Valuation of the ecosystem services provided by coastal ecosystems in Shandong, China: developing a non-market valuation system

1. Introduction

Based on unique geographical, economic and ecological characteristics, the coastal regions have been serving as the most important supports for human benefits. From food provision, ecosystem regulation, wildlife habitat to various recreational and aesthetic activities, humans have been obtaining direct and indirect well-being from the coastal ecosystems. If properly managed and sustainably protected, these benefits should be translated to human welfare for current and future generations (Brenner, et al., 2010) . The lack of complete understanding of total values obtained from coastal ecosystems, especially the underestimating of ecosystem benefits has led to management failures. As a result, most coastal resources are suffering from depletion and even extinction, which pose serious threat to human existence and development.

One of the most important challenges faced for effective coastal management is how to capture the total economic value of ecosystem services. Since most benefits from natural resources lie outside of the market, there are no prices to reveal these values. The majority of social choices, however, are made based on monetary values. When confronting competing uses of ecosystems, the most important thing is to ascertain which choice would be worth more than others (Wilson et.al, 2005) . For example, a wetland can be either converted into agriculture or maintained for wildlife habitat; the shoreline can be either developed for industrial purposes or recreational activities. Whatever choice we make, it probably means that one option is more valuable than the others. Thus, the valuation issue can't be avoided as long as there are competing options for the use of natural resources.

Non-market valuation assesses the contributions of ecosystem services to human well-being by determining the preference of users. That is how much money users are willing to pay for ecosystem improvements or how much they are willing to accept for ecosystem losses. Through exploring these preferences, the natural capital can be accounted for economically and quantitatively. It can not only lead to better understanding of ecosystem benefits, but also make it possible to compare ecosystem services with other conventional goods and services (e.g. real estate) in monetary terms.

Shandong is a coastal province of China, which is located on the eastern edge of the North China Plain and extends out to sea in the form of the Shandong Peninsula (see fig. 1). The coastline is more than 3,000 km in length with some 296 islands. The coast comprises a variety of environments represented by rocky coasts, beaches, estuaries and river deltas, of which the

Yellow River delta has the largest, the most extensive and integrated wetland ecosystems in China. The diverse coastal resources support the prosperous development of marine-based industries, in 2010, which accounted for 16.5% of Shandong's GDP . In 2011, the Chinese government launched the first ocean economic zone in Shandong, which signaled that Shandong coastal regions had become the focus of marine policy decisions. Since every decision should be based on accurate and inclusive values, the following questions arise:

- What benefits are related to coastal resources?
- What are these benefits worth to different stakeholders?
- How should we evaluate these benefits?
- Is there a difference among different valuation techniques?

Answering these questions can help to incorporate ecosystem values into decision making and lead to well-informed coastal management policy. However, there has been little, if any, research on economic valuation of ecosystem services in Shandong. The absence of quantification of the benefits related to the coast has meant that most existing polices and decisions lack reasonable and convincible foundation. Moreover the coastal ecosystems are already under serious threat due to ignoring and neglecting their benefits during development and exploitation.

Fig.1 Geographical location and extent of Shandong

The objective of this study is to identify the ecosystem services provided by coastal ecosystems in Shandong, China. By developing a non-market valuation system, the aim is to apply the range of methodologies to specific benefits derived from various kinds of coastal resources to estimate their values. The paper proceeds as follows. Section 2 demonstrates the demand for valuation of ecosystems services provided by coastal ecosystems in Shandong. A review of existing techniques for capturing the non-market values of coastal ecosystems and an analysis of which technique best suits which context and situation follow in Section3. Section 4 identifies the services and benefits derived from coastal ecosystems and develops a non-market valuation system.

2. Why should we value benefits from coastal ecosystems?

Coastal ecosystems, at the interface between marine and terrestrial ecosystems, play an important role in human life (Heckbert and Costanza, 2011; Costal protection& restoration, 2012) . They provide an array of functions, which range from global scale (e.g. climate regulation) to local and regional scales (e.g. water filtration), from material benefits (e.g. food supply) to non-material benefits (e.g. recreation) (MA, 2005) . Take wetlands for example: they provide purified water for humans and wildlife and protect coastal regions from floods. At the same time, people can also obtain recreational, aesthetic and cultural benefits from various activities related to wetlands. All these functions construct direct and indirect connections between ecosystems and humans, which result in various benefits flows from ecosystems to human welfare (Kumar M, Kumar P, 2008) . This transition of benefits has contributed to substantial net gains in human welfare and economic development (MA, 2005) .

The costs of development- in the form of environmental degradation and depletion of natural resources- are now becoming increasingly apparent. According to the Millennium Ecosystem Assessment (MA), ecosystems all over the world have experienced unprecedented changes over the past 50 years. Approximate 60% of the ecosystem services that support everyone in the world are being degraded or used improperly. Coastal ecosystems are no exception. On the one hand, people plunder coastal resources in order to meet the rapidly growing demand for food, land or development, which results in eutrophication, inundation, erosion and pollution. On the other hand, the devastated ecosystems erode human welfare secretly through declining water quality and decreased coastal protection from flood and storms. Apparently this is a vicious cycle, which is further aggravated by the natural forces such as wave erosion, climate change, and sea level rise. According to statistics, both artificial and natural factors have caused “50% of salt marshes, 35% of mangroves, 30% of coral reefs, and 29% of sea grasses” (Barbier et al., 2011) to become either extinct or deteriorated globally. This worldwide degradation of coastal ecosystems not only lowers the productivity of ecosystems in the short run but also threatens human existence in the long run.

For Shandong coast the problem is particularly prominent. Population increases and development pressures are posing severe threats for coastal ecosystems. First, the discharges of untreated waste from agricultural and industrial sources have caused serious problems to water quality and ecological balance. It is estimated that around 2.57 $bcm.yr^{-1}$ of wastewater is discharged into the sea in Shandong (Wu et al. 2012), most of which includes a large amount of pollutants such as heavy metals, nitrate and phosphorus compounds. In 2009, 85.9% of drainage outlets were reported to deliver overloads of contaminants into the sea. Problems caused by the pollution of ocean water not only result in the frequent occurrence of red tides and the decline of fish populations, but also affect human activities and health. For example, the massive algae "green tide" has occurred in coastal and offshore waters in the Yellow Sea near Qingdao since 2008, which bring enormous burdens for coastal management. It is reported that local government spent more than $100 million to protect water from algae in 2008 (He et al., 2011). Moreover, when toxic pollutants enter the seafood chain, consuming fish or shellfish contaminated with these toxins threaten human health. According to statistics, the levels of heavy metals like mercury, cadmium and lead in shellfish are elevating year after year (Ocean and Fishery Department of Shandong Province, 2011). Meanwhile, the widely distributed oil fields and ports along the coastline exacerbate the deterioration of the marine environment due to oil spills and drainage emissions. The Bohai Bay oil spill serves as a good example. The oil leak in 2011 polluted 6,200 square kilometers of water, which caused aquatic farming industries to suffer huge losses. It is reported that fish eggs in this area were reduced by 83% in that year.

Second, the development of industries marine-based- uncontrolled fishing and over-exploitation- has endangered the biodiversity and the productivity of coastal ecosystems. Shandong is famous for fishing in China. It is, however, experiencing steep declines in fisheries resources in a way unimaginable. The abundant species in the past such as redlip mullet, cutlassfish have disappeared, and some species were reduced to endangered levels. The exhaustion of fishery resources also poses a challenge for fishers and fishing industries. Obviously, unreasonable development and exploitation of coastal resources involves significant economic and ecological consequences. Finally, a combination of anthropogenic and natural factors makes the coast vulnerable to excessive degradation. The land reclamation, for example, has made the area of Jiaozhou Bay shrink by 1/3 (Ocean and Fishery Department of Shandong Province, 2009). In addition, the delta of the Yellow River is shrinking by an average 7.6km^2 a year due to seawater erosion coupled with storm surge (Wu et al., 2012). Obviously, the regional economy has been growing at the cost of depletion of coastal resources and degradation of coastal environment.

Such intense and increasing deterioration of coastal ecosystems suggests that it is high time to manage and protect them. The majority of coastal policies, however, are not effective as expected. One of the core reasons lies in that there is no better and complete understanding of values and benefits of ecosystem services. From an economic perspective, the term "benefit" is defined as "the sum of what all members of society would be willing to pay for it."(Mendelsohn and Olmstead, 2009) In a conventional market, there are prices for goods and services. We can tell how valuable goods and services are based on their prices. Generally, the more expensive, the more valuable. However, this rule doesn't work with ecosystem services, because there are no values assigned to them. For example, we can tell the value of a house with a sea view easily, but we can't tell the value of the sea view. As public goods, most ecosystem services are consumed and enjoyed for free, which leads to ignorance of ecosystem benefits. The ability of coastal ecosystems to help to filter water to supply us with high-quality water, hold the excess runoff after a storm to protect us from floods, stabilize the shoreline to assure us safer living and provide habitats for wildlife to make us enjoy seafood or viewing. Coastal ecosystems perform various functions to support human lives and development, but we seldom realize the true origin of these benefits we obtain every day. The ignorance and negligence of ecosystem values make people develop and exploit coastal resources roughly without paying any visible cost. With the accumulation of invisible cost behind the careless behaviors, however, the tragedy of public lands is playing on coastal ecosystems. That is sad for both human and nature. Unless we become aware of the true value of coastal ecosystem, this sadness will last and bring about disastrous consequences for human.

Additionally, due to the unique geographical characteristics, coastal ecosystems produce multiple functions that are of much more significance than those provided by any other ecosystems (Barbier et al., 2011) . However, people tend to focus on only one or two services associated with their activities while neglecting other functions. As a result, the benefits of coastal ecosystems suffer from underestimation. For example, speaking of the beach, the first thing that springs to mind is that we go to the beach for fun. Actually, the beach provides an array of benefits that are not just for human but for a variety of wildlife. It is the perfect "nesting area for turtles or shorebirds, spawning grounds for horseshoe crabs and habitat for piping plovers and least terns"(Robinson, Zepp and Shoudy, 2001) . Thus when it comes to the erosion of a beach, it doesn't only mean that a recreational option is disappearing, actually which is just a little part of the huge loss, but more importantly, a) large numbers of shorebirds would become homeless; b) spawning habitat would be reduced, and in turn, the wildlife that lives on juvenile populations would lose an important food source (Robinson, Zepp and Shoudy, 2001) . If we just paid attention to recreational benefits from beaches, we would never know our total losses. Moreover, underestimation of ecosystem services leads to inefficient allocation of coastal resources. Allocative efficiency refers to the optimal distribution of goods and services, which occurs at the point where the marginal benefits equal the marginal costs of production. However, underestimation of ecosystem benefits, - the better or worse off of human welfare caused by the change of ecosystems-, tends to result in misleading "cost-benefit" analysis. Consider a project about a wetland. Should it be drained to provide new land for industry, or should it be restored to serve as habitat for wildlife or other ecological functions? Unless the total economic benefits of the wetland are assessed, the uninformed decisions related to coastal development and management would impair ecosystems and human well-being in the long run. However, although some people have realized the importance of coastal ecosystems, it is still difficult to judge how important they are. Even more difficult is to incorporate this understanding into decision-making (Young, 2011) .

The economic values of coastal resources include both market values and non-market values. Most services provided by coastal ecosystems are not traded in markets, thus leading to market failure in pricing these values. For that reason, the way in which the economy is managed too often doesn't take non-market values of ecosystems into consideration, which, in turn, affects both the performance and development of the economy. Let's still consider the example of the wetland project. Should this wetland be converted to agriculture for supplying more food? For that, we have to know the non-market values we would lose in this transformation, which will be taken as a part of the total cost. If not, it is hard to decide whether this project would be worthwhile. Additionally, given a myriad of services provided by coastal ecosystems, communities must choose among competing uses too often (Wilson et.al, 2005) . In this case, it is of great importance to know what these options are worth to users. Similarly, when it comes to preservation and restoration of ecosystems, it is also important for policy makers to decide the level of investment, which largely depends on the specific values that ecosystems provide for human welfare. Therefore, to make informed decisions involving coastal development and management, it is important to know not only what benefits the coastal ecosystems could provide us but also what they are actually worth in monetary terms.

As mentioned above, ecosystem devastation has become a global crisis. One way to address this problem is to "view ecosystems as a form of natural capital which should be properly valued and accounted for in national accounts, financial products and services, and private sector supply chains"(Climate Connections, 2012). Although whether natural resources should be commoditized is still an issue, at least one thing that can be confirmed is that non-market valuation is the most direct way to show the importance and scarcity of natural resources. The measure of non-market values, like market values, is the maximum amount that people would pay to avoid losing or gaining access to goods and services. By eliciting the preference of users for ecosystem changes, the basic task of non-market valuation is to qualify the benefits of coastal ecosystems and estimate the economic impact of coastal decisions. In principle, we can depend on non-market valuation to solve two problems: there are no markets to assign the prices; or there are significant externalities that distort the effectiveness of prices signaling the relative scarcity of goods and services (Schaeffer, 2008) . In practice, given the complexity and multifunction of coastal ecosystems, how to make a choice among various competing uses for a particular ecosystem is an issue faced by every decision maker. Non-market valuation makes the decisions more accessible and effective through comparing the overall net gain to society yielded by each use (Kumar M, Kumar P, 2008) . Also, measuring the values of coastal benefits enables natural assets to be comparable with other sectors of economy. Human welfare is finally decided by the balance between economy and ecosystem. Without the balance, economic and ecological systems would both suffer. Apparently, it is not an either-or decision, but prosperous economy must be developed on the basis of sustainability of natural capital.

Non-market valuation is now a powerful tool that can assist with marine policy decisions: based on non-market valuation, decision-makers could estimate the values of coastal resources and the potential impacts of coastal policy (Pendleton, 2007). For example, the United States Department of Agriculture (USDA) developed potential uses of non-market valuation in land-use policy, which functions in program evaluation, program selection and acreage selection (Feather, Hellerstein and Hansen, 1999). The National Oceanic and Atmospheric Administration (NOAA) serves as another example that non-market values were used to quantify the physical damage to coastal ecosystems in the 1989 Exxon Valdez oil spill (Arrow et al., 1993) and the 1993 Tampa Bay oil spill (NOAA, 2000). Additionally, estimates of non-market value can be used in assessing and justifying the government policies such as beach nourishment, wetland restoration, shoreline protection, biodiversity maintenance or marine protected areas (Pendleton, 2007; McMillan, Scherer and Whelchel, 2009). Since most policy issues are often turned into either-or debates --wetlands for wildlife vs. wetlands for agriculture--, having the values of ecosystem services offers balance in policy debates (Bark, 2011). If non-market value estimates can be collected across time and space, it is impossible to monitor the status and trend of ecosystem services temporally and spatially. Except for functioning by itself, non-market valuation can also serve for other environmental analysis tools. For instance, “Environmental benefits index” can translate an array of measures of environmental characteristics into a single number, based on weights obtaining from non-market valuation (Feather, Hellerstein and Hansen, 1999).

3 Empirical methodologies for measuring non-market values

3.1 Issues implied in non-market valuation

Since most benefits from coastal resources lie outside markets, special economic methods should be developed to measure the values people place on these goods and services. In considering the task of valuing ecosystem services, there are some issues we have to take seriously. Above all, the delineation of ‘ecosystem service’ is central to any effort in non-market valuation, which makes it clear what parts of ecosystem services will be evaluated. Boyd and Banzhaf (2006) define ecosystem services as “components of nature, directly enjoyed, consumed, or used to yield human well-being”, which clarifies that ecosystem services for non-market valuation should be final products rather than intermediate products. Coastal ecosystems provide a range of services, but not all of these services enhance human welfare directly (Turner and Daily, 2008; Fisher et al., 2009). Consider, for example, bird-watching in a wetland. People enjoy seeing all kinds of birds directly, which is the final service provided by the wetland. Although birds are dependent on multiple intermediate ecological services such as nutrient cycling and water purification, these services should not be measured as non-market value of these birds. Accordingly, the obvious distinction between final and intermediate services can be drawn. Final ecosystem services are outputs that directly contribute to human well-being. Intermediate services, on the other hand, are components and functions that benefit humans through other final services (Johnston and Russell, 2011). Ignoring this distinction will lead to double counting the value of ecosystem services and even undermining the credibility of such analysis (Busch et al. 2012).

The Millennium Ecosystem Assessment (MA) delivered a broad definition of ecosystem services as 'the benefits humans obtain from ecosystems', which brings up another issue- are services and benefits the same thing? As mentioned above, non-market valuation is to estimate the contribution of final ecosystem services to human welfare- in economics these are considered as *benefits* (Fisher, Bateman and Turner, 2011). Accordingly, ecosystem benefit is provided by multiple services but not service itself. Consider the bird-watching example again. It is often viewed as an ecosystem service. Rather, it should be considered as a recreational benefit provided by multiple ecosystem services from wetland assets (e.g. birds, clean water), as well as conventional goods and services (e.g. access to the wetland, tour guides or equipment). Obviously, bird-watching doesn't only require ecosystem services to affect human welfare, but also requires other goods and services. For this reason, according to Boyd's definition we are using for this paper, it is not a valid measure of ecosystem services.

Moreover, the distinction between services and benefits underlines another issue that we can obtain quite different benefits from the same ecosystem service due to varied contexts (e.g. location, time of delivery) (UK NEA, 2011). For example, a wetland, accessible geographically, can generate much more recreational benefit than a physically identical wetland in an isolated area. Similarly, the capacity of the ecosystem to provide all kinds of services changes over time. For example, a wetland often functions as carbon storage, wildlife habitat, or flood protection. These functions might decline over time due to erosion, pollution or climate change. Accordingly, benefits people acquire from these services will change based on ecological conditions or functions. This fact, in turn, highlights that non-market valuation is temporally and spatially contextual.

Another important difference needs to be noted between 'value' and 'price'. For instance, we might have to pay an entry fee for access to a wetland park, but this price cannot include all the values of this area. In fact, it is simply a part of its value that is reflected through markets. Admittedly, in some cases, prices can be viewed as perfect indicators of value, especially for some goods and services traded in competitive markets (Fisher, Bateman and Turner, 2011), such as the price of real estate adjacent to the wetland park. Nonetheless, in other cases their performance is poor, which can be reflected in most benefits obtained from coastal resources. Their market prices are either a partial reflection of the value or unobservable. Consequently, the values of ecosystem services should be based on how they affect human welfare, rather than simply their market price (UK NEA 2011). Then how to measure the value of ecosystem services is a challenge posed to any economic valuation. Consumer surplus offers a solution to this problem (Pendleton,2006; Barbier et al., 2011; Riera et al., 2012). Conceptually, it is the difference between the total amount that consumers are willing to pay (WTP) for a good or service and the total amount that they actually do pay (i.e. market price). Practically, economists often consider it as a measure of the welfare that people gain from consuming goods and services, which also underpins the non-market valuation of coastal ecosystems.

3.2 Assessment of non-market valuation methods

3.2.1 Classification of methodologies

In the past three decades, economists have devised a multitude of techniques for non-market valuation. These methods can largely fall into two categories (Table 1): monetary measures and non-monetary measures (Sakuyama and Stringer, 2006; Liu, 2007; Hadley et al., 2011) . The principal distinction among them is based on the metrics by which benefits are quantified. Monetary valuation techniques assign economic values to changes in ecosystem benefits in monetary terms (Feather et al., 1995) , i.e. How much are people willing to pay for a wetland restoration? Or how much are people willing to pay for recreation on a beach? Currency-based tools, dealing with absolute measures of value, can serve as direct inputs to benefit-cost analysis and make ecosystem benefits comparable with other market-traded items. But sometimes it is hard and complex to come up with a dollar value. Or there is no need to do so. In that case, non-monetary techniques that access the relative importance of different services instead of in a single monetary unit tend to be more useful. Consider wetland restoration, for example. There are some options we can choose. It is enough to know one option is better than another instead of quantifying benefits in each case (Worldchanging Team, 2012) . The commonly used non-monetary methods are grouped into proxy methods, distance-to-target methods, panel weighting methods and multi-criteria analysis (Ahlroth et al., 2011) . By ranking or prioritizing ecological impacts based on one or a few quantitative measures (Huijbregts et al., 2006) , proxy methods are the simplest way to measure relative importance of different ecological impacts (Ahlroth et al., 2011) . Distance-to-target methods provide another solution to non-monetary valuation. Through setting targets, importance of different ecological impacts depends on the distance between the current state of ecosystem and future ecological targets (Weiss et al., 2007) . For complicated problems like multiple objectives, panel weighting methods and multi-criteria analysis are proved to be more effective and feasible (Seppälä, 1997; Belton and Stewart, 2002) . Both of methods can be done in different ways. To conclude, monetary valuation techniques summarize ecosystem benefits in currency units, which enable benefit-cost analysis to be made along a common metric. Affected by multiple socio-economic factors, however, the monetary values are not stable over time. On the contrary, non-monetary valuation tends to be directly related to practical decisions, which is more useful and applicable. Lack of definitive sets of indicators and specific ranking criteria, though, non-monetary measures are susceptible to individual’s perception or bias and understanding of ecosystem benefits.

As for monetary valuation methods, they can be subdivided into two groups: valuation approaches and pricing approaches (Hadley et al., 2011) . The former are used to measure total economic values of ecosystem services while the latter generate estimates equivalent to prices.

The most commonly used pricing methods include market prices, opportunity cost and replacement costs. Since pricing approaches estimate values of ecosystem benefits based on observable prices of goods and services related to specific ecosystem, the data are relatively easy to obtain from established markets. Moreover most of those methods are based on well-established economic theories and techniques, such as demand theory or consumer surplus. However, market prices tend to be susceptible to temporal and spatial effects. Especially, suffering from market failure, prices cannot reflect the value of all productive uses of ecosystem goods and services (King and Mazzotta, 2000)**Error! Bookmark not defined.**. In addition, only values with reference to direct use of ecosystem services can be captured by pricing techniques.

In this paper, we will focus on monetary-based valuation approaches. They quantify people's preference on specific ecosystem services when traditional markets don't exist. Depending on how preferences are elicited, there are mainly two categories: revealed and stated preference approaches. Revealed preference methods infer individual preference by observing their choice and/or behavior towards some marketed goods and services with a connection to non-market goods and services of interest (Hadley et al., 2011; Sakuyama and Stringer, 2006) . In this case, since non-market goods and services are indirectly or implicitly traded, willingness to pay (WTP) can be reflected by actual decisions made by individuals or households (Pearce et al., 2006) . These techniques include the travel cost method, hedonic price method, averting behavior and defensive expenditures and costs of illness/lost output approach. In some situations, however, where no market information can be used to estimate WTP, economists resort to survey techniques to elicit people's intended behavior (National Center for Environmental Economics, 2010) , which are termed as stated preference approaches. By means of a well-designed questionnaire, a hypothetical market is constructed where ecosystem goods and services can be traded. Contingent valuation and choice experiments are the main forms of stated preference techniques. The distinguishing characteristics of stated preference methods compared to revealed preference methods is that stated preference methods count on data obtained from people's response to designed questions, while revealed preference methods count on observations of people's actual behavior or choice (National Center for Environmental Economics, 2010) .

Table 1 Classification of Non-market valuation techniques

<table>
<tr><th colspan="3">Monetary valuation</th><th>Non-monetary valuation (Ahlroth et al., 2011)Error! Bookmark not defined.</th></tr>
<tr><td rowspan="3">Pricing approaches</td><td colspan="2">Market price</td><td rowspan="3">Proxy methods</td></tr>
<tr><td colspan="2">Opportunity cost</td></tr>
<tr><td colspan="2">Replacement cost</td></tr>
<tr><td rowspan="2">Valuation approaches</td><td rowspan="2">Revealed preference methods</td><td>Travel cost method</td><td rowspan="2">Distance-to-target methods</td></tr>
<tr><td>Hedonic pricing method</td></tr>
</table>

		Production function	
		Averting behavior and defensive expenditures	**Panel weighting methods**
		Costs of illness/lost output method	
	Stated preference methods	Contingent valuation	**Multi-criteria analysis**
		Choice modeling	
	Benefits transfer		

3.2.2 Stated preference methods

The contingent valuation (CV) is a survey or questionnaire-based method, which deduces people's willingness-to-pay for a specific and proposed change in ecosystem services. In theory, it can be used to capture the economic value of anything associated with ecosystem services—both use value and nonuse value (Ahlroth et al., 2011)**Error! Bookmark not defined.**. There has been an amount of empirical research of CV in coastal management, which ranges from water quality (Ramajo-Hernandez and Saz-salazar, 2012) , biodiversity (Kotchen and Reiling, 2000) to beach use (Barry, Rensburg and Hynes, 2011) and wetland recreation (Yang et al, 2008). When it comes to non-use values, where no behavioral trails can be followed, CV is regarded as most common and most useful methods (Kotchen and Reiling, 2000; Amirnejad et al., 2006) . A report from NOAA proved reliability of this technique by stating that "CV can provide useful information about the economic significance of non-use values" (Arrow et al., 1993). Despite the strength of CV regarding its versatile and flexible application, this method suffers from considerable controversy. On the one hand, questionnaire design is vulnerable to biases (MacMillan, Hanley and Lienhoop, 2006); on the other hand, respondents might be unfamiliar with ecosystem services being valued or unable to articulate their true feelings (Hadley et al., 2011). Additionally, the reliability of CV on non-use values is also an issue. While NOAA recommended several guidelines to improve performance of CV, their effectiveness and feasibility is still questioned (Carson et all., 1997; Kotchen and Reiling, 1999) .

The choice modeling is a family of survey-based methodologies, which share the same theory rationale as contingent valuation. Unlike contingent valuation, however, choice modeling divides the proposed change in an ecosystem service into a set of attributes (Raheem et al., 2009). In terms of these attributes (e.g. different levels of improvement, or payment amounts), respondents have to makes choices between two or more scenarios. These methods include choice experiments, contingent ranking, contingent rating and paired comparisons. Among them, it is arguably choice experiment that has become dominant (Pearce et al., 2006). In a choice experiment survey, respondents are asked to state their preference among a group of options that vary with different costs to the individual. This attribute-based method has been applied to valuation of coastal ecosystem services in recent years, such as benefits of biodiversity enhancement (Meyerhoff, Liebe and Hartje, 2009) , environmental impacts of artificial construction (Han, Kwak and Yoo, 2008) , disaster assessment (Taylor and Longo, 2010) , or valuation of specific resources (Birol, Karousakis and Koundouri, 2006) . The choice modeling has the same advantages as contingent valuation in measuring non-use value and wide application. Compared to contingent valuation, however, it can provide more-detailed information and is less prone to biases (List, Sinha and Taylor, 2006) . More-detailed surveys, in turn, also makes choice modeling more complicated to design and respond to. While it is still debatable whether choice modeling is superior to contingent valuation, estimates of the former exceed those of the latter in the same context (Pearce et al., 2006) .

To conclude, based on survey or questionnaire, stated preference methods are afflicted by several kinds of biases (e.g. survey design, perception of questions, strategic response), to some extent, which impair the credibility and reliability of estimates. As the only methods capturing the total economic values of ecosystem services, however, they make so many contributions to non-market valuation.

3.2.3 Revealed preference methods

The travel cost method seeks to measure non-market values based on consumption behavior in related markets. In another words, people have to spend money and time traveling to a recreational site, which reflects partial recreational value of this site. A large number of studies use travel cost method to measure recreational values related to coastal ecosystems such as recreational fishing (Shrestha, Seidl and Moraes, 2002) , bird watching (Gürlük and Rehber, 2008) **Error! Bookmark not defined.**, beach use (Bin et al., 2005) or access to Marine Protected Areas (Chae, Wattage and Pascoe, 2012) . As the oldest technique to evaluate non-market values, the travel cost method is relatively uncontroversial and inexpensive to apply (King and Mazzotta, 2000)**Error! Bookmark not defined.**. However, the fact that it is difficult to account for benefits derived from travel, multipurpose trips and competing sites makes practical application more complicated and tends to generate overestimated values (Hadley et al., 2011) . Additionally, on the basis of observed actual behavior, the travel cost method just captures use values from recreational resources, which in turn limits the scope of practical application.

The hedonic pricing method is another commonly used revealed preference technique, which infers the value of ecosystem services that directly affect market prices. It is mainly applied to variations in property prices that can reveal implicit values or demand for ecosystem services, such as air quality (Yusuf and Resosudarmo, 2009) , the bodies of water (Kildow, 2009) , aesthetic views (Jim and Chen, 2009) or recreational sites (Sander and Haight, 2012) . Similar to travel cost method, the hedonic pricing is also based on actual behavior and even existing data. Due to the efficiency of the property market, data on sales and attributes are relatively reliable and readily accessed. There are a multitude of issues surrounding the practical application though (Pearce et al., 2006) . First, hedonic pricing is modeled on the premise that people are aware of the linkage between ecosystem benefits and housing values. Actually sometimes people do not realize differences in ecosystem attributes. Or in some cases, two or more ecosystem attributes are mixed together, which make it difficult to isolate the independent effect from multiple factors. Second, this method elicits values of ecosystem services that accrue to owners of property. Thus, for services that provide extensive benefits, their values are likely to be underestimated.

To sum up, revealed preference methods are constructed on the basis of well-established economic theory. They rely on how people behave in actual situations rather than how people respond to hypothetical questions. Thus, the data is relatively reliable and easy to access. Based on actual behavior, on the other hand, revealed preference methods have quite limited application that they can only be used to measure use value (Raheem et al., 2009) .

3.2.4 Benefits transfer

Apparently, stated or revealed preference methods are both costly and time-consuming (Baskaran, Cullen and Colombo, 2010; Martin-Ortega et al., 2012) . Fortunately there has been a wealth of literature on non-market valuation of coastal resources in the past three decades (Pendleton, 2007) . Based on the available estimates of the value at 'study' sites, we can implement some analysis—both qualitative and quantitative—to evaluate the value at another 'policy' site. This approach is called *benefits transfer*. Two broad categories can be identified: value transfer and function transfer (Smith, Van Houtven and Pattanayak, 1999) . In the first case, a single point estimate (e.g. mean of WTP) or value range summarized from the existing studies is used to infer the benefits in a new context. In the case of function transfer, a model that describes how value estimates vary with characteristics of the study (e.g. population, survey methods, geography or socio-culture) has to be estimated. Not just value estimates but the whole function is transferred to policy site in order to meet the characteristics of a new context as closely as possible (Zandersen, 2010) .

It is a valuable tool if used properly when original study is infeasible to conduct (National Center for Environmental Economics, 2010) . Especially along with meta-analysis being increasingly common in non-market valuation, transfer functions can be constructed more accurately and informatively (Bergstrom and Taylor, 2006) . Additionally, quantification of cultural difference makes it possible to transfer benefits between different countries (Ready and Navrud, 2006) . While benefits transfer is typically a quick and economical alternative to primary research, reliable valuation has to meet a selection of conditions (e.g. the similarity between policy site and study site, competent explaining variables). Moreover, available non-market values of coastal ecosystems have not been well organized for the practice of benefits transfer (Pearce et al., 2006) ; and the comprehensiveness and quality of existing literature, to some extent, also hinders the development and application of benefits transfer. In addition, considering the fact that only 11% of the transfer studies have conducted validity tests (Liu et al., 2011) , its validity and reliability is still under discussion (Matthews, Hutchinson and Scarpa, 2009) .

3.3 Challenge

In the past three decades, non-market valuation has made great advances in quantifying the contribution of ecosystem services. While a multitude of methods have been developed, each method has its own strengths and weaknesses, which, in turn, decide the scope of their application. For example, travel cost method is often used to measure recreational values while non-use values like existence value or bequest value are measured only by contingent valuation or choice experiment. While stated preference methods can capture comprehensive value theoretically, people's actual behavior tends to reflect more accurate information about their preference. Therefore, there is no method that is most appropriate for valuing all ecosystem services. Moreover, since values generated by different methods might be measured in different economic constructs, these values might be incomparable (Groot et al., 2012) . Take the contingent valuation of a beach as example. The value estimates might be varied according to different scenarios, such as WTP to avoid degradation and WTP for an improvement. It is not fair to compare them since they represent different welfare measures.

Another challenge in non-market valuation lies in the lack of consistent and replicable typologies of ecosystem services, especially a universal typology of final services (Johnston and Russell, 2011) . Ambiguity in classifying ecosystem services results in failure to differentiate intermediate services from final services, as well as inconsistent valuation of the same service. However, clarity in defining and classifying ecosystem services is based on better comprehension on the role ecosystems serve, which calls for growing demand for interdisciplinarity. (Kumar M, Kumar P, 2008) .

Finally, care should be taken when interpreting ecosystem service values in spatial or temporal terms. For one thing, the provision of ecosystem benefits may not be, and usually is not equal in per unit area (Costanza et al., 2008) . Especially, during conducting benefits transfer, it should be noted that the supply of the benefits is not in proportion with ecosystem size (Ghermandi et al., 2010) . For another thing, perceptions and preference for the same service may vary across time (Groot et al., 2012) . Along with economic development and environmental change, some ecosystem benefits, like carbon sequestration, which was not recognized in the past, may be prominent now. Or a community, who preferred industrial development in the past, may prefer environmental preservation now. All this spatial and temporal heterogeneity might lead to under- or overestimation of ecosystem benefits. Accordingly, it is necessary to take into account this distortion of non-market values across time and geography.

4 Identification and assessment of coastal ecosystems in Shandong

4.1 Key conceptual definitions for non-market valuation

As mentioned above, non-market valuation of coastal ecosystems is to assess the contribution of ecosystem services to human well-being, which is also the process of quantifying benefits from these services in economic terms. Given the fact that these concepts are likely to be confused, it is essential to elucidate what ecosystems, services, functions, benefits and values exactly mean?

An ecosystem refers to "a dynamic complex of plant, animal and micro-organism communities and their nonliving environment interacting as a functional unit" (United Nations, 1992) . Coastal zone is the transitional area between land and sea, which covers a wide band of ocean and the adjoining strip of land (RRC.AP, 2001) . The width of the band varies from place to place and is determined by the interaction of marine and terrestrial coastal process (GDRC) . According to a national multipurpose investigation of the coastal zone and tidal wetland resources, coastal zone is defined as "an area 10km inland and 10-15m isobaths seaward from the mean high water tide line" in China (1991) . Ecosystems located in coastal areas have both aquatic and terrestrial features, which include wetlands, mangroves, coastal waters, as well as beaches.

Ecosystem functions are the conditions and processes by which ecosystems and the species that make them up, sustain and fulfill human life (Daily, 1997; ESA, 2000) . Normally, a mix of several ecosystem functions delivers services to human. For example, nutrient cycling and water purification functions from wetlands and estuaries contribute clean water to humans. In practice, though, ecosystem functions are often mistaken as services and services as benefits. Actually they are not the same thing. Rather, ecosystem functions are inputs of a production function of a service but not the service itself.

Ecosystem services are defined as 'benefits human obtain from coastal ecosystems' (MA, 2005) . According to whether consumed directly by humans, coastal services can be divided into intermediate services and final services. Final services are end-products of coastal ecosystems that have a direct impact on human welfare, while intermediate services are components that combine in complex ways to provide final services (Fisher, Bateman and Turner, 2011) . Boyd (2006) referred to ecosystem services as "directly enjoyed, consumed, or used to yield human well-being", which only put final services into the accounting inventory.

Ecosystem benefits are contributions of ecosystem services to human well-being. They are related but different from services that provide them. In general, benefits from coastal ecosystems include tangible benefits like food and wood, as well as intangible benefits such as cultural aspects, recreation or aesthetic benefits, which vary from place to place and from time to time. In addition, benefits are typically offered in a mixed way of several goods and services (Fisher, Bateman and Turner, 2011) .

Economic value is a metric of satisfaction from benefit provided by a good or service. It is generally interpreted as "what the maximum amount is an individual willing to pay for desirable goods and services?" Total economic value includes market and non-market values. Among them, non-market values are the focus of this research, which can be subdivided into use and non-use values. Use values are derived from the actual use of a good or service, while non-use values are not associated with actual use like existence values (e.g. willingness to pay for the preservation of endangered species). Also, according to different benefits from ecosystems, the non-market values comprise recreational, aesthetic, optional, existence, bequest values, as well as property enhancement.

- Recreational values are referred to as benefits obtained from activities of leisure that are often done for enjoyment, amusement or pleasure, such as hiking, angling, or beach-going.
- Aesthetic values refer to the values that make an object to be a "work of art". For example, spectacular ocean views provide people with visual enjoyment.
- Property enhancement is defined as benefits people obtain from living in proximity to ecosystems like beaches, wetland or ocean due to the increase of property value. For example, the price of houses with an ocean view is often higher than those without.
- Security values are about ability that ecosystems provide safe and healthy living environment or enhance resistibility to ecological shocks and stress (Liu, 2005) . For example, wetlands can reduce risk of flood, which contributes to property safety around it.
- Option values are benefits people derive from maintaining or preserving ecosystem services for their availability in the future. For instance, people might be willing to pay for restoring some wetland they have never been to just for they can visit it in the future.
- Existence values are the non-use values people place on simply knowing that some ecosystem service exists, whether or not they actually use it, especially for some endangered species or ecosystems like grey whales.
- Bequest values are associated with the knowledge that the future generation has the option to enjoy some ecosystem service. For example, people would like to preserve some threatened wetland in order to provide for their descendants.

4.2 Identification of coastal ecosystems in Shandong

Shandong, with the longest coastline in China, is blessed with an abundance of ample and varied coastal resources. A variety of habitats—sandy beaches, wetlands, streams, rivers, lakes and other bodies of water—support a diversity of biotic communities including numerous rare and endangered species. The main coastal resources in Shandong include:

4.2.1 Wetlands

According to the Ramsar Convention (1972) , wetlands are defined as: "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters”. Shandong boasts 1.78 million hectares[①] wetlands, accounting for 11.4% of the province’s land space and 20% of national wetlands. Over half of them are marine and coastal wetlands, while the rest are comprised of estuarine, lacustrine, riverine and palustrine wetlands (fig 2).

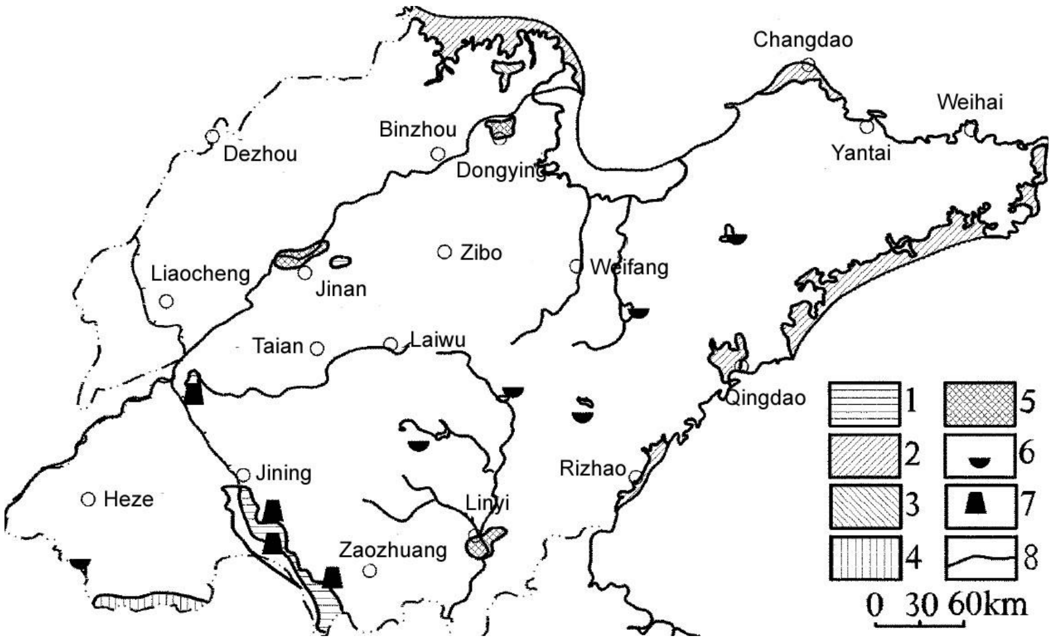

Fig 2. The classification and distribution of major wetlands in Shandong (Lv et al., 2008)
1- Lacustrine; 2- Marine wetlands; 3- Palustrine; 4- Estuarine; 5- Irrigated land; 6- Water storage; 7- Ponds;

Due to both aquatic and terrestrial features, wetlands have richer flora and fauna than other ecosystems. A number of fish, mammals, reptiles, amphibians, birds and invertebrate species depend upon wetlands for living and reproduction. It is estimated that Shandong coastal wetlands provide habitat for half of known species in China, many of which are endangered, such as Grus japonensis, Grus grus, Glehnia Littoralis or Vitex trifolia.

Additionally, wetlands perform a multitude of ecological functions and produce a variety of goods and services that are valuable to humans. As one of nature’s most efficient water filter, wetlands protect water quality by trapping sediments and other pollutants (Michaud, 2001) . As a result, people can acquire high-quality water for drinking, swimming, fishing or other activities. Also, wetlands serve as flood protection and shoreline stabilization, which make people’s living more safe and stable.

4.2.2 Beaches

[①] The wetlands less than 100 hectares in area are not included.

Beaches are dynamic landforms forming ‘at low-lying coastal margins where sand transported by oceanic waves and wind combine with vegetation to produce unique geomorphic structures’ (Barbier et al., 2011) . They are found along the eastern Shandong coast, which accounts for 80% of the whole Chinese coastline. Similar to wetlands, beaches are also characterized by aquatic and terrestrial features. Consequently, people can obtain a variety of benefits from services provided by beaches.

Above all, beaches provide raw materials in the form of sand for industry and agriculture, like glass, ceramic or construction production. Not only human can benefit from beaches, but numerous invertebrates, insects and birds also take them as habitats and nurseries. Thus, they have been making great contribution for biodiversity maintenance.

Another important service provided by beaches is protection of coastal areas from storms, tsunamis, sea level rise and other disasters. Beaches function as powerful buffers to mitigate the intense effects of waves against shorelines. Additionally, sediment stabilization and soil retention from beaches can also prevent coastal erosion and guarantee benefits are transferred from beaches to human and other biological communities.

4.2.3 Nearshore waters

The nearshore is “an indefinite zone extending seaward from the shoreline beyond the breaker zone” (EPA, 1998) . The proximity of the land differentiates nearshore waters from the open ocean, resulting from a variety of functions.

Nearshore waters are inhabited by a multitude of plants and animals, especially commercially valuable fish, shellfish and algae species. These marine organisms are one of the most important sources of human food. In addition, nearshore waters provide an array of amenities for boating, diving, swimming, surfing, snorkeling and fishing.

4.3 Development of non-market valuation system

4.3.1 Identification of ecosystem benefits

As the underpinning of non-market valuation, most efforts have been made to carefully classify ecosystem services (MA, 2005; Vo et al., 2012) . However, it is shown that the majority of categories are not operational for all research purposes, especially for non-market valuation. The problem lies in that not all ecosystem services provide direct benefits to human. Similarly, not all benefits are obtained from only one service. Consequently, taking ecosystem services as objects of non-market valuation tends to cause over- or undervaluation. To solve this problem, some economists devote themselves in distinguishing final services from intermediate services to avoid double-counting. However, services tend to vary in different contexts, which leads to final services in one context might be intermediate services in another context. As a result, it is complicated and confusing to classify them exactly. Since the objective of non-market valuation is to quantify benefits provided by ecosystem services so that they can be incorporated and integrated in national systems of income accounts, it is reasonable to assume that non-market valuation should begin with identifying ecosystem benefits instead of ecosystem services. Most benefits of direct use are reflected in the market system and thus can be stated in comparable units.

As mentioned above, benefits are intimately linked with human welfare, which, in turn, depends on the extent to which people's needs are satisfied. According to fundamental human needs developed by Manfred Max-Neef (1987), nature can provide satisfaction for a human's subsistence, protection and leisure needs. Specifically, subsistence needs are physical requirements for human survival; protection needs are demand for security of body, resources, health and property; Leisure needs are recreational needs for relaxation and enjoyment. As a result, ecosystem benefits can be delineated on the basis of human needs that ecosystems can satisfy. In order to provide appropriate valuation methods, it is necessary to illustrate and categorize ecosystem benefits (see table 2).

Table 2 Ecosystem benefits from coastal ecosystems in Shandong

Subsistence	Protection	Leisure
• Breathing • Food • Water	Security of • Body • Resources • Health • Property	• Angling • Swimming • Boating • Bird-watching • Fish-viewing • Landscape • Other activities

4.3.2 Identification of ecosystem services and functions

According to table 2, majority of ecosystem benefits are offered by a combination of multiple services. Some services lie outside coastal ecosystems. For example, drinking water does not only depend on clean water filtered by wetlands, but also requires other forms of services like urban water distribution system. Thus, there is need of knowledge that services are benefit-specific (Boyd and Banzhaf, 2006) . In another word, ecosystem services are dependent on benefits human acquire from ecosystems, which are delivered through human activities or wants. Since non-market valuation focuses on ecosystem benefits, why do we have to identify ecosystem services? The reason lies in that non-market valuation is not objective but methodology. To measure non-market values of ecosystems aims at bridging non-market values and policy decisions. As policy decisions are concerned with improving and restoring ecosystem services and functions, it is of essential significance to link services and functions provided by ecosystems to benefits obtained by human (see table 3).

Table 3 Ecosystem services and functions from coastal ecosystems in Shandong

Ecosystem benefit	Ecosystem service	Ecosystem function	Ecosystem		
			Wetlands	Beaches	Nearshore water
Breathing	Clean air	Gas regulation	√		√
Food	Seafood	Wildlife habitat	√	√	√
Water	Clean water	Water purification	√		
Body Property Resources	Flood protection	Water regulation	√	√	
	Shoreline stabilization	Soil retention	√	√	
Health	Clean air	Gas regulation	√		√
	Clean water	Water purification	√		
Angling Fish-viewing	Fish population	Wildlife habitat	√		√
Swimming	Water body	Water provision			√
Boating			√		√
Bird-watching	Birds	Wildlife habitat	√	√	√
Landscape	Ecological assets	Natural assets	√	√	√

4.3.3 Identification of non-market values

As obtaining benefits from consuming, enjoying or using ecosystem services, people could evaluate the extent their needs or wants are satisfied. That is so-called non-market valueation of ecosystem services. However, given some benefits might not be consumed currently or personally but in the future or by future generations, non-market values should be identified based on ecosystem services instead of benefits (see table 4).

Table 4 Non-market values of coastal ecosystem services in Shandong

Non-market value / Services	Recreation	Security	Property enhancement	Option	Aesthetics	Existence	Bequest
Clean air		√	√			√	√
Seafood		√		√		√	√
Clean water	√	√		√		√	√
Flood protection		√	√				

Shoreline stabilization		√	√				
Fish population	√			√		√	√
Water body	√			√		√	√
Birds	√			√		√	√
Beautiful views	√		√	√	√	√	√

4.3.4 Selection of non-market valuation methods

Based on non-market values obtained from coastal ecosystems in Shandong, we are able to assign valuation methods to different kinds of values, which further links ecosystem services with non-market valuation (see in table 5).

Table 5 Methods applicable to non-market valuation for coastal ecosystems in Shandong

Non-market value	Valuation method				
	Travel cost	Avoided cost	Hedonic pricing	Contingent valuation	Choice experiments
Recreation	√			√	√
Security		√		√	√
Aesthetics			√	√	√
Property enhancement			√	√	√
Option				√	√
Existence				√	√
Bequest				√	√

Reference

Brenner J, Jimenez JA, Sarda R, Garola A. An assessment of the non-market value of the ecosystem services provided by the Catalan coastal zone, Spain. Ocean& Coastal Management, 2010, 53: 27-38.

Wilson MA, Costanza R, Boumans R, Liu S. Intigrated assessment and valuation of ecosystem goods and services provided by coastal systems. The intertidal ecosystem: the value of Ireland's shores (James G. Wilson ed.). Dublin: Royal Irish Academy; 2005. P. 1-24

State Oceanic Administration. China Marine Statistic Yearbook. Ocean Press, Beijing, 2010. (in chinese)

Heckbert S, Costanza R. Climate regulation as a service from Estuarine and coastal ecosystems. Treatise on Estuarine and coastal science, 2011, 12: 199-216

Coastal Protection & Restoration. Coastal crisis- land loss. 2012, http://coastal.louisiana.gov/index.cfm?md=pagebuilder&tmp=home&pid=112.

Millennium Ecosystem Assessment. Ecosystems and Human Well-being. Island Press, Washington DC, 2005.

Kumar M, Kumar P. Valuation of the ecosystem services: a psycho-cultural perspective. Ecological Economics, 2008,64: 808-819

Barbier EB, Hacker SD, Kneendy C, Koch EW, Stier AC, Silliman BR. The value of estuarine and coastal ecosystem services. Ecological Monographs, 2011,81(2), 169-193.

He MX, Liu J, Yu F, Li DQ, Hu CM. Monitoring green tides in Chinese marginal seas. Handbook of satellite remote sensing image interpretation. 2011. http://www.ioccg.org/handbook/casestudy8_he_etal.pdf.
Ocean and Fishery Department of Shandong Province. Marine Environment Report in Shandong. 2011 (in Chinese). http://www.hssd.gov.cn/article/news/20115/news_43540.asp
Ocean and Fishery Department of Shandong Province. Marine condition of Shandong. 2009 (in Chinese) http://www.gov.cn/jrzg/2008-10/18/content_1124662.htm.
Wu XQ, Gao M, Wang D, Wang Y, Lu QS, Zhang ZD. Framework and practice of integrated coastal zone management in Shandong Province China. Ocean &coastal management, 2012,69,58-67.
Mendelsohn R, Olmstead S. The economic valuation of environmental amenities and disamenities: methods and applications. Annual review of environment and resources, 2009,34,326
Robinson DP, Zepp L, Shoudy HM. The distribution of shore protection benefits: a preliminary examination. http://www.saw.usace.army.mil/coastal/ShoreProtectionBenefits_Part2.pdf
Young RH. Exploring ecosystem service issues across diverse knowledge domains using Bayesian belief networks. Progress in physical geography, 2011,35(5),681-699.
Climate Connections. World Bank pushes 'natural capital accounting' at Rio+20. 2012, http://climate-connections.org/2012/06/30/will-natural-capital-accounting-hasten-ecological-collapse/.
Schaeffer PV. Thoughts concerning the economic valuation of landscapes. Journal of environmental management, 2008,89,146-154.
Pendleton L, Atiyah P, Moorthy A. Is the non-market literature adequate to support coastal and marine management. Ocean &coastal management, 2007,50,363-378.
Arrow K, Solow R, Portney P, Learner EE, Radner R and Schuman, H. "Report of the NOAA Panel on Contingent Valuation." Unpublished, National Oceanic and Atmospheric Administration, 1993.
National Oceanic and Atmospheric Administration and Florida Department of Environmental Protection. Final restoration plan/ environmental assessment for the August 10, 1993 Tampa Bay Oil Spill. 2000. http://www.gc.noaa.gov/gc-rp/tbrecpln.pdf
McMillan E, Scherer B, Whelchel AW. Valuing coastal ecosystem services of the long island sound: key services and opportunities for the future. Yale University, school of forestry and environmental studies and the nature conservancy. New Haven, Connecticut, 2009
Bark RH. Levelling the playing field- a case study of how non-market values can compete in policy debates over wastewater allocation in a semi-arid region. Policy and society, 2011,30,311-321.
Feather P, Helerstein D, Hansen L. Economic valuation of environmental benefits and the targeting of conservation programs: the case of the CRP. 1999. http://webarchives.cdlib.org/wayback.public/UERS_ag_1/20111128221704/http://www.ers.usda.gov/Publications/aer778/
Boyd J, Banzhaf S. What are ecosystem services? The need for standardized environmental accounting units. Resources for the future. 2006
Fisher B, Turner RK, Morling P. Defining and classifying ecosystem services for decision making. Ecological Economics, 2009,68(3),643-653.
Turner RK, Daily GC. The ecosystem services framework and natural capital conservation. Environmental and resources economics, 2008,39(1),25-35.
Johnston RJ, Russell M. An operational structure for clarity in ecosystem services values. Ecological Economics, 2011,70,2243-2249
Busch M, Notte AL, Laporte V, Erhard M. Potentials of quantitative and qualitative approaches to assessing ecosystem services. Ecological Indicators, 2012,21,89-103.
Fisher B, Bateman I, Turner RK. Valuing ecosystem services: benefits, values, space and time. The United Nations Environment Programme. 2011, http://www.unep.org/ecosystemmanagement/Portals/7/Documents/WP03_Valuing%20Ecosystem%20Services_UNEP.pdf
UK National Ecosystem Assessment. Chapter 22 Economic values from ecosystems. 2011. http://uknea.unep-wcmc.org/Resources/tabid/82/Default.aspx

Pendleton LH. The economic and market value of coasts and estuaries: what's at stake? Restore America's Estuaries.
Riera P, Signorello G, Thiene M, Mahieu PA, Navrud S, Kaval P, Rulleau B, Mavsar R, Madureira L, Meyerhoff J, Elsasser P, Notaro S, Salvo MD, Giergiczny M, Dragoi S. Non-market valuation of forest goods and services: good practice guidelines. Journal of Forest economics, 2012.
Liu S. Valuing ecosystem services: an ecological economic approach (Doctoral dissertation). The university of Vermont, 2007.
Sakuyama T, Stringer R. Economic valuation on environmental services from agriculture: stocktaking for incentive design. Policy brief, 2006, Economic valuation on environmental services from agriculture: stocktaking for incentive design.
Hadley D, D'Hernoncourt J, Franzen F, Kinell G, Soderqvist T, Soutukorva A, Brouwer R. Monetary and nonmonetary methods for ecosystem services valuation- specification sheet and supporting material. Spicosa Project Report, University of East Anglia, Norwich. 2011.
Feather TD, Russell CS, Harrington KW, Capan DT. Review of monetary and nonmonetary valuation of environmental investments. Evaluation of environmental investments research program. 1995.
Worldchanging Team. Ecosystem goods and services series: valuation 101, 2012, http://www.worldchanging.com/archives/006048.html
Ahlroth S, Nilsson M, Finnveden G, Hjelm O, Hochschorner E. Weighting and valuation in selected environmental systems analysis tools—suggestions for further developmets. Journal of Cleaner production, 2011,19(2-3):145-156.
Huijbregts MAJ, Rombouts LJA, Hellweg S, Frischknecht R, Dik van de Meent JH, Reijnders L, Struijs J. Is cumulative fossile energy demand a useful indicator for the environmental performance of products? Environmental Science and technology, 2006(40):641-648.
Weiss M, Patel MK, Heilmeier H, Bringezu S. Applying distance-to-target weighing methodology to evaluate the environmental performance of bio-based energy, fuels and materials. Resources, conservation and recycling, 2007(50):260-281.
Seppälä J. Decision analysis as a tool for life cycle impact assessment. Finnish Environment Institute, Finland: Helsinki, 1997.
Belton V, Stewart T. Multiple criteria decision analysis: an integrated approach. Kluwer Academic publisher, 2002.
Pearce D, Atkinson G, Mourato S. Cost-benefit analysis and the environment. OECD Publishing, 2006.
National Center for Environmental Economics. Guidelines for preparing economic analyses. 2010.
Ramajo-Hernandez J, Saz-Salazar S. Estimating the non-market benefits of water quality improvement for a case study in Spain: A contingent valuation approach. Environmental science& policy, 2012,22(10):47-59.
Kotchen MJ, Reiling SD. Environmental attitudes, motivations and contingent valuation of nonuse values: a case study involving endangered species. Ecological economics, 2000,1 (1):93-107.
Barry L, Rensburg TM, Hynes S. Improving the recreational value of Ireland's coastal resources: a contingent behavioural application. Marine policy, 2011,35(6):764-771.
Kotchen MJ, Reiling SD. Environmental attitudes, motivations and contigent valuation of nonuse values: a case study involving endangered species. Ecological economics, 2000,32(1):93-107.
Yang W, Chang J, Xu B, PENG CH, Ge Y. Ecosystem service value assessment for constructed wetlands: a case study in Hangzhou, China. Ecological economics, 2008,68(12):116-125.
Amirnejad H, Khalilian S, Assareh MH, Ahmadian M. Estimating the existence value of north forests of Iran by using a contingent valuation method. Ecological Economics, 2006,7(4):665-675.
Arrow K, Solow R, Portney PR, Leamer EE, Radner R, Schuman H. Report of the NOAA Panel on Contingent Valuation. 1993. http://www.cbe.csueastbay.edu/~alima/courses/4306/articles/NOAA%20on%20contingent%20valuation%201993.pdf
MacMillan D, Hanley N, Lienhoop N. Contingent valuation: Environmental polling or preference engine? Ecological Economics,2006,11(1):299-307.
Carson RT, Hanemann WM, Kopp RJ, Krosnick JA, Mitchell RC, Presser S, Ruud PA, Smith VK. Temporal reliability of estimates from contingent valuation. Land Economics, 1997,73(2):151-163.

Kotchen MJ, Reiling SD. Do reminders of substitutes and budget constraints influence contingent valuation estimates? Another comment. Land Economics, 1999,73(3).
Meyerhoff J, Liebe U, Hartje V. Benefits of biodiversity enhancement of nature-oriented silviculture: evidence from two choice experiments in Germany. Journal of forest economics, 2009,15(1-2):37-58.
Han SY, Kwak SJ, Yoo SH. Valuing environmental impacts of large dam construction in Korea: an application of choice experiments. Environmental impact assessment review, 2008,28(4-5):256-266.
Taylor T, Longo A. Valuing algal bloom in the Black Sea Coast of Bulgaria: a choice experiments approach. Journal of Environmental management, 2010,91(10):1963-1971.
Birol E, Karousakis K and Koundouri P. Using a choice experiment to account for preference heterogeneity in wetland attributes: the case of Cheimaditida wetland in Greece. Ecological economics,2006,60(1):145-156.
List JA, Sinha P, Taylor MH. Using choice experiments to value non-market goods and services: evidence from field experiments. Advances in economic analysis and policy, 2006,6(2), http://karlan.yale.edu/fieldexperiments/uploads/UsingChoiceExperimentstoValueNon-MarketGoodsandServices.pdf.
Shrestha RK, Seidl AF, Moraes AS. Value of recreational fishing in the Brazilian Pantanal: a travel cost analysis using count data models. Ecological Economics, 2002,42(8):289-299.
Gürlük S, Rehber E. A travel cost study to estimate recreational value for a bird refuge at lake Manyas, Turkey. Environmental management, 2008,88(4):1350-1360.
Bin O, Landry CE, Ellis CL, Vogelsong H. Some consumer surplus estimates for north Carolina beaches. Marine resource economics, 2005,20(2):145-161.
Chae DR, Wattage P, Pascoe S. Recreational benefits from a marine protected area: a travel cost analysis of Lundy. Tourism management, 2012,33(4):971-977.
Yusuf AA, Resosudarmo BP. Does clean air matter in developing countries' megacities? A hedonic price analysis of the Jakarta housing market, Indonesia. Ecological economics, 2009,68(5):1398-1407.
Kildow JT. The influence of Coastal Preservation and Restoration on Coastal Real Estate Values in the Economic and Market value of America's Coasts and Estuaries, What's at stake? Linwood Pendleton ed. 2009
Jim CY, Chen WY. Value of scenic views: hedonic assessment of private housing in Hongkong. Landscape and urban planning, 2009,91(4):226-234.
Sander HA, Haight RG. Estimating the economic value of cultural ecosystem services in an urbanizing area using hedonic pricing. Journal of Environmental management, 2012,113(30):194-205.
Raheem N, Talberth J, Colt S, Fleishman E, Swedeen P, Boyle KJ, Rudd M, Lopez RD, O'Higgins T, Willer C, Boumans RM. The economic value of coastal ecosystems in California. National center for ecological analysis and synthesis, 2009. http://www.nceas.ucsb.edu/files/news/Raheemreport.pdf
Baskaran R, Cullen R, Colombo S. Testing different types of benefit transfer in valuation of ecosystem services: New Zealand winegrowing case studies. Ecological Economics, 2010,69(5): 1010-1022.
Martin-Ortega J, Brouwer R, Ojea E, Berbel J. Benefit transfer and spatial heterogeneity of preferences for water quality improvements. Journal of Environmental Management, 2012,106(15):22-29.
Smith VK, Van Houtven G, Pattanayak S. Benefit Transfer as Preference Calibration. Resources for the Future, Washington DC, 1999.
Zandersen M. Benefit Transfer in Practice. National Environmental Research Institute. http://pure.au.dk/portal/files/32898881/G_steforel_sning_KU_BT_211210_mz.pdf
Bergstrom JC, Taylor LO. Using meta-analysis for benefits transfer: theory and practice. Ecological economics, 2006,60:351-360.
Ready R, Navrud S. International benefit transfer: methods and validity tests. Ecological economics, 2006,60(2):429-434.
Liu S, Portela R, Rao N, Ghermandi A, Wang X. Environmental benefit transfers of ecosystem service valuation. Treatise on Estuarine and coastal science, 2011,12:55-77.
Matthews DI, Hutchinson WG, Scarpa R. Testing the stability of the benefit transfer function for discrete choice contingent valuation data. Journal of Forest Economics, 2009,15(1-2):131-146.
Groot R, Brander L, Ploeg S, et al. Global estimates of the value of ecosystems and their services in monetary units. Ecosystem services, 2012,1(1):50-61.

Costanza R, Perez-Maqueo O, Martinez ML. The value of coastal wetlands for hurricane protection. Ambio, 2008,37:241-248.

Ghermandi A, van den Bergh JCJM, Brander LM, et al. Values of natural and human-made wetlands: a meta-analysis. Water resources research, 2010,46

United Nations. Rio Declaration on environment and development. United Nations, New York, NY. 1992.

United Nations Environment Programme Regional Resource Center for Asia and the Pacific. Sri Lanka: State of the Environment 2001. http://www.rrcap.ait.asia/pub/soe/srilanka_toc.pdf.

The Global Development Research Center. Resources on coastal areas—state of coasts. http://www.gdrc.org/oceans/state-coast.html

Commission of national multipurpose investigation of the coastal zone and tidal wetland resources. Report of national multipurpose investigation of the coastal zone and tidal wetland resources. Ocean economy publisher, Beijing, China, 1991, pp3

Daily GC. Nature's services: societal dependence on natural ecosystems. Island Press, Wahington, DC.

Ecological Society of America. Ecosystem services: a primer. 2000, http://www.actionbioscience.org/environment/esa.html

Liu JY, et al. Integrated Ecosystem assessment of western China. Millennium Ecosystem Assessment. 2005, http://www.millenniumassessment.org/documents_sga/Western%20China%20SGA%20Report%20(English).pdf.

Ramsar Convention Secretariat. The Ramsar Convention Manual: a guide to the convention on wetlands (Ramsar, Iran, 1971), 5th ed., 2011.

Lv BP, Jia DW, Tian WX, Tan XB, Jiang FH. Analysis on types and environmental and geological problems of wetlands in Shandong Province. Shandong Land and Resources, 2008,24(4):44-47.

Michaud JP. At home with wetlands- a landowners guide. Wahington State Department of Ecology. 2001, https://fortress.wa.gov/ecy/publications/summarypages/9031.html

Barbier EB, Hacker SD, Kennedy C, et al. The value of estuarine and coastal ecosystem services. Ecological monographs, 2011,81(2):169-193.

United States Environmental Protection Agency. Nearshore waters and your coastal watershed, 1998(07).

Vo QT, Kuenzer C, Vo QM, Moder F, Oppelt N. Review of valuation methods for mangrove ecosystem services. Ecologcial indicators, 2012,12(23):431-446.