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# The Gap between Science and Policy: Assessing the Use of Nonmarket Valuation in Estuarine Management

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## Abstract

Estuaries, which are among the most productive natural systems on earth, provide an array of human welfare benefits if well managed. Non-market valuation (NMV) is considered a powerful tool, which can contribute to informed policies for estuarine management. More than 30 year of research valuing estuaries around the world does not appear to have had a major impact on estuarine management. Published examples of policy applications using estimates from these studies, are rare, leading to the question whether the effort and money spent on this research has been useful and worth the cost.

Despite raising public awareness of the importance of estuaries, NMV should play a wider and more influential role in estuarine management. Our research assumes there is a gap between economic studies and their use in policy decisions. We identify the gap, address the size of the gap, and reasons for it. Our research also seeks to understand the reasons why these values are not used more in the decision making process.

In this paper, we review current literature, and report on a survey of key personnel from two US agencies, NOAA and EPA, that oversee estuaries and sanctuaries, and we will summarize their observations regarding why there is a gap. As an emerging field for many around the world, NMV is receiving increasing attention in China where estuarine resources are threatened by a multitude of human activities. We explore how and whether China can draw lessons from the US cases we have studied and what benefits China can expect from doing NMV studies and encouraging their results be used in Chinese estuarine management.

## Keywords

Policy use; Ecosystem assessment; Ecosystem management; Economic valuation; Ecosystem services

## 1. Introduction

Ecosystems provide implicit benefits to human beings so that people fail to realize their true value until they are missing. By bringing up unnoticed benefits and making a clear statement about how much money they are worth, those who advocate for NMV<sup>①</sup> of ecosystem services

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<sup>①</sup> NMV stands for non-market valuation in this paper.

have had high expectations for changing chronic human disregard for nature. The dominant role of NMV in ecosystem management has been emphasized via different media. And new initiatives have emerged to incorporate ecosystem services into national accounting and investment decisions (Kusher et al. 2012).

NMV of ecosystem services has been a hot topic in a large and growing literature since the 1990s (Bille et al., 2012). Searching through any literature database, it is quite easy to obtain many references concerning “NMV” or “ecosystem service valuation”. However, despite the abundance of literature, there are only rare reports whether NMV has played an influential role in policy decisions with respect to ecosystem management (Kushner et al., 2012). Since NMV is a costly process normally, as well as time-consuming, whether or not these efforts have actually paid off, remains an issue.

Some economists have attempted to answer this question by means of a literature review (e.g. Laurans et al. 2013). The general conclusion from these reviews was that there was a paucity of published papers that report how NMV studies played a role in actual management decisions. The time lag between NMV and their use for decision-making might serve as a possible reason (Laurans et al. 2013). Fisher et al. (2008), through interviews with the authors who had done NMV studies, also reported it was too early to assess the use of NMV studies. Also skepticism about the reliability of methodologies (Turner et al., 2003) coupled with the high cost (SCBD, 2007) of carrying out NMV studies, possibly contribute to its scant use in management to date. Finally, whether decision-makers possess economics skills (Driml, 1997) and whether the regulatory system is supportive (Liu et al., 2010) appear to be decisive regarding the extent to which NMV assists with decision-making.

All these publications have cast a light on this issue. However, both the literature and researchers can only hypothesize the potential reasons for the gap between an extensive literature and its use in management. Determining whether these speculations are true still needs proof from the real world. The best solution is to hear from the actual decision makers. They are the intended users of NMV studies and they decide whether and how to use NMV in ecosystem management.

The purpose of this paper is to report the results from a survey<sup>②</sup> of 55 estuarine program managers across the U.S.<sup>③</sup> to test whether NMV studies have lacked policy traction and the probable reasons. We summarize these results in section 2. In Section 3, we provide a useful set of categories, much broader than those found in the survey, derived from the literature and the survey, for which NMV can serve a useful purpose. In section 4, we address the gap between

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<sup>②</sup> Survey of Estuarine Managers sponsored by the Center for the Blue Economy, MIIS, 2012-13.

<sup>③</sup> Among 55 estuarine programs, 28 came from The National Estuarine Research Reserve System of NOAA while 27 came from The National Estuary Program of EPA. For detailed information, please check the websites: <http://www.nerrs.noaa.gov/> and <http://www.epa.gov/owow/estuaries/>.

scientific research and its policy uses and explore some possible reasons behind the gap. Finally, the lessons China can draw from the U.S. are presented in sections 5, and section 6 has some conclusions.

## 2. The Survey Results

### 2.1 Survey of the use of NMV

The purpose of this survey was to collect data to test the assumption that there is a gap between theory and policy uses of NMV and find out the underlying reasons if a gap was found. An email questionnaire of 5-9 questions (see Appendix A) was sent to the directors of 55 estuarine programs managed by both NOAA and EPA in the US. The purpose was to investigate decision-makers' experiences and their opinions about undertaking and using NMV studies. The survey divided the 55 estuarine programs into two groups with different questions (see Table1). Based on whether or not they carried out NMV studies, these questions were designed as a mix of open-ended questions and multiple choices. The reason why we chose estuarine programs is because estuaries involve varied ecosystems and provide a multitude of ecosystem services. Also, they have been the focus of numerous NMV studies, contributing to an abundant literature.

Table 1.

The organization of the survey questions

| <b>Survey group</b>          | <b>Survey topic</b>                       |
|------------------------------|---|
| Programs with NMV studies    | Potential use of NMV                      |
|                              | Practical use of NMV                      |
|                              | Barriers to use NMV                       |
|                              | Confidence about NMV                      |
| Programs without NMV studies | Reasons why not carry out NMV studies     |
| All programs                 | Economics background                      |
|                              | Suggestion about improving the use of NMV |

### 2.2 NMV in practice

There were a total of 34 responses from 33 identified programs and 1 unidentified program<sup>④</sup>. The responses revealed that NMV was used far less than the extensive literature might have suggested, since only 9 programs of the 33 have carried out studies related to NMV. Despite the fact that no managers had an economics background, of the opinions regarding the policy use of NMV given by all responses, 9 programs commended the practical use of NMV in policy decisions, while the other 21 responses indicated concern and doubt about NMV techniques and

<sup>④</sup> There were two programs that offered two responses from both director and staff. In order to keep the consistency of results, we removed staff responses from multiple choice questions and kept them in open-ended questions.

uses. These responses also reflected administrative limits such as budgetary and personnel restrictions of individual programs.

### (1) Potential use of NMV

The purpose of investigating an individual's intention to carry out NMV was to elicit information about the decision makers' knowledge about the potential use of NMV, the premise for initiating the studies concerned. We listed major potential uses of NMV in the survey in order to capture the spectrum of a decision maker's knowledge about it. The survey results in Table 2 showed that a person's perceptions of ways in which NMV could be used ranged over most options listed, with only regulatory review and NRDA (Natural Resources Damage Assessment) absent. Primarily, programs that have carried out NMV intended to enhance people's awareness of the importance of environmental factors, followed by the purpose of designing market-based instruments and assisting environmental management tools. Other than these, other uses were rare and only mentioned by one program.

Table 2.  
Responses of the potential use of NMV

| Potential use  |   | Responses (total 9)   |   |
|--|---|---|---|
| Cognitive use  |   | To recognize the importance of a given ecosystem or ecosystem service | 8 |
| Operational use                                      | Project evaluation                        | To justify an investment project                                      | 1 |
|  |   | To evaluate an ecosystem development plan                             | 1 |
|  | Trade-off of multiple projects            | 1   |   |
|  | Regulatory review                         | 0   |   |
|  | Natural resource damage assessment (NRDS) | 0   |   |
|  | Market-based instruments design           | 3   |   |
|  | Environmental accounting                  | To assess the effect of climate change                                | 1 |
| To assess total economic value of ecosystem services |   | 1   |   |
| Technical use  |   |   | 3 |

### (2) Practical use of NMV

Based on the survey, the uses of NMV have been realized partially, but not yet achieved completely. Enhancing people's knowledge and awareness of ecosystems serves the top use in the list. On the one hand, unlike economic social systems, the importance of the environment and ecosystems has been considered for only a few decades. Especially since a multitude of ecosystem services still remain unnoticed, as do their values, it is of great significance to improve recognition and understanding, which also underpins environmental preservation and

restoration initiatives. On the other hand, NMV has not been used as widely as anticipated for all kinds of reasons that range from skepticism and doubt about techniques to procedural or technical problems affecting the course of decision making.

Also we found that people might not use the results of NMV as they planned in the first place. Five of nine programs who have already carried out NMV considered the study results as influential on policy decisions. Only two of them have opposite opinions and the other two have not used the results yet. When it comes to practical use, NMV did or is about to support projects with respect to ecosystems or contribute to discussions about them. For example, according to the responses, NMV was successfully used “... to gain support for restoring our coastal landscape”<sup>⑤</sup> and “...to promote the necessity of protecting the estuary...”. And also it is expected to aid in “...making the argument for future funding of projects to protect and restore the estuary.” Only one program reported that they had used it “...to demonstrate that the benefits could out-weigh the costs”. On the other hand, as for the reasons why NMV had no impact on policy decisions, two people agreed that NMV was too new to serve as the basis for broad ranging policy decisions.

### (3) Problems to put NMV into practice

Any theory encounters some problems when it is put into practice. NMV is no exception. The survey results showed that five of eight respondents had problems using the results of NMV in their policy making process. Skepticism about precision and reliability of NMV techniques was considered the most serious problem that hindered the wide use of NMV.

### (4) Confidence in NMV

Acceptance of NMV studies and results could be indicated by whether or not people want to carry out more studies involving non-market values. Confidence in NMV studies will in part help to decide if NMV has a bright future with wide use. According to our results, four directors who have done NVM were hesitant to do more such research due to budget restrictions and their skepticism about methods and results. Two programs said they would not carry out any NMV. On the other hand, support and confidence in NMV was shown by three programs who declared they would do more NMV in the future, some of whom had already put it on their agendas.

### (5) What blocked NMV studies?

Among 34 programs that responded to our survey, 75% (25 responses) have not carried out any studies involving NMV.

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<sup>⑤</sup> Without specific citation, the words that were put in double quotation marks were cited from the survey conducted by Guo and Kildow in 2013.

Through literature review, we assumed a few reasons that might hinder people’s decision about carrying out NMV. Based on responses (see Table 3), financial restriction was the most common reason since NMV was normally expensive while the budget for estuarine programs was limited. Only one program did not consider doing a NMV study due to skepticism about the techniques, while nobody reported “influential stakeholders refuse to do it” as a reason. On top of the reasons listed, social science studies were not a priority of estuarine management, which was mentioned by two respondents. Bottom line, without someone either on staff or easily accessible in the local community to champion economics or the social sciences and their benefits, and with no economists among estuarine managers, estuarine management in the US has and always will choose natural science research over social science and economics research when budgeting occurs<sup>®</sup>.

Table 3.  
Reasons why decision-makers refused NMV

| <b>Reasons</b>   | <b>Responses</b> |
|--|------------------|
| NMV is too costly for our limited budget.                                | 14               |
| The information or data related to NMV is not available.                 | 8                |
| NMV is not our priority to solve existing problems.                      | 7                |
| Policy uses of NMV remain unclear.                                       | 7                |
| Non-market values are not complete enough to inform our policy decisions | 6                |
| There are no economists available to inform us about NMV.                | 6                |
| NMV techniques are not reliable enough.                                  | 1                |
| There are influential stakeholders who do not want it.                   | 0                |

(6) Economics background of estuarine programs

Since NMV is an economic concept and also serves as an important part of economic analysis, whether or not an estuarine program has someone with an economics background, to an extent, determines the level of its interest and knowledge in NMV. Based on this assumption, we surveyed the background information of estuarine program staff. The survey results showed only four programs had staff with an economics background who were able to offer some suggestions about NMV. When it came to the role of economic analysis in estuarine management, half of the programs (17 responses) took economic analysis seriously in decision making, seven of which had already done NMV.

(7) Suggestions about improving the use of NMV

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<sup>®</sup> NOAA’s National Estuarine Research Reserve Program is attempting to change the culture by introducing their managers and upper level staff to non-market economics through experimental workshops and other tools, understanding that social science research needs more attention and their managers need to understand why,

In order to determine the way to enhance the use of NMV, eight suggestions were listed in the survey for prioritization. Based on rating (1-5), improvements of non-market methodologies were considered as the most important while support to increase the knowledge about NMV methods and application got relatively low rating (see Table 4).

Table 4.

Suggestions of decision makers about improving the use of NMV

| <b>Suggestions</b>  | <b>Rating<sup>a</sup></b> |
|---|---------------------------|
| Enhanced credibility and reliability of NMV techniques.   | 4.17                      |
| Clarify the links between policy questions and NMV.   | 4.11                      |
| Develop less expensive methods to carry out NMV studies.  | 4.05                      |
| Expand the range of ecosystem benefits/services that can be measured by NMV.  | 4.05                      |
| Link non-market values explicitly to different stakeholders/ user groups.   | 3.96                      |
| Establish more effective communication channels between economists and estuarine agencies.                          | 3.96                      |
| More support to increase the understanding of the range of non-market values and the array of valuation techniques. | 3.75                      |
| More reports about how to use non-market estimates in policy decision making process.                               | 3.39                      |

a. No.1-5 stand for different level of importance ranging from “not at all important” to “very important”.

### 3. Categories of Useful purpose served by NMV

Even if the extent to which NMV influences policy decisions is still unclear, economists have never stopped exploring the potential use of NMV (Laurans et al., 2013). Laurans et al. (2013) built a synthetic typology of assorted categories from a literature review, which was one of the early attempts at systematic uses of NMV. There are still some uses, however, that were left out of those categories. For this reason, we have built a new classification system based on our literature review and the survey we conducted, in order to make potential uses of NMV more comprehensive and clear. These uses fall into three main groups: cognitive use, operational use, and technical use, based on the application objectives.

#### 3.1 Cognitive use

The primary objective of this NMV category is to influence people’s thinking and enhance their awareness about the importance of ecosystem services. Admittedly, people have been making great advances in understanding and recognizing the contribution of ecosystems. However, before quantifying ecosystem benefits monetarily, people’s conception of the role that ecosystem services played was restricted to limited words like “somewhat”, “very” and “extremely,” etc. These words only delivered a vague idea about different levels of importance, so that nobody could really tell how important ecosystem services were. Since money speaks louder than words, NMV promotes ecosystem services in the most direct way. Not only does it save words that strive to explain complicated ecosystem functions, but it also makes people realize the value of ecosystems in monetary terms that everyone is most familiar with. Although the debate over



whether all natural resources should be capitalized has been heated, it is undeniable that monetization is the most straightforward and effective way to clarify people's views of ecosystem services, especially for a society in which economic growth and development are core pursuits.

Despite growing awareness of ecosystem benefits, people are still inclined to consider free services as “no price, no value”. For example, people have to pay entrance fees for access to a fair while often paying nothing to use a beach. Consequently, it is easy to misunderstand that a beach has less value than a fair. However, the truth is the opposite. In addition, complicated interactions of ecosystem services tend to be beyond public understanding, especially for indirect services<sup>7</sup> that transfer benefits to humans invisibly. Due to limited public knowledge about ecosystem services, an array of threatened ecosystem services that are of great importance are suffering from undervaluation or even ignorance. For instance, water is a necessity in daily life. Even when people appreciate the importance of water resources, they may have no idea about the purification services of wetlands that make a substantial contribution. It is too much to expect everyone to be an environmentalist. It is more likely, however, to expect that NMV might enable the value of ecosystem services to become more understandable and recognizable.

NMV has not only raised public awareness, but it has also brought policy makers a new perspective with which to assess the contribution of ecosystems to human well-being. The non-market value of ecosystem services is a utilitarian value instead of an intrinsic value (Liu et al., 2010), which tells how much human beings are better off or worse off due to changes in ecosystems. Moreover, NMV techniques are built on human preferences directly (revealed preference methods) and indirectly (stated preference methods), expressing how people feel about ecosystem services. Valuing ecosystem services, based on human welfare, can draw more attention from policy makers, since improvement of human welfare is supposed to be a focus of most policy decisions. Although NMV has been criticized as anthropocentrism (Liu et al, 2010, McCauley, 2006), it is justifiable. Given that all policy decisions come from humans, it is more practical to motivate people to conserve ecosystems for their own sake. In this sense, estimating the value of ecosystem services should be considered as a sensible tactic to incorporate ecosystems into policy decisions rather than just as an economic tool.

### 3.2 Operational use

This category explains how NMV can be more effectively used in decision making. The importance of ecosystems has been increasingly recognized. They are not the only things that are important and valuable though. Social and economic development also serves as an important part of human well-being. Ignorance of considering ecosystems in policy decisions mainly results from a bias that social and economic development is more important than

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<sup>7</sup> Indirect service means services they have to work together with other services to provide benefit to humans instead of providing it directly.

ecosystems as most ecosystem services appear abstract and incomparable due to the lack of monetary values. They are also often invisible, to most people, as natural functions either are poorly understood or just taken for granted. To enable people to take ecosystems seriously, not only theoretically but practically, it is important to make them comparable with other market sectors in the economy. Once the values of ecosystem services are “visible”, they can enter economic analysis that has become the basis for most policy decisions.

### 3.2.1 Project evaluation

The most typical role of valuation is cost-benefit analysis of projects (Pearce and Seccombe-Hett, 2000). In most cases, a project can be implemented only when benefits outweigh costs. However, when it comes to environmental and ecosystem services, their values are difficult to quantify due to the absence of conventional markets in which they can be traded. Consequently, decision-makers either avoid considering non-market values of ecosystem services or only take part into account. For example, if the entrance fee of a wetland park is quantified as the only benefit of wetland restoration, this project might suffer from serious undervaluation of the wetland. Moreover, in some countries, governments have already put the use of NMV on the agenda. For example, in the United States, the regulation for guiding federal infrastructure investments suggests that non-market benefits should be given the same weight as market benefits and costs (Raheem et al., 2012). Functioning with careful scrutiny of ecosystem benefits, NMV can contribute to informing project evaluation both a priori and a posteriori.

### 3.2.2 Trade-off of multiple projects

In reality, there is always more than one option for decision-makers to consider. For that, trade-offs are central to decision-making, which, in turn, requires all the attributes of options to be compared in uniform terms. The choices that have to be made might range from a selection of services obtained from a given ecosystem to multiple systems like environment, economy and society. For example, the trade-off might be between human recreation and wildlife habitat on a beach; it also might exist between ecosystem services and urban housing. In either case, it is crucial to quantify non-market values of ecosystems. Although money may not be the best measure for ecosystem values, it has been considered as the most common and straight forward way to make benefits from different sectors comparable. In this respect, a foundation for decision-makers' trade-offs can be built on NMV (Laurans et al., 2013) as can prioritization of alternative options.

### 3.2.3 Regulatory review

NMV is useful in government regulatory reviews when incorporated into CBA. Unlike projects, the effect of a regulation depends largely on public behavior, which means, if economic benefits were to be severely decreased, people might find ways to skirt a regulation. When this happens,

regulations do not become policies. Thus, deciding the magnitude of a regulation's economic effects depends on a complete economic analysis, using NMV.

When environmental regulations are concerned, on the other hand, the absence of monetary values for ecosystem services makes accurate CBA difficult or even impossible. As a result, environmental policies turn out to be undesirable sometimes (Pearce and Seccombe-Hett, 2000). For this reason, non-market values, as a proxy for ecosystem benefits, tend to enable CBA for environmental regulations in order to improve their efficiency. Also, changes in legislation that demand regulations be subject to CBA (Navrud and Prudcner, 1997; Pearce and Seccombe-Hett, 2000), portend great promise for the use of NMV.

### 3.2.4 Natural resource damage assessment (NRDA)

NRDA has been at the forefront of the use of NMV in litigation (Liu et al., 2010), which mainly tackles the restoration of damaged resources and compensation for those injuries. The continuing Deep Water Horizon trial is a case in point, (Nichols and Kildow, 2014)<sup>®</sup> in which NMV studies have been core to arguments assigning monetary losses as guidance for administrative decisions and court rulings (Laurans et al., 2013). In addition to present values of an ecosystem, future values can also be measured with NMV, based on the premise that people desire to preserve options for future use or future generations, indicating a sense of responsibility for preserving natural resources (Kopp and Smith, 1993). Due to the irreversibility of some environmental changes, future values, sometimes termed as "non-use value" can be too great to ignore in NRDA. Preserving pristine parts of the Arctic, where few will ever venture, is one such example where advocacy groups have been vocal.

### 3.2.5 Market-based instruments design

One of the most effective measures for ecosystem preservation is to incorporate environmental systems into socio-economic systems by introducing economic variables to environmental assets and services. Either providing essential original materials or serving as important products themselves, ecosystem services have been making a great contribution to socio-economic development. The attributes of public goods<sup>®</sup>, however, make them suffer from severe market failure. For example, everybody has the right to enjoy a wonderful day on a beach. But nobody feels obligated to pay for beach restoration. Thus, ecosystem services should have a price, which helps to avoid free-riders and internalizes externalities (Laurans et al., 2013). Assigning credible monetary values to ecosystem services is the first step toward the design of market-based instruments. Beyond this, NMV can be used to construct demand curves for specific

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<sup>®</sup> "The Political Economy of Oil Spill Damage Assessment: The NRDA and Deep Water Horizon," White Paper, Center for the Blue Economy, Monterey Institute of International Studies

<sup>®</sup> A public good "is a good that is both non-excludable and non-rivalrous in that individuals cannot be effectively excluded from use and where use by one individual does not reduce availability to others." (Varian, 1992)

services and predict reactions of people involved in the pricing (Pearce and Seccombe-Hett, 2000).

### 3.2.6 Environmental accounting

With increasing recognition of the importance of the environment, current “national accounts” have been criticized for more than a decade as poor indicators of human well-being (Navrud and Prudner, 1997). Especially some irreversible environmental changes arising from economic activities can bring about huge long-term losses. An example might be the extinction of species and the ripple effects. Clearing land for agriculture and logging in the Brazilian Atlantic region has caused fragmentation of rain forests over the past century, which ripples through the surrounding ecosystem by pushing numerous species into extinction (Walsh, 2013). Particularly, when those species play a key role in preserving the integrity of the natural systems, the results could be devastating and costly. Thus, it is important to deduct environmental costs from the national product for a more accurate measure of economic growth (Pearce and Seccombe-Hett, 2000). Moreover, NMV can be used for natural capital accounting, which reflects the contribution of ecosystem services to the economy and livelihoods. In this period of uncertain climate changes, there is growing acceptance of the need to put natural capital into decisions, particularly as they affect sea level rise, estuarine management and coastal developments. Accounting for natural capital losses and gains, can help to monitor the effects of climate changes on ecosystems both temporally and spatially.

### 3.3 Technical use

NMV estimates assist with other environmental systems analysis tools (ESATs)<sup>®</sup>. Ecosystem management is challenged by constantly changing interactions among economic, social and environmental systems, which requires processing a large amount of disparate information simultaneously. Whether more information leads to better decisions largely depends on effective and organized processing and delivery of information. A growing number and more systematic use of analytical tools have been developed to facilitate inclusion of environmental information into decision-making (Moberg, 2006). The core of ESATs is to assess environmental impacts of a given ecosystem. Since there are a multitude of impact factors with respect to the environment, one of the most common ways is to group all of them into one index. In this case, non-market values could serve as both relative and absolute weights for assessment (Ahlroth et al., 2011). In addition, most ESATs simulate the process of decision-making. The operational uses of NMV mentioned above, thus, also suit this category if analytical tools are available.

## 4. Understanding the gap between the science and policy uses

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<sup>®</sup> ESATs include procedural tools such as Strategic Environmental Assessment (SEA) and Environmental Management Systems (EMS), and also analytical tools such as Life Cycle Assessment (LCA), Cost-benefit Analysis (CBA), Risk Assessment (RA) and Input-Output Analysis within the framework of the System of Economic and Environmental Accounts (SEEA) (Ahlroth et al., 2011)

#### 4.1 The gap concerning NMV

The extensive NMV literature does not appear to be balanced with its use in reality, at least not according to our US survey results. The initial NMV, also termed “Economic valuation of ecosystems” dates back to the 1960s (Liu et al., 2010). Over a few decades of evolution of the field, economists’ enthusiasm about it has been growing, if the literature is any reflection. Especially, during these times of intense climate events and degradation of ecosystems, much effort has been made and much evidence has appeared, to demonstrate the value of ecosystems. To prove this, the amount of academic publications involving NMV can serve as a good proxy. When one searches for “economic valuation” in the *Journal of Ecological Economics*, 1723 articles can be found. This popularity, however, has not been translated from the academic world to the world of practice in the U.S. As the agencies responsible for protection and restoration of estuaries have responded, very few estuarine programs have carried out studies concerning non-market values, which might at least partially explain why current literature reports about the policy applications of NMV are so limited.

In practice, NMV is rarely applied as anticipated. Over the period of development of NMV studies, economists have proposed a broad range of potential uses from enhancing perception of the environment to informing economic analysis and management tools, as described in section 3 of this paper. However, in practice, NMV is mostly limited in use to improving people’s recognition of the value of ecosystems. Although most people confirmed some influential role of NMV in persuasion and discussion, the use of NMV could go far beyond this. When non-market ecosystem benefits are valued in market prices, it enables decision makers to take non-market value into CBA that is the basis for most decisions with respect to socio-economic and environmental systems. Nevertheless, due to all kinds of barriers, which involve limited knowledge about NMV, skepticism about techniques and estimated results, or procedural problems, the majority of potential uses of NMV have not made their way into practice, which, in turn, makes NMV less influential than it might be.

The interest that economists show for NMV is in sharp contrast to policy makers’ apparent indifference. Throughout, economists have never ceased to refine NMV. A basic standardized classification system of ecosystem functions, services or benefits has been created for valuation (Sakuyama and Stringer, 2006; Tuan Vo et al., 2012); a selection of methodologies has been developed for different ecosystem benefits and varied contexts (Liu, 2007; Hadley et al., 2011); other tools like GIS (García et al., 2008), Meta-analysis (Brander et al., 2012; Ghermandi and Nunes, 2013), Bayesian belief networks (Haines-Young, 2011) etc. have been incorporated for more reliable valuation. On the other hand, many decision-makers seem to be ignorant of these advances and remain skeptical of valuation techniques and results. As shown in the survey, a considerable amount of respondents lack confidence in NMV since “non-market values are criticized variously”; “methods are questioned”; “skepticism that non-market values could be evaluated” is common; “valuation data are not taken seriously”. The attitude towards NMV that

varies between economists and decision-makers leads to the gap between academic research or the science, and practical use, or policy decisions.

Another gap reflected by the survey is that most US estuarine decision making teams are not qualified to use non-market estimates. Since most uses of NMV that economists proposed in literature require economics skills, a team without any economists or anyone with an economics background is unable to use NMV in policy making. As mentioned above, the use of NMV has to be built upon 1) an understanding of when it is appropriate to do a NMV study, and 2) an appropriate context in which economic analysis, (e.g. using some form of CBA that can incorporate NMV) is necessary and can be useful. However, according to survey results, less than half of the programs that responded executed economic analysis and many fewer had staff with economics background or sought out economists nearby to assist them.

## 4.2 Issues resulting in the gap

The use of NMV is still controversial (Pearce and Seccombe-Hett, 2000), partially because of misunderstandings of the concept itself and partially because of uninformed administrative frameworks – small budgets and the relegation of economics to a lower priority than natural sciences.

### 4.2.1 Intrinsic value vs. utilitarian value

Non-market value of ecosystems is an economic concept, in which “value” indicates utilitarian value instead of intrinsic value. Some decision makers had “... skepticism that non-market values could be evaluated...” and also some said “... we already know it (ecosystem) is valuable”, so “we don't need a study (NMV) to tell us that...”; or “We feel that the non-market values of our coastal landscape are well-known among the public and government and there is no need to spend more time and money on conveying those values.” However, the meaning of “value” varies by context (Champ et al., 2003). Economists and ecologists might use this word in totally different ways. For example, a wetland, for ecologists, is considered as important in that it contributes to the natural balance, whereas the recreational use or protective use that benefits humans directly is more economists’ interest. The former is called intrinsic value (“it is valuable in and for itself”<sup>11</sup>) while the latter is called utilitarian value (“it is valued as a means to some other end or purpose”<sup>12</sup>). As an economic method, NMV aims to assess the contribution of ecosystems to human welfare. For instance, recreational values of an estuary can reflect the value of the estuary as a spawning ground for recreational fisheries by means of investigating how much money people would be willing to pay for fishing there.

Admittedly, intrinsic value of ecosystems is of great importance. It is beyond our discussion of non-market values however. On the other hand, utilitarian value is of more concern to both the

<sup>11</sup> Callicott JB. Intrinsic value, quantum theory and environmental ethics. *Environmental ethics*, 1985,7:257-275.

<sup>12</sup> Costanza R, Folke C. Valuing ecosystem services with efficiency, fairness and sustainability as goals. In *Daily G ed. Nature's services: societal dependence on natural ecosystems*. Washington DC: Island press. 1997,49-70.

public and decision makers. First, non-market value of ecosystems has direct connection with human well-being, which makes it easier to understand and accept conceptually. Second, NMV transforms ecosystem benefits into money, based on which ecosystem services are comparable to other sectors of the economy. In another words, ecosystems will not be excluded from consideration because they do not have a “price”. Moreover, compared to intrinsic value, utilitarian values are more likely to be estimated, because this type of economic evaluation has been well-established in economics for decades (Pearce, 2007).

#### 4.2.2 Science vs. policy

The common objective of applied science and policy—enhancing human welfare (Ingold and Gschwend, 2013)—, connects both to nature. Ideologically-based policy making dominated decisions for centuries, which, mostly turned out to be biased or subjective based on the limitations of knowledge (EC, 2008). For this reason, evidence-based policy making, which encourages the use of science to inform decision making, has often resulted in more effective and robust policies and regulations (Cortner, 2000; Holmes and Clark, 2008). Environmental problems are especially complicated and go far beyond individual perception. So they require scientific research and methods to “produce policies that deal with problems; ... that tackle causes not symptoms” (HM Government, 1999).

For this purpose, many scientists today attempt to support decision-making by providing policy-relevant science. However, the utilization of such scientific knowledge by economists and their translation and persuasion for decision-makers is not self-evident (Runhaar and Nieuwaal, 2010). Based on our limited survey, a large body of scientific research fails to persuade policy makers of the significance of NMV. Estuarine directors either “remain unconvinced that NMV is really helpful” or “doubt the results and... don't actually figure them into cost-benefits.” As a result, economists’ efforts have not played an influential role in policy making concerning estuarine management (Laurans et al., 2013).

The connection between scientific evidence and policy applications does not happen in a vacuum. It needs concerted efforts on the parts of both scientists and policy makers. To date, NMV literature has seldom addressed specific policy problems faced by decision makers (Laurans et al., 2013). Instead, most work is designed only for the sake of developing theory or methodology. For example, in a literature survey, one finds very few NMV studies which clarify or even mention policy questions they attempted to solve. In this case, absence of realistic context makes scientific work less useful to estuarine managers. On the other hand, policy makers might not be experts in NMV, or “do not have time to keep up with recent relevant literature”. It is likely that they have no idea what is going on with scientific advances in NMV methodologies. Consequently, skepticism about NMV has scarcely been dispelled despite economists’ efforts to improve the methodologies. There is a definite need for economists to step up and be more vocal and visible to managers and decision makers. Another obstacle to the transition from scientific (economic) evidence to policy application is that non-market value estimates cannot be fully

operational without economic analysis or other environmental management tools. The fact that very few estuarine programs employ people with economics background or create partnerships with outside economists, hinders the access to information about NMV or other economic techniques.

#### 4.2.3 Social science vs. natural science

Solutions to difficult environmental problems require the synthesis of diverse types of information from both natural and social sciences. In reality, these two disparate but interconnected academic worlds often work separately. For decades, natural scientists such as ecologists ignored human impacts while social scientists excluded nature from consideration, despite tight interactions between human and natural systems. That separation is eroding and both types of scientists in many cases now recognize that they need each other.

Ecosystem management involves ecology, economics, management science, anthropology and other disciplines. Nevertheless, our survey results showed that there was still a large gap between social and natural science. For one thing, most estuarine programs originated based on ecological and other natural scientific research questions, so people with natural science backgrounds occupy the vast majority of management positions. This significant disproportion results in the ignorance of social science or the poor use of economic analysis in policy making. As a result, most programs "...don't have the staff expertise to conduct this type of work (NMV)". For another thing, due to lack of mutual understanding and communication, "these two scientific cultures can show mutual indifference, ignorance, suspicion and even open hostility in situations when funding is shrinking"(Funchs, 1996). For ecologists "...non-market studies would not be areas where" they "would prioritize expending funds from my program..." or they "have not budgeted for social science studies...". Whereas, economists have seldom "approached us (estuarine programs) with an interest in doing this work (NMV)". Despite growing recognition that scientific evidence has limited value without social science analyses, when the majority of programs confront shrinking budgets, social sciences take the brunt of the funding cuts.

Therefore, in order to develop feasible policies for effective solutions to environmental change, there is an urgent need to bridge the gap between social and natural science.

### 5. What can China learn from the U.S. case study?

NMV has drawn researchers' interest in China since 2000. There are a growing number of studies discussing economic values of ecosystem services ranging over all kinds of ecosystems. Although our survey was carried out among estuarine programs in the U.S., some lessons we can draw are still meaningful for improving the use of NMV in China.

(1) Enhancing knowledge of NMV



One of the main findings of this survey was that most decision makers have limited knowledge about 1) how NMV is carried out and the extent to which NMV is accurate and useful and 2) how and when to use NMV to inform policy decisions. Lack of complete understanding results in the general skepticism about the reliability and practicality of NMV estimates, which, in turn, also puts the greatest obstacle in the way of using NMV in decision making. To enhance confidence in NMV, the best way is to give decision makers more access to updates on research involving NMV, such as case studies of policy use, advances in techniques. Additionally, insufficient economic knowledge of decision makers, coupled with the absence of staff with economics background, makes it difficult for NMV to work as expected or even be put on the agenda. For this reason, essential training in relevant economic methodologies and principles would also contribute to building an effective decision team with integrated knowledge, the foundation for informed policy decisions related to estuarine management.

(2) Build partnership between management agencies and economists

Another factor causing scant use of NMV is lack of access to economists. Quite a few offices reported that no economists were identified to inform them about NMV. On the other hand, a large number of NMV studies are on the shelf. To solve this paradox, it is necessary to build partnerships between management agencies and economists. Economists are able to advise decision makers about NMV, by translating economic language or by keeping them updated about new advances in NMV or referring them to relevant studies. Cooperation with management agencies would also encourage NMV investigators to focus on practical problems.

(3) Promoting problem-driven studies

Without a clear statement of problems or description of context, NMV studies are not easily understood by decision makers who do not have a complete knowledge and experience related to NMV. Since NMV is supposed to inform policy decisions and address practical issues, studies that are devoted to specific problems tend to have more traction than theory- or methodology-driven studies. Hence, more problem-driven studies could help integrate NMV into China.

In addition to the general lessons we can draw from this U.S. case study, the different cultural and political systems in China also require special considerations for the development and use of NMV.

(1) Developing valuation methods that suit the Chinese situation

Using a common NMV technique, contingent valuation which seeks to determine how much money people are willing to pay for ecosystem services, might face some challenges regarding selection of the survey sample in China. For example, people feel that the government instead of the public should be responsible for changing the environment. Or they want to be freeloaders rather than pay for it by themselves. In this case, non-market value of ecosystems will suffer from underestimation since people might hide their real preference for ecosystem services. On

the other hand, half of the Chinese population lives in villages, where life and work has close connections with nature. They are also a group of people who are less educated and have lower level incomes and thus less influence. All of these features of potential respondents in China have not been discussed thoroughly in the current literature. For more reliable and convincing research, it will be necessary to develop more suitable approaches to fit the specific situation in China.

## (2) Promoting the use of NMV

The acceptance and use of NMV is supposed to be used in many different ways. However, some uses like CBA require transparent decision systems (Laurans et al., 2013), which do not suit the current situation for the Chinese government. The slow progress toward a transparent regulatory system in China has been criticized (Zhao, 2012). For this reason, different strategies may be necessary to promote the use of NMV. For one thing, the multiple uses of NMV should be illustrated in order to deal with the varied demands of agencies. For another, the uses of NMV should be consistent with decision systems of the government to make sure they are feasible and operational.

Government plays an important role in promoting academic research in China. NMV needs to have an intimate link with policy decisions. In this case, getting government involved from the beginning would be an operational and effective way to promote NMV in China. On the other hand, economic valuation of ecosystems has been studied for more than three decades in the U.S. and Europe, providing a solid theoretical and practical foundation based on a large literature collection. From both theoretical and practical perspectives, thus, it could be feasible to carry out national ecosystem assessments in China to investigate non-market values of ecosystem services. This could serve as the first step of the whole plan to bring ecosystems into policy consideration and seek sustainable economic development.

## 6. Conclusion

Socioeconomic development and ecosystem management are often considered as an “either-or” situation, since human greed often leads to disregard for nature. On the other hand, ecosystems serve as an important source of human well-being that is also the goal of economic development and often provides the very foundations for economic development. It is not appropriate to separate them. Through NMV, ecosystem benefits and economic benefits can not only show linkages between market and non-market assets, they can be measured in comparable units so that decision makers are better able to include ecosystems into policy decisions. Though NMV studies of ecosystems have been drawing more and more attention, papers reporting how a specific NMV study influences policy decisions are still limited.

Our research attempted to find out the reasons for this gap by surveying 55 estuarine program managers across the U.S. The result showed that decision makers have limited knowledge about the use of NMV studies as well as having varied opinions on the role of such studies in

management. Some restrictions that originate from administration agencies, such as tight budgets, limited access to economists and bias against social science research by natural scientists, partially contributes to the lack of policy traction.

The conclusion drawn from this survey is that there are gaps between scientific research and policy use. First, the extensive NMV literature is not matched in policy making reality. Second, NMV studies have not been used in decisions as economists have might anticipated. Third, economists have great confidence in NMV while decision makers seem not to buy into it. Lastly, decision making teams in reality are mostly not qualified to use NMV studies as economists may have assumed.

There are some issues that underlie the gaps based on our survey. (1) People confuse utilitarian value with intrinsic value so that they do not think ecosystem services can be valued. (2) It has never been easy to put a theory into practice and make it influential. (3) The separation between social science and natural science hinders the carrying-out and the use of NMV studies in a field dominated by natural science.

Despite the variations between China and the U.S., we can still draw some lessons from the case study of the U.S. for China. It is still vital, though, to adjust NMV methodologies in order to fit a different socioeconomic and cultural context, as well as to promote the use of NMV studies in a way that is suitable for political systems in China.

NMV develops a new perspective for ecosystem management. It will not change the world, though, if science is only done for science's sake. Economists may have anticipated that NMV would inform policy decisions. Whether or not NMV is just a passing fancy in the history of ecosystem management remains to be seen. Only time and practice can show us the truth.

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