Modern Hawaiian Ahupua'a Approach to Integrated Watershed Management
Hanalei Bay Watershed as an Example

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There has been a general recognition in that last few years that land based sources of pollution affect water resources both on land and in nearshore oceanic waters. Programs and slogans that reflect this include:

EPA's Targeted Watershed Initiative
NOAA's WW2BW White Water to Blue Water
UNEP's H_20 Hilltops-2-Oceans Partnership
TNC's Ridges to Reefs
Surfrider Foundation's Sea to Summits

The pre-western contact Hawaiian's ahupua'a approach incorporated the forested upper watershed, low land agriculture and ocean reef resources under the direction of managers, konohiki, who managed it in a self-sustainable fashion for their community and to provide tribute to ruling ali'i.

Island watersheds, water basins, or catchments, as they are variously known today, are distinctive from mainland U.S. watersheds in at least four ways:

1. The islands are small, therefore the waters often have short reaches, i.e. short distances between their sources or headwaters and the ocean. On Kauai we have an average of 400" of rain annually on Mt. Waialeale yet the watershed is only 26 square miles and the Hanalei River is only 16 miles long. Pollutants on land quickly end up in water.

2. The land has high relief; water goes quickly from the top of the mountain to sea level, causing high flow velocities, great erosion and short residence times. On Kauai, Mt. Waialeale is 5,148' in elevation but only 9 miles from the coast. Pollutants move quickly to the ocean. Of course on flat islands, e.g. atolls, all the relief is now under water, leading to the ocean bottom.

3. Land use is often concentrated in the lower reaches, with agriculture (sugar, taro, cattle) occurring away from the shoreline and urbanization occurring down to, or for example on Bora Bora, right out over the shoreline. This means that the sources of pollution are often localized near the coast and very quickly enter nearshore waters.

4) Islands are experiencing environmental impacts by increasing local population growth, tourism and military uses. These are contributing to the degradation of the streams, rivers, beaches, reefs and oceans of the islands. Greater integrated watershed management is desperately needed.

Community based management in Hanalei

In 1998 the Hanalei River was designated as one of fourteen American Heritage Rivers by presidential executive order and offered federal support in improving the environmental, cultural, and economic conditions of the river basin. The Hanalei community chose to direct these efforts themselves and elected local people to serve as "River Navigators". Through a series of well attended community meetings, operating under the process of consensus, the community began by defining and prioritizing concerns, developed a Watershed Action Plan, and contracted a Watershed Assessment to bring together what was known about the watershed. (www.hanaleiriver.org).

Community concerns about land-based sources of pollution in Hanalei

Being a community centered on the river and the bay, the community's primary concern was whether the waters were clean. To paraphrase the U.S. Clean Water Act, were the waters fishable and swimmable?

1) Was sewage coming from the boats anchored in the bay affecting public health for beach users? Was sewage entering the ground water from houses along the river and restrooms in the county parks along the bay?

2) The river was often turbid, muddy, with suspended sediment. What was the impact on the local fisheries for river crabs and freshwater fishes? What about the nearshore reefs?

3) Were nutrients coming from soil erosion, agricultural practices and sewage affecting the river and the bay?

4) Were any chemicals used as herbicides and pesticides by agriculture or State road maintenance crews entering the waters?

To begin, we tried to identify all of the probable sources of pollution in the Hanalei Watershed. Since there are no factories in Hanalei and no point-source pollution, the list is short.

Table 1. Land based sources of pollution in Hanalei Watershed

Pathogens --	Bacteria/Viruses/protozoans from human sewage and animal wastes	
Turbidity --	Erosion of land	Landslides
		Natural sheet flow
		Alien species of plants' impact
		Alien species of animals' impact
	Erosion of stream banks	
	Erosion of beaches	
Nutrients --	Natural nitrification of soils and water	
	Animal wastes (pigs, rats, cattle, bison, birds)	
	Farming – taro	
	Cesspools/septic systems in riparian and coastal areas	

Chemicals - Herbicides/Pesticides
Pharmaceuticals

Then by looking at the consequences of the pollution, and its severity in Hanalei, we were able to prioritize and focus our efforts.

Table 2. Possible consequences of land based pollution by habitat.

Beach:	Pathogens make us sick
	Murky water – aesthetics, sharks, tourism
Reef:	Sediments cover/kill coral, stop recruitment
	Turbidity blocks sunlight for zooxanthellae in coral
	Pathogens infect corals: white spot disease
	Nutrients cause: algae blooms of macroalgae, red tide, ciguatera
	boring sponge bioerosion of corals
	Acanthaster COTS population explosion
	Phosphorous causes decrease in coral calcification
	Estrogen affects reefs
Ocean:	Pathogens harm monk seals and turtles
Streams:	Sedimentation of o'opu fish habitat
	Spread of diseases in humans and animals
	(Viruses, Leptospirosis, Cryptosporidia ,Giardia)
	More algae for o'opu, hihiwai, opae to eat
	More sediment into taro fields
	Estrogen, pharmaceuticals affect amphidromous fishes

We then looked at where the pollutants were coming from and how we could control them. We wanted to first define water quality limited segments of the river and coast to be listed in the State 303d list of impaired waterways. To do this we formed partnerships with Federal, State of Hawaii and Kauai County agencies, university scientists, other non-governmental organizations, volunteer programs, and the Coral Reef Initiative Local Action Strategy program.

We began our own Hanalei Watershed Hui monitoring programs:

Enterococcus using IDEXX technology
Turbidity using a nephelometer to measure NTU
Salinity/Temperature/pH using refractometer and Hydrolab multiprobe.

An EPA Targeted Watershed Initiative grant gave Hanalei the resources to implement changes and monitor the effects.

Actions:

1. Up-grade cesspools & septic systems in riparian areas
2. County cesspool & septic system up-grades at beach parks
3. Strategic planning of a centralized wastewater system for the county
4. Taro fields/bird ponds sediment discharge control BMPs
5. Livestock & feral pig riparian exclusion
6. Upper watershed USGS-BRD alien species BMPs

Studies:

1. Water Quality monitoring (HWH)
    - Enterococci – weekly
    - Turbidity – weekly
    - Nutrients/Chemistry/TSS – monthly
2. Coral Reef monitoring
    - Coral planulae recruitment (Dr. Brown)
    - Benthic habitat photometric surveys (U.H. CRAMP)
3. O'opu Long-Term Ecological Monitoring Program (HWH)
    - Transect surveys
    - Larval collection
    - Juvenile recruitment
4. Suspended Sediment Monitoring (USGS-WRD)
5. Biological Resources Assessment (USGS-BRD)

Other major funding and collaborative efforts include the following:

Coral Reef Initiative – Hawaii Local Action Strategies

Long-Term Benthic Habitat & Fish surveys (Dr. Friedlander & Dr. Brown)
Coral Disease Surveys (Dr. Aeby)
USGS-BRD, HWH, DLNR, Univ. Hawaii Hilo

USDA Watershed Mapping

Satellite and aerial mapping of the upper watershed
USGS-NMD, USGS-BRD, HWH

NRCS AnnAGNPS Computer Modeling

Develop a hydrologic and sediment model of the Hanalei Bay watershed.
NRCS, USGS, NOAA, HWH.

Total Maximum Daily Loads - Hanalei Estuary

TMDL determination for nutrients, turbidity and bacteria
EPA, HIDOH, HWH, Tetra Tech Inc.

Community-Based Fishery Habitat Restoration (NOAA)

1. Remove hau from Waipa Stream to increase flow, remove mud, restore O'opu habitat.

2. Clean out a Hawaiian estuarine fishpond off the Wai'oli Stream to create nursery habitat for native fishes.

Organic Contaminants and Elements in the Hanalei River

A survey for pollutants in the water, sediment and biota of the river.
USGS Columbia Environmental Research Center, USGS-BRD, HWH, KPNHA

It is essential to remember that this is a community based watershed management program. Community members are involved in the planning and operation of these projects. In addition to public meetings, a quarterly newsletter, and our website (www.hanaleiriver.org), we also use community public television and community public radio to keep the public informed about what we are doing and to get feedback. Finally, we have an educational outreach program, where we bring school children to their local beaches and test the waters on location. We are trying to instill within them a sense of stewardship for their uniquely Hawaiian ahupua'a.

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