Economic valuation of mangrove forest: The case of Kim Son district, Ninh Binh province using contingent valuation method

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Abstract:

Contingent valuation method (CVM) is used to estimate the value of an environmental good and service. By applying the CVM method, this study estimates the value of mangrove forests in Kim Son district through the willingness to pay (WTP) of residents in the coastal area for two mangrove protection and development funds, for both present and future purposes. Data were collected from a survey in May 2023 using questionnaires with 90 farming households living in the coastal area of Kim Son district, employing a convenience sampling method. Benefits from mangrove forests recognised and appreciated by Kim Son coastal residents include the ability to block waves, protect dykes, block wind, limit soil erosion, limit human and economic risks caused by storms, improve air quality, filter water, provide breeding grounds for organisms, form soil, and provide food. Payment Card technology was used to determine WTP levels for mangrove protection and development in Kim Son district. According to calculations, the value of Kim Son mangrove forests is equal to 741 million VND/year, with WTP levels depending mainly on the gender of the respondent.

Keywords: **contingent valuation method, mangrove forest, valuation of mangrove forest.**

Classification numbers: **2.1, 4.1**

1. Introduction

Resource and environmental valuation is an applied field of environmental economics that developed in the 1980s to serve the decision-making process of resource and environmental management. Thus, resource and environmental management agencies can evaluate the value of resources and effectively implement exploitation policies.

CVM is a method that allows the estimation of the value of an environmental good and service. The method's name derives from the contingent response to a valuation question based on describing a hypothetical market to the respondent. CVM was first introduced by Davis in 1963 to estimate the benefits of outdoor recreation R.K. Davis (1963) [1]. Applying CVM to consider the WTP for the use of public goods or services has been studied in several countries such as Italy [2]; Indonesia [3, 4]; and the Philippines [5]. WTP can be used as a basis for determining ticket prices and improving the quality of bus services or choosing high-speed mass transit systems, including streetcars or subways. CVM is used to estimate economic values for all types of ecosystems and environmental services, which can be used to estimate both use and non-use values.

In Vietnam, numerous studies have applied the CVM method to value environmental services. For instance, N.T. Hai (2000) [6] used CVM to ascertain the WTP level of tourists for improvements in roads and protected areas for wildlife at Cuc Phuong

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National Park. T.V.H. Son, et al. (2002) [7] investigated the WTP for establishing a protected sea area in Nha Trang bay, Hon Mun island. N.T. Ha (2009) [8] used the random assessment method to determine the community's WTP to preserve the cultural space at the gate of Mong Phu village, Duong Lam, Son Tay, Hanoi, targeting both tourists and locals. N.V. Song, et al. (2011) [9] determined the WTP of farming households for domestic solid waste collection management and treatment services in Gia Lam district, Hanoi. L.T.D. Hien, et al. (2014) [10] estimated the WTP for tourism needs of Can Tho city residents. All studies consider factors that affect willingness to pay, and the main factors identified include distance, age, gender, marital status, monthly income, family background, educational status, and religion.

Mangrove forests are considered one of the ecosystems with the highest biological productivity [11], thus playing an important role in local socio-economic development. Mangrove forests are valuable ecological and economic resources, providing essential services such as food and fuel; nurseries for many animal species; filtering pollutants, absorbing carbon and other elements; and protecting against coastal erosion caused by tsunamis and tropical storms [11]. This study aims to estimate the value of mangrove forests in Kim Son district through the assessment of people living, working, and benefiting directly from mangrove forests as a basis for effective exploitation and use of natural resources.

2. Research area and methods

2.1. Research area

Kim Son district's coastal mangrove forests are formed in the delta of the Day and Can rivers. This area, along with the entire land south of the 20th parallel of Ninh Binh province, is recognised by UNESCO as the buffer and transition zone of the Red River Delta Biosphere Reserve, with a total area of 10,088 hectares, accounting for 14.2% of the entire biosphere reserve (Ninh Binh Provincial People's Committee, 2021) [12]. Kim Son mangrove forests have been planted by the Vietnamese government, the Japanese government, and the Ninh Binh Protection Forest Management Board since 1995, mainly on coastal mudflats. The total area of forests and forestry land is 1,558.9 hectares, of which the planted forest area is 633.25 hectares; the area of vacant land is 955.65 hectares. The entire forest area is currently protected by forest owners signing contracts with households according to the provisions of Decree No. 168/2016/ND-CP of the government. Forest protection is carried out very strictly. Kim Son mangrove forest is shown in Fig. 1.

Fig. 1. Map of mangroves in Kim Son district, Ninh Binh province [13].

2.2. Research methods

2.2.1. Sociological investigation methods

The present study used a questionnaire survey with 90 households using a convenience sampling method. The convenience sampling method has several advantages, such as being easy to implement and time-saving, making it suitable for studies with limited resources. The disadvantage of this method is that the representativeness of the sample is not guaranteed due to non-compliance with the rules of random sampling. To overcome this drawback, the authors selected subjects living and working in the coastal alluvial area of Kim Son district whose main livelihood is extensive coastal aquaculture. These are the subjects who directly benefit from coastal mangrove forests and most clearly identify the benefits of mangrove forests, thereby making the decision to

be willing to pay for the mangrove protection fund. At the same time, these subjects were selected to be as diverse as possible in terms of their age, education level, and income. Information was collected based on a previously designed questionnaire.

The survey sampling formula can be applied if the population is known [14]:

$$n = \frac{N}{1+N*e^2}$$

where *n* is number of samples to be determined, *N* is overall quantity, and *e* is allowable error.

In 2022, the number of extensive aquaculture households in 3 coastal communes (Kim Hai, Kim Trung, Kim Dong) was 1,427 households (N = 1,427). Taking the error e = 0.1, the number of samples to be determined is n = 93.43 households. Due to the rate of unanswered or incompletely answered questions due to the complexity of the questionnaire, the total number of people interviewed was 90 households.

2.2.2. Mangrove forest value quantification method using contingent valuation

The CVM is used to evaluate goods and environmental quality by building a virtual market through people's WTP or willingness to accept (WTA) posed in a hypothetical situation. CVM is applied to many environmental factors such as air quality, landscape value, and wildlife conservation.

Some techniques to determine WTP levels from interviewees used in surveys are:

• Open question: Allows each person to freely state their willingness to pay. This can lead to intentional bias.

• Bidding game: The interviewer offers increasingly higher prices to respondents until they reach their maximum willingness to pay.

• Payment card: Shows a series of prices written on the card, and the respondent is asked to choose a price.

• Close-ended referendum (dichotomous choice): The answer is Yes or No.

In this study on WTP levels for mangrove protection and development in Kim Son district, payment card technology was used to present a series of prices that respondents are willing to pay in a year, ranging from 10,000 VND to 200,000 VND, for one person to choose. There are 2 funds to protect and develop mangrove forests for current and future purposes. The average price given by the group of respondents will be the average WTP and is calculated according to equation (1):

$$\overline{wtp} = \frac{\sum_{k=1}^{i} wtp_k n_k}{\sum_{k=1}^{i} n_k} \quad (1)$$

Source: Author's summary.

where $\overline{wtp}$ is the average WTP for the mangrove protection and development fund of coastal people in the Kim Son district, *k* is the index of WTP levels, wtp_k is the WTP at level *k*, and n_k is the number of people willing to pay the *k* willingness level.

Next, based on the total population in the coastal area of Kim Son district (three coastal communes) directly benefiting from Kim Son mangrove ecosystem services, we calculate the total WTP according to the equation (2):

$$WTP_{total} = WTP_{avg} * N \quad (2)$$

where: *N* is the total number of households in the area; WTP_{total} is the total WTP of all people in the study area; WTP_{avg} is the average amount a person is willing to pay.

3. Results and discussion

3.1. General information about the interviewee

To conduct this research, the authors interviewed 90 people living and working in 3 coastal communes of Kim Son district: Kim Hai, Kim Trung, and Kim Dong communes. Their livelihood is extensive aquaculture. These are the direct beneficiaries of the coastal mangrove forests of Kim Son district. Therefore, these subjects will most clearly identify the benefits from mangrove forests and thereby make the decision to be willing to pay for the mangrove protection fund. Information of the interviewees is shown in Fig. 2.

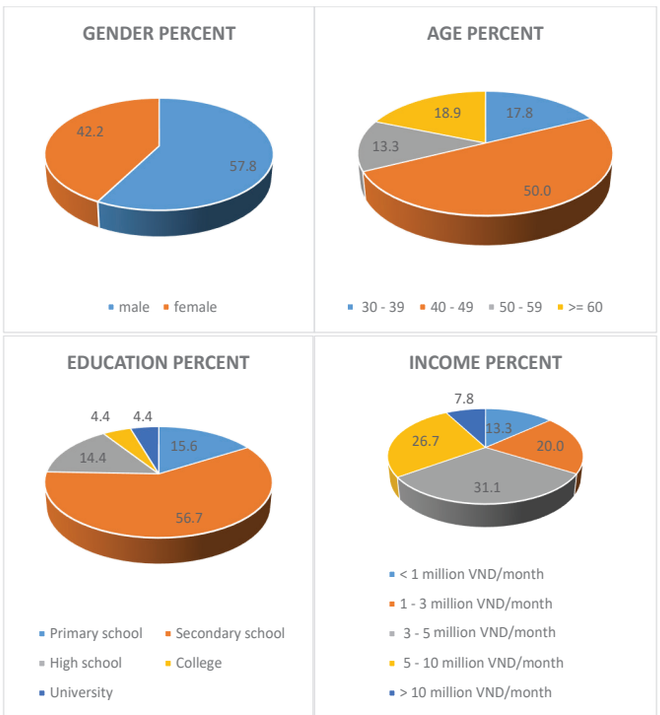

Fig. 2. General information about the interviewees. Source: Author's research results.

Of the respondents, 42.2% were female and 57.8% were male; 50% were aged 40-49, 18.9% were older than 60 years old, 17.3% were aged 30-39, and the remaining were aged 50-59 (13.3%). The education level of the respondents (86/90 responses) was mainly secondary school (56.7%), followed by primary education (15.6%), high school degrees (14.4%), while the remaining respondents had intermediate college and university degrees (8.8%). The income of the households questioned (89/90 responses) was mainly 3-5 million VND/month (31.1%), 5-10 million VND/month (26.7%).

3.2. People's recognition of the benefits from Kim Son district's mangrove forests

From a theoretical basis on the role and benefits of mangrove forests combined with practical surveys, we offer some perspectives on mangrove forests. Through questionnaire interviews, people's assessments of the contribution of the benefits of Kim Son mangrove forest were obtained as shown in Table 1. The level of contribution is expressed on a scale of 1-5; where: 1 - don't care/don't know; 2 - not important; 3 - less important; 4 - important; 5 - very important. Local people's assessment is shown in Table 1.

Table 1. Local people's assessment of benefits from mangrove forests.

	N	Minimum	Maximum	Mean	Std. Deviation
Contribution of mangrove forests to the local economy.	81	2.00	5.00	4.5	0.82
Mangrove forests provide exploited food.	81	2.00	5.00	4.2	0.84
Mangrove forests provide pollen to raise bees for honey.	83	1.00	5.00	3.5	1.09
Mangrove forests provide wood and firewood.	83	1.00	5.00	2.7	1.24
Mangrove forests help store and replenish groundwater sources.	79	1.00	5.00	3.2	1.53
Mangrove forests have the ability to filter water and improve water quality.	81	1.00	5.00	4.0	1.22
Mangrove forests improve air quality by removing dust particles and emissions from the environment.	81	1.00	5.00	4.5	0.88
Mangrove forests store water and regulate it during heavy rains.	85	3.00	5.00	4.5	0.73
Mangrove forests have the ability to block wind.	82	4.00	5.00	4.9	0.36
Mangrove forests absorb large amounts of carbon dioxide, helping to regulate the climate and reduce the greenhouse effect.	89	3.00	5.00	4.7	0.50
Mangrove forests limit soil erosion caused by wind or storms.	87	4.00	5.00	4.9	0.27
Mangrove forests limit human and economic risks caused by storms.	89	4.00	5.00	4.9	0.29
Mangrove forests have the ability to block waves and protect sea dikes.	83	4.00	5.00	5.0	0.22
Mangrove forests provide habitat for wild plants and animals.	87	3.00	5.00	4.6	0.51
Mangrove forests provide breeding grounds for wild plants and animals.	88	3.00	5.00	4.6	0.56
Mangrove forests contribute to sedimentation and soil formation.	87	4.00	5.00	4.7	0.44

Source: Author's research results.

Survey data indicates that the benefits from mangrove forests most recognised and appreciated by Kim Son coastal people are the ability to block waves and protect sea dykes, with an average rating of 5.0 - very important, with high agreement among local residents shown by a standard deviation of 0.22. According to residents, the dyke is better protected from the impact of ocean waves if it is shielded by mangrove forests.

Near the very important rating are the roles of wind protection, limiting soil erosion, and limiting human and economic risks due to storms (4.9), with a standard deviation below 0.5. Next are the roles of improving air quality, regulating water, providing habitat, providing breeding grounds for wild animals and plants, and soil formation, evaluated at levels 4.5-4.7 with standard deviations ranging from 0.44 to 0.88.

The ability to provide food for exploitation is assessed at 4.2, with a standard deviation of 0.84. According to local people, about 50 individuals exploit aquatic products in the mangrove forests manually as a secondary livelihood for these households. Additionally, there are about 72 fishing and trawling boats in coastal estuaries and shallow coastal waters. The contribution from exploited food supply is therefore assessed as slightly above the level of importance.

The ability to filter and improve water is rated at 4.0, and the ability to store and replenish groundwater is rated at 3.5 because many people do not know about this role of mangroves. The role of providing pollen to raise honeybees is rated at 3.5 (less important) because this benefit of mangrove forests only supports a small number (about 10 households) in the Kim Son coastal area.

Rated lowest is the ability to provide wood and firewood from mangrove forests, with an average of 2.7 points, almost unimportant. According to the Kim Son district Statistical Yearbook (2022), the amount of firewood exploited has gradually decreased from 240 ster of firewood in 2018 to 162 ster in 2021 and 130 ster in 2022. However, in reality, protection forests are strictly protected, and people are not allowed to harvest firewood, so this role of mangrove forests is underestimated.

On average, mangrove forests with their many roles and benefits are rated by people at 4.5 (between important and very important) in contributing to local economic development.

3.3. Valuing mangrove forests based on people's willingness to pay

3.3.1. Optional value

To determine the optional value that mangroves bring, the research team assumed the formation of a fund to protect and develop mangroves for current uses. As a result, out of 90 interview participants, 87.8% of people were willing to pay for this fund, with the most chosen WTP being 100,000 VND, with a rate of 8.9%. The amount and WTP for the mangrove protection and development fund for current use are shown in Table 2.

Table 2. The willingness to use mangrove protection and development current funds.

WTP (VND/person/year)	Number of people	Percentage (%)
0	11	12.2
10000	42	46.7
20000	8	8.9
30000	6	6.7
40000	6	6.7
50000	3	3.3
60000	2	2.2
90000	4	4.4
100000	8	8.9
Total	90	100

Source: Survey data in 2023.

Applying equation (1), we calculate the average WTP of coastal people in Kim Son district:

$\overline{wtp}$ = 27,000 VND/person/year

According to the 2022 Statistical Yearbook of Kim Son district, the population of the 3 coastal communes of Kim Son district is: Kim Hai (4,095 people), Kim Trung (4,668 people), and Kim Dong (5,080 people) for a total of 13,843 people [15].

Applying equation (2):

WTP = $\overline{wtp}$ * N

we can calculate the option value in the study area as follows:

WTP_1 = 27,000 * 13,843 = 373,761,000 (VND/year).

3.3.2. Existence value

For residual value, the research team assumed the formation of a fund to preserve and develop mangrove forests for future use. The results recorded that out of 90 interview participants, 76 people (equivalent to 84.4%) were willing to pay for this fund. The most chosen WTP is 10,000 VND, with a rate of 36.7%. The amount and WTP for the mangrove protection and development fund for future use are shown in Table 3.

Table 3. Willingness to use the mangrove protection and development funds in the future.

WTP (VND/person/year)	Number of people	Percentage (%)
0	14	15.6
10000	33	36.7
20000	15	16.7
30000	6	6.7
40000	7	7.8
50000	4	4.4
100000	11	12.2
Total	90	100.0

Source: Survey data in 2023.

Applying equation (1), we calculate the average WTP of coastal people in the Kim Son district:

$\overline{wtp}$ = 26,550 VND/person/year

According to the 2022 Statistical Yearbook of Kim Son district, the population of the 3 coastal communes of Kim Son district is: Kim Hai (4,095 people), Kim Trung (4,668 people), and Kim Dong (5,080 people) for a total of 13,843 people.

Applying equation (2):

WTP = $\overline{wtp}$ * N

We can calculate the option value in the study area as follows:

WTP_2 = 26,550 * 13,843 = 367,531,650 (VND/year).

Thus, the total value of mangrove forests through people's WTP is as follows:

WTP = WTP_1 + WTP_2 = 373,761,000 + 367,531,650 = 741,292,650 (VND/year).

(equal 741 million VND/year)

3.4. The influence of factors on people's willingness to pay

After correlation and regression analysis using SPSS 22.0 software, the results show that people's WTP for two mangrove protection and development funds for the present and future depends on gender (sig coefficient = 0.04<0.05) (Fig. 3). The regression model is defined as follows:

WTP = - 0.319GEN + ε

where GEN is the gender variable and ε is the random element.

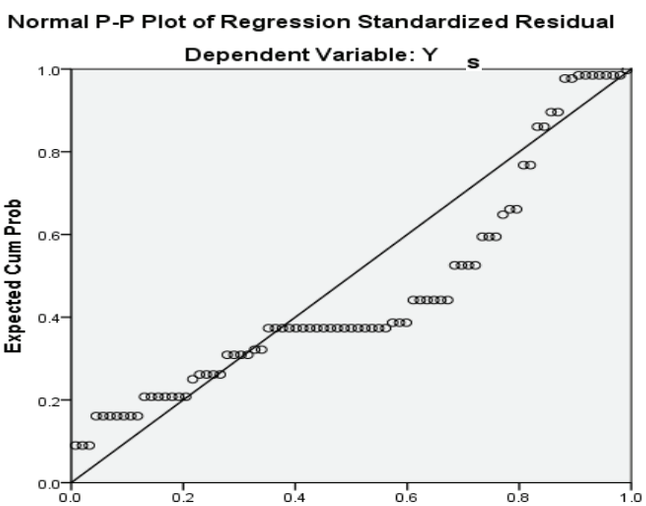

Fig. 3. P-P plot of normal distribution of the dependent variable WTP.

In the research area, people's WTP depends mainly on the gender of the respondent. Women tend to be willing to pay at a lower level than men. Also, related to income, when considering the correlation between the level of WTP for forest environmental services, P.T. Thuy, et al. (2020) [16] found a positive correlation between the payer's income, profit, and WTP to protect

mangrove forests; fishermen with larger boats tend to pay more for forest protection.

Analysing the survey data, the authors obtained a correlation matrix between gender and other factors, as shown in Table 4.

Table 4. Correlation matrix table between gender and other factors.

		Gender	Income	Education	Age
Gender	Pearson correlation	1	-.460**	-.110	.077
	Sig. (2-tailed)		.000	.312	.472
	N	90	89	86	90
Income	Pearson correlation	-.460**	1	.251*	-.196
	Sig. (2-tailed)	.000		.020	.065
	N	89	89	85	89
Education	Pearson correlation	-.110	.251*	1	-.244*
	Sig. (2-tailed)	.312	.020		.024
	N	86	85	86	86
Age	Pearson correlation	.077	-.196	-.244*	1
	Sig. (2-tailed)	.472	.065	.024	
	N	90	89	86	90

According to Table 4, the gender factor is only correlated with the income factor, as the coefficient sig=0.000<0.05. Moreover, Pearson correlation=-0.460 demonstrates that gender is negatively correlated with income, indicating that women have lower income than men. This also explains why women's WTP is lower than men's.

3.5. Discussion

L.A. Kiet (2018) [17] used the CVM method to estimate the value of the nipa palm ecosystem in Binh Phuoc commune, Binh Son district, Quang Ngai province. The author also assumed the formation of two funds to preserve and protect the nipa palm ecosystem, serving current and future uses. The total value willing to pay for nipa palm ecosystem conservation funds is 101,893,230 VND. Thus, it can be seen that the value of Kim Son mangrove forest estimated by the CVM method is higher than the value of the nipa palm ecosystem. The reason is that only 59.62% of people in Binh Phuoc commune are willing to pay for the fund to maintain the nipa ecosystem for current use, and 66.03% of people are willing to pay for the fund to maintain the nipa palm ecosystem for future use, whereas in Kim Son mangrove forest, this number is 87.8% and 84.4%, respectively. Another reason why the value of Kim Son mangrove forest is higher than the nipa ecosystem in Binh Phuoc commune is that Le Anh Kiet calculated only 2,097 households in Binh Phuoc commune would benefit, while with mangrove forests in Kim Son, the authors calculated for 13,843 people in all three coastal communes of Kim Son district.

In fact, wetland ecosystems in general provide many important values for a region, even nationally and internationally, so the number of beneficiaries estimated only in a small widespread area of wetlands is an incomplete count of those willing to pay for the conservation of these ecosystems. T.T.T. Ha (2022) [18], when calculating the WTP for Can Gio mangrove forests, also assumed that many people living outside Can Gio district (for example, people living in other districts of Ho Chi Minh city or people living in the southern coastal area of Vietnam) are willing to pay for the long-term survival of Can Gio mangrove forests. However, that research also calculated the WTP for all households in Can Gio district (18,250 households) and obtained the result that the existence value of the Can Gio mangrove ecosystem is 4.26 billion VND/year.

Another explanation can be considered in T.H. Tuan, et al. (2015) [19]'s study estimating the level of WTP for the economic value of preserving and restoring Thi Nai mangrove forests. When using the non-parametric estimation method to estimate the total economic value of mangrove forests, the total willingness of households at the research site is 14,633,320 VND. If we apply the parameter estimation method, the total WTP for the total number of households in the study area is 15,694,439,000 VND/year, much higher than the WTP for flooded forests, Kim Son saltwater, Can Gio mangrove forest, and Binh Phuoc commune nipa ecosystem. This is consistent with the theory of stochastic pricing since the non-parametric method uses the lower bound of the bids.

Through the above studies, it can be seen that the advantage of the CVM is that it can easily collect the WTP of different individuals for the same environmental goods and services. However, respondents are willing to offer hypothetical payment levels that are not influenced by the rules of the real market, so they can offer very high or very low prices. In addition, during the investigation process, the interviewer's guidance can cause errors in the results. To overcome these disadvantages, it is necessary to select direct beneficiaries of these goods. Moreover, the interviewer needs to be objective and use testing and filtering questions to evaluate the appropriateness of the answer.

Finally, although this study uses a convenience sampling method, there is a focus on the main beneficiaries of mangrove forests. In addition, during the investigation process, the authors always try to diversify interview subjects in terms of age, gender, income, and education level to ensure representativeness of the research area. However, it cannot be denied that expanding the investigation with a larger sample size will help make the research results more reliable.

4. Conclusions

The CVM is used to evaluate goods and environmental quality by building a virtual market through people's WTP or WTA posed in a hypothetical situation. CVM is applied to many environmental factors such as air quality, landscape value, and wildlife conservation. The study uses the CVM combined with sociological surveys to examine local people's assessments of the role and benefits of mangrove forests in local economic development. According to the people's assessment, the most important benefits of Kim Son mangrove forests include the ability to block waves, protect sea dykes, block wind, limit soil erosion, limit human and economic risks caused by storms, improve air quality, regulate water, provide habitat, provide breeding grounds for wildlife, contribute to soil formation, provide food for exploitation, filter water, and improve water storage capacity and groundwater replenishment of mangrove forests. However, many people do not know about the role of mangrove forests. Mangrove ecosystem services that contribute little include providing pollen to raise honeybees and providing firewood.

Through two mangrove protection funds for current and future purposes, the study determines the optional values and residual values of mangrove forests. The total value of mangrove forests through people's WTP reached 741 million VND/year, and the factor affecting WTP depends mainly on the gender of the respondent. In the research area, people's WTP depends mainly on the gender of the respondent. Women tend to be willing to pay at a lower level than men. This can be explained by the fact that women's income is lower than men's income (according to the survey results), while women often manage expenses, thus creating a cautious mentality in public service contributions.

CRediT author statement

Ha Thi Thu Nguyen: Conceptualisation, Methodology, Data collection, Data analysis, Writing, Validation; Anh The Luu: Data collection, Methodology, Writing; Thu Tuyet Thi Tran: Data collection, Writing.

COMPETING INTERESTS

The authors declare that there is no conflict of interest regarding the publication of this article.

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