Understanding Invasive Alien Species as an environmental bad: Some Environmental Governance and economic valuation Imperatives in the Philippines

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Abstract

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The dynamics governing the spatial and temporal spread of invasive alien species need to be understood from the lens of institutional theory to fully understand how environmental governance mechanisms could be better wielded to formulate a management plan that is both efficient and effective. This paper clarifies the varying impact pathways of invasive alien species that would span from the physical phenomenon governing the spread over space and time, to the set of physical impacts and environmental outcomes, and down to its effects on the utility of farming communities. All these need to be systematically and comprehensively identified and quantified to sufficiently measure its true economic impact using various tools and techniques appropriate to the case of invasive alien species. This paper however noted that the issue as to whether invasive species are favorable or detrimental is highly contextual, and the ability therefore of management agencies to identify appropriate scale of governance of invasive species would be very critical.

Methods - Conceptual Framework

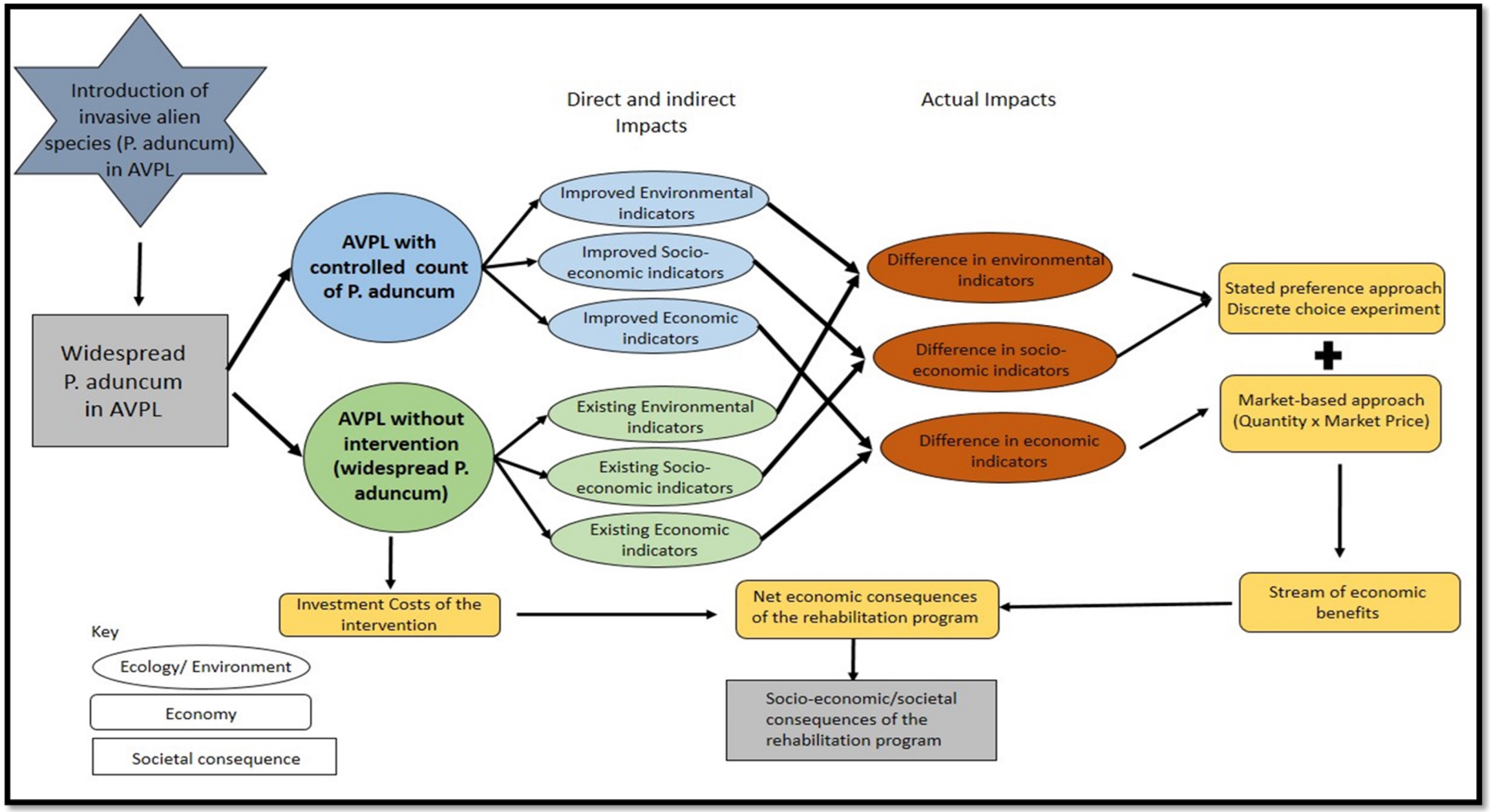

Figure 1. - Environmental Impacts

- Three diameter classes:
  - 2-5cm
  - 5.1-10cm
  - 10 cm and above
- Three 20mx20m sample plots per diameter class
- *Piper aduncum* were counted
- 10 random *Piper aduncum* measured in terms of basal diameter (cm)
- Five(5) 1mx1m per plot
  - Identification and counting of understory vegetation

Diameter Classification (cm)	Replicate			Mean
	Plot 1	Plot 2	Plot 3	
2-5	1.91	1.982	1.79	**1.894**
5.1-10	1.757	1.773	1.865	**1.798**
≥10.1	1.484	1.905	1.553	**1.647**

Modified Fernando Biodiversity Scale

Relative value	Shannon-Weiner index
Very high	3.5-4.0
High	3.0-3.49
Moderate	2.5-2.99
Low	2.0-2.49
Very low	1.99 and below

Very low diversity

- Relative abundance and relative frequency of all the species found inside the plots were computed.
- In general, the sampling sites are covered by species that are of lesser value. Most of them are growing on shifting cultivation areas and are also considered obnoxious species competing with agricultural crops.
- There was a decrease in the biodiversity index as the plantation became older, indicating that indeed, *P. aduncum* could suppress other plant species that are shade intolerant.

Figure 2. Socio-economic Impacts

- The overall productivity per hectare was computed as the product of the productivity per hectare among farms with or without the presence of P. aduncum and the number of hectares with or without the presence of P. aduncum.
- Corn, rice, and banana were the considered crops because these are the major crops based on the survey. Among these crops, the respondents highlighted the negative impact of P. aduncum on corn.
- The change in productivity can be interpreted as the increase in productivity P. aduncum is mitigated in the farm level.

Variable	Estimated Value	Total Value
Productivity (without P. aduncum)		
• Corn	4,133,350.50	5,476,149.62
• Rice	970,952.96	
• Banana	371,846.16	
Productivity (with P. aduncum)		
• Corn	2,998,786.50	3,700,932.67
• Rice	574,226.17	
• Banana	127,920.00	
Alternative Use Value (Charcoal, Stake Production, and Fencing Material)		36,250
Change in Productivity (Without P. aduncum – With P. aduncum)		1,738,966.95

Figure 3. Willingness-To-Pay Estimation for the Intervention to control P.aduncum

With active control of P. aduncum

Explanatory Variables	Coefficient	Mean
Household Size	0.5574	5.1964
Bid price	-0.0435**	125.3247
Years of farming experience	0.0021	38.1342
Dominant Slope	1.6300*	2.4615
Presence of rice	-0.0532	0.0693
Difference	2.1652	32.4199
Constant	1.4396	

** significant at 10%; * significant at 15%

Scenario	Computed Mean WTP (PHP)	Annual Estimated Benefit (in PHP)
With active control of P. aduncum	166.44	463,363.89

$$mean\ WTP = \frac{1}{|\beta|}\ln(1 + e^{\alpha})$$

- The combination of the explanatory variables below gave the most significant logit regression model.
- A logistic regression will be employed to the results of the survey to compute for the respondents' WTP and to determine the significant factors that influence their WTP.
- The formula to compute for the mean maximum WTP developed by Hanemann (1994) was used for the study.

Figure 4. Cost - Benefit Analysis

Cost-Benefit Analysis									
Year	Costs			Benefits			Net benefits		
	Low control	Medium control	High control	Low control	Medium control	High control	Low control	Medium control	High control
0	25,524,662	24,200,552	20,058,952						
1	3,926,292.08	3,722,612.91	3,085,537.59	27,305,162.94	48,547,062.76	62,056,336.62	23,378,870.86	44,824,449.85	58,970,799.03
2	5,281,505.32	5,975,364.19	7,603,534.00	43,123,949.58	31,396,947.76	62,062,542.26	37,842,444.26	25,421,583.57	54,459,008.26
3	6,892,549.74	7,798,059.90	9,922,878.63	32,591,300.00	23,730,727.23	62,056,398.68	25,698,750.26	15,932,667.32	52,133,520.05
4	8,683,538.94	9,824,340.69	12,501,281.28	46,200,762.58	33,636,415.32	62,056,337.24	37,517,223.64	23,812,074.63	49,555,055.97
5	8,141,118.90	9,210,660.11	11,720,384.75	56,373,868.97	41,040,941.27	62,056,336.63	48,232,750.07	31,830,281.16	50,335,951.88
6	10,263,118.22	11,611,437.53	14,775,327.04	68,534,638.35	49,892,193.68	62,056,336.62	58,271,520.13	38,280,756.15	47,281,009.58
7	13,067,448.01	14,784,186.73	18,812,588.31	74,887,162.03	54,515,897.07	62,056,336.62	61,819,714.03	39,731,710.34	43,243,748.31
8	15,392,480.19	17,414,670.51	22,159,827.44	90,182,049.77	65,648,326.91	62,056,336.62	74,789,569.58	48,233,656.41	39,896,509.18
9	17,235,900.84	19,500,270.93	24,813,713.17	109,281,338.37	79,549,801.32	62,056,336.62	92,045,437.54	60,049,530.39	37,242,623.46
10	20,588,628.69	23,293,464.11	29,640,477.26	129,209,679.58	94,054,704.15	62,056,336.62	108,621,050.90	70,761,240.04	32,415,859.37
Present Value***	**70,846,894.55**	**50,650,801.14**	**63,016,140.70**	**282,490,221.21**	**230,581,884.04**	**311,451,128.80**	211,643,326.66	179,931,082.89	248,434,988.10
Net Present Value							**211,643,326.66**	**179,931,082.89**	**248,434,988.10**

- The total net benefit under scenario 3 is at **73.8 million**. This is followed by the scenario of low impact control with projected net present value at around **66.4 million**
- The most ideal strategy to address the ongoing threat of P. aduncum as an IAS in AVPL is the implementation of eradication measures to the whole area of AVPL. With the computed positive net benefit on the long run, all scenarios can be accepted with scenario 3 as the most optimal.

Scenario 1: Low control of P. aduncum. The presence of P. aduncum must be eradicated for Barangays falling within forest reserve areas.
Scenario 2: Medium control of P. aduncum. The presence of P. aduncum must be eradicated for Barangays falling within forest reserve and civil reservation areas.
Scenario 3: High control of P. aduncum. The presence of P. aduncum must be eradicated for the whole area of AVPL

Conclusion

- With the integration of the environmental, socio-cultural, and economic assessment on the impacts of P. aduncum in AVPL, the cost benefit analysis showed the potential value of preserving the biodiversity within AVPL.

- Based on the land use maps, majority of the Barangays surveyed fall into forest reserve areas. This is one of the major factors contributing to high benefit value for scenario 3 with high level of control.

- Although the alternative uses of P. aduncum was included in the computation for scenarios 1 and 2, projections on the long run showed that the cost of mitigation measures may continuously increase due to the increasing spread of P. aduncum on the long run.

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