



Ecosystem Services and Land Use Research Centre

Trade-offs between ecosystem services and opportunity costs in the Tonle Sap Lake agro-ecosystem (Cambodia)

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Objective:

Understand links between ecosystem services and rice production systems Measure the costs of providing ES for farmers

Theoretical framework:

Combined approach using Agrarian System Analysis and Diagnosis and ES (Ecosystem Services) and EDS (ecosystem dis-services) framework



Empirical Framework: Kampong Thom Province (Sentok and Stung Sen district

- 2010 Feasibility study (78 farmers)
- 2012 Identification of ES and EDS and opportunity costs of farmers in maintaining ES (36 qualitative + 172 in-depth interviews)

Ecosystem services provided by Tonle Sap Lake ecosystem

Adapted from (Millennium Ecosystem Assessment, 2005)

Provisioning Services

- Fish and other aquatic species, including plants
- Non timber forest products (wild foods, honey)
- Rice
- Grass for grazing
- Timber for firewood, house construction, equipment for agriculture and fisheries

Regulating Services

- Carbon sequestration by flooded forests
- Regional and local water regulation
- Natural habitat/biodiversity
- Nursery
- Waterways for transportation

Cultural Services

- Ecotourism (floating villages, birds, Tonle Sap trips)
- Cultural heritage (floating villages)
- Sense of place in cultural practices (Water festival)
- Spiritual services (Arak Teuk "Water Guardian")
- Cambodian culture

Supporting Services

- Soil formation and fertility
 - (Sedimentation,

Biomass from forest)

- Nutrient cycling
- Primary production

ES and EDS framework suggested by (Zhang et al., 2007)



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An agro-ecosystem with high risk of flood



3 main strategies from farmers to combine different rice cropping systems on 3 different zones of TLS agro-ecosystem:

- Increase productivity with short-term rice
- Continue to produce despite floods with rainy season and floating rice
- Increase value-added with organic rice

Adopters of organic rice face to economic, ecological and socialinstitutional constraints

Adopters of organic rice reach a higher social status

ES and EDS from rice cropping systems

	Zone 1	Zone 2	Zone 3	
Provisionin g services	-Food for humans and animals -Water for agriculture (rice) and human use	-Food for humans and animals -Water for agriculture and human use	-Food for humans and animals -NTFP -Water for agriculture (rice) and human use	
Regulating services	-Flood regulation by water retention in soil	-Flood and drought regulation (water is stored in soil, pond and flooded shrub)	-Flood and drought regulation (water is stored in soil, pond and flooded grassland, flooded shrub and flooded forest)	Agriculture and human
Supporting services	-Low sedimentation - Habitat for Agro- biodiversity	-Medium sedimentation -Habitat for Agro- biodiversity	-High sedimentation -Habitat for Agro-biodiversity and natural habitat for biodiversity (especially endanger bird species)	
Cultural Services	-Palm tree as Cambodian Heritage and beautiful landscape of rice field -Spiritual termite mount	-Spiritual Highlands with big trees	-Floating rice varieties and practices exist only in South- East Asia	
EDS	-Flood disaster -Lack of water in early and end of rainy season -Label loss for OR -Poisonous foods	-Flood disaster -Damage caused by rats -Poisonous foods	-Flood disaster -Damage caused by rats higher that zone 2 -Impossible to travel by foot or vehicles in rainy season - Dangerous wild animals(snake) -Poisonous foods	in 6/1

ES and EDS from rice cropping systems

Rice cropping systems (i)			Practices and Land Use	Ecosystem services (non-marketed) FROM Agro-ecosystem	Ecosystem dis-services FROM Agro-ecosystem	
Early Season Rice (ESR)	Z1: 21% Z2: 34% Z3: 45%		Using the existent rice field in zone 1	<u>Cultural Services:</u> Preserve spiritual practices and beauty of agricultural landscape, such as rice fields with palm trees. <u>Provisioning Services:</u> leaves, trunks, fruit and juice from palm trees for		
Z1: Recedi 17% ng Rice Z2: (RR) 36%	Short-term rice	Ring dike, canal and reservoir construction for irrigation and drainage or for preventing water from flowing into rice fields	farmers' basic needs Ensure flood regulation for short-term rice	Disturb water regime, alluvial deposits and flood regulation capacity of ecosystem		
Z3: 47% Z1:		Chemical use (cocktails of pesticides and fertilizer) in all zones with the same practices		Degrade soil and agro- biodiversity and pollute water		
Early + 2 Recedi , ng Rice 4 (ESR+ RR) 3	24% Z2:	-% 2: 0% 3: 5%	New hybrid variety « High Yield Variety »		Reduce the genetic resources in daily food consumption	
	40% Z3: 36%		Deforestation of flooded clear forest, shrub and grassland in zone 3		Degrade habitat, biodiversity and flood regulation capacity of this ecosystem	

Rice cropping systems (i)		าร	Practices and Land Use	Ecosystem services (non-marketed) FROM Agro-ecosystem	Ecosystem dis-services FROM Agro-ecosystem
Medium Term rice			Dependence on water regime from flood pulse of TSL with less than 30cm height of ring dikes	<u>Regulating Services</u> : Respect water regime and alluvial deposit	
Direct- seedling (MTD) Medium Term rice Transpla	Z1: 90% Z2: 10%		Maintenance of existing high lands, spiritual places and palm trees. Furthermore <u>palm trees are replanted</u> <u>every year in zone 1.</u>	<u>Cultural Services</u> : Preserve spiritual practices and beauty of agricultural landscape, such as rice fields with palm trees. <u>Provisioning Services</u> : Leaves, trunks, fruit and juice from palm trees for farmers' basic needs.	
nted (MTT)		-	Absence of chemical use or small amounts of fertilizer and pesticides used if needed	<u>Regulating Services: Preserve Agro-</u> <u>biodiversity</u> fauna, flora and amphibians of rice fields. and Water quality	
Term rice	Z1: 38% Z2: 62%	e	Use of natural and local varieties (Fragrant and Non-Fragrant rice)	<u>Regulating Services</u> : Preserve natural varieties for the genetic bank	
Direct- seedling (LTD)		season ric	Use of hybrid Medium Term rice fragrant varieties in case of flood or drought.		Degrade natural varieties in genetic resources
Long Term rice	ng rm e		Use of only existing rice fields, thus absence of new deforestation of flooded forest, shrub or grassland	<u>Regulating Services</u> : preserve indirectly flooded clear forest for <u>Habitat and</u> <u>Biodiversity</u>	
Transpla nted (LTT)	Z1: 100%		High land and spiritual place, Palm tree are kept. <u>Palm tree are replanted every year in</u> <u>zone 1.</u>	<u>Cultural Services</u> : Preserve spiritual practices and beauty of agricultural landscape (Rice field with palm tree). <u>Provisioning Services</u> : leaf, trunk, fruits and juice for farmers' basic peed	
Organic Rice (OR)			Restrain from use of chemicals	Regulating Services: Preserve Agro- biodiversity (fauna, flora and amphibians of rice fields) and Water quality	
			Use new hybrid varieties « Fragrant Rice »	Reduce the genetic resources in daily food consumption	
			Rice field are protected from flood by ring dikes around 40cm high to avoid chemical contamination for preserving label		Degrade regulating services: soil formation from deposit*

Rice systems	cropp (i)	oing	Practices and Land Use	Ecosystem services (non-marketed) FROM Agro-ecosystem	Ecosystem dis- services FROM Agro- ecosystem
Floatin g Rice (FR)	Z2: 64% Z3: 36%	Floating rice	Use of only existing rice fields with many trees (flooded clear forest in zone 3) on it Dependence on water regime from flood pulse of TSL Existed High land for spiritual place and Palm tree are kept	Conserve <u>directly</u> flooded clear forest <u>Regulating service</u> : Flood regulation, Habitat and Biodiversity <u>Provisioning services</u> : firewood, NTFPs and inland fish Respect water regime and alluvial deposit. <u>Regulating services</u> : soil formation from deposit* <u>Cultural Services</u> : Preserve indirectly spiritual places and beauty of agricultural landscape (Rice field with palm tree). <u>Provisioning services</u> : leaves, trunk, fruits and juice for farmers' basic need. <u>Provisioning services</u> : Materiel and food from palm trees	
			Absence of chemical use or use of small amount of fertilizer and pesticide if needed Use natural and local varieties	Preserve fauna, flora and amphibians of rice fields. No chemical residue leaching into water.Regulating service: soil biodiversity and water qualityPreserve natural varieties for genetic bankRegulating Service: Natural variety conservation	

Rice production system typology with ES (+) and EDS score (-)

Number of farmers		Provisioning Services		Regulating Services				Cultural Services		
	Rice production system (j)	Surface (ha/fl)	Value- added (\$/fl)	Agro- biodiversity	Natural Variety	Habitat/ biodiversity/ water quality	Flood regulation	Spiritual/ Scenic		
11	A. System intensive providing high provisioning services and high EDS (-9 in average)									
3	A1. (ESR+RR)	1.35	1004.67	012	22.5	1222		+		
3	A2. (ESR+RR)+RR	1.43	785.54					+		
5	A3. RR	1.47	478.28					+		
38	B. System intensive providing medium to high provisioning services and low regulating + cultural ES (+3 in average)									
5	B1. (ESR+RR)+RR+FR	2.24	1077.81	+	-	-	2	++		
5	B2. RR+MTT+LTD	2.55	994.43	+	+	+	8	++		
3	B3. ESR+RR+LTT	2.24	908.2	+	+	+		++		
3	B4. RR+MTD+FR	1.41	456.41	+	++	++		++		
2	B5. (ESR+RR)+MTD	0.59	344.61	+				++		
2	B6.(ESR+RR)+MTD+FR	0.88	316.19	÷	-		-	++		
7	B7. ESR+ FR	0.61	261.45	.+	+	++		++		
11	B8. RR+FR	1.00	260.92	+	+	++	-	++		
22	C. System organic rice pr (+6 in average)	oviding 1	nedium p	rovisioning se	ervices an	d medium reg	gulating + c	ultural ES		
6	C1. OR + LTD	0.75	235.86	++	-	++	5	+++		
11	C2. OR	0.29	132.1	+++		+++	÷.	+++		
5	C3. OR + FR	0.48	106.87	+++	-	++	+	++++		
6	D. System intensive providing low provisioning services and high EDS (-9 in average)									
3	D1. (ESR+RR)	0.37	127.63	212	1111			+		
3	D2. ESR	0.15	54.3					+		
37	E. System traditional providing low provisioning services and high regulating + cultural ES (+11 in average)									
14	E1. MTD + FR	0.63	129.37	++	+++	+++	+	+++		
6	E2. LTD	0.46	117.4	++	+++	++	8	+++		
11	E3. MTT + MTD	0.41	113.64	++	+++	++	×.	+++		
6	E4. LTD +FR	0.32	69.13	++	+++	+++	+	+++		
42	F. Floating rice system providing low provisioning services and high regulating + cultural ES (+15 in average)									
42	F1. FR	0.78	151.08	+++	+++	+++	+++	+++		

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ES and EDS framework of rice production system



Comparison of opportunity cost with the score of ES provided



Conclusion

Reconcile economic and ecologic performance as following:

(1) Promote production system with medium performance for ES but low opportunity cost is to promote adoption of rainy season rice excluding floating rice in combination with short- term rice.

(2) Promote production system with medium performance for ES with medium opportunity cost is to promote adoption of rainy season rice including floating rice in combination with short-term rice.

And (3) Promote production system with high performance for ES with high opportunity cost is to promote adoption of floating rice alone in production system.

Win-win solution corresponds to a good balance

Theoretical perspective: Payment for Ecosystem Services provided by rice producers

- Measure rice-based ES monetary value
- Identify financing sources
- Measure Willingness to Pay for ES-based rice or products

Policy recommendations:

To achieve both economic and environmental benefits:

- \Rightarrow Organic label on ES
- \Rightarrow Eco-label for ES-based rice
- \Rightarrow Geographical Indication
- \Rightarrow Rural eco-tourism

Thank you for your attention

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