Ecosystem Services for Watershed Management
A framework for connecting hydrologic science to watershed policy

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RISKBASE: 25 June 2009, Venice

Ecosystem Services are the benefits (goods and services) people obtain from ecosystems

Watershed Ecosystem Services

Outline

- Ecosystem services as a tool for watershed management
- Hydrologic services in practice
- Hawai‘i case study
Assessing and Increasing Total Value

Benefits of the Ecosystem Services Framework

- Account for multiple services from single ecosystem
- Create a feedback loop: connect users to suppliers
- Possibility of payments for ecosystem services - supplement to regulation
- Flexibility in place, duration, participation

Ecosystem Services Applications

- Assess impact of changes to the landscape
  - Marginal value, not total value
- Create possibility of co-benefits when investing in desired ecosystem service
  - Manage for water, get pollination, carbon sequestration

Categories of Information Central to Policy Decisions

- Ensuring drinking water quality in New York City
- Paying farmers to keep Perrier Vittel’s source water clean
Ecosystem Services as a Management Tool

- Framework for connecting ecosystem processes to human users
- Flexible supplement to management toolbox
- Valuation identifies important focus areas and tradeoffs; monetization is not necessary

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Ecosystem Effects on Water

- Terrestrial effects on aquatic systems
- Ecosystem modification of water, not production
- Simultaneous, and sometimes conflicting, effects of the landscape on water

Hydrologic Services

*focus on what the beneficiary receives*

- Municipal water supply, irrigation
  - Diverted Water Supply
- Hydropower, recreation
  - In-Situ Water Supply
- Reducing flood damage
  - Water Damage Mitigation
- Education, tourism
  - Spiritual and Aesthetic Services
- Water and nutrients for estuaries
  - Supporting Services

Ecohydrologic Processes

Hydrologic Service

*Water Supply*
Hydrologic Service (what the beneficiary receives)

Hydrologic Attribute (direct effect of the ecosystem)

Quality
- Water Supply

Location
- Ground/surface, up/downstream, in/out of channel

Timing
- Peak flows, base flows, velocity

Quality
- Pathogens, nutrients, salinity, sediment

Water Supply
- Quantity (surface and ground water storage and flow)
- Quality

Figure adapted from Brauman et. al. ARER 2007

Ecohydrologic Processes

Environmental Filtration

Soil Stabilization

Supporting

Spiritual and Aesthetic

Water Damage Mitigation

In-Situ Water Supply

Diverted Water Supply
Hydrologic Services Conclusions

- Focus on benefits
- Identify key attributes
- Use attributes to identify which ecosystem processes matter, then focus on those for research and management

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Water use by plants

Hydrologic Service (what the beneficiary receives)

Local climate interactions

Quantity

Water Supply

Water Supply

Upland Areas = Water Source

Coastal Areas = Water Use

Ocean

Recharge

Submarine groundwater discharge

Subsurface flow

Pumping

Wastewater recycling

Precipitation

Evapotranspiration

Water Balance

R = P - ET

Precipitation

Evapotranspiration

Land Cover

Recharge

Kahalu’u Forest

Kealakekua Ranch
Rainfall Partitioning by Forests

- Direct rainfall through canopy
- Interception by tree canopy
- Drip through tree canopy
- Evaporation from tree canopy
- Fog incorporated directly onto water film on trees

Comparison of Throughfall-Rainfall Relationship at Two Sites

Cumulative Throughfall (mm) vs. Cumulative Rainfall (mm)

Categories of Information Central to Policy Decisions

- Biophysical System
- Policy
- Beneficiaries and Producers
- Valuation
- Ecological Value
- Economic and Social Value
- Protection and Management
- Service Use
- Policy Formation

Figure adapted from Brauman et al. ARER 2007
Categories of Information Central to Policy Decisions

- **Biophysical System**
- **Policy**
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- **Protection and Management**
- **Economic and Social Value**
- **Ecological Value**

Figure adapted from Brauman et al. ARER 2007

Economic Valuation

Savings to water department by using water supply ecosystem services instead of increasing infrastructure

- Avoided cost method
- Expert solicitation
- Benefit to water supplier
- Constrained optimization

- "incorrect" price of water
- Immediate, real world meaning

Case Study Lessons

- Identify human needs / drivers
- Allows simplification of complicated biophysical system and focus on key ecohydrologic processes
- Valuation provides insight into whether it’s worth investing in management

Conclusions

- Hydrologic services can provide management incentives when regulation is impossible or impractical
- It is useful to first consider hydrologic service benefits and then the quantity, quality, location, and timing of flows that affect those benefits
- Both biophysical and economic information drive ecosystem service policy

Acknowledgements


Advisors and Colleagues: Gretchen Daily, David Freyberg, Greg Asner, Joe Berry, Jake Brito, T. Adam Durrant, Jody Fergerstrom, David Field, Nina Gancedo and the NSF Infrasound Lab, Rebecca Goldman, Josh Goldsmith, Larry Goddard, Tim Hughes, Austra Kapala, Robin Martin, Guillermo Mendez, Lilia Pejchar, Heather Tallis, Buzz Thompson, Peter Vitousek, Adam Wolf

Landowners: Kamehameha Schools, Kealakekua Ranch, Palani Ranch

Research Assistant: Jody Fergerstrom

Thank You! Questions?