean currents. These rare arrivals found a diverse range of habitats, and evolved into many new species found nowhere else in the world. Many of these can be found only on a single island, a single valley, or perhaps a single hillside or stream. As these plants and animals adapted to their habitats, they became interdependent, and together created a rich diversity of native ecosystems — alpine, dry and wet forest, wetland, stream, coastal and coral reef.

With the arrival of the first Polynesians, native habitats changed due to cutting, burning, and harvesting of native species, and the introduction of new plants and animals, including pigs, chickens, dogs, rats and at least 32 plant species. Some native species became extinct at this time, including about half of Hawai'i's land birds (Loope, 1999). The destruction and loss accelerated after Europeans began arriving in 1778.

Hawai'i's ecosystems have been greatly modified by humans, although remnants of native ecosystems and many native species remain. Our challenge is to preserve and enhance these ecosystems and species while providing for the needs of Hawai'i's residents and visitors.

History of environmental change

Natural resources were managed by the ancient Hawaiians through the *ahupua'a* system, which operated on the scale of landscapes or watersheds. The Hawaiians were keen observers of nature and were able to develop a wide range of food crop and aquaculture production systems adapted to existing land or sea conditions. For example, the main staple crop of taro or *kalo* was grown in irrigated wetlands, natural marshes and rain-fed uplands. Similar creative development could be seen in the wide range of freshwater, brackish, and saltwater fishponds, and mariculture systems (fish produced with crops).

Ahupua'a were governed originally by local groups called aha *councils, consisting of various experts in resource management chosen by the community.*

Ahupua'a were governed originally by local groups called *aha* councils, consisting of various experts in resource management chosen by the community. Governance and decision-making were based on group consensus (Kaimikaua, 2000). As populations grew and political control became more centralized in hereditary chiefs, management authority shifted to an appointed headman, the *konohiki*. Stewardship and management of resources were formalized through the *kapu* system, in which restrictions were placed on specific activities, such as catching fish or cutting trees. Breaking of the *kapu* could result in severe punishment. This vertically integrated management system existed for well over a thousand years until the arrival of Europeans when it was replaced with private ownership and control of land and water resources (Derrickson, Robotham, et al., 2002).

In the early 1800s, ports in Hawai'i became major suppliers for trading and whaling ships. A cash-based economy was introduced. Natural resources were degraded through overuse, such as the harvesting of sandalwood and fuel wood, and mismanagement, like uncontrolled grazing of newly introduced cattle and goats.

Major political, social and economic changes ensued, associated with increasing trade for exotic goods; privatization of lands; the growth of the sugar and

pineapple industries; high mortality rates of native Hawaiians due to introduced diseases; and the marginalization of large segments of Hawaiian society. The close connections of resource management at the ahupuaʻa level — a transect from the mountain to sea — were often severed. Ahupuaʻa management was replaced with localized management by private organizations and government agencies with specific functions and little coordination. The expansion of towns and agriculture led to a rapid decline in the integrity and extent of many native ecosystems especially coastal and dry lowland forests.

By the 1880s, extensive plantations and cattle ranches had transformed Hawaiʻi's landscape along with widespread denuding of upland forests by feral animals. These and related changes severely compromised groundwater recharge in many areas and water tables rapidly fell. The Hawaiian Kingdom responded with legislation to protect and replant forests, especially in the Oʻahu and Maui uplands. Before and after annexation to the United States, efforts ensued to expand forest reserves, livestock fencing, and protection of water-recharge areas. By 1914, nearly a quarter of the islands' land was in forest reserve, including most recharge areas (Cox, 1992). However, reforestation was pragmatically focused on revegetation, introducing exotic tree species without regard to preserving native forests.

Since the mid-1990s, thousands of other acres of former sugar and pasture lands on Hawaiʻi and Kauaʻi have been converted to commercial forestry, and large landowners.

As the amount of land devoted to sugar and pineapple grew in the 20th century so did plantation irrigation systems. Many streams on Kauaʻi, Oʻahu, Maui and Hawaiʻi were diverted, reducing fresh water available for native ecosystems, taro and coastal areas. Increased tourism and military land use put added pressures on water supplies, waste disposal and coastal recreation areas. In the 1970s, plantation agriculture began to decline while diversified agriculture, forestry and urbanization expanded. Many former plantation lands became idle, including extensive areas degraded by erosion, nutrient depletion, periodic fires and invasive weeds. Today, thousands of acres are underutilized as unimproved rangeland, and reforestation has been suggested as a way to improve productivity. Since the mid-1990s, thousands of other acres of former sugar and pasture lands on Hawaiʻi and Kauaʻi have been converted to commercial forestry, and large landowners like Kamehameha Schools, several ranches and the state have begun koa reforestation projects.

Land and coastal use in Hawaiʻi currently is a patchwork of federal, state and private management which tends to conform to concentric circular patterns, rather than the pie-shaped divisions more typical of the ahupuaʻa system. As water flows from the mountain to the sea it crosses various jurisdictions and management authorities, which often lack coordination.

Issues of human and ecosystem health

Soil and water quality: Clean and abundant water is fundamental to life and the maintenance of natural ecosystems, human health, and economic vitality. It is an essential resource that islands often find in limited supply. Water also serves as a medium to transport harmful pollutants and pathogens; pollution control often entails tracking and controlling the flow of water across land.

We must preserve water quality, recognizing that different levels of "quality" are acceptable for different purposes, such as drinking, recreation or irrigation. Hawai'i 's water quality is assessed for surface water, coastal water, and groundwater.

Surface water ranges from pristine streams to heavily polluted canals, streams and lakes. In a 2002 report, the Environmental Protection Agency rated 64 percent of the state's 3,900 miles of streams as "impaired" by pollutants, including nutrients, pathogens, sediment, nonnative species, and organic matter that lowered oxygen levels. Over 95 percent of coastal shorelines were assessed as having good water quality but about half of the 55 square miles of bays and estuaries were impaired, mainly by sediments and nutrients (EPA,2002).

Clean and abundant water is fundamental to life and the maintenance of natural ecosystems, human health, and economic vitality. It is an essential resource that islands often find in limited supply.

Groundwater quality, based on tests of well water, show the presence in many wells of solvents, pesticides and other organic chemicals, generally below minimum reporting levels. Organic compounds were detected in 73 percent of the public-supply wells on O'ahu, for example, but drinking-water standards were exceeded in only a few cases (Hunt, 2004). Those wells were closed.

Soil quality considers the capacity of soil to support productive ecosystems, as well as providing services, like filtering and removing wastes. Soil and water quality are intrinsically linked, since preventing water pollution is difficult and expensive if soil degradation is not controlled. However, there can be significant tradeoffs in trying to improve soil and water quality. For example, farmers are often encouraged to improve soil conservation by applying practices which protect soil from erosion by slowing the flow of water and increasing its infiltra-

Table 1. Tradeoffs Between Soil and Water Quality

Soil conservation practices	
Less sediment loss	More agrichemical leaching
Nutrient application	
More plant productivity	More surface and leaching loss of nutrients
Mechanical weed control	
Less agrichemical use	More soil compaction
Chemical weed control (e.g. no-till)	
Less soil loss	More agrichemical use and loss

tion into the soil. However this increases the likelihood of groundwater contamination by fertilizers and pesticides. Solving one problem can create another. Balancing tradeoffs must be considered as we plan for the future.

Endangered ecosystems and species: With hundreds of plants and animals listed as endangered or threatened, Hawai'i often is called the "endangered species capital of the world." It accounts for about a third of all endangered species in the nation. As arrivals adapted to a protected environment and evolved into unique species, many lost their defenses against predators. Habitat loss and competition from alien species further contributed to the decimation of native populations.

The full consequences of a species becoming extinct often are not known, but it certainly impairs the native ecosystems and deprives future generations from using or enjoying them. Some efforts underway to save species are fencing to control feral animals like pigs and goats, controlling competing invasive species, propagation and release of endangered species, and preservating habitats.

Invasive plants and animals: Many of Hawai'i's ecosystems are being overwhelmed by the spread of introduced plant and animal species. When a nonnative species causes economic or environmental damage or harms human health, it is termed an "invasive species." Not all new species cause extensive damage. But those that do have driven native species extinct, destroyed native forests, and caused millions of dollars in crop losses.

Invasive weeds, such as koa-smothering banana poka vine, can threaten economically important species.

Invasive weeds, such as koa-smothering banana poka vine, can threaten economically important species. They can create conditions leading to the loss of environmental benefits: Miconia shades-out understory vegetation in wet forests, and degrades watersheds. Fountain grass spreads fire through ranches and native dryland forests. Fireweed, gorse, strawberry guava and lantana reduce range-land productivity.

Feral pigs and goats destroy vegetation and increase soil erosion. And the coqui frog — a recent accidental introduction on nursery plants — is not only disruptive with its loud chirping, but also alters ecosystems by eating large numbers of arthropods, including native and beneficial insects, some rare. Another potential invader that Hawai'i is desperately trying to keep out is the brown tree snake.

Invasive species also impact our coastal waters. Recent estimates list 343 marine alien species in Hawai'i, including 287 invertebrates, 24 algae, 20 fish and 12 flowering plants. Like many of their terrestrial counterparts, they often are difficult to eradicate since they have no natural predators. Many are thought to have arrived in ballast water, or on the hulls of ships, in a condition known as hull biofouling. Of special concern are invasive algae, which can smother coral reefs and replace native algae. When excessive growth occurs, such as in West Maui in the 1990s, it washes up on shore and forms large, rotting piles that are a nuisance to residents and visitors alike.

Coastal environment: Hawai'i's physical, economic and cultural links to the ocean are many and strong. The shorelines and coral reefs forming our coastal environment seemingly touch everyone directly or indirectly. They are a mainstay of the tourism industry and central to our identity. The benefits from

Rainforests of the Sea

Coral reefs are especially important to coastal areas and deserve particular attention.

Often called the "rainforests of the sea" because of their rich biodiversity, coral reefs are complex and productive ecosystems composed of countless millions of interdependent plants and animals. There are 410,000 acres of living reef in the main Hawaiian Islands, containing more than 7,000 know species of marine organisms. Over 25 percent of these species are found only in Hawai'i.

The reefs provide resources and services worth billions of dollars, and are the economic foundation for more than a thousand ocean tourism companies, with annual gross revenues of about $700 million a year.

Coral reefs, though, are fragile environments, and remain healthy only within a narrow band of temperature, light and water quality conditions. Hawai'i's reefs are increasingly endangered by overfishing, land-based pollution, recreational uses, alien species, and coral bleaching and disease. The loss of these aquatic treasures would be an inconceivable tragedy to Hawai'i.

coastal ecosystems are substantial. Reefs protect and stabilize shorelines from seasonal storm damage. Coral forms and replenishes white, sandy beaches. Waves breaking over reefs create favorite surfing spots. Commercial and recreational fishermen harvest from the coral-reef food chain.

But the coastal environment is in danger from beach erosion and the degradation of water quality, marine life and reefs. Escalating conflicts among commercial, recreational, residential and preservation uses add to the challenges in managing the health of our coastal ecosystems.

Agricultural pollution and protection: Agriculture is an important contributor to the economy, and helps preserve green space and rural lifestyles. Yet it also produces pollutants such as sediments, nutrients, pesticides and pathogens.

The last several decades have seen dramatic changes in Hawai'i's agricultural climate. Sugar and pineapple plantations have shut down, replaced to a small extent by diversified farming, forestry and grazing. With less land under active cultivation, the total quantity of agrichemicals used has dropped. But the variety of types used has increased, presenting a more complex range of pollutants and additional regulatory difficulties.

Sediments in particular can cause serious environmental harm. They impair surface waters by reducing clarity and smothering aquatic organisms. They hold and transport other pollutants, and can contribute to losses in land productivity by removing nutrient-rich topsoil. Animal production, notably confined-livestock facilities, also deserves mention. The facilities can be concentrated sources of nutrient, pathogen and organic-matter contamination. Their impact could be mitigated by utilizing manure as a nutrient-rich and soil-improving resource, rather than treating it as waste.

Large tracts of agricultural land now lie fallow, providing conditions for growth of exotic weeds, fires and soil erosion. The land also faces steady urbanization pressures, a concern for many who value green space and consider it an essential component of a quality life.

Management initiatives

Promising efforts in protecting our natural ecosystems have been initiated over the past several decades ranging from government regulation to voluntary public-private initiatives.

Legislation and regulations: Federal laws provide a framework for environmental protection. These include the Clean Water Act, the Safe Drinking Water Act, the Endangered Species Act, the National Environmental Policy Act, and legislation controlling pesticide use. State and local governments adopt these regulations for implementation at the local level. They can develop more stringent regulations, but must meet minimum federal standards. In Hawai'i, most federal laws have their counterparts in state statutes. Administrative rules are developed to give direction to state agencies which implement the laws. At the county level, land use policy is also established through zoning ordinances and permits.

Watershed partnerships: Nine watershed partnerships have been created in Hawai'i since the first one for East Maui in 1991 (Gutrich, 2005). Their purpose is to conserve watershed areas and native habitats. The composition of these partnerships may vary, as does funding and specific goals, but they can include governmental agencies, private landowners, environmental organizations, local water-supply boards and the National Park Service. These public-private partnerships are on the islands of Hawai'i, Maui, Lana'i, Moloka'i, O'ahu and Kaua'i, and encompass over 900,000 acres of upland forest. The partnerships leverage federal, state and private funding to implement best management practices like reducing soil erosion, controlling invasive species and fencing-out destructive animals. They are a promising example of concerned citizens managing locally relevant issues on a watershed scale.

More than 20 federal, state and private agencies work in Hawai'i to control invasive species.

Invasive species councils: More than 20 federal, state and private agencies work in Hawai'i to control invasive species. To coordinate efforts in developing prevention, control, research and outreach programs, the state in 2002 established the Hawai'i Invasive Species Council, with local councils on major islands to address particular concerns. State funding for the council in the fiscal year 2005 budget was $5 million.

Additionally, funding to manage, research or provide outreach on various invasive species come from the federal departments of Agriculture and Interior, and the National Science Foundation; the state departments of Agriculture and Land and Natural Resources; and private agencies such as the Nature Conservancy and the National Fish and Wildlife Foundation. Opportunities for collaboration with the U.S. Department of Defense are considerable through the Hawai'i-Pacific Cooperative Ecosystem Unit, a coalition of government agencies, non-government organizations, and universities. Also the U.S. Forest Service's Institute of Pacific Islands Forestry holds promise as a potential collaborating entity.

Marine and coastal protection initiatives: The Draft Ocean Resources Management Plan, produced in 2006 by the Hawai'i Coastal Zone Management Program, is a recent initiative to develop comprehensive and holistic solutions to coastal issues. The ambitious goal is to move from fragmented government efforts toward an integrated, area-based approach with greater collaboration between government and communities.

Many programs are focusing on the protection and preservation of the state's coral reefs. One such initiative is the U.S. Coral Reef Task Force, which has identified priority areas for future work to protect reefs. In Hawai'i, the six "component strategies" are land-based pollution, recreational impacts, fisheries management, climate change and marine disease, aquatic invasive species, and lack of awareness.

One of those areas is being actively addressed through "Hawai'i's Local Action Strategy to Address Land-Based Pollution Threats to Coral Reefs," a multi-agency plan issued in 2004. Demonstration projects have begun in three watersheds: Honolua, Maui; Hanalei, Kaua'i; and Kawela to Kapualei, Moloka'i. The overall goal is to improve coastal water quality and coral ecosystems by reducing land-based pollution through (1) reducing the pollutants in

surface and ground water by using best management practices at specific sites, (2) conducting scientific research and monitoring to understand the links between pollution and coral health, and (3) raising awareness of how to prevent and control pollution.

Toward 2050

The history of environmental change in Hawai‘i is a grim record of loss and degradation. Nonetheless, the islands remain a remarkably beautiful and desirable place to live. Although heavily modified from their original state, our ecosystems still function well enough to provide essential services: clean water, productive soils, moderate weather, and beautiful landscapes which feed our spirit. Their ability to continue functioning effectively will be tested by population growth and urbanization. While some native ecosystems are gone forever, partly because species that were components became extinct, remnants remain to enrich Hawai‘i biologically. They should be preserved and restored, because they are unique and have value just in being.

Although heavily modified from their original state, our ecosystems still function well enough to provide essential services: clean water, productive soils, moderate weather, and beautiful landscapes which feed our spirits.

The future holds many challenges and opportunities for the people of Hawai‘i. We need to plan for an uncertain future, recognizing that our current actions have long-term implications. One of the chief uncertainties is the extent and consequences of global climate change. As the planet warms over the next 50 years, sea levels will rise, impacting our coastal areas. Hawai‘i also could be struck by stronger and more frequent storms and suffer from more pests and diseases, among other likely outcomes.

In determining our plans, it is important to consider perspective and approach. Most of Hawai‘i can be considered as human-modified ecosystems. In this context, we are not just observers of the ecosystem, but are a part of it. If we keep this perspective, it will be easier to recognize management options that will continue to provide the benefits which keep us healthy while sustaining the health of the environment.

Our approach should also reflect this integrated quality. Ecosystem processes interact; activities in the mountains affect the shore regardless of property lines. We must approach these large-scale issues in environmental quality with plans conceived on a similarly large scale. The *ahupua‘a* is an appropriate model. At the same time, execution should take place at the local community level with targeted responses to specific or changing conditions.

This will take agreement and cooperation, and even sacrifice for the greater good. The watershed partnerships and other initiatives are encouraging signs that Hawai‘i’s people understand the power and spirit of consensus and are willing to work together when the stakes are high. A collaborative and cooperative approach is critical to developing dynamic and responsive actions that can adapt to a changing environment. The stakes could not be any higher. In fact, our future depends on it.

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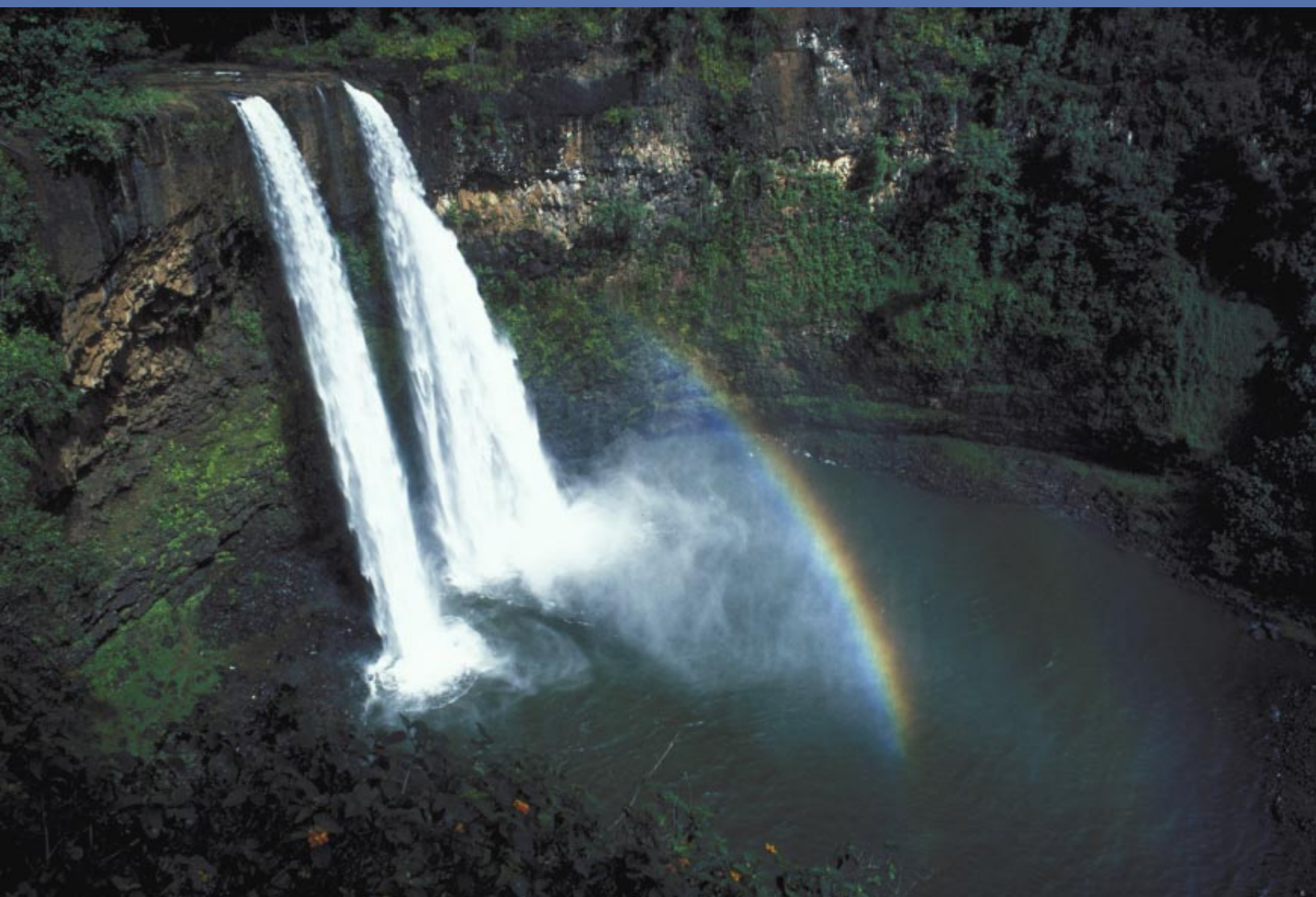
The state has good supplies of freshwater now, but occasional warnings to voluntarily limit use serve as reminders that supply and human need do not always mesh.



Water

By Carol Ferguson and Philip Moravcik

Under the main entry of water, the Hawaiian Dictionary lists *wai* as freshwater and *kai* as saltwater. In other parts of the world, that might suffice. But the dictionary, a classic reference by Mary Kawena Pukui and Samuel H. Elbert, goes on to include 21 separate subentries — for conditions like agitated water, flowing water, brackish water, sparkling water, abundance of water — and ends with a chant: *I ka wai kau a Kane me Kanaloa, he wai puna, he wai e inu, he wai e mana, he wai e ola, e ola no* (Water given by Kane and Kanaloa, spring water, water to drink, water for power, water for life, may there be life).

All of the islands' freshwater begins as rain, generated simply because the islands exist.

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We must have water. Human beings have always understood this — from the time we knelt at watering holes with other creatures to our current era of space exploration, where the presence of water is equated with the possibility of life. In Hawai'i, that consciousness perhaps is accentuated by our geography: The islands can be considered in ways a watering hole in the midst of a vast saltwater desert. We cannot count on supplies from roaring rivers fed by glacial discharges, inland seas or headwaters thousands of miles away. The islands themselves are the source, interacting in a closed loop with other natural elements. We should respect water's place in the natural world and conserve finite freshwater supplies.

As Hawai'i looks toward sustainability, it would do well to remember the lessons of history. The state has good supplies of freshwater now, but occasional warnings to voluntarily limit use serve as reminders that supply and human need do not always mesh. The population and pressures could grow in the future. Water will be needed not just for drinking, but also to irrigate farms, to remove wastes, and to maintain the health of island ecosystems. It will be, as it has always been, needed for life. May there be life.

From the start: rain

All of the islands' freshwater begins as rain, generated simply because the islands exist. Moist air moving across the ocean is forced upward when it meets mountain slopes, cooling as it rises and leading to condensation of the moisture, which falls back to Earth. This phenomenon, known as the orographic generation of precipitation, causes the amount of rain that falls on the islands to be several times greater than the surrounding ocean. (Lau and Mink, 2006).

The windward sides of the islands, which face the prevailing northeast trade winds, get considerably more rain than the leeward sides. The air has moisture stripped away as it rises on windward slopes and is much drier when it drops down into leeward areas. Consequently, rainfall on the windward sides and at higher elevations can be as much as 400 inches a year, while a leeward location on the same island might get less than 10 inches.

Rainfall is highly seasonal, with winter much wetter than summer. There also are large variations between years, believed to be associated with the El Niño phenomenon, and the linked and more recently discovered Southern Oscillation (described overall by the acronym ENSO). The mechanics of these cyclical atmospheric-oceanic events are complex, but the net result for Hawai'i is displacement of the winter rain that normally occurs in the state. (Lau & Mink, 2006).

Historically drought has been a recurrent problem in Hawai'i. Severe droughts occurred in Hawai'i in 1983-1984, 1996, and the winters of 1997-2001. Maui County was designated a primary natural disaster area because of the April-September 2006 drought (Pacific Disaster Center,2007). As with rainfall, drought is more common on some parts of the islands than others. Usually those areas that are normally dry (leeward) experience more frequent droughts. As global warming intensifies, the prospect of drought increases. In Honolulu in 1998 the average temperature had increased 4.4 ℉ over the previous 100 years, and precipitation had decreased approximately 20 percent over the previous 90 years. Future changes in precipitation are highly uncertain because reliable projections of changes in El Niño and global climate change have yet to be made (USEPA, 1998).

Once it falls, rain follows one of three paths: It can return to the ocean as runoff, be transpired from plants and evaporate from surfaces, or infiltrate into the ground. Determining factors include ground permeability and topography, climatic conditions, vegetation, alteration of ground surfaces by humans, and interception. For Hawai'i as a whole, about 40 percent of rainfall evaporates, 30 percent enters the subsurface to become groundwater, and 30 percent runs off in streams or other forms of surface water (Lau and Mink, 2006).

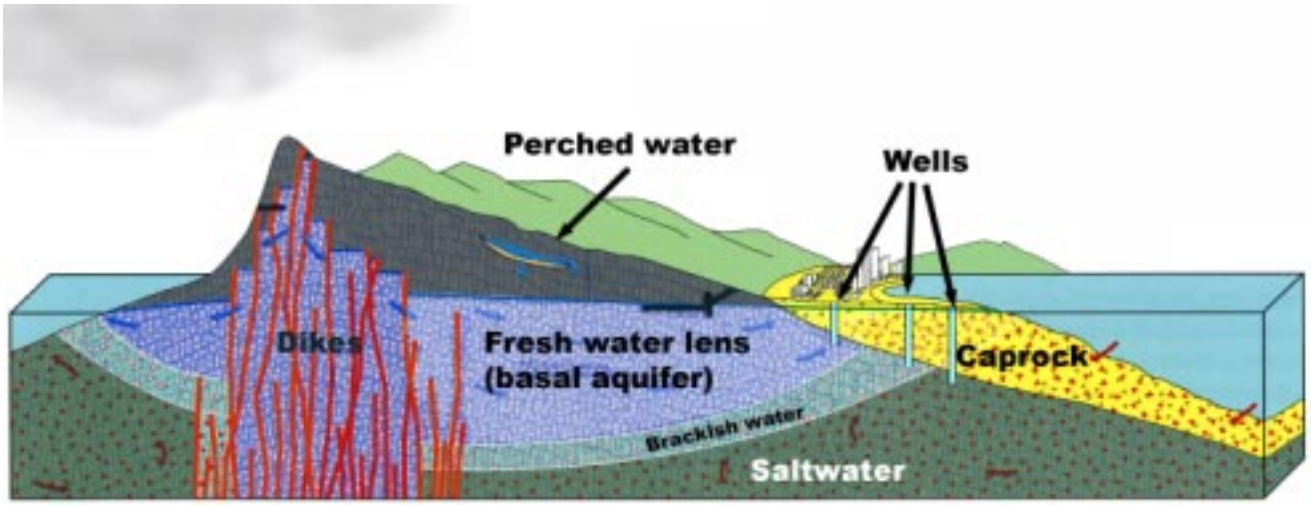
More than 98 percent of the state's drinking water, and half of all freshwater used, is groundwater.

Groundwater

More than 98 percent of the state's drinking water, and half of all freshwater used, is groundwater. Hawai'i's small, high islands give little opportunity for rain to infiltrate the ground before running into the ocean. Fortunately, we can tap huge stores accumulated in the rock that makes up the islands.

The water is stored in aquifers, or underground layers of porous rock that can be saturated with water and tapped by wells. The largest and most productive aquifers were formed during the initial, shield stage of the islands' formation. The material that built the islands exuded during this period in relatively thin flows, all of which comprise more than 90 percent of the islands' volume (Gingerich et al., 2000). Water that seeps through these layers, sometimes descending hundreds of feet, is generally of excellent quality, with virtually all particles and microorganisms filtered out.

Figure 1. Island Hydrology Map



Source: adapted from Gingerich and Oki.

On parts of the older islands, a caprock near the shoreline impedes the flow of groundwater from the basal aquifer into the ocean and allows a deeper zone of freshwater to accumulate.

The greatest amount of groundwater is stored in the so-called basal aquifers. These aquifers consist of a lens of freshwater that floats on top of seawater because it is lighter, lacking seawater's minerals and salts. The transition between the two types of water is gradual, with degrees of brackish water, but the aquifers still represent a tremendous amount of water fresh enough to drink that can be accessed by wells drilled far below sea level (Figure 1).

After shield building, additional processes took place that affect the way water moves through the parent rock. In some areas, magma squeezed upward and laterally through the parent rock to form "dikes," barriers of less permeable rock that confine smaller pockets of groundwater which also can be exploited.

On parts of the older islands, a caprock near the shoreline impedes the flow of groundwater from the basal aquifer into the ocean and allows a deeper zone of freshwater to accumulate. The caprock is a vestige of a time when sea levels were higher, and is composed of fossil reefs, sedimentary deposits and weathered rock laid on top of the parent rock.

Quality: Groundwater quality in the islands is generally excellent. Agricultural and other chemicals have been detected in very small amounts in most wells on Oʻahu and some on the neighbor islands. The U.S. Geological Survey (USGS) recently reported that 63 percent of Oʻahu's public-supply wells contained at least one pesticide or volatile organic compound. The most commonly found substances were solvents and soil fumigants (used in pineapple fields against rootworm), trihalomethanes (byproducts of water chlorination) and herbicides. Some of the contamination reflects application decades earlier, often with products no longer used (Anthony et al., 2004). Concentrations are low, and generally below federal drinking water standards. Wells exceeding standards are removed from service or treated/blended back to acceptable levels. In some agricultural areas, elevated nutrient levels have been found in groundwater.

Cesspools and septic fields pose a significant threat to water quality. Cesspools are used more widely in Hawaiʻi than in any other state, according to the Environmental Protection Agency (USEPA Region 9, 2007). Many systems

provide little effective treatment of human waste, which is free to infiltrate into the ground without passing through the natural barrier of plants and soil on the surface. This waste may contain a wide array of pharmaceutical compounds that could have a profound impact on aquatic life and human health. Levels and impacts are unknown because no agency monitors their presence in drinking water. The waste also may contain nutrients and pathogenic microorganisms, although the presence of live microorganisms in drinking water is generally precluded by the thickness of rock they must pass through before reaching a well.

Salt is another possible contaminant. Wells near the shore or drilled close to the brackish zone sometimes are subject to saltwater intrusion. Over the years, some Honolulu wells have been abandoned because of this.

Quantity: Groundwater levels generally are higher in underground areas where rocks of lower permeability impede the water's seaward or lateral movement. Actual levels vary depending on a number of factors, such as the amount of rain and withdrawals from wells.

Levels in some parts of the state have been affected by the recent phasing-out of plantation agriculture. The plantations used to import water from wetter to drier areas through an extensive system of ditches and tunnels. Thus agriculture caused a net recharge of local groundwater in areas to which it imported water (both ground and surface) and a net withdrawal of groundwater in other areas through the use of wells. A recent USGS study stated, "Water-balance computations indicate that the sugarcane industry had, at its peak, artificially increased recharge by about 25 percent over natural conditions" (Izuka et al., 2005). Levels have been rising the last few years in some areas due to the relatively wet weather and the recent reduction in agricultural use.

"The surface water resources of Hawai'i are of significant economic, ecologic, cultural, and aesthetic importance."

Surface water

Surface water can be a valuable resource as well as a threat to life and property. A USGS report states "The surface water resources of Hawai'i are of significant economic, ecologic, cultural, and aesthetic importance. Streams supply more than 50 percent of the irrigation water in Hawai'i, and although streams supply only a few percent of the drinking water statewide, surface water is the main source of drinking water in some places. Streams also are a source of hydroelectric power, provide important riparian and instream habitats for many unique native species, support traditional and customary Hawaiian gathering rights and the practice of taro cultivation, and possess valued aesthetic qualities. Streams affect the physical, chemical and aesthetic quality of receiving waters, such as estuaries, bays and nearshore waters, which are critical to the tourism-based economy of the islands" (Oki, 2003).

The short length of stream courses and steep topography of the islands means runoff from rain storms reaches the ocean very quickly, often causing erosion and degradation of nearshore waters. Occasionally, property is damaged and lives lost. The older islands, Kaua'i and O'ahu, have developed channels that concentrate stream flows, and well-weathered ground surfaces that decrease the amount of water infiltrating the ground/recharging aquifers, and increase runoff. Development and paving of surfaces, accelerates runoff, reduces infiltration, and exacerbates erosion problems on all the islands.

During the first flush of a rain storm, quantities of garbage, dirt, oil and grease, pesticides and other material are washed into streams, storm sewers and eventually into the ocean.

Quality: The quality of surface water varies according to the amount of rain. When it hasn't been raining, streams get a larger part of their flow from groundwater discharge, and more closely reflect local groundwater quality. During the first flush of a rain storm, quantities of garbage, dirt, oil and grease, pesticides and other material are washed into streams, storm sewers and eventually into the ocean. In larger storms, streams can erode a great deal of soil, which can damage nearshore ecosystems after discharging into the ocean.

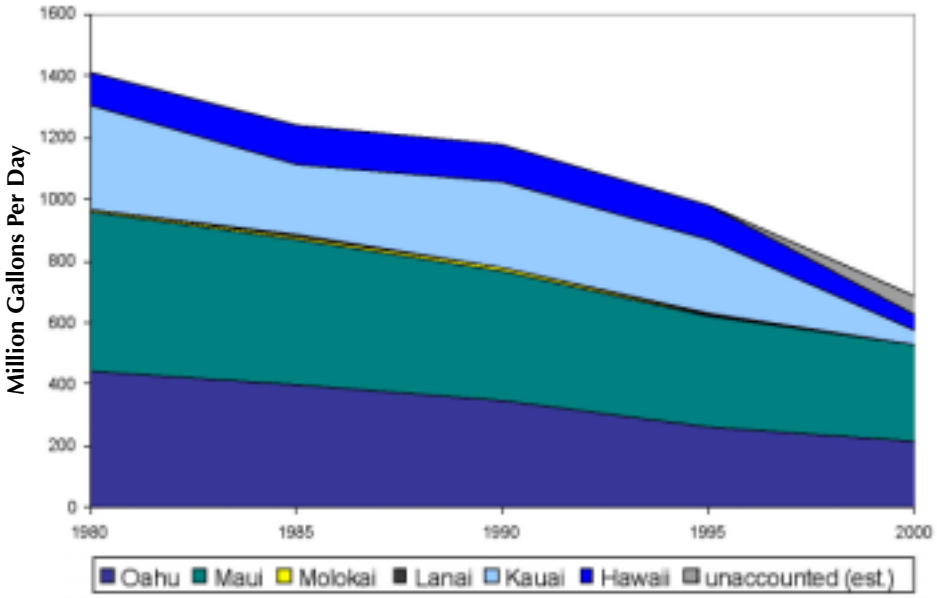
Surrounding land use largely determines the type of chemical contamination found in streams. For instance, in urban Manoa Stream, more insecticides have been found than herbicides. The opposite is true for Waikele Stream, which runs through agricultural areas (Anthony et al., 2004). From a bacteriological standpoint, no stream in Hawai'i meets water quality standards. University of Hawai'i research reports that fecal indicator bacteria multiply in Hawai'i's soil and that this is the major source of the elevated concentrations of these bacteria in streams. Fecal indicator bacteria, which have multiplied in the environment (soil) are not reliable indicators of sewage contamination and the associated risk for sewage borne diseases (Byappanahalli and Fujioka, 2004).

Quantity: The principal quantity issues for surface water are having an overabundance at times, and ensuring that we have enough to sustain habitat the rest of the time. To allow for rapid removal of storm water, many streams in urban areas have been channelized, making them virtually uninhabitable for wildlife.

Water usage

Water in Hawai'i is used primarily for domestic and agricultural purposes, reflecting the lack of a manufacturing base. Agricultural consumption has declined about 40 percent in the last 25 years due to the demise of the water-intensive sugar industry in the 1980s and 1990s (Figure 2). Water use for other purposes has remained fairly steady.

Figure 2. Total Water Use in 2000 by Island



Source: computed from Hawai'i DBEDT and USGS.
Note: Maui Co. data not available by island for 2000. Unaccounted estimates are for self-supplied domestic and commercial uses available for 1995.

The USGS makes national, state and county water use assessments every five years, the most comprehensive account made. Data from 1980 to 2000 (DBEDT, 2000-2005; USGS, 1995 and 2000; Hutson et al.) are consistent enough in coverage and methodology to indicate trends. Estimates for 2005 are not available at this time.

From 1980 to 2000, water use in Hawai'i has fallen 52 percent (Figure 2), reducing the amount used in a day by 729 million gallons. Reductions in surface water use by agriculture account for the majority (63%) of the decline. This is due to the shrinking or closure of sugar plantations over the period. That water is being gradually reallocated to county water departments or for other uses, like diversified agriculture. Huge amounts are legally tied-up to varying extents, since owners of agricultural land are reluctant to surrender water rights grandfathered during the plantation era. There have been no sugar plantation closures since 2000, so coming figures may well show a reversal in the overall downward trend.

Total use has declined on an island-by-island basis as well. The biggest drops occurred on Kaua'i (290 million gallons per day (mgd)) and O'ahu (228 mgd), where most sugar lands were irrigated. Maui County also saw a significant decline (206 mgd), but overall use is still high because one large sugar plantation remains. Sugar production has completely ceased on the island of Hawai'i, but not much water has been freed up because much of the land used was unirrigated.

In 2000, average domestic use per capita in Hawai'i was 18 percent higher than in the nation as a whole (Table 1). This is understandable given the state's hot and windy climate, uneven rainfall distribution and year-round growing conditions for landscape plants. Per capita consumption was lowest in Honolulu County, which is more urbanized and has smaller house lots.

Table 1. Average Water Usage Rates in 2000 by County

Water use in gallons per day	U.S.	State	County			
			Honolulu	Maui	Kauaʻi	Hawaiʻi
Public/domestic per capita*	167	196	178	220	199	201
Irrigation per irrigated acre	2,213	2,992	1,639	4,913	1,103	1,359
Irrigation per crop acre	397	2,844	2,035	5,460	1,030	644

* Public water supply plus, for U.S. and state, self-supplied water for domestic use.

Data Sources: USGS (water, irrigated ac., U.S. population), Hawaiʻi DBEDT (defacto population), USDA and HASS (crop ac.).

Irrigation consumed more than half of all water used statewide in 2000. The irrigation rate per acre here is 35 percent higher than the national average, a reflection of the crops grown — sugar is one of the most thirsty crops in the world — and our tropical location. Maui, with its large plantations, consequently leads all counties in irrigation usage. Hawaiʻi farms overall are much more dependent on irrigation, and water use per crop acre is seven times higher than the U.S. average.

Water institutions and services

Despite the relative abundance of water, several contentious disputes have been brought before the commission.

Water law: The overall legal framework governing water in Hawaiʻi is the State Water Code (Chapter 174C Hawaiʻi Revised Statutes), passed by the 1987 Legislature. The code defines public and private rights and responsibilities, and authorized creation of the state Commission on Water Resource Management. The commission coordinates policies and planning on water allocation and resource development, and sets flow standards for perennial streams.

The commission directly regulates water use in designated areas when groundwater withdrawals reach 90 percent of an aquifer's "sustainable yield," or when declining levels or increased diversion poses a threat to public health, the environment or other sectors. To date, the commission has designated groundwater management areas that cover all of Molokaʻi, all of Oʻahu except Waianae, and the Iao aquifer in central Maui (Hawaiʻi CWRM, 2007). All water users in a designated management area (except individual domestic users) must obtain a permit from the commission that restricts water withdrawals and may impose specific use practices. In undesignated areas, water is shared among users with common law rights to a particular source.

The code was enacted during a time of declining water use. Despite the relative abundance of water, several contentious disputes have been brought before the commission. Among them are disagreements over allocations from Oʻahu's Waiahole Ditch, pumping from the Iao aquifer, and diversions from east and central Maui streams to irrigate sugar cane. In the Waiahole Ditch case, commission hearings and related litigation have been going on for 13 years, including two appeals to the Hawaiʻi Supreme Court. A third appeal was filed last summer and is pending in state appellate court.

Agricultural irrigation: Hawai'i has a legacy of privately run irrigation systems, constructed by plantations in the late 1800s and early 1900s (Wilcox, 1997). With the decline of the plantations, some of the systems fell into disuse, while others shifted to irrigating different crops. In the past decade, the state has taken over operations for the Waiahole Ditch and the Lower Hamakua system after plantation closures. More recently, farmers have organized their own cooperatives to manage the Kekaha and East Kaua'i systems. The state and Maui County also developed several smaller systems for diversified agriculture.

In the past decade, the state has taken over operations for the Waiahole Ditch and the Lower Hamakua system after plantation closures.

Currently, agricultural irrigation systems serve many types of crops, including export items like sugar, pineapple, coffee, seed corn and nursery plants. Several systems also deliver water to users like golf courses or resorts, with revenues from sales helping to cover operation and maintenance costs.

Health and environment: The Hawai'i Department of Health (DOH) is responsible for ensuring the quality of water resources is protected. DOH agencies involved in water management include the Drinking Water Branch, the Wastewater Branch, and the Clean Water Branch (environmental waters). They administer federal regulations for the U.S. Environmental Protection Agency.

Freshwater services: For Hawai'i's general population, the most important water institutions are the county water departments, which operate distribution systems on O'ahu, Maui, Kaua'i, Hawai'i and Moloka'i. Counties provided 80 percent or more of the public water supply in 2000, with the exception of the Big Island, where county systems supplied 68 percent (USGS, 2000; Hawai'i DBEDT, 2007). The Honolulu, Kaua'i, and Hawai'i departments operate as semi-autonomous agencies under an appointed board. Maui's department is part of the county government, and its board serves in an advisory capacity. The Honolulu Board of Water Supply is by far the largest water purveyor, supplying almost twice as much as the other counties combined in 2005 (Table 2).

All of the counties use an "inverted block schedule" of water charges for residential use. The price charged for water depends on the amount used. The first block provides basic service at the lowest price. Water use above that is charged a higher price. Currently, a typical family of four in Honolulu pays about $53 a month for 6,600 gallons of water, including surcharges.

Hawai'i counties have different block structures and water prices (Table 2). Despite tightening water supplies, Honolulu has the largest first-block water allowance, more than double that of Maui and Kaua'i Counties. It then has the smallest relative price increase in the second block. Maui County, on the other hand, has the opposite policy: A small first-block quantity at a low price, then a relatively high price for the second block.

County pricing differences can be explained by the fact that users are not actually being charged for the water, but to recover costs in providing water services. Public utilities frequently exhibit economies of scale, in which unit cost is tied to system size. The Honolulu board serves the largest population, and its lower per-gallon cost has led it to offer the relatively large first-block allowance, and the smaller price increase in the second block.

Wastewater: Most domestic water is used for non-consumptive purposes like washing clothes, and the water flows into some sort of wastewater disposal system. An estimated 82 percent of Honolulu's water deliveries are returned through its sewage system. County governments provide the bulk of wastewater

Table 2. County Services in Fiscal Year 2005

	Honolulu	Maui	Molokaʻi	Hawaiʻi	Kauaʻi
Freshwater usage					
No. of services	166,445	31,510	1,613	38,844	20,378
Water consumption million gallons per day	139.8	34.6	0.9	25	11
Residential water pricing*					
Monthly base charge per unit	$4.18	$7.00	$7.00	$12.00	$9.00
First block water use gallons/month per customer	13,000	5,000	5,000	5,000	10,000
First block usage charge	$2.00	$1.55	$1.55	$2.25	$2.25
Second block usage charge per 1,000 gallons	$2.40	$2.40	$2.40	$3.05	$2.70
Single family residential sewerage pricing*					
Monthly base charge per unit	$31.06	$18.00	$18.00	$27.00	$45.00
Volumetric charge for sewage gallons/month	over 2,000	first 9,000	first 9,000	none	none
Volumetric fee per 1,000 gallons	$1.07	$2.25	$2.25	n.a.	n.a.

*In effect Dec. 2006 (2004 for Kauaʻi sewerage). Hawaiʻi water price includes power charge. Honolulu sewerage charge adjusted for water use credit.

Data Sources: Hawaiʻi DBEDT, county webpages, Whittier (2006).

disposal in Hawaiʻi, using about 125 mgd of water. Military sewage systems serve only their bases, and all private facilities are relatively small operations (U.S. Census Bureau, 2004).

Institutionally, county wastewater departments operate separately from water supply boards. The federal Clean Water Act requires various sectors to pay an equitable share of wastewater treatment costs, and Hawaiʻi households commonly have higher bills for sewage than for freshwater service.

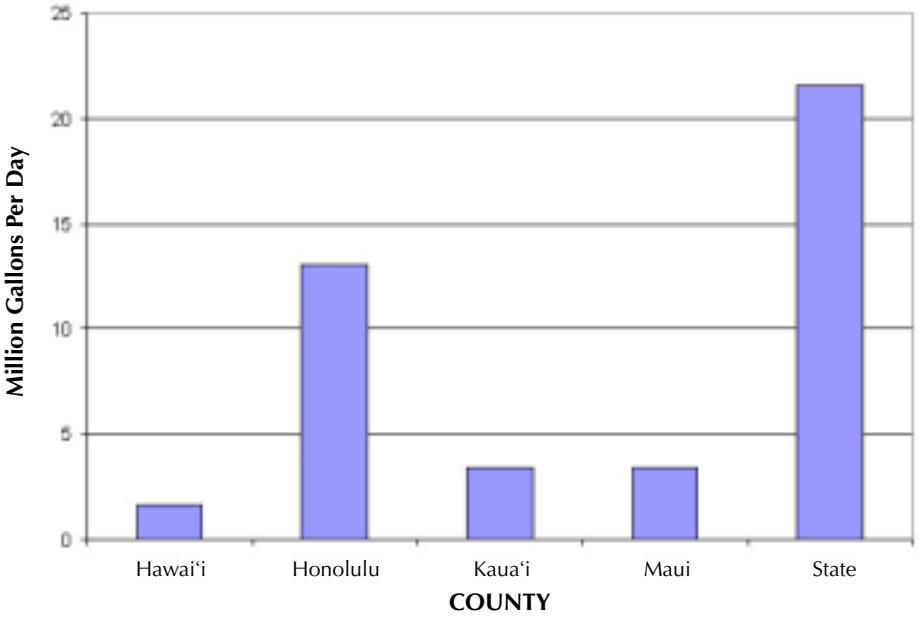
Honolulu charges additional fees for sewage flows over 2,000 gallons per month (Table 2). This is far below the 13,000 gallons of freshwater allowed in its first supply block for freshwater. Again, Maui County takes an opposite approach. Maui's volumetric sewage charge applies only to the first 9,000 gallons per month, much higher than the 5,000-gallon first block for water supply. Hawaiʻi and Kauaʻi counties only charge a fixed monthly fee for sewage treatment.

Although water systems are designed to flow in a cycle, important institutional functions like management and pricing have become disconnected in Hawaiʻi.

Wastewater pollution and reuse: Under the Clean Water Act, the EPA regulates wastewater treatment and disposal. Most wastewater is discharged into injection wells or through ocean outfalls. On Oʻahu, the greater part of the effluent is not treated to full secondary standards, under a waiver granted it by the Environmental Protection Agency.

Wastewater facilities discharging into surface waters are covered by National Pollution Discharge Elimination System (NPDES) permits. A recent search on compliance (USEPA-ECHO, 2006) for Hawai'i shows that among 20 major permittees, 75 percent had exceeded effluent discharge standards at least once over the past three years. The incidents occurred mostly at sewage treatment plants and electricity generating stations. There were also five major facilities considered in significant noncompliance or outright violation of the Clean Water Act. These include three military facilities (two at Pearl Harbor, one at Kaneohe) and two county sewage treatment plants (Sand Island in Honolulu and Wailua on Kaua'i). Properly disposing of wastewater is becoming a larger problem for Hawai'i.

Figure 3. Wastewater Reuse in 2006



Source: Parabicolli (2006)

With the recognition that disposal of wastewater into the ocean or injection wells is a waste of resources and a pollution source, there has been a push in recent years toward reusing wastewater for non-drinking purposes. Currently, about 21.5 million gallons per day (16 percent) of the state's wastewater is reused (Parabicolli, 2006).

Flash floods

Runoff from storm events is a common feature of Hawai'i's water cycle. Sometimes, high intensity rains cause flash floods which result in significant property damage or loss of human life. The National Weather Service found flash floods to be the leading direct cause of weather-related death in Hawai'i, with 46 fatalities reported from 1960 through 2005 (NWS Honolulu Forecast Office, 2006).

The National Climatic Data Center maintains an online database of storm events by location. Analysis of their information reveals that Hawai'i experienced a total 141 flash floods from 1993-2005, or an average 10 events per year. O'ahu and Kaua'i — which are more weathered, and have well-developed stream systems and steep topographies — account for about half of the flash floods. Most of the others occurred on Maui or the Big Island.

Information on damage caused by floods is not as reliable. A recent paper (Downton, Miller and Pielke, 2006) reanalyzed National Weather Service data collected since the 1920s, and found the agency consistently underestimated or ignored damage from smaller floods. Reporting has improved since 1990, with rough estimates being provided for floods with at least $1 million in losses.

Analysis of the property loss data for Hawai'i (in *Flood Damage in the United States*, 2003) from 1960-2003 shows a fairly steady increase in very damaging floods. This is consistent with national trends. More development at higher values and building densities results in greater flood losses. Hawai'i flood damage averaged $16.5 million a year from 2000 to 2003. If the Manoa flood in 2004 is included, the figure would rise to about $26 million a year. Property damage from floods is not very high when compared to the total value of private and public property, including infrastructure. However, such damages befall an unfortunate few and exclude losses like disruption to households and business. The long-run trend is troubling.

Toward 2050

In developing a vision for sustainable management and use of water, there are some key issues that need to be addressed.

Are the people of Hawai'i willing to change the ways they use water in order to conserve natural supplies? Technology, practices, and management systems are available that would significantly reduce the rate of water use for just about any purpose. Implementing such measures will cost money. However, because water is relatively cheap in Hawai'i, there may be little incentive to adopt water-saving innovations. Water pricing policies do not value the scarcity of the resource or the negative impacts on the environment. Will people change their water practices anyway? Why? How?

What tradeoffs are people willing to make for water uses that degrade the environment or pose risks to human health and natural resource systems? The plantations built irrigation systems that diverted large quantities of water. This had serious negative impacts on natural streams and native species. Modern society has created other types of water pollution. Are people willing to pay to stop, or even reverse, environmental degradation? This could mean out-of-pocket expenditures, or changing ways of doing things, like land development. Prospects for global climate change present a different challenge, perhaps larger than we have ever faced before. Scientists can't say for sure how global warming will affect water systems in Hawai'i. Should we do something now to prepare for such an uncertain future? What kinds of things could we do?

At what levels should water be managed — by the state, county, island, community, business, and/or household? Water institutions in Hawai'i have changed a lot since Native Hawaiians managed water as part of the ahupua'a system. The state government regulates the overall allocation of freshwater supplies. County

governments provide water services to the majority of people but there are still many private water systems. Households, businesses, farms, the military and operations like golf courses and resorts are the primary users. Public and private landowners are responsible for maintaining watersheds. The federal government regulates water pollution. The average citizen is largely divorced from water management, aside from paying bills. Who should be making the decisions on water policy, allocation, investment in infrastructure and environmental protection?

What mechanisms can better coordinate management and use of water and related natural resources? The state and county governments prepare long-term plans for water quantity and quality. Implementation is contingent on the actions of the larger society as environmental stewards to use water wisely. But there are no real incentives to do so. Can we regulate our way to a sustainable future? Are there other mechanisms that would bring about wider ownership of the problems and a more collaborative approach to water management? What policy or other changes would be needed to do this?

Water — our most precious and life-sustaining resource — must be protected and managed to ensure its quality and quantity for future generations. We hope this paper provided the necessary information on the challenges and efforts to date as well as insights and possibilities to guide our collective and individual decisions and actions.

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Our isolation in the middle of the Pacific Ocean, and a growing general awareness of the geopolitics of energy, are among the factors turning more attention toward alternate ways of generating power.

Energy

By Scott Turn

On his last Sunday in New York, near the end of a world tour, King David Kalakaua stepped down from a carriage on Fifth Avenue and was shown around the offices of the Edison Light Company by the famous inventor himself. It was 1881. Kalakaua had seen Thomas Edison's incandescent bulb in Paris and wanted to replace Honolulu's gaslights with electric ones, but was waiting for a system to be perfected. He listened intently as Edison displayed models, "and appeared to be more than ordinarily familiar with the theoretical aspects of the subject," according to The New York Times. Seven years later, Princess Kaiulani flipped a switch, and power from a turbine driven by a Nuuanu Valley stream lit Honolulu's streets. Printers, policemen and other night people rushed outside. "The long looked for and anxiously expected moment had arrived," the Honolulu Gazette reported.

Not only had the moment arrived, it stayed. Within a couple of years, 797 homes were hooked-up, and electricity today is so ubiquitous we rarely think about it except when paying bills or enduring blackouts. Yet Hawai'i has learned through hard experience some of the tenuous aspects of its energy position, evidenced best recently by the state's brief attempt to cap gasoline prices, the first such move in the nation. Our isolation in the middle of the Pacific Ocean, and a growing general awareness of the geopolitics of energy, are among the factors turning more attention toward alternate ways of generating power. Fortunately, Hawai'i has a number of options — solar, geothermal and ocean among them — and some almost certainly will need to be incorporated into our power grid to achieve a sustainable future.

Fortunately, Hawai'i has a number of options — solar, geothermal and ocean among them — and some almost certainly will need to be incorporated into our power grid to achieve a sustainable future.

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The basics

Commercial energy pervades all aspects of daily life, from the fuels to propel our vehicles to the electricity used to run our air conditioners, computers and dishwashers. Energy is needed in all sectors of society, including agriculture, industry, transportation, commerce and residential. The primary energy we use is derived from the sun, the Earth, and interactions between the two. Solar radiation is used by plants in photosynthesis to produce new biomass. Sunlight falling on land and sea is absorbed as heat, generating winds and evaporation, and rain. Gravitational attractions between the Earth, sun and moon cause tides that combine with wind to create waves. And the planet itself can be tapped for energy through its molten core and the radioactive elements in its crust.

Each of these energy flows is associated with a different time scale, a consideration in long-term planning. Some show no signs of abating: Those directly tied to the sun and gravitational forces occur in regular cycles, for instance, and heat from the core is steady and constant. Other energy flows have limits. Radioactive elements like uranium were formed with the Earth was created, and fossil fuels like petroleum, coal and gas were created only after millions of years of heat and pressure on accumulated biomass. Thus, supplies of these two are fixed and will vanish if trends in global energy consumption continue — with the not

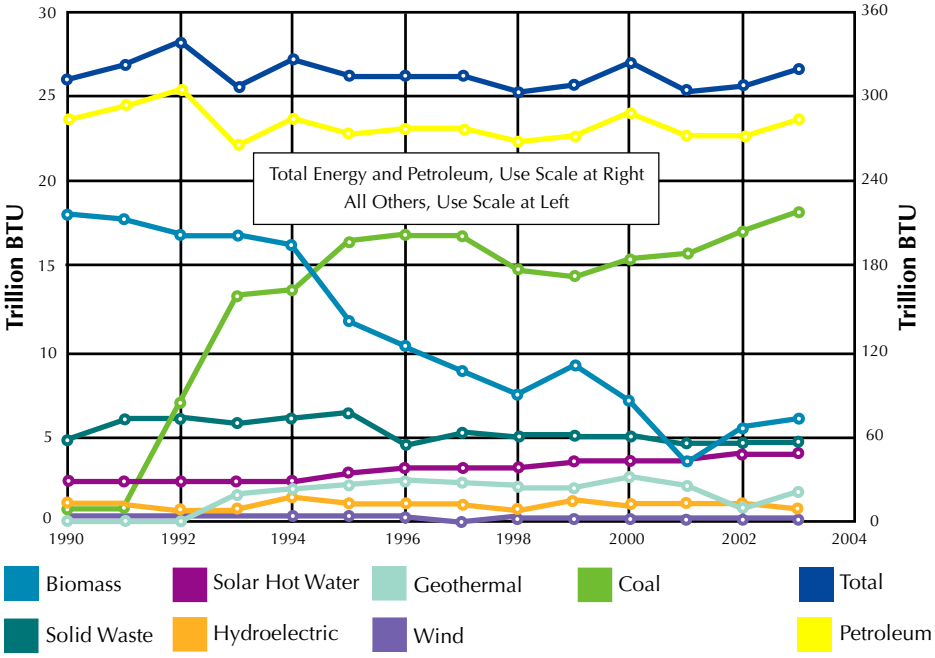
inconsiderable side impact of adding to global warming as we burn fossil fuels and release carbon dioxide into the atmosphere.

Long-term energy sustainability hinges upon conserving currently available primary supplies and developing new systems based on primary supplies that are renewable.

Past and present energy use: a graphic look

Much of the information in the following baseline profile of energy use in Hawai‘i is derived from data from the U.S. Energy Department and the state Department of Business, Economic Development and Tourism.

Figure 1. Hawai‘i’s Annual Energy Consumption 1990–2003



BTU stands for British Thermal Unit, a standard measure of energy defined as the amount of energy needed to raise a pound of water by one degree Fahrenheit. Eight gallons of gasoline contain about one million BTU.

Source: U.S. Energy Department and the state Department of Business, Economic Development and Tourism (2005).

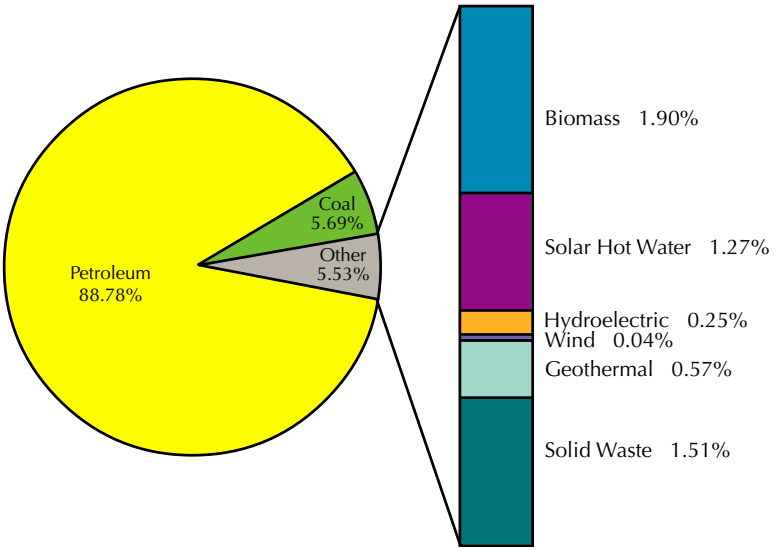
From 1990 through 2003, Hawai‘i’s primary energy consumption ranged from 300 to 350 trillion BTUs as shown in Figures 1 and 2. Petroleum accounted for nearly 90 percent of the 2003 total. Coal came in second, at more than 5 percent. The remaining primary energy sources — hydroelectric, wind, geothermal, solid waste and solar hot water — each accounted for less than 2 percent of the total.

The increase in coal use since 1992 is attributable to completion of a coal-fired power plant on O‘ahu. At the same time, the closure of sugar mills on Kaua‘i, O‘ahu, Maui and Hawai‘i led to a marked decline in biomass.

Hawai‘i has no indigenous fossil fuel resources, so nearly 95 percent of the primary energy supply is imported. Foreign petroleum and coal account for 73 percent of the primary supply, and petroleum-based fuels from Alaska and the West Coast make up 22 percent (DBEDT, 2005).

Petroleum accounted for nearly 90 percent of the 2003 total.

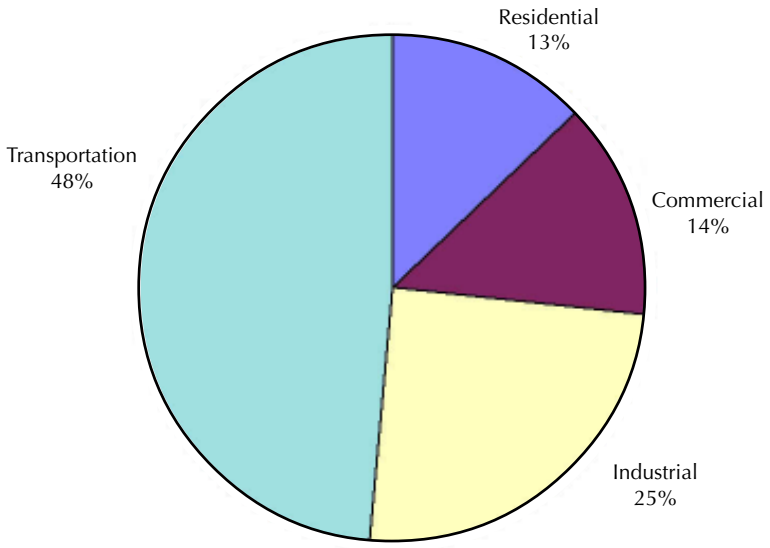
Figure 2. Hawai'i's Sources of Energy, 2003



Source: U.S. Energy Department and the state Department of Business, Economic Development and Tourism (2005).

The transportation and industrial sectors consume 73 percent of total state energy use.

Figure 3. Hawai'i Energy Use by Sector, 2002



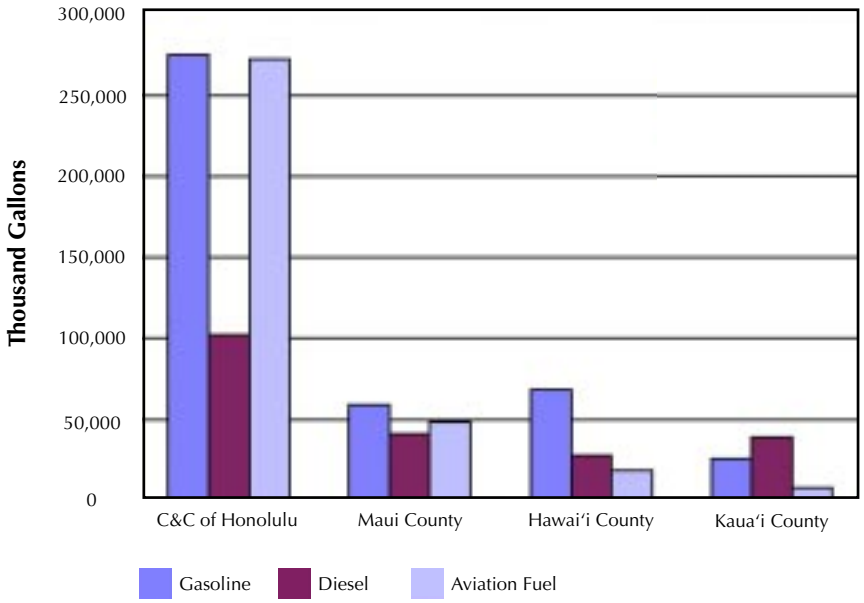
Source: U.S. Energy Department and the state Department of Business, Economic Development and Tourism (2005).

Clearly, Hawai'i is dependent on fossil fuels, with a high percentage coming from foreign countries.

Consumption can be divided into four end-use sectors: transportation, industrial, residential and commercial as shown in Figure 3. The transportation and industrial sectors consume 73 percent of total state energy use. The remainder is split almost evenly between the residential and commercial sectors.

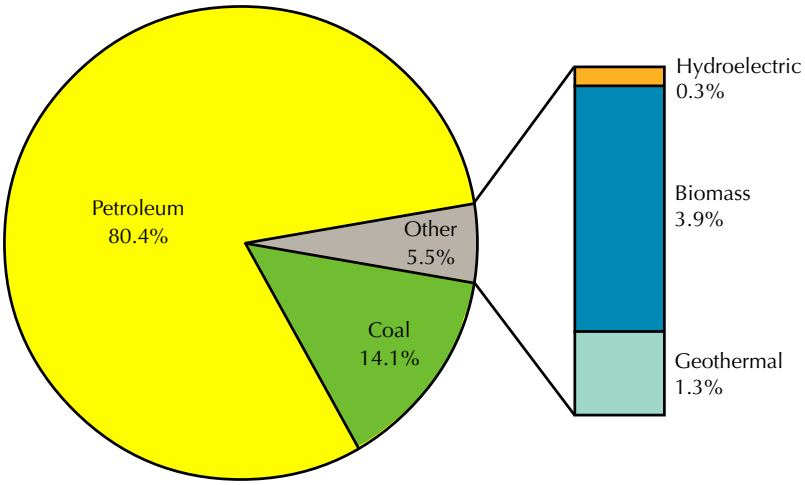
In 2002, transportation alone accounted for nearly half of Hawai'i's energy consumption. Statewide, 350 million gallons of aviation fuel and 210 million

Figure 4. Hawai‘i Liquid Fuel Use by County, 2002



Source: U.S. Energy Department and Department of Business, Economic Development and Tourism (2005)

Figure 5. Hawai‘i’s Electricity Use by Source, 2002



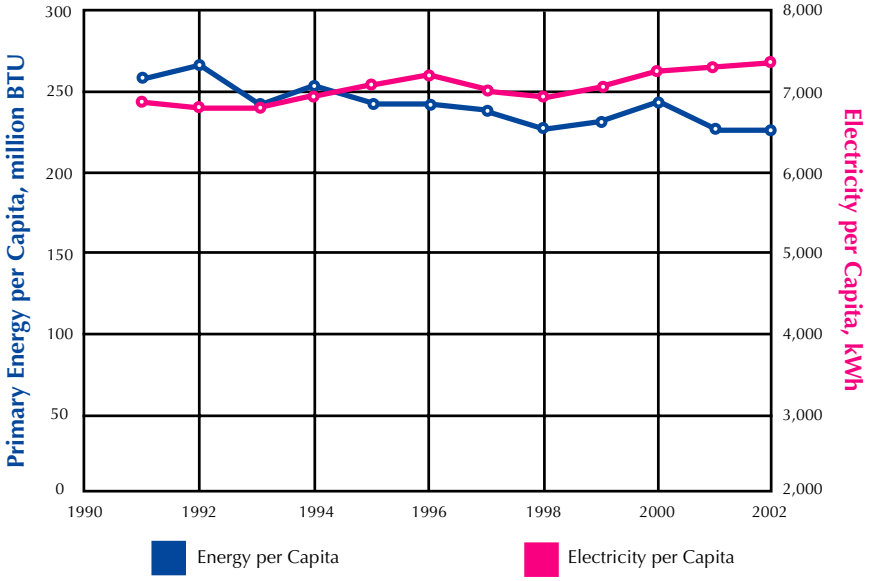
Source: U.S. Energy Information Administration (2006)

gallons of diesel fuel were consumed in 2002 as shown in Figure 4. Gasoline usage was 430 million gallons, rising another 5 percent — or roughly 24 million gallons — by 2005 Honolulu led all counties in liquid fuel usage with 66% of the total volume, followed by Maui (15%), Hawai‘i (12%), and Kaua‘i (7%) counties.

In the residential sector, electricity comprises more than 90 percent of the total energy used in homes. Solar water-heating (about 4 percent) and liquid-propane and natural gas combined (6%) account for the rest. Total residential energy usage in 2002 was 36 trillion BTU.

A kiloWatt-hour is a measure of energy equivalent to one kiloWatt of power expended for one hour. It almost always refers to electricity.

Figure 6. Summary of Hawai'i's Energy and Electricity Consumption (per capita), 1991–2002



Source: Department of Business, Economic Development and Tourism (2005)

While Hawai'i showed a downward trend in total energy use per capita, its electricity use per capita went up.

Electricity also was the dominant form of energy consumed in the commercial (90%) and industrial (60%) sectors.

Electricity is an intermediate energy product derived from a primary energy source. In Hawai'i, most of it is generated by burning fossil fuels, primarily petroleum as shown in Figure 5. Total retail sales of electricity in 2002 was 3.2 billion kiloWatt-hours (kWh). It is noteworthy that energy losses associated with generation, transmission and distribution amounted to 7.6 billion kWh, more than twice the amount consumed by end-users.

Hawai'i's energy usage can be compared to national patterns by looking at indices like energy use per capita (measured as BTU per capita), electricity use per capita (kWh per capita), and energy use per dollar of gross state product.

From 1991 through 2002, energy use per capita for the defacto population in Hawai'i – including military and tourism – decreased roughly 1 percent a year. As shown in Figure 6, per capita usage in the 1990s typically was above 250 million BTU, dropping to 226 million BTU in 2002. Meanwhile, national energy use per capita in 2002 stood at 340 million BTU, about a third more than in Hawai'i (DBEDT, 2005; US EIA, 2006; US Census Bureau, 2006; US EIA, 2006a).

While Hawai'i showed a downward trend in total energy use per capita, its electricity use per capita went up. From 1991 to 2002 it rose by an average 0.7 percent each year, ending at 7,300 kWh per capita. Still, that only is about 55 percent of the 2002 national average of 13,400 kWh per capita (DBEDT, 2005; US EIA, 2006; U.S. Census Bureau, 2006; US EIA, 2006a).

Hawai'i residents consumed 7,045 BTU for each dollar of gross state product, the value of all goods and services produced here annually (DBEDT, 2005; DBEDT, 2005a). Economic activity in the nation as a whole was more energy

intensive, requiring 9,374 BTU per dollar of gross domestic product (US EIA, 2006a; U.S. Department of Commerce, 2006).

Sustainability and life cycles

Sustainable energy has been defined as the dynamic harmony between two goals: The availability of energy-intensive goods and services to all people on an equitable basis and preservation of the Earth for future generations (Tester, 2005).

In looking at energy in this context, a method called life-cycle analysis applies particularly well. Life-cycle analysis attempts to identify all the materials and energy that goes into producing a specific item or service — a cradle-to-grave inventory from raw materials to manufacturing through use, repair, and maintenance, and finally disposal or recycling (Tester, 2005).

An example is a bicycle used for transportation. No fuel-up is needed, and no exhaust is created. However, life-cycle analysis also would take into consideration the energy used to mine the iron and aluminum ore needed to make the bike; the energy used in manufacturing its metal components; the completely different process needed to make tires, with a whole other set of material and energy requirements; the electrical generators needed to power the service-station air compressor to fill the tires; and the regular maintenance that must be done over the bike's lifetime, such as replacing tires and the lubricating chain with oil. On top of that the rider, as the primary energy source for transportation, will need food, water and sleep. Each of system parts has its own material and energy flow. The complexity of this simple example demonstrates some of the enormous difficulties that can arise when trying to make valid comparisons of larger energy systems.

Energy conservation is a general term for practices that reduce energy consumption.

Conservation: preserving energy sources for future generations

Energy conservation is a general term for practices that reduce energy consumption. The simplest of these is changing behaviors — by, for instance, cutting the number of miles driven in the family car, opting for a manual can opener instead of an electric one, or replacing an electric hot water heater with a solar unit. Consumption also can be reduced by using energy more efficiently to achieve the same result, such as driving a car with better gas mileage, or storing food in a refrigerator that keeps contents as cold as other models but uses less electricity.

Conservation is encouraged by utility companies, and the state and federal governments, through tax credits and incentive programs, like issuing rebates for installing solar hot water heaters. New home construction has joined the effort, touting energy-saving building features and energy-efficient appliances, including those labeled with the Energy Star by the Environmental Protection Agency and U.S. Energy Department (HECO, 2005; USEPA, 2006).

Conservation approaches energy from the user end of the chain. But in discussing sustainability, it also is necessary to examine the renewable technologies available on the supply side. Such technologies convert renewable energy sources — like geothermal, wind and biomass — into the electricity, transportation

fuels and other forms of energy Hawai'i residents use, and can cut the state's dependence on imported fossil fuels.

In discussing sustainability, it also is necessary to examine the renewable technologies available on the supply side.

Biomass: Biomass — typically plant matter and organic wastes — is a versatile primary energy source that can be converted into electricity, liquid transportation fuels and heat. It also can be used to manufacture bio-based materials and chemicals. Biomass currently is used in Hawai'i to produce biodiesel fuel, "process heat" for industrial purposes, and electricity that independent power plants sell to utilities for distribution.

Liquid fuels made from biomass, or biofuels, have received much public attention. The state Legislature mandated that, as of April 2006, 85 percent of the gasoline sold must contain 10 percent ethanol — a biofuel derived from starch, sugar or fiber. Under existing levels of gas consumption, that would require about 40 million gallons of ethanol. Several companies are developing in-state production facilities to meet the demand, but all ethanol currently is imported. In contrast, about 700,000 gallons of biodiesel fuel are being recovered annually from waste cooking oil. Ethanol and biodiesel are candidates in meeting standards set by state legislators in 2006 requiring the proportion of alternative fuels for highway driving be 10 percent in 2010, 15 percent in 2015, and 20 percent in 2020. To meet these targets, a more extensive biofuels production industry will have to be established in Hawai'i, particularly if a broader goal is to increase self-sufficiency (RMI, 2006).

Legislators have established the same proportions and timetable for using renewable resources to generate electricity. In 2003, about 4 percent of Hawai'i's electrical demand was produced from biomass, more than half of that from municipal solid waste. Bagasse from the sugar industry was the largest agricultural contribution. Several counties are considering increasing the use of municipal solid waste to generate electricity. About 60 percent of O'ahu's municipal solid waste is renewable and biogenic (produced by life processes). It is unclear what portion could be considered sustainable as nearly a third consists of paper products that were imported. Combustible plastic derived from petroleum makes up 10 percent of the municipal solid waste total. Although a good energy source, plastics are not renewable or sustainable.

Agriculture would play a key role in supplying the feedstocks — the starches, sugars, fibers or oil — needed for energy production. Expanding biomass supplies for sustainable electricity generation and transportation fuel production will require that the impacts on land and water use, environmental preservation, and economic and social impacts be equitably addressed. Biomass grown for energy production has the advantage of being carbon-neutral because carbon released as carbon dioxide during the energy conversion process is used by the next biomass crop.

But, as with any other renewable technology, it depends on the inputs throughout the production cycle: if nonrenewable sources like fertilizers, pesticides and equipment fuel are used, it could increase atmospheric carbon dioxide levels. To date, no life-cycle analyses have been done on biomass production in Hawai'i.

Geothermal: Geothermal energy is the thermal energy stored in the Earth's interior that can be tapped for generating electricity or direct heating. It provides a steady source of renewable energy all the time unlike the fluctuations that exist with wind and solar. In its most recent survey in 2005, the state

identified seven "high-temperature resource areas" on the islands of Maui and Hawai'i suitable for geothermal development (GeothermEx Inc., 2005). They have temperatures exceeding 250 degrees Fahrenheit no deeper than 9,800 feet below the surface, and at a maximum elevation of 7,000 feet. Currently, Puna Geothermal Ventures in the Kilauea East Rift Zone on the island of Hawai'i is the sole geothermal power plant in the state, delivering 25 to 30 MW of power to the Hawai'i Electric Light Co. for distribution to its customers. One megaWatt supplies enough power for about 1,000 homes.

Future geothermal electricity development may be limited because of the distances between point-of-production and point-of-use. Each island has its own transmission and distribution grid, and efforts to connect them with undersea cables have proven prohibitively expensive. Thus, geothermal electricity could not be sent to O'ahu where the demand is greatest. Geographic hurdles also exist within islands. The greatest potential for geothermal energy in Hawai'i County is the East Rift Zone, but electrical demand is growing fastest on the other side of the large island, in Kailua-Kona. Linking the two would require added transmission capabilities.

Other energy intermediates, such as hydrogen could be generated from geothermal resources and moved between islands. Technologies, such as fuel cells, that use hydrogen to produce power are still under development and not ready for commercial use.

In addition to logistical considerations, geothermal development may also be limited by pre-existing land uses such as national parks, state natural area reserves, population centers, and cultural sites. Despite that, the latest state assessment concluded geothermal energy could be economically developed by 2025 to produce 180 megawatts of electricity on the island of Hawai'i and 25 megawatts on Maui (GeothermEx Inc., 2005). The main environmental concerns are noise, land and water issues, and creation of gas, liquid and solid wastes during construction, operation and decommissioning. Many geothermal plants operate successfully with near-zero emissions or wastes (Tester, 2005).

Hydropower is a renewable energy technology that uses the kinetic energy of flowing water to power a turbine.

Hydropower: The energy of the sun evaporates water which returns to earth as precipitation and then flows from higher to lower elevations under the force of gravity. Hydropower is a renewable energy technology that uses the kinetic energy of flowing water to power a turbine. The turbine's rotating shaft is often connected to a generator, thereby producing electricity (DBEDT, 2005b). Hydropower currently provides electricity on Hawai'i island (17 megaWatts), Kaua'i (8.7 megaWatts) and Maui (6.2 megaWatts), for a statewide total of some 32 megaWatts. A 1981 study found a potential for double that amount (Greer, 1995; Hirai and Associates, 1981).

Two common types of hydropower installations differ in the way they manage the path of water. A run-of-the-river installation diverts a river's flow through a hydroelectric unit before steering it back to a downstream location. In contrast, natural or man-made impoundment dams block flows, storing water behind the dam for eventual release through hydropower turbines. Although hydropower plants are emission-free sources of electricity, both types would have an impact on stream ecosystems. Plant construction also is associated with greenhouse gas emissions and other environmental concerns. Additionally, flooding caused by man-made dams may cause loss of habitat (Tester, 2005).

Solar: Solar energy can be collected for direct use as thermal energy, or used to generate electricity. The most familiar example is the residential solar hot-water system, consisting of a roof-mounted solar collector, a water storage tank and a circulation pump. An estimated 80,000 systems have been installed in Hawai'i in single-family homes, multi-dwelling buildings and institutional facilities. Rebates and state and federal tax credits are offered to cut costs. They also provide a repository of information on popularity, performance and other such measures (DBEDT, 2005c).

Solar energy can be collected for direct use as thermal energy, or used to generate electricity.

Photovoltaic systems, also used in Hawai'i, harness the photoelectric effect in semiconductor materials to convert solar energy directly to electricity. They initially were adopted in locations distant from the utility grid as a lower-cost alternative to a grid connection. With rising electricity costs, particularly on the neighbor islands, they are an increasingly competitive option. Furthermore, recently enacted net-metering legislation allows the owner of a system to bank electricity with the utility during the day — when the system produces more power than is required — and withdraw it at night (DBEDT, 2006). Investment in PV systems also is encouraged by a state tax-incentive program.

Although solar energy clearly is a renewable resource in thermal and photovoltaic systems, the hardware used to capture and convert it to a useful product have life-cycle costs embodied in the materials for construction and maintenance (Tester, 2005).

Ocean: Tidal and wave action and thermal differences between surface water and lower depths present opportunities to extract energy from the oceans.

Tidal energy is similar in operating theory to hydropower: Water is retained by an impoundment structure at high tide, and then released through a turbine during lower tides. The economic feasibility of this scheme depends on suitably large differences in the tides, and coastlines shaped favorably for construction (Tester, 2005).

Wave energy captures the pitching, heaving and surging motion of waves to power the generation of electricity. Many different devices have been tested on a moderate scale. Wave sizes in Hawai'i are manageable for most of the year, but storm-induced waves of much greater intensity means the devices must be designed and built to withstand severe conditions, adding to their cost (Tester, 2005).

Ocean thermal-energy conversion (OTEC) exploits the temperature difference between water at the surface and at depths of 2,000 feet or more, about 40 degrees Fahrenheit. The cooler, deep water is pumped through a pipe to a power plant at the surface. The temperature difference between surface- and deep-water streams powers a heat engine, which drives a turbine to generate electricity. Additionally, the process can yield desalinated water, and cold water for air conditioning or mariculture. Different configurations have been proposed. For land-based plants, close access to cold water — meaning a steep, near-shore dropoff — is fundamental to reducing pipeline costs. The National Energy Laboratory of Hawai'i Authority operated a small experimental facility in the 1990s at Keahole Point on the Big Island. Since then, larger systems have received continued interest, but none have been built (DBEDT, 2005d).

All three ocean-based energy systems are assumed to be land-based or near the shore. Such installations can alter coastal zones and affect currents, wave patterns, and marine flora and fauna (Tester, 2005).

Wind: Modern wind turbines use energy from the wind to drive a shaft, which turns a generator to produce electricity. They range from off-grid residential units that may generate as little as 1 kiloWatt, to utility-scale units that produce from 500 to 5,000 kiloWatts. Commercial facilities, which may have several large machines, are sited in areas with consistent winds of roughly 15 mph or greater.

As with solar, wind is not a constant energy source, varying by season and time of day. Matching peak supply with peak demand is a primary issue for renewable technologies like this, and one of the reasons behind the great interest in economical means of energy storage. Transmission issues also may arise because of the distance between wind farms and demand centers. The state currently encourages investment in wind energy systems through a tax-incentive program (DBEDT, 2005e; AWS Truewind, 2004).

As with solar, wind is not a constant energy source, varying by season and time of day.

Net energy analysis of wind farms show that the energy expended in constructing a wind machine and locating it on site can typically be recovered within a year of operation. Wind turbines do not produce emissions during operation and emissions associated with their manufacture are largely associated with steel production making them a clear improvement over fossil fuel power plants. Other environmental impacts may include visual aesthetics, noise, and danger to birds (Tester, 2005).

Indicators of energy sustainability

Much of Hawai'i's current energy use is not sustainable in the long-term. It is likely that future energy use practices and policies will be enacted to increase the availability and use of sustainable energy products. To assess progress toward this goal, it is useful to identify indicators that can be measured and monitored (IAEA, 2002). Some of these indicators are already being tracked by the Strategic Industries Division of the state Department of Business, Economic Development and Tourism. Other agencies may also be collecting relevant data as part of their regular duties.

Hawai'i energy future

Movement toward a sustainable energy future will require a transition from our current, fossil fuel-dependent energy use to one based on renewable energy resources. Conserving energy by reducing consumption and improving energy use efficiency can ease this transition and reduce greenhouse gas emissions and negative environmental impacts associated with current energy use patterns. Hawai'i's energy consumption is small compared to the continental U.S. and the

Table 1. Energy Sustainability Indicators

INDICATOR	MEASURE
Indigenous energy production	Total for state Total for generating electricity Amount consumed by end use sectors (transportation/commercial/industrial/residential)
Net energy import dependence	Total for state Total for generating electricity Amount consumed by end use sectors
Efficiency of fossil-fuel use for electricity generation	Value for each generating unit
Energy mix	State primary energy supply Total for generating electricity Mix by end use sectors
End use energy prices	Price without tax Price with tax
Average energy use per capita	Total energy use per capita Electricity use per capita
Average energy use intensity	Use per dollar of gross state product Use per value-added dollar for end use sectors
Greenhouse gas emissions	Total for state Total for generating electricity Amount per end use sector
Emissions of other pollutants: particulate matter, volatile organic compounds, CO, NO_x, SO_2	Total for state Total for generating electricity Amount per end use sector
Fraction of disposable income spent on private consumption of fuel and electricity	For average household For households in lowest 20 percentile income bracket

Source: International Atomic Energy Agency (2002)

rest of the world, and production and use elsewhere will drive fossil energy prices and changes to the global environment. Development of Hawai'i's indigenous renewable energy resources is a means to buffer the state from these global impacts. At the same time, no energy conversion technology is without environmental consequences and life cycle analysis provides a systematic approach to evaluate the various options. The state's high-energy prices make it a natural proving ground for new technologies that are approaching commercial viability. Well reasoned support for existing and developing renewable and conservation technologies by individuals, businesses, and communities, and at all levels of government is necessary to move us toward a sustainable energy future.

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We now have a chance to fulfill in a meaningful way a 1978 state constitutional mandate to promote diversified agriculture, increase self-sufficiency and conserve agricultural lands.

Agriculture

By C.N. Lee and H.C. "Skip" Bittenbender

The need for wheat was dire in early 19th-century Hawai'i. Flour shipped on U.S. schooners arrived sour, buggy and so solidly-caked that a chisel and mallet was always included. "In those days the demand for saleratus (sodium bicarbonate) was imperious," moaned J.S. Green, noting the digestive woes striking those who dared consume their shipments. Only a little wheat was grown partly because milling had to be done by rubbing grain on lava rock and mostly because it was much more profitable to grow Irish potatoes.

The decline of the sugar and pineapple industries has — for the first time — opened-up vast tracts of prime agricultural land to a variety of potential crops.

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That changed in 1848 with the introduction of a better harvesting tool. Four years later, about 140 acres of golden wheat field were growing in Makawao, Maui. The next year, there were 1,200 acres planted, and a power mill was built in Honolulu that eventually ground enough flour to meet all home-consumption needs plus a bit for export. But settlers following the Gold Rush to California soon had larger-scale operations that yielded a lower-cost product, and island growers saw a better cash crop in sugar. "Thus, this industry had a comparatively brief day in Hawai'i, for by the late 1860's it was a thing of the past" (Crawford, 1937).

The story of wheat mirrors the story of commercial agriculture in Hawai'i — its existence driven by profit-maximization and outside market forces. Sustainable agriculture demands a reassessment of approach; one that is more in line with definitions of sustainability as "living in ways that meet our present needs without limiting the potential of future generations to meet their needs."

As it turns out, the reassessment could not come at a more opportune moment: The decline of the sugar and pineapple industries has — for the first time — opened-up vast tracts of prime agricultural land to a variety of potential crops. We now have a chance to fulfill in a meaningful way a 1978 state constitutional mandate to promote diversified agriculture, increase self-sufficiency and conserve agricultural lands (Hawai'i State Constitution, 1978). We can supply more food to residents and have more flexibility in providing for their changing needs. But land speculation, urbanization, and a lack of bold leadership work against this.

A brief history

The Polynesians who discovered Hawai'i came from self-sufficient homelands. They assumed they would find trees for lumber and fuel, and grasses for thatch and fiber. They brought with them food plants (taro, sweet potato, sugar cane), medicinal plants (kava and noni) and food animals (dogs and pigs). Just as significantly, they brought technology: tools, navigation, fire-making, cooking, construction, farming and fishing. The population and impacts grew. Some forests were cut down for agricultural land, and some bird species were driven extinct.

European, American and Chinese immigrants arrived in the 1780s, followed a century later by the Japanese and Filipinos. All came from self-sufficient countries, and all brought with them their own technologies and foods, adding to the cornucopia that would be raised here. Plants included potato, corn, rice, wheat, beans, onion and cabbage. Among the animals were cows, horses, hogs, goats, sheep, ducks and chickens.

Early trade centered on whaling and sandalwood. After sandalwood forests were depleted, trade turned to products that could be raised easily and sold profitably in the U.S., including sugar, coffee and cattle. As statehood approached, military expenditures and agricultural exports — sugar, pineapple, and coffee, joined later by macadamia and papaya — provided income to buy imported goods, including food that could be raised at a price advantage. Statehood brought tourism and trickle-down impacts, like chocolate-covered macadamia nuts.

The lay of the land

Hawai'i is a rich mini-lab of farming environments. Its islands have eleven of the 12 soil types (based on factors like moisture and temperature) in the world —quite remarkable given its limited land area (Hue, et al., 2006). It also has 10 of the 14 climactic zones, with the Big Island alone displaying the entire local range (Juvik, et al., 1978). Simply put, the state is structured for diversified agriculture as seen in the extraordinary range of crops successfully grown here over the years: peaches and apples, coffee and tea, strawberries and rambutan, asparagus and green onions. As one of world's most geographically isolated sites with a significant population, Hawai'i is clearly in an advantageous position for diversified agriculture.

Hawai'i has 4.11 million acres of land, or roughly 6,500 square miles. Based on 2005 state land use records, they are classified as Conservation (48 percent), Agriculture (47 percent), Urban (4.7 percent) and Rural (0.3 percent) (DBEDT, 2005). Of the 1.93 million acres designated as agriculture, nearly two-thirds — 63 percent — are on the Big Island. Some of these lands, such as on the eastern slopes of the Waianae mountain range on O'ahu, have not been cultivated for decades.

Some of these lands, such as on the eastern slopes of the Waianae mountain range on O'ahu, have not been cultivated for decades.

While the acreage may sound impressive, that is not the complete picture. The statewide inventory includes lava-rock plains and hilly slopes. Only about 13 percent of the total — or 249,000 acres — are considered good farmland suitable for crops (150,000 acres), grazing (43,600 acres), forestry (25,100 acres) or pasture (15,500 acres); or used for parks, golf courses, or gardens.

The current land market does not favor a commitment to long-term farming operations. Lands classified as Agriculture carry the second lowest tax burden next to Conservation. Landowners can raise prices and easily hold vacant land, allowing it to lie fallow or be used only for short periods, as they await a turn in the market. In 2006, for example, 1,600 acres of former sugar land on O'ahu, now slated for housing, reportedly sold for about $44,000 an acre (Honolulu

Star Bulletin, November 2006) — far out of reach of any farm enterprise and on a far greater order than the $1,000-$5,000 per acre typically paid in the continental U.S. (NASS, 2007a).

Many farmers are further burdened by an inability to obtain long-term leases — the last such leases were granted to the sugar and pineapple industries. The majority of leases now are for 5- to 10-year terms. They can be canceled with 120-days notice. Not only does this limit individual investment strategies, it also can be a deal-breaker for fruit and other crops that may take years to mature and turn a profit. Most significantly, it hampers efforts by the state and others to pursue with confidence any growth plans for agriculture beyond the relative short-term.

Diversified Agriculture, as a consequence, has seen remarkable recent growth, even in the absence of strong incentives like the tax credits granted the high-tech industry.

Trends, truck crops and tropical exotics

Sugar has so dominated Hawai'i agriculture for the past century that its decline represents a break with history. Consider just this: Sugar and pineapple — which also has retreated from our shores — constituted 76 percent of all agricultural lands planted in 1994. Combine them with the third major crop, macadamia nuts, and the figure rises to 87 percent. It is evident a sea change is taking place. In 1994, there were 121,100 acres planted in sugar. Just 10 years later, the acreage had plummeted to 43,000 and the value of unprocessed cane fell from $160 million to $61.5 million.

This has created an opening for diversified agriculture that is unprecedented and likely will never arise again. Some entrepreneurs quickly sensed the opportunity and were able to lease large parcels when early plantation closures made landowners initially desperate to find new tenants. Two such truck farmers on O'ahu, for instance, now have successful operations on more than 5,000 acres of former plantation land. They are testing the feasibility of new crops and employing displaced sugar workers.

Diversified agriculture, as a consequence, has seen remarkable recent growth, even in the absence of strong incentives like the tax credits granted the high-tech industry. Over the past 12 years, dollars earned by so-called diversified agriculture grew at a pace of about 3.5 percent a year, including during a period in the 1990s when the state was experiencing an overall economic downturn (NASS, 2007b). Farm-gate value — the price paid to the farmer at the gate, without costs like shipping and storage — rose to $576 million in 2005, a 7.5 percent jump from the previous year. Cash receipts are greater than sugar and pineapple combined.

At the forefront of the advance were seed crops, flowers and other nursery products, coffee, cow-calf operations and truck crops (products like vegetables, herbs and melons grown for commercial purposes by larger-scale farms that require trucks). Other sectors of agriculture, however, did not fare as well. Since 1999, Hawai'i's production fell by 18 percent for eggs, more than 30 percent for swine, 40 percent for dairies and 100 percent for broiler chickens.

Vegetables: Hawai'i is close to self-sufficiency in production of cabbage, green onions and Asian vegetables, such as choi sum, Shanghai pak-choi, shinjiku, malunggay leaves and yard-long beans. Most lettuce and other vegetables are imported. Immigrant farmers, with contacts from their homelands living in

other states across the nation, have begun exporting fresh herbs and ethnic vegetables that also appeal to gourmet- and high-end restaurants. Fresh basil, rosemary, thyme and oregano grown in Hawai'i reportedly have been consumed on the East Coast.

Fruit: Hawai'i meets much of its resident's demands for watermelon, papaya, pineapple and banana. There also are healthy seasonal supplies from backyards and small orchards of mango and tropical-exotic fruit such as lychee, rambutan and jack fruit. Much of the local produce is not found in mainstream markets, but is sold at farmer's and ethnic markets. Other types of fruit mostly are imported. Potential is seen in fruit like blueberries, dragon fruit and pomegranate.

Livestock: Cattle numbers decreased steadily from 1970-2001. They stabilized in 2002, and now are increasing slowly. About 150 head of cattle are slaughtered weekly, representing roughly 6 percent of the local consumption. Over the past decade, dairy and swine operations declined drastically because of retirement, rising feed costs and stricter environmental rules. The operations were shunted by urbanization to a corner of West O'ahu 40-50 years ago, where space shortages limit growth potential and the hot climate stresses animals, diverting efforts away from production and toward maintenance.

Hawai'i meets much of resident demands for watermelon, papaya, pineapple and banana.

Milk: As a necessity food item whose overall supply could be disrupted by dockworker strikes or other events, milk deserves separate attention. Milk production declined from 142 million pounds in 1995 to 69.6 million pounds in 2005, or 51 percent, representing a loss of more than 100 jobs and about $15 million in farm-gate revenues (NASS, 2007b). Local dairies now produce from 35 to 40 percent of the milk consumed here. The addition of 8,000 milk cows could raise that amount to 70 percent, but would require 10,000 acres of land for pasture and to grow feed crops, like corn silage. A closed-loop system — in which manure from indoor pen facilities (confined animal feeding operations) is used as fertilizer to grow crops — could reduce the cost of importing petroleum-derived inorganic fertilizers, but little such activity is taking place in Hawai'i.

Organics: National demand for organically grown food is rising 20 percent annually. While a staple at farmer's markets and health-food stores, commitments by mainstream supermarkets to sell more and the expected arrival in Hawai'i of the organic-oriented Whole Foods chain attest to the broadening market. The state's year-round growing season and its climactic variety would allow quick adaptation to meet the growing local and national markets. The amount of land needed for organic farming is difficult to assess, as it has lower yields and requires additional land for fallowing, crop rotation, and growing of "green mature."

Aquaculture: Repeated warnings about overfishing, along with wide knowledge about the health benefits of eating fish, make aquaculture the only solution to meeting demand. The majority of salmon in the marketplace is already farm-raised. The industry has been steadily growing in Hawai'i, and shifting from land-based operations to the raising of fin fish in deep-ocean cages — a technology developed here and representing a significant return on research investment (NASS, 2007c). Moi and kampachi now are being grown offshore of Kona. Explorations also have started into growing algae for pharmaceutical purposes.

Agricultural tourism: Agricultural tourism — giving visitors a hands-on opportunity to experience the Hawai'i farming lifestyle — grew by 30 percent

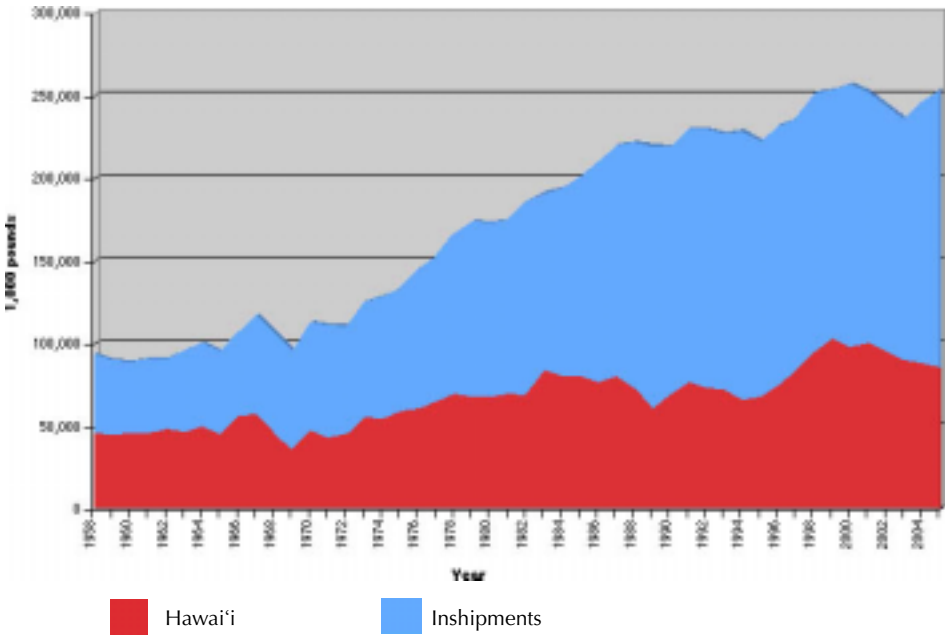
from 2000 to 2003. It is one of the fastest-growing tourism sectors, and has estimated revenues of $33.9million, with activity strongest on Kauaʻi and the Big Island (NASS, 2007d). Ag tourism often augments new niche markets, like organic Kona coffee, and gives them a synergistic boost. One operation on Maui is linking tours to its national award-winning goat cheese.

Independence from imports

Considerations of sustainability often invoke thoughts about self-sufficiency. While neither the state department of Agriculture nor of Business, Economic Development, and Tourism has an index of imported food consumption, it is generally agreed that over 80 percent of what we consume is imported. So, can Hawaiʻi turn that around and begin to supply all the food that its residents need? The answer, simply, is no.

Considerations of sustainability often invoke thoughts about self-sufficiency.

Figure 1. Hawaiʻi Market Supply of Fresh Vegetables (1958–2005)

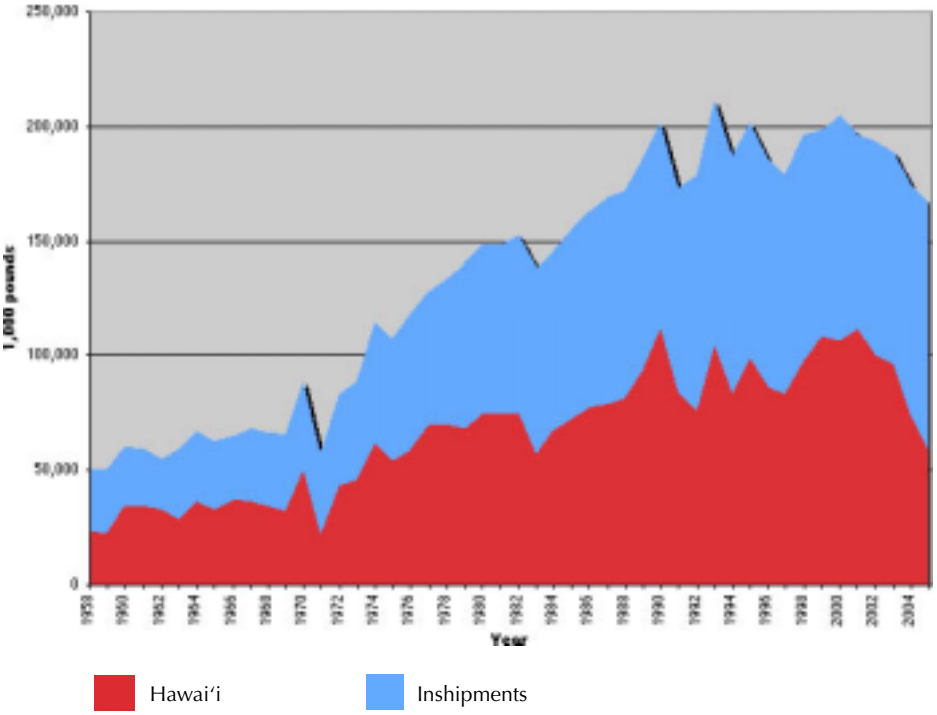


Source: Adapted from data provided by the Hawaiʻi Agricultural Statistics Service (Hollyer, J. 2007)

The reason is the cold, hard fact of our limited land supply. As previously noted, there are about 249,000 acres of good farmland in the state. By extrapolating from data about consumption habits and acreage needed per product, we calculate that near self-sufficiency would require an estimated 243,000 acres — and that does not include frozen, canned, or dried fruits and vegetables sold in restaurants and stores. and is only to meet projected resident needs in 2007, not those from the swelling visitor and resident populations expected by 2050.

The possibility is further diminished by competing uses for the farmland, which almost inevitably will continue to see a pattern of erosion. Thus, Hawaiʻi will remain dependent on imported foods, which in some cases would be the cost-efficient choice. We can, however, reduce that reliance significantly by more

Figure 2. Hawai'i Market Supply of Fresh Fruit (1958–2005)



Source: Adapted from data provided by Hawai'i Agricultural Statistics Service (Hollyer, J. 2007)

prudent use of our agricultural lands. In 2005, because of difficulties in acquiring use, and other reasons, only 102,000 acres of the available inventory made it into crop.

Toward 2050

Hawai'i's people have a deep appreciation for and value agriculture — and not just because of the harvest. Native Hawaiians speak eloquently about relationships with the land and perpetuate cultural values through traditional farming. Many residents live here because their ancestors migrated to work on the plantations. And nearly everyone, it can reasonably be assumed, shares a love of the green and open spaces around them — so removed from metropolitan stress and cacophony and so increasingly scarce.

In fact, Hawai'i's people have expressed their feelings many times, often in legally binding ways.

The foundation was built into Hawai'i's Constitution. In 1978, a constitutional amendment called for the protection of Hawai'i's natural beauty and resources, including agricultural land, which allows for land banking as a control on growth. A 1995 survey found that 81 percent of those polled thought maintaining open space was important, and households were willing to pay an average of $81 annually to keep former sugar lands open (Vieth et al.,1995).

Native Hawaiians speak eloquently about relationships with the land and perpetuate cultural values through traditional farming.

O'ahu voters in 2006 approved by a ratio of 2.5 to 1 an initiative to set aside 0.5 percent of annual property taxes each for land conservation and affordable housing programs (Honolulu Star Bulletin, 2006).

Table 1. Hawai'i's Current Agricultural Acreage and Additional Acreage Required for Food Self-sufficiency

Use	Current acres	Additional acres required for self-sufficiency
Vegetables, taro, sweet potato	6,400	15,000 (potato 2,300 acres, sweet potato 410, taro 8,300 acres)
Rice	0	12,750 (10)
Wheat, soybeans, corn	0	50,000 (11)
Sugar	40,000	Ethanol production from current sugar cane acreage
Pineapple	14,000	0
Fruits	6,200	1200
Macadamia	18,300	0
Coffee	8,000	6,000 (12)
Other crops	9,100	0
Beef cattle		36,000 (13)
Dairy		20,000 (14)
Poultry and hogs		(15)
Total	**102,000**	**140,950**
Estimated acreage for near self-sufficiency in food does not include additional acreage for fuel beyond current land in sugar.	242,950	

O'ahu voters in 2006 approved by a ratio of 2.5 to 1 an initiative to set aside 0.5 percent of annual property taxes each for land conservation and affordable housing programs (Honolulu Star Bulletin, 2006). Big Island voters endorsed a similar conservation set-aside. And Act 156, the legacy land act passed by the state Legislature in 2005, raised the conveyance tax partly to provide a permanent mechanism to fund the protection of natural areas and to purchase land for public conservation, including agricultural lands. Purchase grants available for 2006 totaled $3.6 million. Meanwhile non-government organizations such as The Trust for Public Lands have emerged to preserve some agriculture lands (Honolulu Advertiser, 2007).

For the most part, however, the clear public sentiment has not been matched by an equally forceful governmental response — the type of bold political strokes needed to ensure a strong agricultural potential for future generations. The majority of the good farmland is owned by private entities that generally seek

the highest-priced use through rezoning for development. Since developments can also provide a quick boost to the local economy, as well as adding housing or addressing other present-day issues, they consistently succeed.

As Hawai'i looks at sustainability and, in effect, accepts future generations as equal partners in planning, the erosion of agricultural land must be reassessed immediately. Many reasoned arguments can be made about competing uses so perhaps we need to be reminded of a basic fact: Food is fundamental to life, and the bulk of what we eat — from the fast-food hamburger to the latest culinary concoction — are derived from a farm. There are no realistic alternatives. In this context, we might ask: Would citizens in 2050, looking back, wish we had urbanized a piece of farmland? Or might they wish we had kept it available to agriculture, both to cultivate fresh food, and as a buffer to the unpredictable vagaries of shipping food from suppliers at least half an ocean away? What would they consider the highest and best use of the land? And what might they want to pass along to their descendants?

Sometimes we understand the value of a thing only after we have lost it.

Hawai'i and agriculture have been so long associated that we wonder about other consequences of a shift away. For one thing, open land reduces runoff, which helps recharge aquifers. But there may be impacts that go deeper inside — to an understanding of who we are and how we fit in the world. Unlike big-city urbanites, agriculture has kept us connected to the basic levels of the food chain and, thus, to the interconnectedness of life with earth and sun and water. It is part of our character. Perhaps we sense this only subliminally. But the tourists paying money to visit farms in Hawai'i should serve as a caution: Sometimes we understand the value of a thing only after we have lost it.

We will be judged by our children, and their children. Hopefully, they will say we acted prudently.

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The way we choose to use our land dictates
much of our identity and the manner in which we live.

Land Use

By Tom Dinell

Kalama Valley, Nukolii, Waiahole Valley, Kaho'olawe, Sandy Beach, Hokulia, Waahila Ridge.

The place names of Hawai'i are poetry to the casual ears. But in the history of Hawai'i they are flashpoints of land use and development conflicts emblematic of a current that has flowed through the islands since The Great Mahele reforms of 1848. The relative scarcity of land in Hawai'i magnifies its value and intensifies the struggle among competing uses. Control the land, and you control much more.

Land is enshrined in the state motto, Ua mau ke ea o ka 'aina i ka pono *(The life of the land is perpetuated in righteousness)*

***Tom Dinell**, MPA, FAICP, Emeritus Professor, Department of Urban and Regional Planning, College of Arts and Sciences, University of Hawai'i at Mānoa*

Those living in Hawai'i have long understood this. Native Hawaiian traditions are closely linked to relationships with the land. Land is enshrined in the state motto, *Ua mau ke ea o ka 'aina i ka pono* (The life of the land is perpetuated in righteousness), a phrase attributed to King Kamehameha III in 1843 speaking at the time of the return of the kingdom by the British. And while Hawai'i was the last state to become part of the Union, it was the first to embrace statewide land-use planning.

The way we choose to use our land dictates much of our identity and the manner in which we live. That has been true in the past and shows no signs of changing in the future.

The central role of land in Hawai'i

Land in Hawai'i is limited. The islands are surrounded by water. Just head *makai* (toward the ocean) of wherever you are and you will come to the Pacific Ocean. There is none of the vast frontiers of the American West.

When land is limited, there is intense competition for lands that can be developed. Shoreline land is ideal for the visitor industry, public recreation, residential homes and the U.S. Navy. Relatively flat lands with access to water are desirable for agriculture; they are also great for building subdivisions. A site on which affordable homes can be built may also be the nesting ground for an endangered species. Even the mountaintops are not spared: Mauna Kea is perfect for conducting astronomical research, but it also is a place sacred to Hawaiians. Perhaps the most intense competition comes from wealthy outsiders seeking luxury condominiums or country estates as second homes or retirement dwellings.

Competition for the land has grown more intense over the years, bringing into sharper focus competing concepts about the role of land in society. There is the dominant market concept — namely, that it may be bought, sold and used as the owner sees fit, within the parameters established by law. The market approach conflicts with the Hawaiian concept of the *'aina* as a communal resource, the well being of which is the responsibility of every member of the community; and also runs into conflict with the belief of many that preventing degradation

of the environment, and hopefully enhancing it, takes precedence over the right of owners — whether an individual or a company or a public jurisdiction — to do as they see fit with their land.

Add to this the fact that ownership is concentrated. Hawai'i is comprised of 4.1million acres of land. Government owned about 38 percent of it in 1988[1] — the state with 29.4 percent, the federal government with 8.4 percent, and the counties with 0.4 percent (DBEDT, 1988). The eight largest landowners accounted for another 20 percent in 2003, though the percentage is decreasing with changes in the Damon Estate, the break-up of Amfac/JMB and C. Brewer, and the transformation of the Campbell Estate into a private corporation (DBEDT, 2005). Still, a single eleemosynary estate, Kamehameha Schools, owns 8.9 percent of the state's land.

One of the consequences of concentrated ownership is that a relatively limited number of entities controls the rate at which land is released for development. There is an inherent conflict between such concentrated ownership and a marketplace governed by the uninhibited operation of the law of supply and demand. All of this makes land use a dominant political issue in Hawai'i.

One of the consequences of concentrated ownership is that a relatively limited number of entities control the rate at which land is released for development.

Planning and land use: how we got to where we are

One land use conflict after another ends up in a political arena, whether it be the City Council, the State Legislature, the chief executive's office, the courts, the Land Use Commission . . . the list goes on and on. Tip O'Neill, the former speaker of the U.S. House, once famously said, "All politics is local." In Hawai'i, the expression might be paraphrased to say, "All land use conflicts are political."

A spate of land use plans emerged in Hawai'i, starting at the time of statehood. The newly empowered Democratic Party sought to control the actions of major landowners and saw planning as a means to accomplish a range of goals, in particular, preventing what they perceived as the exploitation of public and private lands (Dinell, 1995). The litany through the 1970s include:

- The State Land-Use Law in 1961, the first instance of state control of land use in the nation.
- The Hawai'i General Plan in the late 1960s.
- The Planning-Programming-Budgeting Act in 1970.
- The Commission on the Year 2000 in 1970.
- The Tourism Impact Plan in 1970.
- The Temporary Commission on Population Stabilization in 1970 and the permanent Commission on Population and the Hawaiian Future in 1972.
- The Office of Environmental Quality Control and the Environmental Council in 1970, the environmental impact statement requirement in 1971, and *A Plan for Hawai'i's Environment* in 1973.
- *The Growth Policies Plan* 1974-1984 in 1974.
- The Coastal Zone Management Act and Plan in 1977.
- The Hawai'i State Plan authorized in 1975 and adopted as state legislation in 1978.
- A host of county general and community development plans produced during this same period.

[1]Comparable data do not appear in subsequent DBEDT Data Books.

Planning is a process that needs implementation. It is in the implementation that the infrastructure of Hawai'i's land use planning system has come up short. In 2005, the American Planning Association, Hawai'i Chapter, identified the following challenges (American Planning Association, 2005):

- Extraordinary amounts of time required to secure development approvals;
- Duplicative state and county review processes;
- Substantial degree of uncertainty as to what can and cannot be done;
- A reliance on litigation to resolve planning and zoning issues and settle specific disputes;
- Confusion over the purpose of the State Agricultural District, the rules for allowing residential use, and the criteria for designating agricultural lands;
- Use of the Agricultural District as the "residual" or "default" class, leading to far more acreage designated "agricultural" than will ever be actively cultivated and thousands of acres that are not suited for any kind of farming;
- Too many public resources spent on project-by-project regulation and too few spent on effective planning;
- Poor coordination between the state (i.e., education, transportation) and the counties (i.e., water supply, wastewater, solid waste systems) in terms of land-use planning and capital program planning; and
- Limited public participation in long-range planning and over-emphasis on narrowly-focused, often heated public hearings on specific projects.

The state Land Use Law, however, remains one of the most influential mechanisms for controlling our future.

Implementing a process focusing on sustainability will require changes to our system of land use regulation and control.

The pioneering state Land Use Law, for example, was intended to provide that focus, but in many ways the law is zoning, not planning. This is particularly true since the seventies when the state Land Use Commission was transformed from a quasi-legislative body with responsibility for five-year boundary reviews into a quasi-judicial body holding contested case hearings and making decisions on a project-by-project basis that have tended to duplicate the efforts of county planning entities.

The state Land Use Law, however, remains one of the most influential mechanisms for controlling our future. Briefly, the law creates four classes of land: Urban (under county jurisdiction), Agriculture (joint state-county control), Rural (joint state-county control), and Conservation (governed exclusively by the State Department of Land and Natural Resources). Land, with some exceptions, only moves from one classification to another with the approval of the Land Use Commission.

Currently, of the 4,112,388 acres of land in the state, the Land Use Commission has classified 1,973,636 acres or 48% as conservation (DBEDT, 2005). Such lands, as noted earlier, are managed by the State Department of Land and Natural Resources and are either not available for development or may only be developed in a very limited manner. The Agricultural District accounts for 1,930,797 acres or 47% of the total. The estimates of what portion of this acreage constitutes important agricultural lands varies, generally running between 400,000 and 600,000 acres. A fair portion of the acreage in the Agricultural District is land covered by lava. Lands classified Urban total 197,085 acres or slightly less than five percent of the state acreage. Finally 10,870 acres are classified as Rural or about a quarter of one percent of all lands (DBEDT, 2005).

Since 1987 the acreage in the Agricultural District has decreased by 35,658 acres while the Urban District has gained close to 29,000 acres and the Conservation District has increased by a little less than 7,000 acres. The Rural District acreage figure has remained relatively constant as well as minute.[2]

The major land use challenges[3]

Deciding how we use these lands in the future, and who decides on that use, will be critical to the future of these islands. We continue to struggle with the problems of designating important agricultural lands and distinguishing what are rural lands and uses therein that should be regulated. The counties demand greater control over their own lands; others fear exclusive county control. And, there is the continuing conflict between the rights of private owners to do what they see fit with their land and the rights of the public to preserve the environment.

What is needed is moving from a project-by-project approach to a coordinated planning process. This will require not only cooperation among the state and counties but structural reform as well. One possibility, for example, would be transforming the State Land Use Commission into a state Planning Commission that would set planning goals and guidelines for the state and standards and guidelines for counties focused on sustainability (American Planning Association, 2005). This kind of coordinated planning process is necessary if Hawai'i is to have a reasonable chance of achieving a sustainable future.

We continue to struggle with the problems of designating important agricultural lands and distinguishing what are rural lands and uses therein that should be regulated.

Structural reform such as this, and there are others that could be considered, will be critical to dealing with the major land use challenges facing us in the future.

Whether we continue with our existing land use management system or adopt reforms such as above, we still face some critical dilemmas related to sustainability. In addition to the impact of global warming — perhaps the major non-structural land use challenge facing Hawai'i and every other area of the world, especially those with shorelines (see sidebar on global warming), we need to consider the following:

Sustainable land development: The accepted wisdom among planners is that compact land development is energy efficient. People can walk to work and to shop and to be entertained. This means less use of cars and therefore reduced oil consumption. Among the land use instruments to encourage compact development are urban growth boundaries, density bonuses, transfer of development rights, modernization of urban schools, improvement of urban infrastructure, ohana housing, provision of convenient, comfortable public transit in town, and refusal to invest public funds in areas where growth is not desired.

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[2]State law, as currently written, inhibits use of the Rural District by prescribing a half-acre minimum lot size. If 100,000 acres were to be developed in half-acre lots, even designating 30% of the land for roadways and similar infrastructure, the result would be 140,000 building lots or rural sprawl with very high infrastructure and service costs.

[3] The steps recommended in this section to address the major land use challenges do not constitute a definitive listing of possible measures, but rather reasonable sets of initiatives, which are designed to facilitate further discussion and formulation of action programs.

We can take steps locally to be a model for other states and nations – so together we can work toward saving our planet.

Do We Plan for Global Warming?

Global warming is a worldwide problem that threatens our future. If it continues to increase, the impacts on Hawai'i will be devastating: rising sea levels, climbing ocean and land temperatures and increasing ocean acidification that will adversely impact the marine food chain. Global warming may decrease Hawai'i's desirability as a place to live and to visit. If the nations of the world, especially the United States, fail to reduce the emission of carbon dioxide and other greenhouse gases that lead to global warming, any positive steps that Hawai'i takes will have little impact on protecting and preserving the islands. There is no land use policy that Hawai'i can adopt that will keep the rising sea levels away from our shores.

So what can Hawai'i's residents do? We can insist that our political and corporate leaders take every measure possible, nationally and internationally, to reduce carbon dioxide and other greenhouse gas emissions. And we can take steps locally to be a model for other states and nations — so together we can work toward saving our planet. Here are a few ways:

(1) reduce our dependence on the automobile — use public transportation, bike, or walk;

(2) develop and use energy efficient transportation alternatives such as public transportation and hybrid, electric or solar-powered vehicles;

(3) facilitate energy efficient compact development;

(4) stop developing along the shoreline;

(5) install solar units and photovoltaic cells on every roof-top;

(6) promote alternative energy sources and technologies;

(7) adopt green building codes applicable to new buildings and retrofit existing structures;

(8) use energy efficient light bulbs, small engines, and appliances; and

(9) plant trees.

Confronting global warming is crucial in planning for the future of Hawai'i and every other part of the world. If we do not successfully face up to global warming, our planning will be either an exercise in futility or a rear guard action.

Within the context of compact urban development, green building standards become important. So does recycling all the way to the possibility of using sewage sludge in the generation of electricity. Planning for the microclimate is equally important, whether it is lawns on office building roofs or trees and other landscaping at ground level. The point is that compact development by itself is not an answer to energy efficiency. It is how compact development is carried out that counts.

Sustainable residences: Green building standards apply to construction of single-family residences, duplexes, row housing, garden apartments, and other low-rise housing as well as to major structures. So does solar power to heat water and photovoltaic systems to produce electricity with excess power being fed back into the power grid. Toilets that consume less water or have two flush phases also reduce water consumption. The use of grey water to irrigate lawns and the recycling of all kinds of household refuse, including green waste, also contributes to energy efficiency. Whether it is possible to reduce household waste by decreasing excessive packaging is more a matter for national attention than local initiatives, though distribution of bulk item in food stores in the manner used at Kokua Market on Oʻahu would help.

Hawaiʻi has one of the great success stories in restoring a species threatened with extinction, namely, the saving of the nene.

Sustainable water supply: Sustainable land use requires a sustainable water supply. The single most important element in maintaining the water supply is assuring the recharge of the aquifers. This means protecting existing recharge areas against development. It also means reducing, or at least not increasing, the amount of impervious surfaces created as an adjunct to urban and suburban development, namely, roads, sidewalks, and driveways. Roads and sidewalks can be designed so that runoff water percolates into the soil subsurface, while driveways can easily be constructed of permeable materials. There is a whole battery of low intensity development techniques that can be used in suburban areas to reduce runoff and increase recharge.

Protection of threatened and endangered species: Protecting threatened and endangered species is part and parcel of sustainability. Hawaiʻi has one of the great success stories in restoring a species threatened with extinction, namely, the saving of the nene. Hopefully Hawaiʻi can protect other endangered species, of which the State has many, both fauna and flora, before they are on the verge of elimination. This means protecting wetlands, expanding habitat areas, and eliminating, or at least controlling, invasive species that are already here and preventing new ones from entering the State.

Protection of agricultural lands, rural areas and open space: The first step in protecting agricultural land is identifying the important agricultural lands. The second step is restricting the use of such lands to productive agricultural uses, explicitly described, and limiting development on such lands to farm dwellings and auxiliary uses, strictly defined. There are a bevy of techniques available that are useful in preserving agricultural and rural land and open space including zoning (a temporary measure), purchase of development rights, conservation easements, transfer of development rights, cluster zoning in conjunction with conservation easements, form based zoning codes, and marketing and promotion assistance.

Toward 2050 and beyond

This is by no means a definitive list of challenges and initiatives. It is a starting point for putting together a plan of action for a sustainable future.

In the end, although planning is about land and buildings, water and energy, it is most basically about relationships, namely, the relationship of each us to one another and to the world we live in. Relationships improve not because we mandate such an outcome but because we live and work and play in an environment that invites people to relate humanely to one another and to sustain that environment for themselves and those that come after them. The job of planning is to create that humane, sustainable environment.

Planning for that humane, sustainable environment requires developing a vision of what we want Hawai'i to be and encouraging a continuing dialog between policy makers, planners and members of the public about the common good. It is not that such a dialogue will result in a set of tablets being brought down from Mount Waialeale that will forever define the common good. That's not going to happen, but what will happen is that people involved in the dialogue will begin to think in terms of their island community and other persons rather than just their own immediate self-interest.

Planning for that humane, sustainable environment requires developing a vision of what we want Hawai'i to be and encouraging a continuing dialog between policy makers, planners and members of the public about the common good.

A sustainable future is a future that emphasizes relationships and participation, and continuing dialogue about the common good. Land use planning will be successful in the future if it becomes an efficient tool to advance these goals and make Hawai'i a more sustainable community than it is today.

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Holomua Kākou[1]

By James H. Spencer

At the start of 2007, Hawai'i faces critical decisions that will shape the living conditions of current and future residents. The Hawai'i 2050 effort focusing on sustainability is an important first step in helping residents reach a set of collective decisions on the development they would like to see. As legislators, citizens and other stakeholders move forward, we should remember two key points that underlie this process.

Only through strategic, long-term planning can we make the minor adjustments necessary to preserve our quality of life, while precluding major and dramatic changes.

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First, change is inevitable. As one of the most physically isolated areas of the world, Hawai'i risks underestimating the significant ties that bind it to the continental U.S., the Asia-Pacific region and the rest of the globe. Rapid changes in technology, communications, transportation and diplomatic relations have created new opportunities, challenges and risks — from reduced costs of inter-island travel, to gridlock, to the threat of avian influenza. We cannot avoid these changes, and we cannot hide our heads in the sand and watch small changes spiral into uncontrollable problems. Only through strategic, long-term planning can we make the minor adjustments necessary to preserve our quality of life, while precluding major and dramatic changes.

Second, planning for such challenges and risks may not entail what many people think. Since the Reagan era, Americans have legitimately questioned the efficiency of governmental agencies and planners, demanding greater accountability and attention to taxpayer dollar expenditures. This has led to many bitter political fights and controversial reassessments of the role of government, which significantly affect citizens' material conditions and trust. Whatever the political party, such erosion of public confidence raises an unnecessary barrier to efforts at sustainability.

Accountability is at the cornerstone of long-term planning in Hawai'i. In acknowledgment of that, centralized planning has been giving way to a more modern version of "deliberative planning," which engages citizens in a long-term consultative process and has a record of success. Among planners, the Chicago Plan of the early 1900s has long been a shining example (Chicago Municipal Public Library, 1997). Rather than having a monolithic group of central planners decide how to invest public dollars, the plan created a diverse commission of policy, business and civic leaders, to chart a long-term vision for the city's future. The commission knew it would be difficult to develop the will to make the needed investments in transportation, housing and parks, for example, so they turned the discussion into a region-wide effort that incorporated citizens, going so far as to teach the plan to public school students. When these students became voters years later, they had a better sense of their city and of the investments necessary to successfully adapt to current changes.

[1]Let's move forward together

Five principles

Hawai'i is not Chicago, and the 20th century is not the 21st. Nonetheless, the example illustrates the importance of citizen engagement in debating the implications of long-term social, political and economic trends, and reposes at the public, private and civic levels.

An examination of state revenues and expenditures from 1997 to 2004 would seem to support this position. Although there were exceptions, tax and most other revenue sources maintained a consistent gradual increase during those years. Expenditures also exhibited a remarkable overall consistency, increasing moderately. Spending for education, police protection, public welfare, health and other categories rose at roughly comparable rates, while spending on natural resources, highways and hospitals showed less consistent growth trends. Improvements were seen in some problem areas. But many problems persist, and may worsen (DBEDT, 2005).

Absent a major increase in spending, this suggests there is no easy policy fix to the many challenges facing Hawai'i. With trends showing the population getting older and poorer, and less able or willing to pay taxes, the issue may not be whether to create more programs, or even to cut government spending. Rather, the overriding question may be whether the state is able to respond to challenges by tapping unused social and economic resources.

With trends showing the population getting older and poorer, and less able or willing to pay taxes, the issue may not be whether to create more programs, or even to cut government spending.

This basic question is likely to shape the coming decades of the policy debate in Hawai'i, and evidence from other regions suggest five principles that might be useful starting points for Hawai'i 2050 efforts.

Local policy partnerships: There is growing recognition that many solutions to socioeconomic and environmental challenges require coordination among the public and private sectors, and civic organizations. The Grameen Bank, co-recipient of the 2006 Nobel Peace Prize, is a global example of harnessing market principles to serve the very poor, through micro-loans and supportive services. Community development corporations have long been used to battle poverty through a similar model. Another excellent example is the Location Efficient Mortgage, which creates economic opportunities at minimum cost, and is particularly relevant to Hawai'i's current housing problems (Locationefficiency.com).

Sustainable macroeconomic transitions: The state has experienced a major macroeconomic change in the past 50 years — going from a plantation economy to one based on tourism and the military. Although it has had to adapt to changing markets and competition, in the short term Hawai'i will continue to exploit its comparative advantages. There are early signs of threat, though, as the state's political power in Washington, D.C., declines over time, and as comparable destinations in areas with lower labor costs begin to attract vacationers. This need not be a harbinger of worse things to come. Global changes have always created transitional periods, and the impact on residents depends on the quality of planning for the transition. Successful macroeconomic transitions require creative thinking, financing, resource reuse and education. For example, the Ruhr Valley in Germany — which transitioned from an economy based on coal mining and steel to one based on service and high-technology while simultaneously improving the environment — shows some of the results that can come from good and creative planning (U.S. Environmental Protection Agency, 2006).

If the intent of Hawai'i 2050 is to achieve sustainable norms, then public policymakers will need to set a coordinated agenda.

Revitalization of a cultural economy: Hawai'i has a unique culture that is a mixture of Native Hawaiian, Asian, and American influences adapting to one another to form a uniquely "local" flavor. Although such a local culture continuously evolves and incorporates new ideas, there is a recognized need to socialize new residents, as well as educate long-term residents on how this local tradition is changing and adapting to a new global environment. While there is often agreement that there exists a "local" flavor, these characteristics often are not well-adapted to the material and economic realities of residents. Cultural identity is a difficult objective to regulate and legislate. On the other hand, light-handed policy incentives could work toward creating a living culture that balances cultural uniqueness with material sustainability. Santa Fe provides an interesting example of the benefits and pitfalls of using historic districts to achieve a living and materially sustainable cultural coherence (City of Santa Fe, 2005).

Setting a coordinated agenda: A project-based approach to sustainability will inevitably fail to work on a large enough scale. Thus, creative partnerships for homeownership or environmental resources will remain idiosyncratic if they do not lead to the development of new norms. If the intent of Hawai'i 2050 is to achieve sustainable norms, then public policymakers will need to set a coordinated agenda. This task is, perhaps, the most difficult aspect of achieving sustainability because it requires a comprehensive strategy that is itself legislatively sustainable. There are numerous examples of states and regions that have attempted to create a coherent policy agenda for sustainability. The most often cited is Portland, Oregon. With demographics and socio-economic inequality challenges resembling those of Hawai'i, California has also tried to embark on a similarly coherent sustainability policy agenda. Initiated by the State Treasurer's office, this agenda cuts across government agencies and makes low-cost state investments in the environment, education and the economy based on a set of clear statewide objectives that integrate economic growth with environmental quality and social equity: the Three E's (Angelides, 2005).

Realistic accountability: Any policy agenda should have a strong component for addressing outcomes. Traditional policy evaluation has centered on formal qualitative and quantitative studies. Such types of analyses are critical to ensure accountability, but contribute little toward public debate. The clearest way to debate that encourages positive steps towards sustainability lies in the development of a system that promotes a "race to the top." In such a system, the performance of "competitors" would create pressures on officials to spur economic growth, while maintaining adequate distribution of economic opportunities and a quality living environment.

Such systems have been greatly facilitated by two developments: the application of modern data management systems to publicly available quantitative data and indicators, and the growing technical sophistication of civic organizations. Chicago's Center for Neighborhood Technology has developed a "Neighborhood Early Warning System" accessible to even the poorest resident so they can identify early signs of neighborhood decline and make appropriate engagements with government agencies and the private sector to address these problems before they spiral out of control (Center for Neighborhood Technology, 2004). Similarly, "Neighborhood Knowledge Los Angeles," a partnership between the University of California, Los Angeles and a local nonprofit group, led to a multi-language online neighborhood monitoring system that allows citizens direct access to publicly available, but formerly inaccessible, data so they can educate

themselves on changes to their region and make informed personal decisions (Neighborhood Knowledge, 2001).

Starting today

Hawai‘i has many efforts broadly dealing with sustainability issues. A preliminary scan showed at least 21 island organizations or campaigns currently working to promote the idea of sustainability. These efforts range from representatives of national organizations working at a statewide level, to professional local organizations created to protect a particularly valued resource, to purely voluntary efforts. In addition, there is a wide range of definitions of sustainability used by these groups. Some advocate for the protection of open space, others train school teachers in ecology, while still others produce research and data on demographic, economic and ecological issues.

Despite great population differences, these organizations are dispersed throughout the islands, with four on the Big Island, five on Kaua‘i, four on Lana‘i, three on Maui, and five on O‘ahu. Some of these efforts are highlighted below and at the HI2050 website. Several efforts that combine environmental, social and, to some degree, economic issues stand out as taking a broadly applicable and inclusive approach to sustainability.

The Kohala Center: Founded on the Big Island, the Kohala Center is dedicated to building an independent institute to better tap the island's natural and cultural heritage. Programs include workshops on ecology for school teachers, symposia on dryland forests, and scholarships to promote leadership in the environmental field. Its focus on leadership development at both the teacher and student levels engages a segment of society likely to have the greatest impact on sustainability in Hawai‘i (Kohala Center).

Malama Kaua‘i: Malama Kaua‘i's motto is "sustainable solutions for Kilauea and beyond." It tries to meet this motto through broad-based activities such as recycling initiatives, public education on environmental issues, community gardens, and the promotion of alternative energy solutions for households.

The Kauaian Institute: The Kauaian Institute is an independent research organization aimed at providing information for decision-makers on various topics in Hawai‘i. It maintains a website with various publications it produces, covering topics ranging from economic development to local demographic and cultural change, as well as ecological trends. This community-based "think tank" also maintains a blog, providing an interesting forum in which residents can consider and debate local community change (Malama Kaua‘i).

The Urban Land Institute, Hawai‘i: The Urban Land Institute is a national organization active in Hawai‘i on sustainable urban development. The main objective of the independent Hawai‘i branch is to encourage the development of mixed-use urban areas and the creation of "livable communities." It invites national and local experts to speak in Hawai‘i on current topics such as light rail, transit-oriented development, and affordable housing. In addition, it sponsors informal meetings for young leadership (Urban Land Institute, 2006).

As Hawai‘i 2050 moves forward to engage the state in an extended dialogue on developing sustainability, three things should be kept in mind. First, we should take a broad definition of sustainability that simultaneously includes environ-

mental conservation, economic, and socio-cultural development. Second, we should find a good balance between research, debate, projects and policy. And third, the education of young and old leaders, and others, is the starting point on a pathway to living sustainably.

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The Paradise Index

An Invitation to Dream, Act, and Be Accountable

By Paul Berry

The time has come to rethink what we mean when we call Hawai'i paradise. As the preceding chapters show, we have been taking too much from paradise without leaving the qualities we value for future generations.

We need to make decisions and act today to ensure that future generations can continue to live in and nurture "Paradise."

Along with others in the community, the Hawai'i 2050 Sustainability Task Force believes we must begin thinking seriously about the future — 2050 and beyond. We need to make decisions and act today to ensure that future generations can continue to live in and nurture "Paradise." To assure that our long term hopes become realities, the Task Force is asking the community to tell us what should go into a plan to ensure a better Hawai'i by mid-century and thereafter. We need to begin deciding what we should or shouldn't do to make Hawai'i livable and enjoyable for ourselves, yet leave the right legacy for those who follow us.

In Hawai'i we measure nearly everything — numbers of visitors, average dollars per hotel room, pounds of trash per person, the number unemployed, even how many potholes we still have to fill; but, ironically, we have no system for measuring the quality of life — not just the essentials but the things we love; what for each of us makes paradise a paradise.

If we want the future we hope for, I propose that all of us join in creating what we'll call "The Paradise Index."

The 2050 Task Force has identified many of the essentials of an index from community input throughout the past year — building upon our cultural roots, a diversified economy, better jobs, more renewable energy, better use of our limited land, ensuring health, and doing a better job of protecting the environment. But we need specifics, the measurements that will make for sound decisions based on good information; and how we can be accountable — knowing whether we are moving in the right direction.

Accountability means making sure that individually and collectively we see ourselves as both part of the problem and a necessary part of the solution. The indicators in our Paradise Index could give us the information to gauge our actions and check whether they lead to solutions — every day, but especially at election time. We need measures that tell us how we're doing — as individuals, families, and communities — and it should become a way for our elected officials and all of us to be held regularly accountable for responding to what the measurements reveal.

Finally a Paradise Index ought to be practical — show us how individuals, groups, schools, businesses, and government can change their behaviors to keep "Paradise" as paradise.

***Paul "Doc" Berry**, MA, author, filmmaker.*

What is the Paradise Index?

The Paradise Index is yet to be created. Some of the principles have already been articulated, drawing on the wisdom of Hawaiian culture, which for centuries understood how to remain self-sustaining. Based on what we know, some indicators have been suggested in the previous pages; they might include:

- Water consumption per person;
- Percentage of food we consume that is grown in the islands;
- Percentage of compact fluorescent lightbulbs used in the household;
- Diversity, health, and balance of resident plant species;
- Shoreline and river/stream water quality;
- Sewage and trash produced per person;
- Percentage of registered hybrid cars;
- Percentage of living wage jobs;
- Percentage of affordable housing units compared to total demand; and
- Percentage of residents with chronic disease.

The final list will depend on all of us. If a Hawai'i 2050 Plan is to succeed and reflect what most of us think about the do's and don'ts that make Hawai'i a paradise, we need you to help us think through and create collectively those useful indicators that will lead to principles, policies, and actions for a sustainable Hawai'i. These will guide how we as a community and government can hold each other accountable to ourselves and to those who follow us.

How we go about measuring such concerns, who should do the measuring to make sure it's fair and reliable, and how we keep the public informed — all need to be worked out before we have a useful Paradise Index.

So here is your invitation to participate. Please find your way to our website at http://www.hawaii2050.org [online] and give us your ideas on The Paradise Index.

Together let's shape a better future for Hawai'i.

The Future: A Call to Action

When this publication was being planned, an early working title was "A Citizen's Guide to Sustainability in Hawai'i." As it came into being, though, it became apparent it wasn't going to be that — not through any shortcoming, but because of the false premise of the title itself. There is no authority that can guide a citizen toward a sustainable future. Rather, it is the citizen who must serve as the guide, showing the way to others by personal example and action. Sustainability is not a government program we have the luxury of observing with detached interest. It is here, it is now, and it involves everyone.

Now we are being called upon to care about living conditions decades away, as much as we care about conditions today.

Recognition is a good first step, and we have tried to offer that by pointing out some of the key issues that fall within the purview of sustainability. But that is only the first step. Consider this: Thirty-seven years ago, the *Hawai'i 2000* report pointed to economic equity as one of the important principles for building a future society. This year, as we look toward 2050, we have identified income inequity as one of the key problems. Many different theories could be spun about why the problem persists, many figures cited, many fingers pointed. But the stark and simple reason is, not enough people cared enough.

Now we are being called upon to care about living conditions decades away, as much as we care about conditions today. We recognize the rationale. We see the potential problems. We have a window of opportunity. The question then is, will enough people care enough?

Governmental bodies can be enlisted to focus funding and muster manpower. When issues are on the magnitude of an ecosystem, coordination is needed. But more is needed to reach a sustainable future. The main front will be in our homes, when we install solar panels, or eat local produce, or turn off the shower when we soap-up. It will be in our cars, when we choose alternative fuels, or abandon them altogether in favor of public transport. It will be in our offices, when we open the windows and turn off the air conditioning. It will be in our minds, when we see this not as sacrifice, but as basic good sense.

Hawai'i begins this effort in a position of flexibility. We are guests in a land of incredible beauty and generosity, with crystalline water and fertile land. Our record here has been spotty, if not destructive and shortsighted. Many have been at work for years trying to reverse that, and through their work have regained a sense of how they fit in the world, of their duties to people now and to come — a self-awareness that is both a prerequisite for sustainability and one of its rewards. Now the rest of us must choose, individual by individual. The moment is at hand. The future is watching.

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