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Harmonizing People and Nature: the Natural Capital Project ~Making Conservation Profitable~

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First, I wish to say how grateful I am to receive the International Cosmos Prize for 2009. I thank you very much for taking part in this event; for the chance to talk with you; and for making Japan a world leader in the quest to harmonize people and Nature. The initiatives in Japan to promote the science and practice of *satoyama*, and to host the 10th Session of the Conference of the Parties to the Convention on Biological Diversity, are fostering critical and inspiring advances.

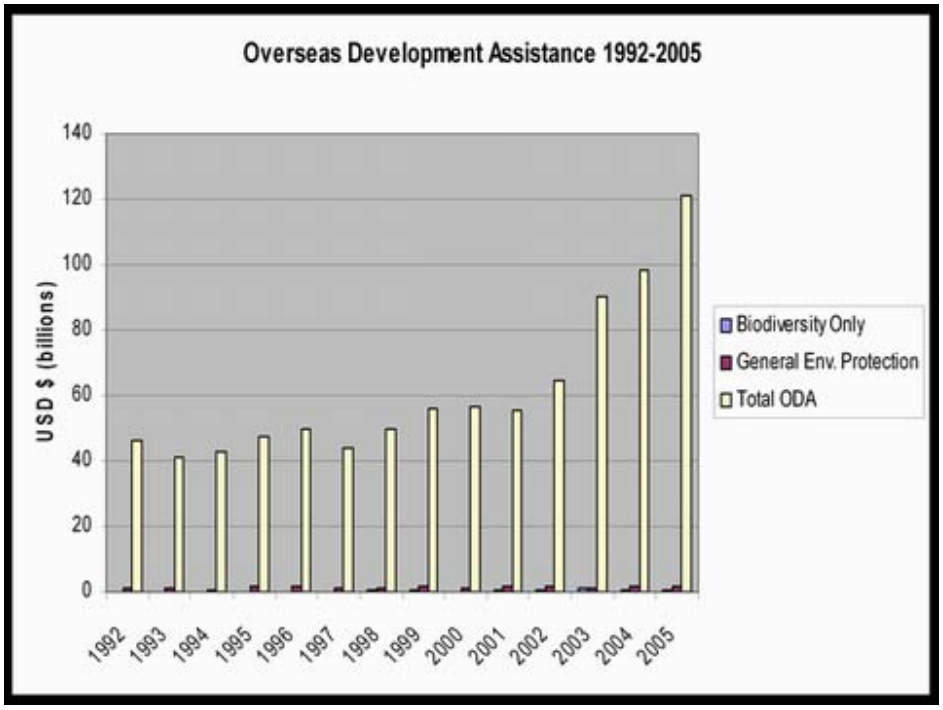
We come together here by many different paths, but in pursuit of a shared vision and dream. We seek a world in which people, governments, and corporations recognize the values of natural capital – embodied in Earth's lands and waters – in supporting human well-being, and routinely incorporate these values into decision-making.

Although the forces we must overcome to achieve this vision are daunting, sometimes even to the point of paralysis, I wish to share now the growing feeling of *renaissance* in the conservation community. This flows from the promise in reaching – together with a much more diverse and powerful set of leaders than in the past – for new approaches that align economic forces with conservation, and that explicitly link human and environmental well-being. We are reaching for a future that no one could hope to achieve alone, and I thank you for your personal part in this.

I find it absolutely stunning to realize that until the next asteroid hits Earth, it is humanity – more than any other force – that will dictate the future course of all known life. Collectively, we have the power to wipe out most macroscopic species, and to change dramatically the future course of evolution of the rest. We exercise this power with little regard for the implications for human well-being, let alone that of our living companions.

And the realization is dawning that traditional approaches to conservation are doomed to fail. Nature reserves are – and are likely to remain – too small, too few, too isolated, and too subject to change to sustain more than a tiny fraction of Earth's biodiversity (maybe just 5%) and life-support services to society, over the long run.

For conservation to have enduring success, it must become both economically and culturally attractive and common-place in the sea of human activity. Innovative conservation approaches that seek to achieve this are emerging in promising cases around the world. I will give an overview of these models of success – such as *satoyama* landscapes in Japan – and explore how they might be scaled up and replicated to make an impact globally.



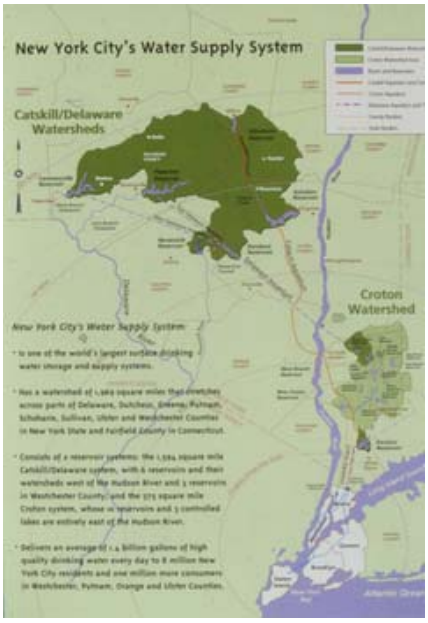
Overseas Development Assistance 1992～2005

This graph shows the fractions of overseas development assistance that go into protection of biodiversity or the environment generally – almost invisible fractions. We need a new business model, in which we recognize natural systems – Earth's lands and waters – as capital assets. If properly managed, natural capital sustains a flow of vital benefit, such as food production, water purification, climate stabilization, and protection of biodiversity, the working parts of Earth's life-support systems.

Yet in today's economic systems, too often only market commodities like food production are recognized. We need to develop policy and finance mechanisms that reward production of the many other valuable goods and services from landscapes and seascapes.

This idea has great appeal – it makes a light bulb go off in people's minds. But turning the idea into action is a challenge not yet solved on a large scale. Moving from idea to action requires specifying a suite of things, such as the benefits to be sustained, who will pay for them, how much will be paid and to whom, for what measurable actions or outcomes, and for how long. Doing this well requires new scientific and policy tools and approaches, an area of great innovation – and the focus of the Natural Capital Project and the rest of my presentation.

Let's look first at an iconic, real-world success: New York City.



New York City's Water Supply System

You can see the city in the lower right of the figure. It's 9 million water consumers draw 90% of their drinking water from the Catskills Mountains about 150-200km away. The water was long the envy of many – so pure that it was bottled and sold for its putative health benefits. But during the development boom of the 1980s, water quality was seriously compromised – for example, by construction of homes like this one, right alongside streams.


Development of the Catskills Mountains

To summarize a complex story that has been unfolding over more than a decade, City officials faced a choice: they could secure water quality either by building a physical water treatment plant or they could recognize the natural water purification system of the Catskills watershed and invest in restoring this natural capital. The investment in physical capital was estimated to cost US$6-8 billion with annual operating expenses of US$300-400 million and a 10-year lifetime. The investment in natural capital, by contrast, would cost about US$1.5 billion and endure.

In 1997, New York City embarked on a bold experiment in choosing – on economic grounds – to invest in natural capital. They recruited over 90% of farmers and foresters into programs of sustainable production practices designed to protect and enhance water quality.

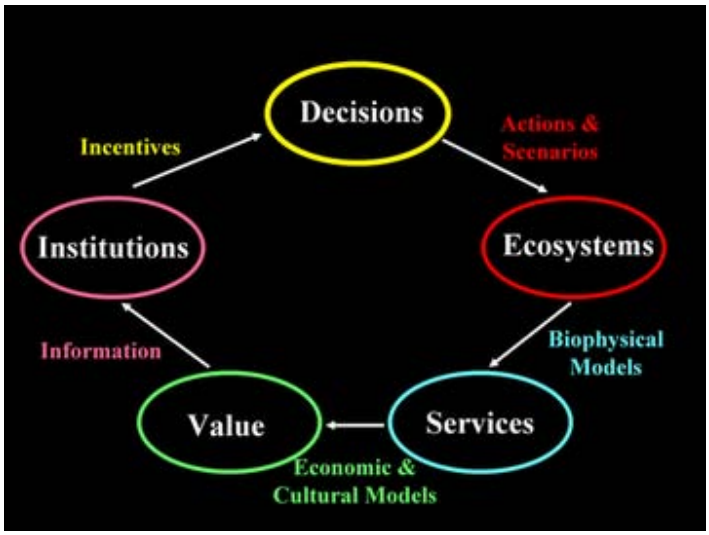
Investment in Natural Capital

They paid for farm infrastructure, such as the improved barn (for dairy calves) and fencing (in the photos), and they bought land (at fair market value) along streamsides to restore natural wetlands and other ecosystems good at trapping sediments, nutrients and pathogens.

When I first visited, I felt a bit let down. Why hadn't this been done all along? Where was the "rocket science"? Then I came to appreciate how much of the rocket science is on the policy side – and that political outcome was a tremendous breakthrough, in yielding a triple win. The people in NYC are getting clean drinking water at the lowest cost; the people supplying it are – for the first time – being compensated; and the third win is for all the other benefits, from climate stabilization to biodiversity and scenic beauty, being protected under the umbrella of water purification. (To appreciate these, one can ask whether a romantic weekend away would be better spent at a water treatment plant or up in the Catskills Mountains?)

In the same year, Costa Rica demonstrated further "rocket science" to the world, enacting a nation-wide, voluntary payment system for a suite of life-support services critical to the well-being people there and globally: climate stabilization, water purification (for drinking, irrigation, and hydropower supply), biodiversity conservation, and protection of scenic beauty. The payments come, for each of these services respectively, from investors in "forest carbon offsets" (of greenhouse gas emissions), from the national electricity company (which relies heavily on, and exports, hydropower), from the Global Environment Facility, and from a gasoline tax paid at the pump. They offered a very low payment – about US$50 per hectare per year – in the hopes of getting a few volunteers and time to work out kinks in the institutional system collecting revenue and issuing payments. But they were immediately oversubscribed, even at that low payment level. With this and related policies intended to harmonize people and Nature, Costa Rica has gone from having the highest rate of deforestation in the world to the lowest, alongside Bhutan.

The challenge now is to replicate and scale models like these, and to develop science and policy foundations that ensure their credibility and sustainability.



The Research Thrusts of Our Work

This simple schematic highlights the research thrusts of our work, starting with the role of biophysical sciences in illuminating the link between decisions and ecosystems (e.g., the effects of agricultural practices or climate change on biodiversity and ecosystem functioning), and the link between ecosystems and services (e.g., the provision of agricultural pollination, flood control, water purification, and other benefits). Social sciences are central to understanding the value of services to people, as well as the social impacts of alternative schemes to protect service provision (e.g., the effects on the poor of ecosystem service payments). Finally, finance and policy research is key to designing effective institutions – public and private – for aligning economic forces with conservation and mainstreaming natural capital into decisions.

With that background, let's look at the elements of this framework in more detail, starting with biodiversity – the plants, animals, and microorganisms that are the working parts of Earth's life-support systems. How do we move beyond reserves, and into the sea of human activity? The conventional scientific view has been that most organisms are highly adapted to their native habitats and that few, therefore, would be able to exploit areas heavily modified by human activities. In general, those few would not require or merit protection. Through my own work and recent research of others, such as on *satoyama*, it is clear that, to the contrary, that human-dominated ecosystems can retain very substantial conservation value.

In extensive field work in Costa Rica, my group has found a wide array of plants and animals living in the farming countryside, including a diversity of birds, mammals, reptiles, amphibians, butterflies, moths, bees, and herbaceous plants. We are now focused on determining exactly which habitat elements on farms – trees, hedgerows, crop plants, and remnants of native habitat – are most important for sustaining biodiversity, using radio telemetry and other approaches. We are also focused on which elements of biodiversity are most important for sustaining human benefits, such as crop pollination and pest control.

This work shows that at least half of the native species (and the vast majority of families) in each group persist, over at least the short to medium term (50-100 years), in countryside typical of much of the tropics. Two landscape characteristics stand out as important in conferring a survival advantage to native species in the countryside. First, species richness is considerably higher in the vicinity of large remnants of relatively intact forest, suggesting that many species which occur in the countryside can persist only in the nearby presence of that native forest. Second, the presence of native vegetation in human-dominated habitat facilitates persistence.

But will these agricultural landscapes continue to support native species over centuries to millennia? We surveyed bird diversity in an ancient agricultural landscape, cultivated continuously for over 2000 years and inhabited by people for at least 20,000 years. On the fringes of the Western Ghats in southwest India, the area retains many habitat features known to be important for biodiversity (landscape heterogeneity, vegetative structural complexity, and native vegetation). Most of the land covers – rice, peanut, cashew, arecanut palm, extremely degraded shrublands, and native forest – have been present for well over 200 years. The native forests are designated here either as "Forest" (relatively intact, no extraction officially allowed) and "Production Forest" (extraction of non-timber products permitted).

We found a rich bird fauna, of which only 4% of species were restricted to Forest. Arecanut palm plantations and Production Forest together harbored a distinct bird community, including 90% of the forest-affiliated species of most conservation concern, such as the Great Hornbill and the Malabar Grey Hornbill.

Arecanut is consumed by over 10% of the world's population, concentrated in south and Southeast Asia. In traditional cultivation practices of the area, arecanut is intercropped (with pepper, vanilla, coffee, banana, cacao, etc.), increasing the economic return to farmers and the structural complexity so critical for forest birds. Further, as arecanut palm plantations have high water demands, they displace rice production, in effect trading a low conservation value land cover with a much higher one. There is a strong economic incentive to maintain the Production Forests of the region as forest, since they provide a critical component for traditional arecanut cultivation: leaf litter, used as mulch in plantations, as shown being hauled by ox-cart.

Examples in South and Southeast Asia

Arecanut may be key to conservation in south and southeast Asia. This example shows that agricultural landscapes can sustain high levels of biodiversity over centuries to millennia, and offers hope that other such production systems can be found.

So, in reaching to extend conservation beyond reserves, the overarching lessons from this work are two-fold. First, many species and ecosystems can survive only in relatively extensive native habitats, so protected areas will remain key. And, second, many widespread agricultural production systems have high potential conservation value, and there is a critical window of opportunity now to capture this value, in the face of rapidly intensifying production in many regions.

Now let us turn to the other dimensions of making conservation mainstream: moving beyond charity and beyond biodiversity as the primary arguments for protecting Nature. We've just seen how better production practices represent key "actions and scenarios" (on this slide) for improving the status of biodiversity and ecosystems. Now let us look at the services and values that flow from well-managed ecosystems.

"Ecosystem services" are the benefits that people derive from ecosystems. One way to think about them is to imagine there was a space ship outside awaiting you, to take you on a one-way trip to the moon. Which elements of biodiversity would you bring with you, for a happy life up there? I know I'd start my list with my kids and husband – definite parts of wild Nature – and some cacao trees (for chocolate), along with the ingredients in the wonderful cuisine of Japan. But if all one thought about were "provisioning services," the ecosystem goods we consume directly, one would not last long. There are critical "regulating services" that include climate stabilization, water purification, flood control, and pollination, among many others. And, of course, one would aspire to a fulfilling life, with some of the many cultural benefits we draw from Nature, like spiritual, aesthetic, and recreational values, and scientific and other inspiration. Finally, one would want to consider all the underlying processes, like renewal of soil fertility and growth of plants – and maybe take out an insurance policy, bringing onto the spaceship species with unknown values for the preservation of options.

Earth is looking more and more like a moonscape, with ever expanding and intensifying agriculture and urban centers. This is where the initiatives to promote *satoyama* are so interesting and important – to find high-value systems that draw from the knowledge and wise traditions of the past together with practices and policies that allow them to thrive today.

But how do we achieve this harmony of people and Nature in today's world? How do we value ecosystem services – and translate those values into policies that achieve meaningful protection? The Millennium Assessment went a long way toward valuing services at the global scale. And it built on the recent proliferation of local studies, such as this one led by Taylor Ricketts on the value of rainforest to coffee production. But there is a lack of tools for valuing services at the scales relevant to most decisions, of governments, corporations, NGOs, and people – and a lack

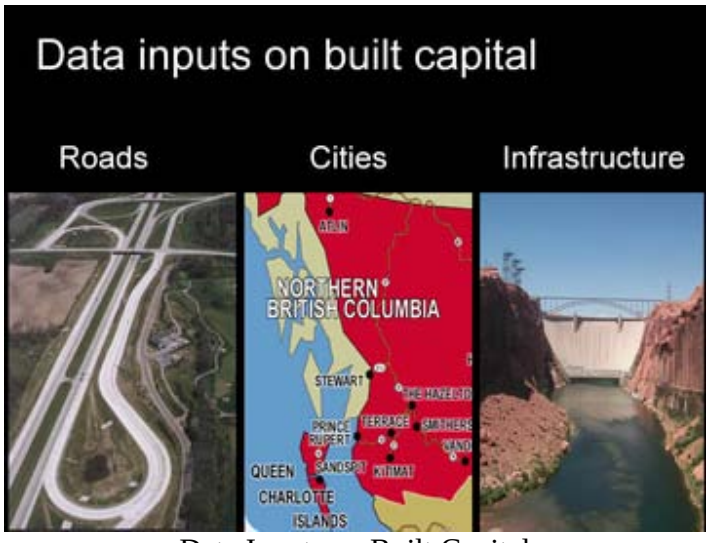
of models, like New York City and Costa Rica, for engaging leaders and mainstreaming those values into decisions.

To make these advances, I co-founded the Natural Capital Project, a joint effort of Stanford University and two of the world's most effective and influential conservation organizations, The Nature Conservancy and World Wildlife Fund, along with many other partners. The power of the partnership is melding the creativity of leading research institutions with a global laboratory of conservation practice.

Let me show you InVEST, the software system we are developing to reveal, for decision-makers, the values of ecosystem services across a landscape or seascape – and how these values would change under alternative scenarios of change, such as in climate, population, or policy. InVEST can answer questions such as, What is the return on investment (ROI) of restoring riparian habitat, in terms of agricultural revenue, drinking water quality, erosion control, carbon sequestration, and biodiversity?

In October 2008, the Natural Capital Project released Version 1.0 Beta of InVEST, for widespread testing and improvement. We are now about to release Version 2.0, which can map the services named above, as well as hydropower production, avoided reservoir sedimentation, irrigation supply, flood control, timber production, crop pollination, open access harvest, and tourism & recreation. We are also about to release Version 1.0 Beta of InVEST for seascapes, focused initially on fisheries production (capture and aquaculture), coastal protection (from storms), and tourism & recreation.

We have designed InVEST for use anywhere in the world, with readily available data inputs on natural capital of land use, soil type, topography, temperature & precipitation, and so forth.



Data Inputs on Built Capital

Data inputs on built capital include roads, cities, and infrastructure, such as the hydropower dam shown here. There are more complex models for parts of the world with higher data availability. Outputs are quantity of biodiversity and ecosystem services supplied and demanded, in both

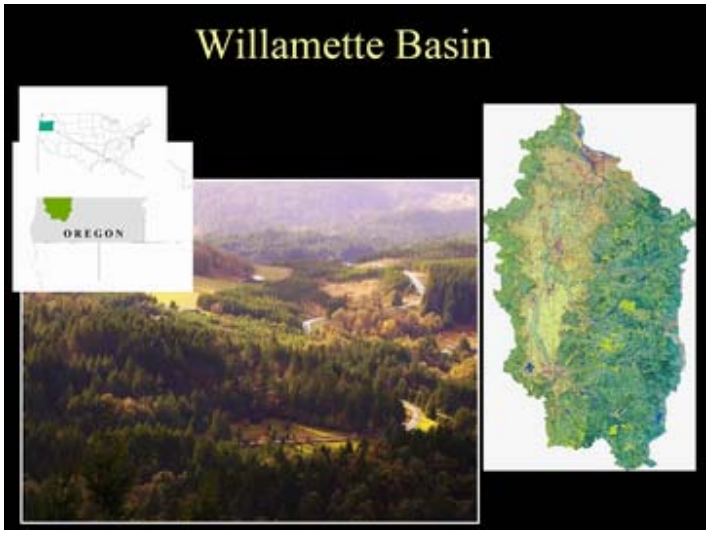
biophysical and – in most cases – economic terms. We use standard economic approaches to ascribe dollar values, but only where appropriate; we do not put a dollar value on biodiversity, for instance.

We use InVEST in an iterative process with decision-makers, first engaging stakeholders to discern the choices facing them (in terms of scenarios of change), then running the software, and working through the implications of the alternative choices (in the form of maps, tradeoff curves, and balance sheets). InVEST has more sophisticated models for parts of the world with greater data availability, on things such as water flow and quality in rivers

This decision-support tool is extremely useful in shining a light on the many values of natural capital. But, obviously, it alone is not going to change the world. How do we turn awareness of such values into enduring change in institutions and incentives to promote the deep, game-changing, and global transformation we all seek to harmonize people and Nature?

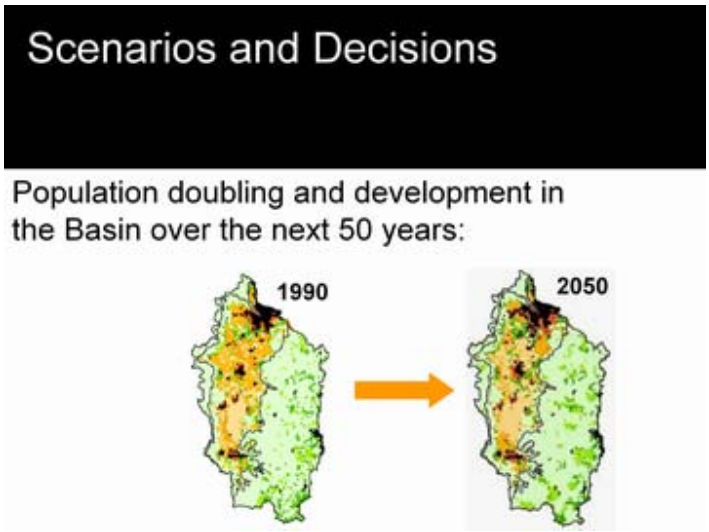
Inspired by the pioneering steps taken in New York City, Costa Rica, and other places, the Natural Capital Project established a suite of "demonstration projects," in which our aim is to design, replicate, and scale compelling models that illustrate how to embed natural capital approaches into formal business and government planning widely. We are working in a suite of important places and sectors, engaging policy makers, resource managers, corporate executives, scientists, and other leaders. Our principal projects are in Africa (Tanzania), Asia (China and Indonesia), Latin America (Colombia and Ecuador), North America (Canada, California, Oregon, and Washington), and Oceania (Hawai'i).

Land use planning in the state of Oregon illustrates the use of InVEST.



Willamette River Basin

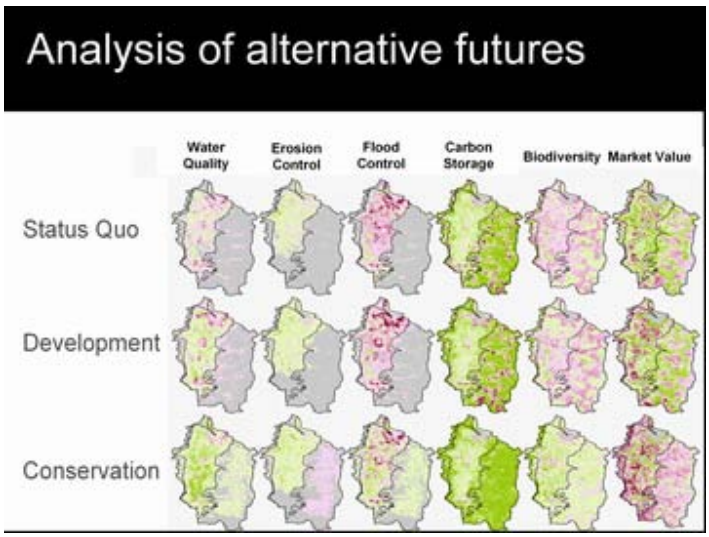
You can see the Willamette River Basin here – about 270km long, and where most people live in the state. A suite of government, NGO, and private sector stakeholders are engaged in long-term planning – especially worried over the tradeoffs of letting too many Californians (like me!) move into this beautiful region.

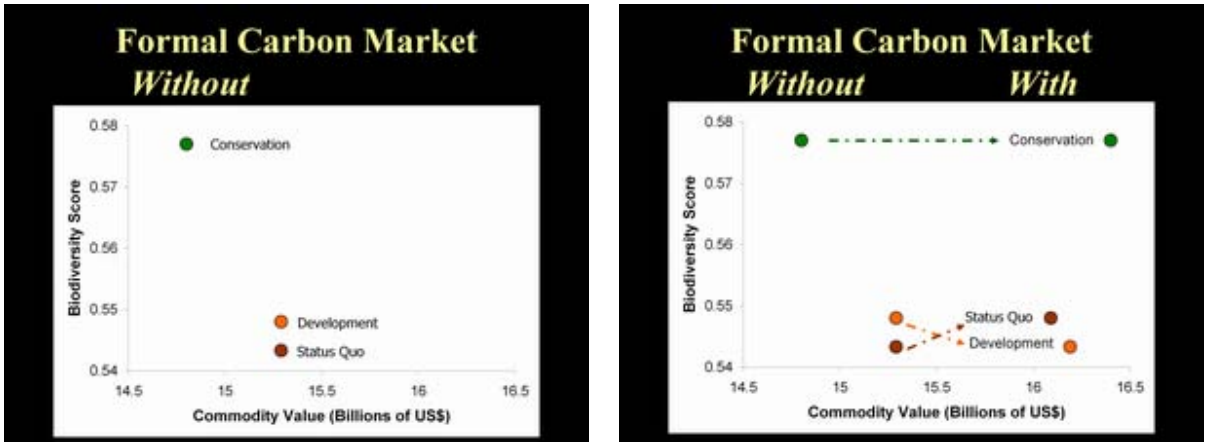


Scenarios Out To 2050

They have developed a range of scenarios out to the year 2050, like this one here. These are translated into changes on the landscape – growth in urban centers, in suburban development, and change in agriculture and forestry.

The Natural Capital Project used InVEST to quantify the changes in ecosystem service values that would result under the different scenarios.





Analysis of alternative futures

Our maps look like this one, for carbon storage (mostly in trees, and for climate stabilization): green shows an increase in the service, and red a decrease. We can compare changes in different services with these side-by-side maps of water quality, erosion control, flood control, and carbon storage, along with biodiversity and market values of the landscape. Market values include commercial real estate, agricultural, and forestry values.

The three main scenarios are shown here, and differ mostly in terms of how many Californians move into the state.

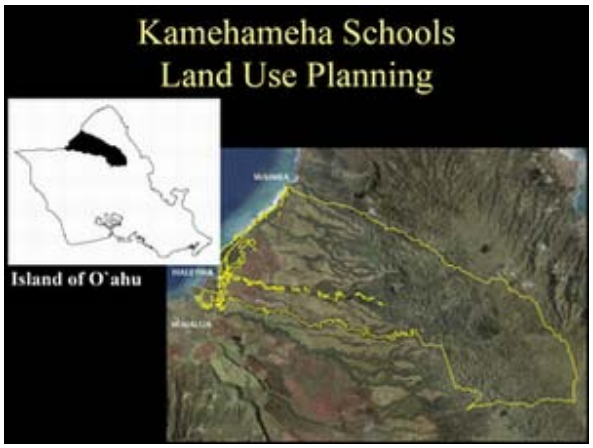
To see more specifically how InVEST can be useful, let us consider attaching economic value to just one of the services: carbon sequestration. In the absence of a carbon market, there is the typical tradeoff between the biodiversity and overall market value of the landscape, with the "conservation scenario" scoring high on biodiversity but much lower than the "status quo" or "development" scenarios on market value. Yet, introducing a carbon market changes the picture dramatically: now the conservation scenario is favored on both biodiversity and economic grounds, and there can be harmony between people and Nature! Oregon decision-makers are now working to develop finance and policy mechanisms that reward protection of a range of services.

We'll look next at the case of Hawai'i, the beautiful island chain that is a favorite destination for many Japanese and others from around the world. There, a range of services – including even traditional cultural services – are being factored into land-use decisions. We are working with Kamehameha Schools, the largest landowner in the state (with about 8% of the islands' land base) and, incidentally, the largest trust in the United States.

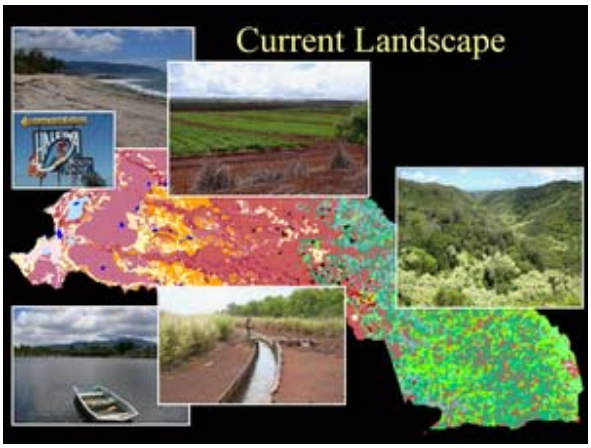
Kamehameha Schools was founded in 1884 by Princess Bernice Pauahi Bishop, who witnessed the decimation of native Hawaiian population from more than half a million people at the beginning of the century to a mere 40,000 by the 1880s, a result of disease and other change brought by outsiders. To address these desperate conditions and help assure the perpetuation of Hawaiian culture and the welfare of her people, Princess Pauahi established Kamehameha Schools (KS), dedicated to improving the wellbeing of Hawaiian people through educational services.

For much of KS history, its land assets were managed to maximize revenue for the schools. But the commercial and other development that achieved this often was conducted without sufficient regard for environmental, cultural, or community values. This tendency, coupled with rapid immigration to Hawai'i of people, as well as many other invasive animals and plants, further displaced native Hawaiian people and the natural resources their culture depended upon. KS' economic maximization approach faced increasing resistance in the latter 20th century.

KS underwent a paradigm shift in the early 21st century, promising a balanced approach to restoring land and culture, Nature and people. The Natural Capital Project began to learn from KS' innovative efforts early on, and we are working together now to test and hone new approaches to achieving this balance. We started at a very significant KS landholding called Kawailoa, on the famous North Shore of O'ahu.



Kamehameha Schools Land Use Planning

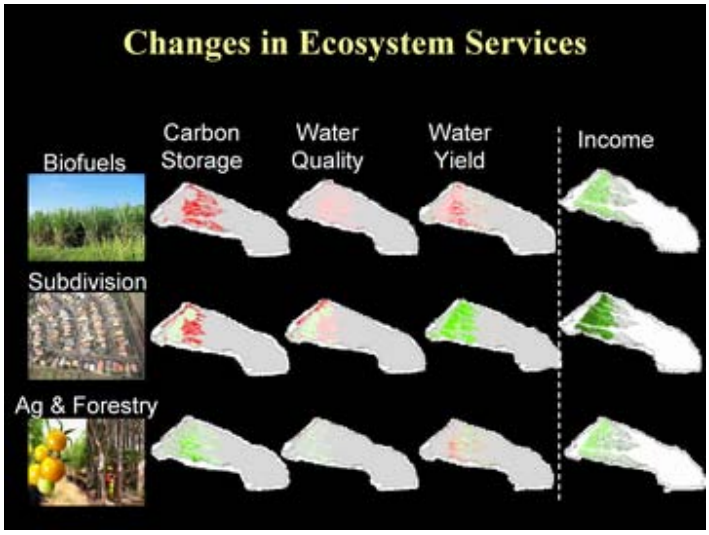


Current Landscape

Here is an image of the ca. 10,000 ha area, extending from some of the last undeveloped coastline in Hawai'i, where there are important cultural resources such as this fishpond constructed some hundreds of years ago, up through some of the last highly productive agricultural land in the state, and on up to biodiverse mountain ridges.

What should this landscape look like in the future to achieve the desired balance of goals? We met with KS scientist, land-use planners, and others to consider realistic scenarios, or options. There were three, addressing the state's tremendous challenges with energy security, residential housing, and food security. (Over 90 percent of Hawai'i's energy economy is based on imported oil and coal; and people estimate that there is only a 2-day food supply on O'ahu at any one time.)

Here we can see a map of land use that would address energy security by growing sugarcane as a biofuels feedstock. And here are maps indicating possible residential development and, as the third alternative, diversified agriculture and forestry.



Changes in Ecosystem Services

The questions for InVEST were two-fold: what is the flow of ecosystem services today, and how would this change under each of these scenarios of the future? We quantified and mapped a range of services, such as water quality. (This is the area famed for international surfing competitions, so water quality is especially valued by locals and visitors.)

Looking at the services together, one sees that while residential subdivision and biofuels production would yield the highest income, they are paired with steep losses of carbon storage and water quality (planting sugar cane would involve clearing land of shrubs, incurring a 10-year carbon debt). So, KS chose to pursue a strategy of diversified agriculture and forestry, along with (in further iterations of planning) a wind farm and a native biofuels feedstock (from the kukui tree) to address energy security. Finally, they plan to renew educational and cultural activities on the Kawailoa parcel, to achieve the desired balance of goals. In great appreciation of the planning effort, KS was given the "Outstanding Planning Award" by the American Planning Association in 2008.

We are now scaling this work with InVEST and KS to the state level. In 2007, Hawai'i was the second state in the United States (and there are still just two) to pass a state-wide climate bill. The bill mandates greenhouse gas emissions reductions to 1990 levels by 2020. The Natural Capital Project was invited to analyze the scope for achieving these reductions through reforestation with native forests. We are also analyzing the co-benefits that would result from reforestation, for biodiversity, flood control, erosion control (to protect coral reefs), groundwater recharge for drinking supply, and for cultural practices of hula and voyaging (in canoes made from koa and other trees and plants in native forests).

I didn't want to get overly formal in telling these stories, but here I wish to remind us of some of the questions that must be answered in embedding the values of natural capital into decisions. At the state-wide level, the chief goal is to reduce greenhouse gas emissions, with payments ultimately from consumers, via a tax on oil (this may take a while to be enacted, politically), with payments to land managers for reforestation.

Let us look at a few other sites… In each, our aim is three-fold, namely to: (i) influence major resource decisions; (ii) demonstrate the power of natural capital tools and approaches; and (iii) advance sustainable, replicable, and scalable processes for integrating natural capital into policy worldwide.

Colombia and Ecuador are at the leading edge of a wave of "water funds," being established to ensure drinking water supply to urban centers from upstream, rural reaches of watersheds. Our focus is on (1) establishing new water funds that direct payments from downstream water consumers to inhabitants of upstream watersheds, in exchange for changes in land management that are expected to improve water quality; and (2) informing the remaking of resource licensing and mitigation policy for all major infrastructure development in the country, including agriculture, forestry, energy, mining, transportation, and water supply.

And it's appropriate to close on China, where the biggest efforts are now underway. China has committed an amazing US$100 billion to "ecocompensation," through a variety of finance and policy mechanisms. InVEST is being used to informing the design and management of a new national system of "Ecosystem Function Conservation Areas" (EFCA's), whose implementation is intended to enhance delivery of vital ecosystem services and alleviate poverty across the country. We're also using InVEST to inform county-level master planning (for conservation and development zoning, and embedded in EFCA planning), with our first demonstration in Baoxing County. Working with colleagues at Xi'an Jaotong University, we are quantifying the economic and social impacts of ecosystem service payments at the household level, especially for poverty alleviation, and working to refine payments to achieve greater social benefit and avoid unintended negative consequences.

Looking ahead, I see tremendous promise in these approaches. We are in early phases of experimentation, with a great deal of work to do, especially in linking ecosystem services to human health and poverty alleviation, and in devising policy and finance mechanisms that embed ecosystem service values in decision-making at all levels. And Japan is playing a crucial role in helping to show the way to harmonizing people and Nature.

I am extremely grateful to the EXPO 90 Foundation for their generosity and leadership. I am also most grateful to my lifetime mentors, Peter Bing, Paul Ehrlich, John Holdren, and Harold Mooney; my co-founders of the Natural Capital Project, Peter Kareiva, Stephen Polasky, and Taylor Ricketts; and the many members of the Beijer Institute for Ecological Economics (of the Swedish Royal Academy of Sciences), the Center for Conservation Biology (of Stanford University), and the Natural Capital Project. And with all my heart, I thank my husband Gideon Yoffe, our children Luke and Carmen, and my mother and father.

Thank you very much.