ECOSYSTEMS SERVICES ECONOMIC VALUATION MODEL: CASE STUDY IN LATVIA

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Abstract: Ecosystem services are the benefits that people obtain from using ecosystems and can be divided into the following four categories: provisioning, regulating, cultural and supporting services. Strategic importance of ecosystem services is set by United Nations Millennium Ecosystem Assessment in 2005, which put ecosystem services firmly on the EU policy agenda. The aim of the paper is to present and discuss the model for ecosystem economic (monetary) valuation for the territory socio-economic development planning in two Latvian administrative areas. The study was based on the data of Baltic Sea coastal *Saulkrasti* and *Jaunkemeri* pilot areas in Latvia using standardized assessment, which provides different ecosystem services indicators' units to transform into one monetary unit of measurement, such as EUR/ha per year, which makes it possible to compare different services. Using ecosystem services economic valuation model three scenarios have been modelled: current situation, planned development and uncontrolled development, when in two pilot areas about 50% increase in construction and 50% decrease of the forest area is foreseen. After analysing the ecosystem services' monetary values, it is concluded that the greatest monetary value in both areas are provided by regulating services, so the maintenance and protection of ecosystems ensuring regulating services can be considered as a priority in both pilot areas. The second priority is cultural services, assuming, that the use of cultural services will not generate additional anthropogenic load. The lowest priority is given to provisioning services, taking into account the fact that the real possibilities to obtain the market values are limited, because tree felling is prohibited.

Keywords: Monetary valuation, Land use planning, Sustainable management.

1. Introduction

Ecosystem services (ES) assessment can be implemented by applying bio-physical, social and economic methods. Bio-physical assessment of ES characterizes ecosystem structure and functions by using precise measurements, regular monitoring data and ecosystem services modelling. Social assessment of ES evaluates significance of ES for existing and potential recipients, different stakeholders and interest groups. The Millennium Ecosystem Assessment presents the conceptual and methodological approach for evaluation of ecosystems contribution to human well-being (Alcamo et al. 2003).
Economic assessment of ES evaluates the willingness to pay for ecosystem services in monetary or relative terms. Decision on the most appropriate ecosystem services management scenario mainly depends on indicator selected for ecosystem services assessment. There is developed a common Ecosystem Services Partnership Visualization Tool which is an open-access interactive platform that hosts a catalogue of ecosystem services maps including information on indicators, data and models useful for ES assessment (Drakou et al. 2015).
There are several researches on ES assessment in coastal areas, for instance the research study in Australia examines the willingness-to-pay for marine environmental improvements, based on policy-determined scenario (Östberg et al. 2015). The conclusion is that economic valuation of coastal and marine ecosystem services is applied in decision-making process in Australia, but its impact on policy is weak (Marre et al. 2015).
It must be considered that economic assessment of ES is extensive scientific work with considerable time and human resources consumption. ES economic assessment mainly is implemented on basis of secondary data analysis and using TEEB (The Economics of Ecosystems and Biodiversity) Ecosystem Service Validation Database (ESVD) (Ploeg et al. 2010). TEEB ESVD presents the monetary values of the ecosystems services for the main bioms/ecosystems, and it is possible to use these monetary values for analysis of different scenario (Groot, Kumar, et al. 2011). In research an overview of the value of ecosystem services of 10 main biomes expressed in monetary units is given (Groot et al. 2012). Following the global TEEB initiative, the TEEB Nordic carry out development of recommendations for policy actions on ecosystem services in the Nordic countries (Kettunen et al. 2012).
The estimated monetary value is the tool for the comparing different policies, where not absolute values are important, but the amount and direction of the monetary values changing (Notte et al. 2012). In research (Wolff et al. 2015) was found that for applying ecosystems services approach in planning, decision-making and management it important to evaluate impacts on potential land use changes. There was also discussed the necessity of the ecosystems services and landscape ecology concepts and their integration into assessment procedures and landscape planning practice (Pelorosso et al. 2016). According to Groot F. (Groot, Fisher, et al. 2011) ecosystem assessments should be set within the context of contrasting scenarios, as a function of changes between alternative options. To model different economic scenarios it is necessary to integrate the ecosystems services monetary values into decision support systems for the scenario development in public applications (Klein et al. 2015).
There are a wide variety of methods for the ecosystems services evaluation. One of the method is ecosystem services assessment implemented by experts, using matrix modeling technigues (Jacobs et al. 2015). Ecosystems Service Partnership working groups have provided the guidance in ecosystems services mapping and assessment practices (Willemen et al. 2015). For example, a value transfer analysis was used for ecosystem services evaluation in the coastal zone of Catalonia, Spain (Brenner et al. 2010) and in northwest Mexico wetlands (Camacho-Valdez et al. 2013). For applying the combination of market-based and value transfer methods the authors (Sharma et al. 2015) recommend recognizing the ecosystems services as an integral part of the policy of local community. Benefit transfer

can be a practical, swift and cheap method to estimate the ecosystems services values (Pascual et al. 2011). The biotope value assessment method was development in Poland wetlands area, using Czech methodology for estimating the monetary value of biotopes (Trzaski & Mana 2008).

The study is based on the data of Baltic Sea coastal pilot territories in Latvia - *Saulkrasti* and *Jaunkemeri*. The necessary ecosystem servives categories and assessment indicators are indicated and assessed in the framework of European Commission LIFE project „LIFE EcosystemServices - Assessment of ecosystems and their services for nature biodiversity conservation and management" LIFE13 ENV/LV/000839". There is carried out collection of primary data, aggregation and comparative assessment of secondary data by using approbated scientific research methods and ES assessment indicators. The obtained data is adapted to Latvian social-economic situation by using correction factors. Depending on ES category there were used following assessment methods(Pascual et al. 2011):

- for assessment of provisioning services – direct market pricing method;
- for assessment of regulating services – benefit transfer method and direct market pricing method;
- for assessment of cultural services - benefit transfer method and travel cost method.

The aim of the paper is to present and discuss the model for ecosystem economic (monetary) valuation for the socio-economic development planning in Latvian coastal areas.

2. ES assessement methodology based on secondary and primary data analysis

For ES and assessment indicators, it is neccessary to standardize received data in in unite spatial, time and currency units, for example EUR/ha/year. In addition, standartized data monetary values must be corrected taking into account inflation and other factors to compare over time. ES economical impact mainly determines the value of ES in annual terms, it is neccessary to perform seasonal corrections (equalization). ES usualy are assessed in certain place for certain services. Total economic value (TEV) and received economical values of services can be converted to Latvian situation by using Gross domestic product (GDP) deflator and GDP purchasing power parity (PPP) conversion factors:

- by applying GDP deflator, the economical value of services (*USD/ha/year)* in fixed year is converted in (*USD/ha/year)* in prices of current year;
- by applying GDP purchasing power parity (PPP) conversion factors, the economical value of services in other currency (for example, USD) is converted in EUR.

Purchasing parity method is theoretical price comparison, calculated on the basis of certain basket of consumer goods price in certain currency in its basic country. It is often significantly different from market currenecy exchange rate as well asi n one currency the prices can differ in different countries due to geographical situation, diferencies in production and market situation. In the result there is received economical value of services EUR/ha/year in current year prices.

ES value is relative contribution to sustainable human well-being. ES monetary assessment is not the same to privatization and exactly value how much the service costs in terms of money in the market, because it depends on the assumptions and limitations of the study during of assessment of ES (Costanza et al. 2014). Although, if we have ES monetary values, it is possible to develop and implement different management scenarious and determine trade-off mechanisms. ES monetary assessment is standartized assessment as it is neccessary to transform different ES indicator units in one monetary unit, for example EUR/ha/year. It gives possiblity to compare different ES and determine which service is valuable. The absolute value of the ecosystem services are uncertain and for practical use, it is necessary to compare the relative values of changes in the provision of ecosystems services (Price 2007).

ES economical assessment methodology consist of following stages:

- provisioning, regulating and cultural service monetary evaluation, including

- standartization of secondary and primary data in unite spatial, time and currency units, for example EUR/ha/year;
- corrections of secondary and primary data, taking into account inflation and other factors for comparison over the certain time period;

- asssessment of ES in larger areas in longer time period which includes data aggregation by geographical unitsa and by ecosystem services and determines ES economical impact range/area;
- ES economical assessment meta analysis based on ES assessment model;
- ES economical model for modelling development scenarious.

2.1. Economic impact area of ecosystem services in pilot territories

The two pilot areas in the coastal zone - Jaunkemeri and Saulkrasti - have been selected to test the approach of assessment the ES for the Latvian coastal conditions. Pilot area "Jaunkemeri" is located within the city and is part of Kemeri national park. It includes sandy beach and biologically valuable habitat of EU importance – wooden dunes. The area is not much transformed and relatively poorly visited (90,85 ha). Pilot area "Saulkrasti" is located in Saulkrasti municipality. It includes sandy beach and biologically valuable habitat of EU importance – wooden dunes and remarkable cultural and nature monument – White Dune. The well-maintained nature object is frequently visited and subjected to excessive anthropogenic pressure and erosion (132,86 ha).
To evaluate economic impact area of ES in pilot territories at the first, it is necessary to identify the relation or link of pilot territories within larger area considering distance, number of visitors and total monetary value of ecosystem services depending on place of residence. The determination of economic impact area of ES allows: (1) to determine average number of visitors in pilot territories per year per 1000 inhabitants depending on place of residence; (2) to assess the average monetary value (EUR) per year, depending on place of residence; (3) to calculate the proportion of ecosystem services in pilot territory and all other area; (4) to assess number of visitors of pilot territory depending on distance from visiting place.
There was implemented the social survey with aim to obtain primary data for economic assessment of following ecosystem services in pilot territories:

- Provisioning ecosystem services: Medical plants (herbs);
- Cultural and recreational ecosystem services: Bird watching, Active/passive recreation; Environmental education; Cultural Heritage, Landscape.

The surveys were implemented in August and September of 2016 and in total 750 respondents (375 in each pilot territory) were interviewed. Analyzing the number of active/passive recreation visitors in Jaunkemeri depending on distance travelled it is possible to estimate that economic impact area of Jaunkemeri pilot territory is 50 km (Fig.1).

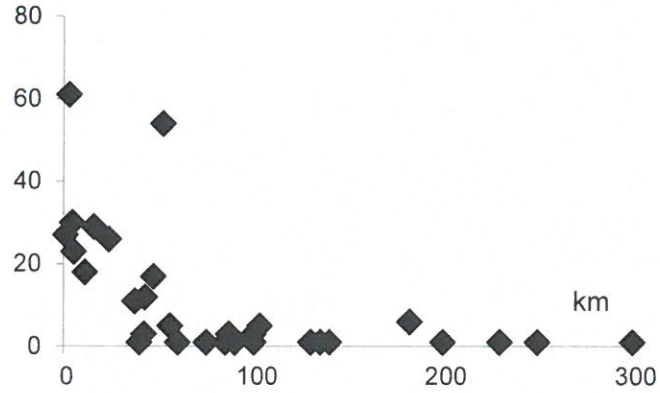

Fig. 1 The number of Jaunkemeri pilot territory active/passive recreation visitors depending on distance (km).

Analyzing the number of active/passive recreation visitors in Saulkrasti depending on distance travelled it is possible to estimate that economic impact area of Jaunkemeri pilot territory is also 50 km (Fig.2).

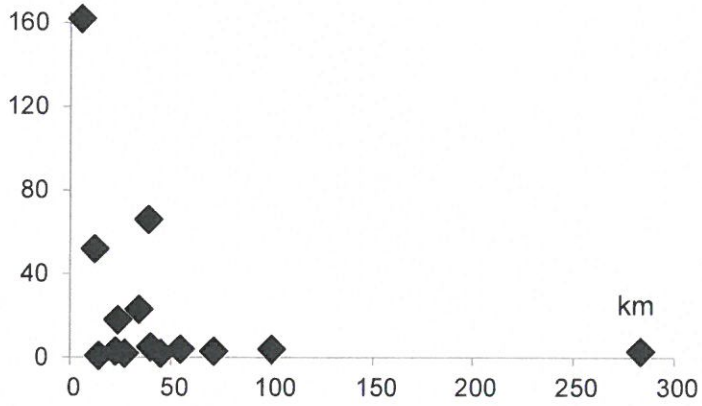

Fig. 2 The number of Saulkrasti pilot territory active/passive recreation visitors depending on distance (km).

2.2 Ecosystem services assessment meta-analysis

Meta-analysis of ecosystem services economic assessment is based on multiple regression analysis (1):

$$Ln(Y_i) = \beta_0 + \beta_1 X_{1i} + \cdots + \beta_k X_{ki} + \varepsilon_i \quad (1)$$

Y_i - economical (monetary) value of ecosystem and X_i are factors characterizing geographical location, social-economic situation and other factors of selected territory. Considering the small number of total visitors, ES assessment meta-analysis was applied for data obtained in survey only about active/passive recreation. It was used such quantitative factors as average monthly net income, age, costs spend current visit, duration of visit, willingness-to-pay for conservation of place, and qualitative factors as gender and educational level. Correlation analysis shows that in case of active/passive recreation there is average linear or strong linear relationship between economic (monetary) value of ecosystems (EUR/ha) and quantitative factors (Tab. 1).

Table.1. Correlation coefficient of economic (monetary) value (EUR/ha) of ecosystems and quantitative factors in Jaunkemeri un Saulkrasti pilot territories

No.	Quantitative factors	Pilot territories	
		Jaunkemeri	Saulkrasti
1	X_1: average monthly net income (EUR)	0.99	0.09
2	X_2: age (years)	0.63	-0.82
3	X_3: costs of visiting the place (EUR/ per person)	0.79	0.41
4	X_4: duration of visit (hours)	0.81	0.67
5	X_5: willingness-to-pay once a year for conservation of place (EUR/per person)	0.68	0.17

It can be concluded, that there are higher costs (EUR/per person) related to active/passive recreation in Jaunkemeri than in Saulkrasti. Analyzing costs, we can conclude that higher costs are in build-up areas and lower costs are in forest area in Saulkrasti and in beach area in Jaunkemeri (Fig.3).

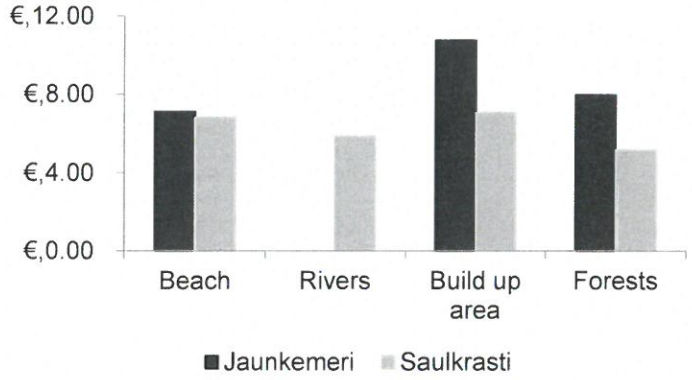

Fig. 3 Average costs related with active/passive recreation in the pilot territories (EUR/ per person).

There is lower duration of visit related active/passive recreation (h) in Jaunkemeri than in Saulkrasti. Analyzing the duration of visits depending on recreation place it can be concluded that longer duration of visits is in build-up areas and in river areas, conversely the shorter duration is in forest area in Saulkrasti and in beach area in Jaunkemeri (Fig.4).

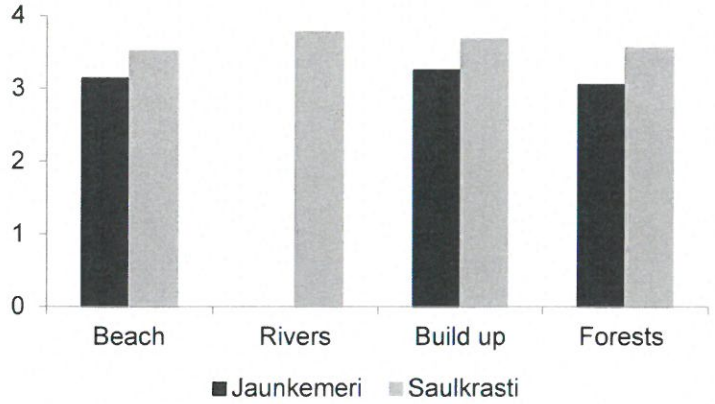

Fig. 4 Average duration of visit related with active/passive recreation in pilot territories (h)

3. Economic model of ecosystem services for modelling development and land-use scenarios

In the framework of the study, there is developed model for determining economic values of ecosystem services. The model is based on developed and approbated methodology and intended to use for monetary assessment of ES in coastal areas. In a case of the study the scenarios are developed against the current status of the land use in the pilot territories. Saulkrasti and Jurmala are popular recreation and tourism destinations, therefore the main controversial interests are – nature conservation versus tourism development.
To provide leisure opportunities including sport activities and other activities outside the summer season, Jurmala city has designated a part of Jaunkemeri pilot area as a resort park. Saulkrasti municipality anticipate the establishing a nature design park in a part of the pilot area. There are data provided and analyzed for modelling of three following scenarios for pilot territories:

- 1st scenario reflects the existing situation - current monetary values of ecosystem services in Saulkrasti un Jaunkemeri pilot territories;

- 2nd scenario is related with tourism and recreation development in Jaunkemeri and Saulkrasti pilot territories – nature territories for active/passive recreation and sport activities, environmentally educational activities covering all seasons;
- 3rd scenario is modelling a hypothetical situation where in both pilot territories about 50% increases build-up area instead of forests displaying changes of ES monetary values in a case of uncontrolled development in pilot territories.

The results of economic assessment of ES in Saulkrasti un Jaunkemeri in current situation (EUR/ha/per year) distributed by provisioning, regulating and cultural services are shown in Figure 5. The monetary value of ES in Jaunkemeri is higher than ES monetary value in Saulkrasti. The 2nd development scenario doesn't have large impact of ES monetary values. There are increase of monetary value of provisioning services in Jaunkemeri territory (about 4%) and decrease of value of regulating services (about 4%).

The regulation services gave the largest monetary value in both pilot territories both at the existing situation and at the implementation of 2nd scenario. At the same time, comparing changes of implementation of 3rd scenario, there are significant decrease of monetary values of regulating and provisioning services. The lower decrease has cultural services.

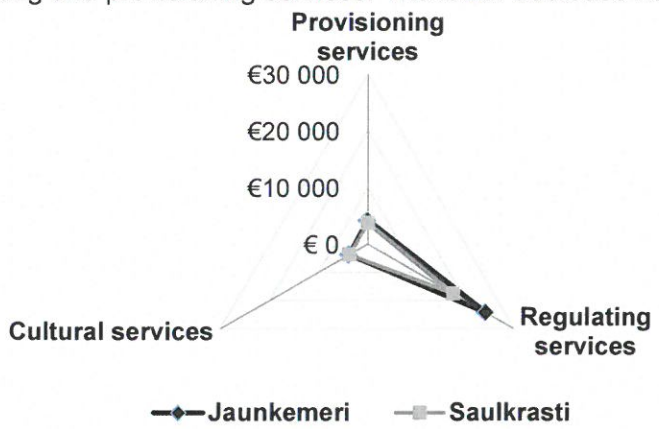

Fig.5. Economic assessment of ES in Saulkrasti un Jaunkemeri pilot territories in current situation (EUR/ha/per year).

The comparison of all three development scenarios in Jaunkemeri pilot territory based on secondary data and distributed by provisioning, regulating and cultural services are shown in Figure 6.

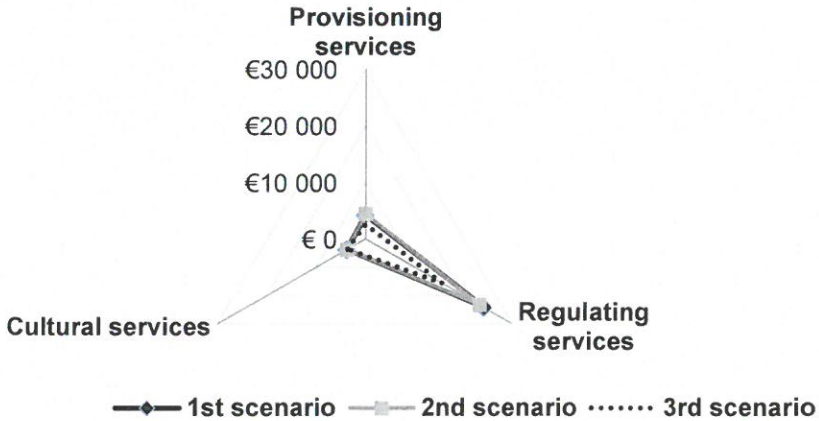

Fig.6. Economic assessment of ES in Jaunkemeri pilot territory in a case of implementation of 1st, 2nd and 3rd scenario (EUR/ha/per year)

The 3rd scenario provides visible losses of ES monetary value comparing with 1st and 2nd scenario. The most significant are losses in values of regulating and provisioning services. The regulating services have the largest monetary value in a case of implementation of all scenarios.

The comparison of all three development scenarios in Saulkrasti pilot territory based on secondary data and distributed by provisioning, regulating and cultural services are shown in Figure 7. The same as in Jaunkemeri, the implementation of 3rd scenario provide visible losses of ES monetary value comparing to other scenarios, particular for regulating and provisioning services. There are no significant changes in ES values by implementation of 1st and 2nd scenario. The regulating services have the largest monetary value in a case of implementation of all scenarios also in Saulkrasti pilot territory.

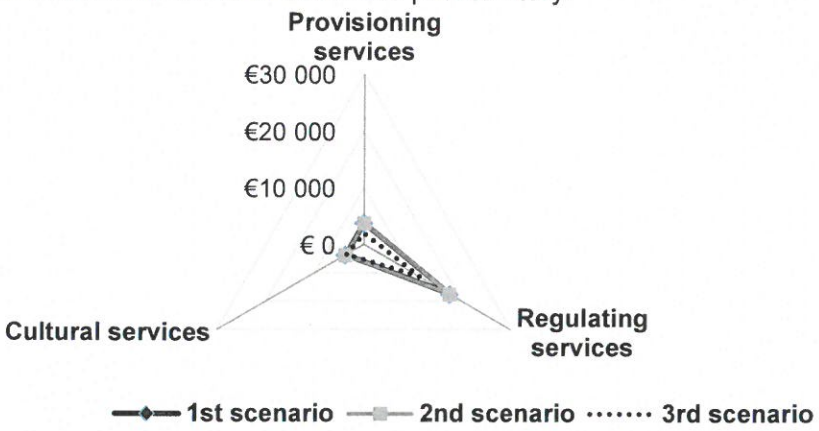

Fig.7. Economic assessment of ES in Saulkrasti pilot territory in a case of implementation of 1st, 2nd and 3rd scenario (EUR/ha/per year)

As it was explained above, the regulating services have the largest monetary value in both territories and it is mainly provided by forest areas. Forest areas have the largest common rate of ES monetary value comparing to other areas - beach, build-up, rivers. Thus, the largest monetary value of ES in Jaunkemeri territory can be explained with larger forest covering comparing with Saulkrasti (in Jaunkemeri forests covers 78% of all territory, in Saulkrasti – 48%). By implementing 3rd scenario which means decrease of 50% of forest area Jaunkemeri territory still remain more valuable than Saulkrasti territory.

There are no changes of ES monetary values in Saulkrasti by implementing 2nd scenario, which means that this scenario is gentle to existing ecosystems in territory and don't change the ES provision. A similar conclusion can be done also for Jaunkemeri territory, although there is a little decrease of regulating services about (4%) and a little increase of provisioning services (about 4%). The implementation of 3rd scenario is not recommended for both pilot territories because it can cause significant monetary and ecological losses of all ES categories.

4. Conclusions

It can be concluded that implementation of 2nd scenario is a well-considered decision - there are no losses of common ES values and no negative impact on ecological status of ecosystems in both pilot territories. At the same time, it has a positive impact on tourism and recreation development by implementing different leisure and sport activities and establishing environmentally friendly visitor infrastructure.

Implementation of 3rd scenario is hypothetical scenario and there are limitations to make reasonable conclusions of changes of ES values by changing only land use of areas without detail description of planned infrastructure (resort, museum, watch tower, etc.) and evaluations of its impacts environment and socio-economic situation.

In common, in the result of ES monetary assessment, the following priorities and recommendations can be outlined:

- the largest monetary value has regulating services provided by forest areas. The forest areas are the most valuable areas from ES monetary assessment perspective. Therefore, the priority should be given to management scenarios and measures which are towarded to maintain and protect forest ecosystem;
- The second priority from ES monetary assessment perspective is given to cultural services assuming that development of tourism and recreation activities would not create additional anthropogenic load on ecosystems but on the other hand will be directed toward nature education and decrease of negative impacts on ecosystems.
- The lowest priority is for provisioning services considering that both territories are located in coastal areas and there are legal and physical restrictions to obtain these services (for example restriction of tree felling and fishing).

Acknowledges

The study underlying this manuscript has been conducted within LIFE "EcosystemServices" (LIFE13 ENV/LV/000839) project, co-finansed by European Union.

References

Alcamo, J. et al., 2003. *Ecosystems and human well-being: a framework for assessment* J. Sarukhan & A. Whyte, eds., Washington, Covelo, London: World Resources Institute.

Brenner, J. et al., 2010. An assessment of the non-market value of the ecosystem services provided by the Catalan coastal zone, Spain. *Ocean and Coastal Management*, 53, pp.27–38.

Camacho-Valdez, V. et al., 2013. Valuation of ecosystem services provided by coastal wetlands in northwest Mexico. *Ocean and Coastal Management*, 78, pp.1–11.

Costanza, R. et al., 2014. Changes in the global value of ecosystem services. *Global Environmental Change*, 26, pp.152–158.

Drakou, E.G. et al., 2015. A visualization and data-sharing tool for ecosystem service maps: Lessons learnt, challenges and the way forward. *Ecosystem Services*, 13, pp.134–140.

Groot, R. De, Kumar, P., et al., 2011. Estimates of Monetary Values of Ecosystem Services. In P. Kumar, ed. *The Economics of Ecosystems and Biodiversity. Ecological and Economic Foundations.* Liverpool: TEEB: The Economics of Ecosystems and Biodiversity, p. 35.

Groot, R. De et al., 2012. Global estimates of the value of ecosystems and their services in monetary units. *Ecosystem Services*, 1(1), pp.50–61.

Groot, R. De, Fisher, B., et al., 2011. Integrating the ecological and economic dimensions in biodiversity and ecosystem service valuation. In P. Kumar, ed. *The Economics of Ecosystems and Biodiversity. Ecological and Economic Foundations.* Liverpool: TEEB: The Economics of Ecosystems and Biodiversity, p. 40.

Jacobs, S. et al., 2015. "The Matrix Reloaded": A review of expert knowledge use for mapping ecosystem services. *Ecological Modelling*, 295, pp.21–30.

Kettunen, M. et al., 2012. *Socio-economic importance of ecosystem services in the Nordic Countries. Synthesis in the context of The Economics of Ecosystems and Biodiversity (TEEB)*, Copenhagen: Nordic Council of Ministers.

Klein, T.M., Celio, E. & Gret-Regamey, A., 2015. Ecosystem services visualization and communication: A demand analysis approach for designing information and conceptualizing decision support systems. *Ecosystem Services*, 13, pp.173–183.

Marre, J. et al., 2015. The use of ecosystem services valuation in Australian coastal zone management. *Marine Policy*, 56, pp.117–124.

Notte, A. La et al., 2012. *Biophysical Assessment and Monetary Valuation of Ecosystem Services. Scenario analysis for the case of water purification in Europe*, Luxembourg:

European Commission, Joint Research Centre, Institute for Environment and Sustainability.

Östberg, K., Hasselström, L. & Håkansson, C., 2015. Non-market valuation of the coastal environment - Uniting political aims, ecological and economic knowledge. *Journal of Environmental Management*, 110(2012), pp.166–178.

Pascual, U. et al., 2011. The economics of valuing ecosystem services and biodiversity. In P. Kumar, ed. *The Economics of Ecosystems and Biodiversity. Ecological and Economic Foundations.* Liverpool: TEEB: The Economics of Ecosystems and Biodiversity, p. 133.

Pelorosso, R. et al., 2016. Evaluation of Ecosystem Services related to Bio-Energy Landscape Connectivity (BELC) for land use decision making across different planning scales. *Ecological Indicators*, 61, pp.114–129.

Ploeg, S. van der, Groot, D. De & Wang, Y., 2010. *The TEEB Valuation Database: overview of structure , data and results*, Wageningen: Foundation for Sustainable Development, the Netherlands.

Price, R. ed., 2007. *An introductory guide to valuing ecosystem services*, London: Department for Environment, Food and Rural Affairs.

Sharma, B., Rasul, G. & Chettri, N., 2015. The economic value of wetland ecosystem services: Evidence from the Koshi Tappu Wildlife Reserve, Nepal. *Ecosystem Services*, 12, pp.84–93.

Trzaski, L. & Mana, V., 2008. Monetary value assesment of biotopes in the Bobrek river valley, Sosnowiec - a methodology proposal for Poland. *Research Reports. Mining and Environment*, 3, pp.79–90.

Willemen, L. et al., 2015. Editorial: Best practices for mapping ecosystem services. *Ecosystem Services*, 13, pp.1–5.

Wolff, S., Schulp, C.J.E. & Verburg, P.H., 2015. Mapping ecosystem services demand: A review of current research and future perspectives. *Ecological Indicators*, 55, pp.159–171.