An Estimate of Economic Value for the Kenting National Park Coral Reef Area

Tung-Yung Fan[1], Nathaniel John Maynard[2], Yi-Yuan Su[3]
[1]Department of Law, National Chung Hsing University, Taiwan

[2]International Doctoral Program in Asia-Pacific Studies,
National Chengchi University, Taiwan

[3]Department of Law, National Chung Hsing University, Taiwan

Corresponding author, E-mail: suyiyuan@nchu.edu.tw

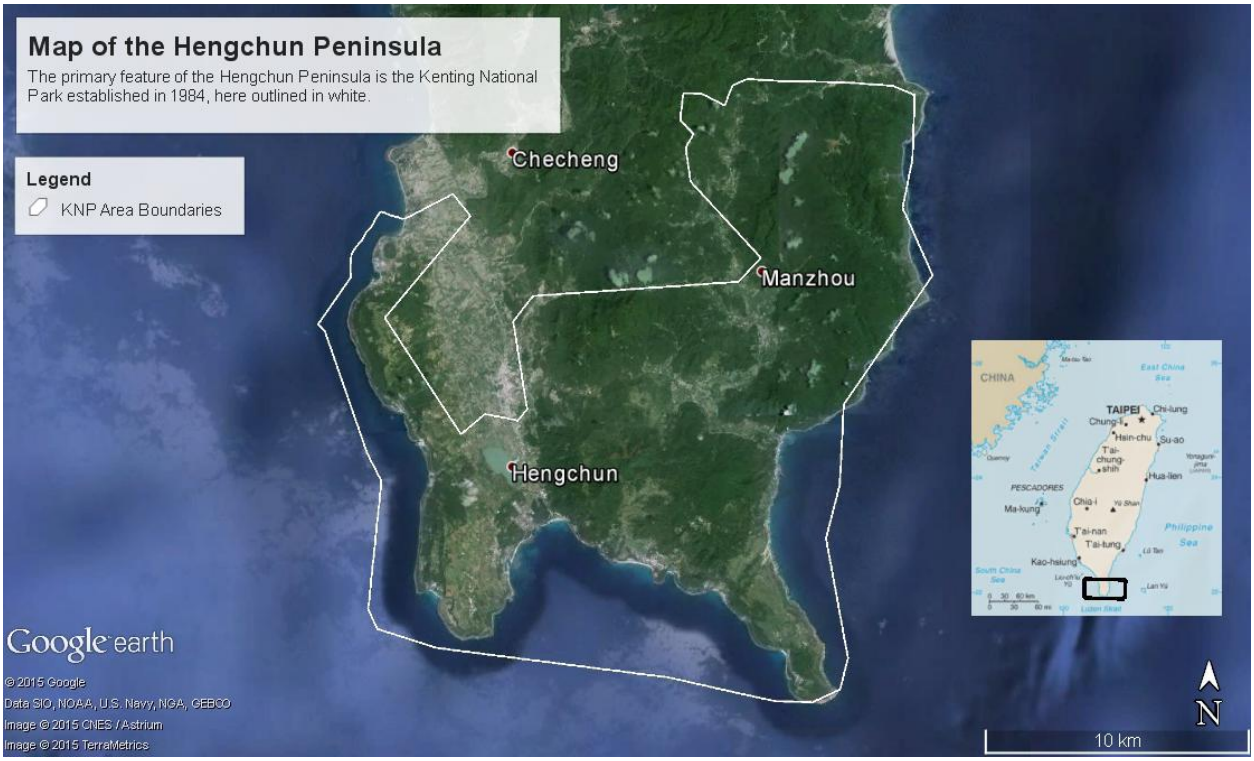
INTRODUCTION

Synergistic cumulative anthropogenic impacts degrade biodiversity across the ocean, especially in the Pacific (Caldwell et al. 2009) . Coral reefs, a critical source of biodiversity face intense threats from multiple sources including overfishing, nutrient pollution, direct destruction, and invasive species. To address gaps in management, increase funding options, and improve communication, governments and more businesses have turned to natural resource economics (Kumar et al. 2013).

Successful application of market based incentives reduces coral loss, improves community understanding, and engenders increased support (Waite et al. 2014; Nordlund et al. 2013; Cisneros-Montemayor et al. 2013;). Unfortunately, full economic studies require teams of researchers working over multiple years which is not always financially feasible. To speed up surveys, several institutions have created rapid valuation protocols, but with little field-testing for the final methods their final effectiveness is unclear. This work analyzes and adapts the valuation guidelines "Coastal Capital Ecosystem Valuation for Decision Making in the Caribbean" to provide an initial estimate for economic value for the Kenting National Park Coral Reef area (Waite et al. 2014).

KENTING NATIONAL PARK

The Kenting National Park (KNP) established in 1984 in the southern Hengchun Peninsula of Taiwan covers a terrestrial area of 181 km^2 and a marine area of 150km^2 and contains high levels of biodiversity (Wu 2010). Unfortunately, concerns over excessive nutrient pollution from tourism, continued overfishing, and coastal development threaten to degrade biodiversity over time (Kuo et al. 2012; Meng et al. 2008; Chang, Hong, and Lee 2008). Instead of sudden regime shifts from destructive fishing practices commonly found in Asia-Pacific coral regions, the KNP reefs risk slowly yet irreversibly shifts to a lower biodiversity state with decreasing ecosystem services.



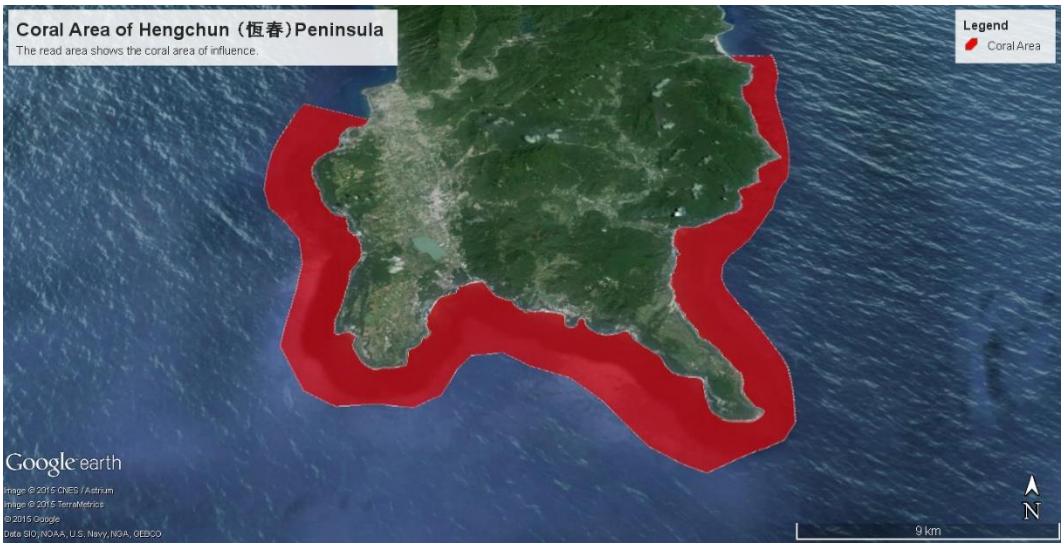
Besides harming ecological function, decreased biodiversity can impact local economies (Sala et al. 2013). Corals with higher health draw more tourism, provide more ecosystem services, and secure key cultural services (Rees et al. 2010; Needham and Szuster 2011). Due to KNP's importance, many biological surveys have identified the ecological quality of the area, as well as the type and volume of tourism. Combining these two data sets allows for a rapid analysis of the economic benefits of the coral reef area of KNP.

METHODS

Determining Scope

Previous maps of the coral reef area in KNP failed to reveal the entire coral area. Using a method from NOAA and the findings from NMMBA's coral lab, we developed a new coral range (Rohmann et al. 2005). Coral in the Hengchun peninsula grow until a depth of 30m and fringe away from the shore. Combing this information with frequent field surveys, we could delineate a coral area of influence within the national park boundaries to form a new scope for the valuation analysis.

The TEV analysis exists in three parts. First, a spatial benefits transfer of the ecosystem services of the coral excluding tourism. Second, a benefits transfer of recreational consumer surplus from coral. Finally, a benefits transfer of a contingent valuation study on marine protected area expansion.



Part 1: Spatial Benefits Transfer

In order to estimate the ecosystem services of the coral reef area, we developed a composite score of the low end values of coral reef ecosystem services from two meta studies (De Groot et al. 2012; Burke and Maidens 2004). We used a composite score of the two values to reflect the diversity of data sources. Burke focuses primarily on Indonesia and the Philippines, while De Groot focuses on global sources with many of the higher end values from Australia and the United States specifically Hawaii. Past studies have shown that income, education, dependency and proximity to resource all significantly impact the final value (Londono-diaz and Johnston 2012; Tuan and Lindhjem 2008). Since Taiwan shares characteristics with Southeast Asia, the US, and Australia, we felt a composite score better demonstrated this blend. Furthermore, using the lower end values ensure the final outcome is conservative.

We removed tourism values from the ecosystem services estimate and instead used a different method to value those benefits. Due to the unique cultural status of KNP and our access to data from the national park authority on visitor numbers, a more refined method based on willingness to pay (WTP) was appropriate.

Part 2: Recreational Willingness to Pay

The Brander meta-study of recreational value from coral reefs offers the least biased method to quickly estimate the value of corals (Brander 2007). Some authors have found the range of possible transfer variance is sometimes too large to be accurate (Ready and Navrud 2005). However, these recreational meta values remain a useful tool in initially estimating the potential benefits. Brander displays the value in number of dollars per person per tourism day. Using information from the Kenting National Park on average estimated single day tourist visits per year by site, we could find out the additional estimated willingness to pay and thus consumer surplus of visitors to the Kenting national park for all marine KNP sites. Again, we use the lower end values of this study to avoid overestimating.

Non-market Benefit Transfer

The non-market or "intrinsic value" transfers adapts a comprehensive survey on the non-market benefits of Hawaiian coral reefs. The survey asked residents to decide how much they would pay in additional taxes to increase Hawaiian MPA coral coverage from 1% to 25% and to restore damaged Hawaiian reefs. Both of these scenarios are realistic in KNP and similarity between transfer scenarios reduces bias (Liu and Stern 2008). Currently the only marine reserve within the KNP marine, the Houbihu Marine Reserve, does not provide adequate protection for fish populations for the corals as it occupies only 1.5km^2 Some areas remain damaged from typhoons as well as ship strikes, similar to the study site in Hawaii (Jan, Chen, and Lin 2009).

Furthermore, Hawaii and Taiwan, especially Kenting, share similar economies, political systems, levels of education, and tourism markets. Yet Taiwan has much higher coral biodiversity, lower levels of income, and lower levels of environmental organization membership (Bishop et al. 2011; Wu 2010). Despite this, Taiwanese people have a much closer relationship to Kenting than United States Citizens due to Hawaii. Over 90% of the Taiwan's population have traveled to Kenting at least once in their lives and based on our findings a vast majority of those people will go to marine areas (Kenting National Park Authority, personal correspondence). Many of these trips involve government sponsored school trips, but the destination remains a top weekend travel destination, as one can reach the park from almost anywhere on the island within four hours.

Therefore, given KNP's national importance we estimated the potential WTP for conservation per household per year, using only the lower end values from the study, and then cut those in half to avoid further bias or over estimation.

RESULTS

Ecosystem Services (excluding tourism):

Using the coral reef area of influence (146 km^2) we find an average value of US$14,261,351 (NT$427,840,590) (value in 2013) per year, with a low-end value of US$ 920,087 (NT$27,602,614) per year and a high end value of US$ 27,602,618 (NT$828,078,566) per year.

Ecosystem Service Value (NT$)		
Range	Area Value (US$/year)	By Km^2 (US$/year)
Lower End	$ 920,087.13	$ 6,301.97
Average	$ 14,261,353.00	$ 97,680.50
High End	$ 27,602,618.87	$ 189,059.03

TOURISM VALUE

The meta analysis found that for a standard "tourism day" including diving, snorkeling, beach going, boat viewing, or surfing, users would pay between US$17 and US$184 extra per visit. For simplicity, we will isolate this amount to a single one-time payment of visitors to each national

park area. While some of the tourists in the area are individual travelers, many take pre-packaged tour groups, and others come from abroad. Since we do not have accurate demographic information, we used the lowest value to remain conservative and analyze the average value (US$100).

Coral Sites	Yearly Total (people)	Value per site US$ 17 per visit	Value per site US$ 50 per visit
鵝鑾鼻公園 Eluanbi Park	1,056,495	$25,552,137.30	$105,649,500
貓鼻頭公園 Mobitou Park	1,704,995	$41,367,244.40	$170,499,500
佳樂水風景區 Jialeshuei Scenic Area	150,410	$3,673,022.60	$15,041,000
小灣遊憩區 Little Bay	131,163	$2,966,784.83	$13,116,300
南灣遊憩區 Nanwan	262,327	$5,933,569.67	$26,232,700
砂島貝殼砂展示館 Shadao	96,844	$2,447,202.50	$9,684,400
海洋生物博物館 NMMBA	913,873	$21,656,234.70	$91,387,300
Total Visitors Coral Sites	5,205,839	$103,596,196.00	$520,583,900
Total Visitors KTNP	6,697,818	Source: Kenting National Park Authority,	

Non-Market Value

WTP per household for both goals (coral restoration and MPA expansion) is US$193.46 (average US$224.81). According to the National Statistics Bureau of the Republic of China, Taiwan had ***8,458,223 households in 2016.*** Taking into account differences income, donation practices, and conservation culture, we reduced the WTP to 25% making it $48 per household per year. Thus, we simply multiply the amount of households in Taiwan by their yearly willingness to pay equaling NT$ 11,877,878,000
25% of $193.46 = US$48.36
$48.36 x 8,458,223 households = $409,039,664 per year

Total Economic Value

$ 14,261,353 (ecosystem services) + $520,583,900 (recreational) + $ 393,198,720 (non-market) = NT$ 943,884,917

This total economic value does not include the market benefit of tourism, research activities, or education. Though the recreational surplus does try to get at a relative measure of the impact of tourism, this still does not capture the potentially large value of hotels, restaurants, dive shops, and other business in the coastal areas of the KNP.

DISCUSSION

Rapid valuation: A rapid valuation of coral reef ecosystems using benefits transfer remains an important exercise. Although this information should not directly shape policy decisions, it does provide the wider community with an understanding of the relative importance of coral. In addition, it can help to prioritize areas of future research and clarify thinking.

Previous critiques of benefits transfers found that they overestimate low values and underestimate high values, this same situation likely occurs within our analysis. For one, the ecosystem services are spatially bias. KNP has fringing reefs which do not occupy large seabed areas like the majority of studied reefs, thus their benefits are further concentrated within a smaller area. But how do you decide the appropriate value to apply when previous studies found values ranging from US$25,000 to US$1,000,000? There are no clear answers when making this decision for a benefits transfer.

Total Economic Value: As we can see from the final result, the majority of value comes from tourism or from the personal values. As a national landmark, KNP draws millions of domestic tourists annually. This estimate does match other studies of famous reefs in the United States and Australia, which receive similar numbers of tourism yet concentrated in a smaller area (NOAA 2013; Rolfe and Windle 2010). The KNP has three times as many corals as Hawaii and receives similar numbers of coral visitors at certain sights, however the same level of conservation awareness and tourism infrastructure has not yet existed.

Further studies should focus on ways of developing proper payment for ecosystem services (PES) projects to incentivize conservation. Furthermore, increased access fees could reduce the total volume of tourists but keep economic activity high. Maintaining economic value while decreasing tourist numbers is essential in decreasing the environmental damage to coral, therefore preserving the ecosystem value, but maintaining high financial returns from tourism ensures the survival of local communities.

In terms of further valuation research, we still need to understand the value of medicine, science and education. Given these industries role in the region they surely have a strong impact. Furthermore, “blue industries” could help increase or better utilize the ecosystem services that do exist. Largely underutilized harbors serve as easy existing access points for eco-tourism. With proper integrated coastal management, the KNP authority could focus on maximizing coral growth while maintaining revenue.

While no clear policy decisions have emerged from this work, it does start a dialogue of engagement between the KNP’s various groups. Sometimes, the process of understanding the value and engaging with different groups can outweigh the tangible value of the product itself.

REFERENCES

Bishop, Richard C, David J Chapman, Barbara J Kanninen, Jon A Krosnick, Bob Leeworthy, and Norman F Meade. 2011. "Total Economic Value for Protecting and Restoring Hawaiian Coral Reef Ecosystems." Silver Spring Maryland.

Burke, Lauretta, and Jonathan Maidens. 2004. "Reefs at Risk in the Caribbean." Washington, DC.

Caldwell, Margaret, Arlo Hemphil, Tegan Churcher, Stephen Palumbi, Jessica Telsch, and Chelsea Tu. 2009. "Pacific Ocean Synthesis."

Chang, Y.C., F.W. Hong, and M.T. Lee. 2008. "A System Dynamic Based DSS for Sustainable Coral Reef Management in Kenting Coastal Zone, Taiwan." *Ecological Modelling* 211 (1-2) (February): 153–168. doi:10.1016/j.ecolmodel.2007.09.001. http://linkinghub.elsevier.com/retrieve/pii/S0304380007004504.

Cisneros-Montemayor, Andrés M., Michele Barnes-Mauthe, Dalal Al-Abdulrazzak, Estrella Navarro-Holm, and U. Rashid Sumaila. 2013. "Global Economic Value of Shark Ecotourism: Implications for Conservation." *Oryx* 47 (03) (May 30): 381–388. doi:10.1017/S0030605312001718. http://www.journals.cambridge.org/abstract_S0030605312001718.

De Groot, Rudolf, Luke Brander, Sander van der Ploeg, Robert Costanza, Florence Bernard, Leon Braat, Mike Christie, et al. 2012. "Global Estimates of the Value of Ecosystems and Their Services in Monetary Units." *Ecosystem Services* 1 (1) (July): 50–61. doi:10.1016/j.ecoser.2012.07.005. http://linkinghub.elsevier.com/retrieve/pii/S2212041612000101.

Jan, Rong-Quen, Jeng-Ping Chen, and Ching Lin. 2009. "Establishment and Management of Marine Resource Protection Demonstration-Areas in Kenting National Park." In *The 10th APEC Roundtable Meeting on the Involvement of the Business/Private Sector in the Sustainability of the Marine Environment*. Taipei, Taiwan: Asia-Pacific Economic Cooperation.

Kumar, Pushpam, Eduardo Brondizio, Franz Gatzweiler, John Gowdy, Dolf de Groot, Unai Pascual, Belinda Reyers, and Pavan Sukhdev. 2013. "The Economics of Ecosystem Services: From Local Analysis to National Policies." *Current Opinion in Environmental Sustainability* 5 (1) (March): 78–86. doi:10.1016/j.cosust.2013.02.001. http://linkinghub.elsevier.com/retrieve/pii/S1877343513000079.

Kuo, Chao-Yang, Yeong Shyan Yuen, Pei-Jie Meng, Ping-Ho Ho, Jih-Terng Wang, Pi-Jen Liu, Yang-Chi Chang, et al. 2012. "Recurrent Disturbances and the Degradation of Hard Coral Communities in Taiwan." *PloS One* 7 (8) (January): e44364. doi:10.1371/journal.pone.0044364. http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3431363&tool=pmcentrez&rendertype=abstract.

Liu, Shuang, and David I Stern. 2008. "A Meta-Analysis of Contingent Valuation Studies in Coastal and Near-Shore Marine Ecosystems." *Munich Personal RePEc Archive* (11720).

Londono-diaz, Luz, and Robert J Johnston. 2012. "Enhancing the Reliability of Benefit Transer over Heterogeneous Sites: A Meta-Analysis of International Coral Reef Values." *Ecological Economics2* 78: 80–89.

Meng, Pei-Jie, Hung-Jen Lee, Jih-Terng Wang, Chung-Chi Chen, Hsing-Juh Lin, Kwee Siong Tew, and Wei-Jiun Hsieh. 2008. "A Long-Term Survey on Anthropogenic Impacts to the

Water Quality of Coral Reefs, Southern Taiwan." *Environmental Pollution (Barking, Essex : 1987)* 156 (1) (November): 67–75. doi:10.1016/j.envpol.2007.12.039. http://www.ncbi.nlm.nih.gov/pubmed/18262698.

Needham, Mark D., and Brian W. Szuster. 2011. "Situational Influences on Normative Evaluations of Coastal Tourism and Recreation Management Strategies in Hawai'i." *Tourism Management* 32 (4) (August): 732–740. doi:10.1016/j.tourman.2010.06.005. http://linkinghub.elsevier.com/retrieve/pii/S0261517710001160.

NOAA, Coral Reef Conservation Program. 2013. "The Total Economic Value of U.S. Coral Reefs A Review of the Literature." Silver Spring, MD.

Nordlund, Lina M., Ulrike Kloiber, Eleanor Carter, and Sibylle Riedmiller. 2013. "Chumbe Island Coral Park Governance Analysis." *Marine Policy* 41 (September): 110–117. doi:10.1016/j.marpol.2012.12.018. http://linkinghub.elsevier.com/retrieve/pii/S0308597X1200259X.

Ready, By Richard, and Ståle Navrud. 2005. "Benefit Transfer – The Quick , the Dirty , and the Ugly ?" 20 (3): 195–199.

Rees, Siân E., Lynda D. Rodwell, Martin J. Attrill, Melanie C. Austen, and Steven C. Mangi. 2010. "The Value of Marine Biodiversity to the Leisure and Recreation Industry and Its Application to Marine Spatial Planning." *Marine Policy* 34 (5) (September): 868–875. doi:10.1016/j.marpol.2010.01.009. http://linkinghub.elsevier.com/retrieve/pii/S0308597X10000102.

Rohmann, S. O., J. J. Hayes, R. C. Newhall, M. E. Monaco, and R. W. Grigg. 2005. "The Area of Potential Shallow-Water Tropical and Subtropical Coral Ecosystems in the United States." *Coral Reefs* 24 (3) (August 12): 370–383. doi:10.1007/s00338-005-0014-4. http://link.springer.com/10.1007/s00338-005-0014-4.

Rolfe, John, and Jill Windle. 2010. "Valuing Environmental Improvements in the Great Barrier Reef: Ecological and Preference Heterogeneity in Loca Area Case Studies." Canberra, Australia.

Sala, Enric, Christopher Costello, Dawn Dougherty, Geoffrey Heal, Kieran Kelleher, Jason H Murray, Andrew a Rosenberg, and Rashid Sumaila. 2013. "A General Business Model for Marine Reserves." *PloS One* 8 (4) (January): e58799. doi:10.1371/journal.pone.0058799. http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3616030&tool=pmcentrez&rendertype=abstract.

Tuan, Tran Hu, and Henrik Lindhjem. 2008. "Meta-Analysis of Nature Conservation Values in Asia & Oceania: Data Heterogeneity and Benefit Transfer Issues." *MPRA* (11470).

Waite, Richard, Lauretta Burke, Erin Gray, Pieter Van Beukering, Luke Brander, Emily Mckenzie, Linwood Pendleton, Peter Schuhmann, Emma Tompkins, and W R I Org. 2014. "Coastal Capital Ecosystem Valuation for Decision Making in the Caribbean." Washington, DC.

Wu, Tai-Ying. 2010. "Exploring Stakeholder's View of Management Effectiveness in Kenting National Park, Taiwan." Duke University.

Date submitted: Nov. 13, 2017
Reviewed, edited and uploaded: Dec. 20, 2017