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Valuation of Regulating Services

Pushpam Kumar, Ph. D.
Chief, Ecosystem Services Economics Unit
United Nations Environment Programme (UNEP)
Email: Pushpam.Kumar@unep.org

Services Provided by Ecosystems

1. **Provisioning services** – Products obtained from ecosystems (e.g. genetic resources, food and fiber, fresh water)
2. **Regulating services** - Benefits obtained from the regulation of ecosystem processes (e.g. regulation of climate, water, and some human diseases)
3. **Cultural services** – Nonmaterial benefits people obtain from ecosystems (e.g. spiritual enrichment, cognitive development, recreation)
4. **Supporting services** – Ecosystem services that are necessary for the production of other ecosystem services (e.g. biomass production, nutrient cycling, water cycling)

Examples of Regulating Services

- Air quality regulation
- Climate regulation
- Water regulation
- Erosion regulation
- Water purification and waste treatment
- Disease regulation
- Soil quality regulation
- Pest regulation
- Pollination
- Natural hazard regulation

Why Value the Regulating Services?

- Helps in a situation of trade off
- Valuation enables Extended CBA
- Facilitates the innovative response mechanism
- Strengthens the argument in favour of conservation
- Establishes the links of ecosystem management with poverty alleviation
- Helps in ecosystems accounting

Economics of Ecosystem Services: Caveats

Not very helpful!

- **Benefits people obtain from ecosystems**

Conceptual Lenses of Economics

- **Stock Vs Flow**

Metrics of ES- Stocks (ecological) and flow (ecosystem services)

ES are flow on DD and SS side and imbalance would affect the stock!

Ecosystem Services

- Possess intrinsic value

Lenses of Economics

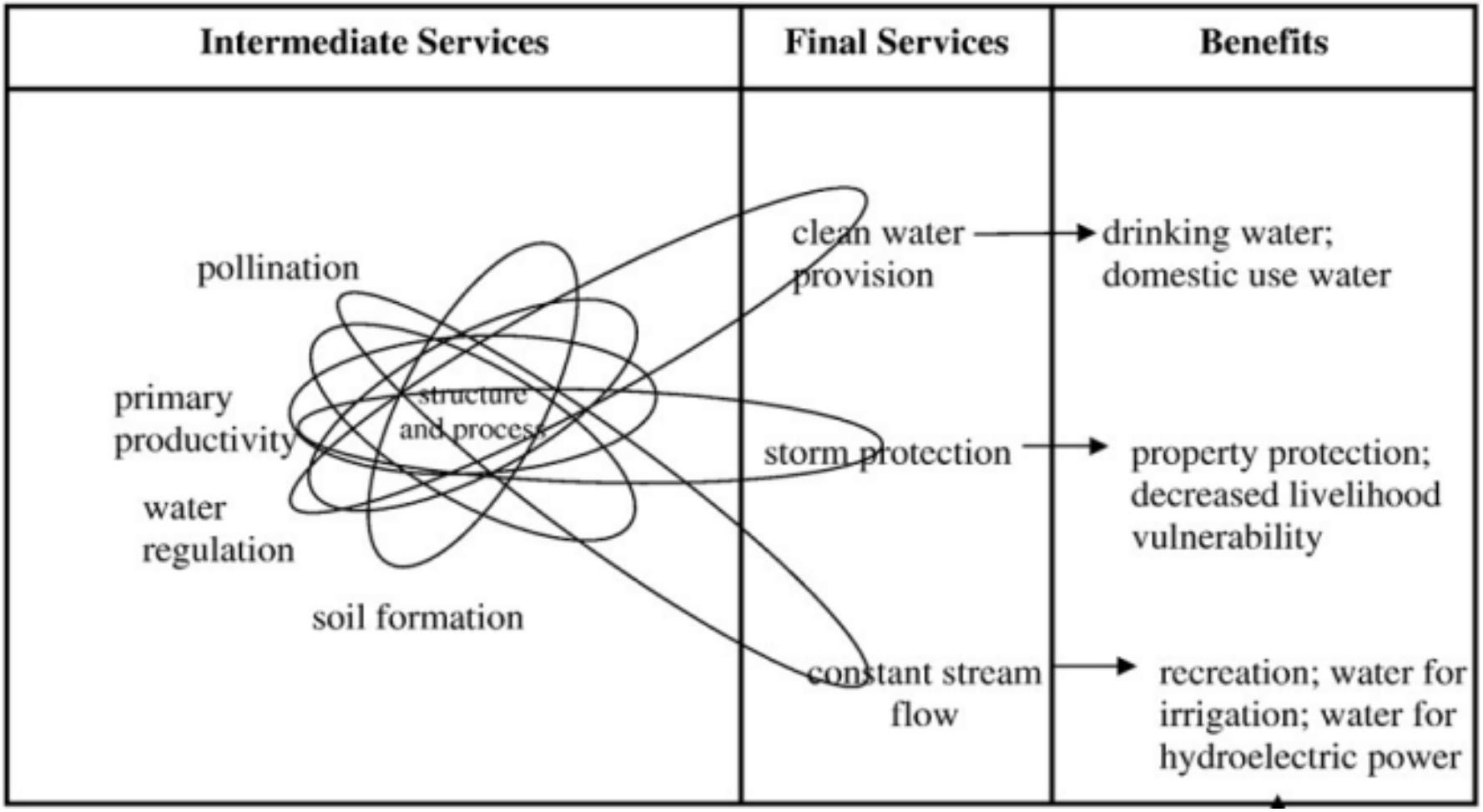
Equivalent economic value of a stock that underlies a flow can be estimated from the present and assumed time course of ecosystem services flows by applying appropriate discount rate (natural capital)

Contd..

- vector of services produced by a vector of inputs
- intermediate / final goods
- externalities over space and time (soil erosion and flooding)

Conceptual Relationship between Intermediary and Final Services

(Source: Fisher et. al, 2009)



Hydrological ecosystem processes, hydrologic services and HWB

Ecohydrologic process (what the ecosystem does)		Hydrologic attribute (direct effect of the ecosystem)	Hydrologic service (what the beneficiary receives)
Local climate interactions Water use by plants	→	Quantity (surface and ground water storage and flow)	**Diverted water supply:** Water for municipal, agricultural, commercial, industrial, thermoelectric power generation uses **In situ water supply:** Water for hydropower, recreation, transportation, supply of fish and other freshwater products **Water damage mitigation:** Reduction of flood damage, dryland salinization, saltwater intrusion, sedimentation **Spiritual and aesthetic:** Provision of religious, educational, tourism values **Supporting:** Water and nutrients to support vital estuaries and other habitats, preservation of options
Environmental filtration Soil stabilization Chemical and biological additions/subtractions	→	Quality (pathogens, nutrients, salinity, sediment)	
Soil development Ground surface modification Surface flow path alteration River bank development	→	Location (ground/surface, up/downstream, in/out of channel)	
Control of flow speed Short- and long-term water storage Seasonality of water use	→	Timing (peak flows, base flows, velocity)	

Economic Values of Watershed Protection

Some examples (Source: CBD 2001)

Study	Type of watershed protection function	Results
Guatemala forest	Prevention of soil erosion	Negligible
	Prevention of nutrient loss	$12 ha/a out of $30 ha/a for all NTFPs and environmental services
Malaysian forest	Protection of irrigation water	$15/ha
	Protection of domestic water	$0/ha
Northern Nigeria	Shelterbelts for crop protection	Rate of return increases from 5% to 13-17%
	Farm forestry	Rate of return increases from 7% to 14-22%
Venezuela	Avoided sedimentation of hydro-reservoir	$14-21/ha
Citrus fruit	Urban water supply	$6-13/ha
Coffee, green	Protection of irrigation	$1-6/ha

Valuation Method

Valuation Tools (Quantitative)	Valuation Tools (Qualitative)
Market price approaches	Consultative methods:
Market cost approaches	Questionnaires
Replacement costs approaches	In-depth interviews
Damage cost avoided approaches	Deliberative and participatory approaches:
Production function approaches	Focus groups, in-depth groups
Revealed preference methods	Citizen juries
Travel cost method	Health-based valuation approaches
Hedonic pricing method	Q-methodology
Stated preference methods	Delphi surveys
Choice modelling	Rapid rural appraisal
Contingent valuation	Participatory rural appraisal
Participatory approaches to valuation	Participatory action research
Deliberative valuation	Methods for reviewing information:

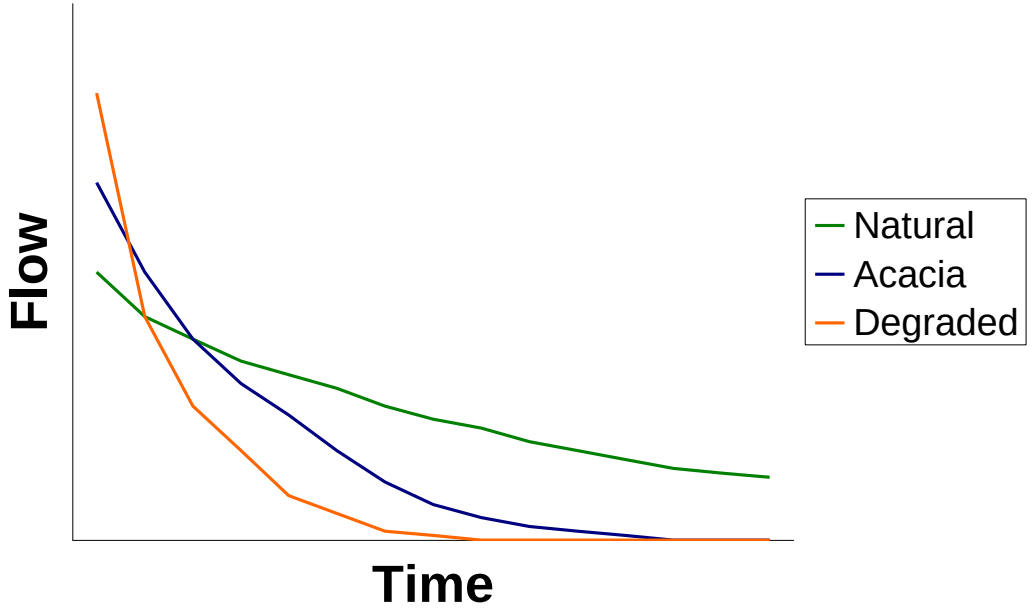
Evidences of Application of PF Approach

Author(s)	Case	Regulating Services	Methods used
Acharya and Barbier (2000)	Hadejia-Nguru, Nigeria	Ground water recharge	agriculture production function
Kumar et al (2004)	Yamuna Floodplains, Delhi	Ground water recharge by floodplain	Agricultural production function
Pattanayak and Cramer (2004)	Manggarai, Indonesia	Watershed services	Production function
Cajsa Coldingb,and Söderqvist (2006)	Stockholm National Urban Park, Sweden	Seed dispersal by Eurasian jay (Garrulus glandarius)	Production function and replacement cost

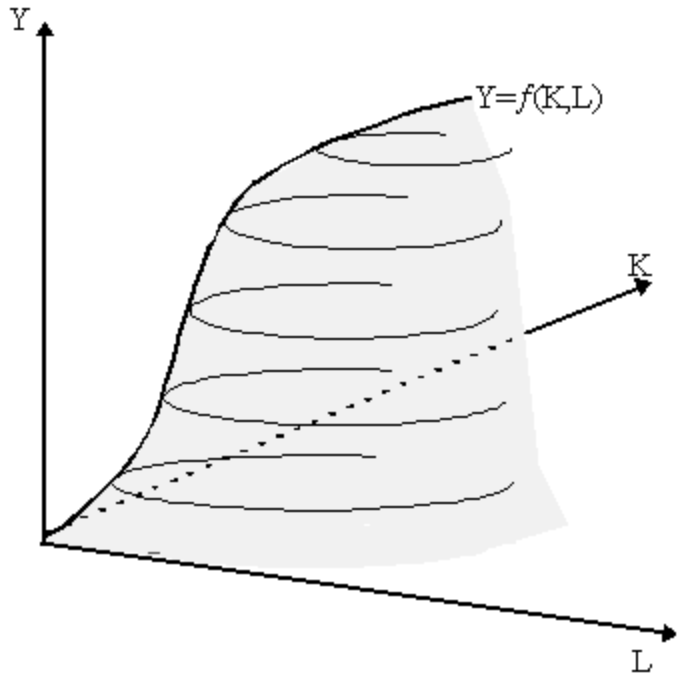
Influence of forest cover on stream flow

- More water retained by forested natural forest
- Gradual release of water from forested areas maintains post-monsoon flow for longer
- Conceptual diagram shows change in flow with increasing time post-monsoon

Forest cover	Runoff (%)
Natural	21
Acacia	32
Degraded	41



Methodological choice: Agricultural production function



Set of inputs, delivering set of outputs, depending upon environmental conditions

Environmental condition, determining the profit or revenue of the farmer

Estimating the production function

The Cobb-Douglas function is most common specification for an agricultural production function.

$$y_t = \alpha_0 L_1^{\alpha 1} L_2^{\alpha 2} L_3^{\alpha 3} L_4^{\alpha 4} L_5^{\alpha 5}$$

y_t is harvest, and L_1, L_2, etc. are inputs. There are five inputs:

L_1 *labor*
L_2 *farmsz*
L_3 *flow*
L_4 *irrih*
L_5 *slope*

Only the first one, *labor*, can be varied by farmers.

Conclusions

1. Regulating services not fully considered in policy-making processes as they are outside of the conventional market
2. Valuation of regulating services would benefit public policy cost benefit analysis, resource allocation for conservation goals, etc.
3. Valuation of regulating services is still evolving and is in a nascent stage
4. Not many reliable studies based on sound ecological economic foundation using credible dataset currently available
5. Further inter-disciplinarily efforts and studies required by economists and ecologists in this field

Thank you all