Identification of Ecosystem Services in the City of Onkaparinga

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Abstract: In recent years, the concept of ecosystem services is a vital issue among the environmental scientists and policy makers as a linkage between environment and human well-being. Ecosystem services can be seen as the capacity of ecosystem that provides goods and services to satisfy human needs directly or indirectly. This paper focuses on the ecosystem based approach to improve environmental decision making in the city of Onkaparinga by identifying the major ecosystem services. This study classifies ecosystem services at the local level and describes the ecosystem services provided by the landscape and the main threats and drivers that conflict regarding ecosystem demand. It is expected that identifying the currently obtainable benefits will support the city of Onkaparinga in making decisions from unintended loss of any ecosystem which can contribute for economic and social welfare of growing population in the council area.

Key Words: cultural, ecosystem, provisioning, regulating, supporting, - services

Introduction

The concept of ecosystem services (ES) has gained enormous attention among the environmental scientists and policy makers as a linkage between environment and human well-being interactions [14], [17], [32], [37], [41]. It is commonly understood as the benefits people obtain from an ecosystem [32] which can be classified into categories of provisioning (material benefits such as fresh water, raw material, food etc.), regulating (important process for human functioning such as air quality regulation, climate regulation, flood mitigation etc.), cultural (aesthetic, spiritual, educational, recreation etc.) and supporting services (secure and maintain the production of other services such as nutrient cycle, photosynthesis, etc.). The four broad ecosystem services identified by Millennium Ecosystem Assessment (MEA) can be categorized depending on their material and non-material values. Provisioning, supporting and regulating services have direct and tangible value but cultural services like tourism, aesthetic, spiritual and recreation hold the nonmaterial and intangible benefits. Thus, ecosystem services can be seen as the capacity of ecosystem [17] that provides goods and services to satisfy human needs directly or indirectly. However, these benefits are rarely quantified, rewarded and acknowledged in the decision making process by local and national governments [25], [21], [22], [37]. In this work, the case of the City of Onkaparinga (CO), South Australia, was highlighted to integrate ecosystem services into environmental decision making at council level by identifying the major ecosystem services.

The ES provides a framework for linking conservation interest to local economy through identification, description and assessments of both the current and potential benefits of the ecosystems [33]. The United Nations Sponsored MEA [32] assesses how loss of biodiversity and resultant ecosystem change affect human well-being and provides a

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framework to identify and classify ES. Identification and classification of ES is necessary because landscapes simultaneously produce multiple services and are inter-related with very dynamic ways [3], [6]. Trade-off of these services can adversely affect the other ecosystems [28] and globally, it is established that increasing demand for provisioning services such as food production, timber, etc. has resulted in decline in most regulating services like flood control, pollination or genetic resources [32]. The MEA [32] assesses 24 ecosystems among which15 ecosystems have been degraded worldwide and used in an unsustainable way.

To address the loss of ES at local, regional and global level, it is important to include them into environmental decision making [15], [17]. European Commission [19], UK National Ecosystem Assessment [43], The Economics of Ecosystems and Biodiversity [41], all emphasise on net loss of biodiversity and ecosystem services. Therefore, ecosystem based approach that identifies and assesses ES is required to incorporate into decision making to manage natural resources.

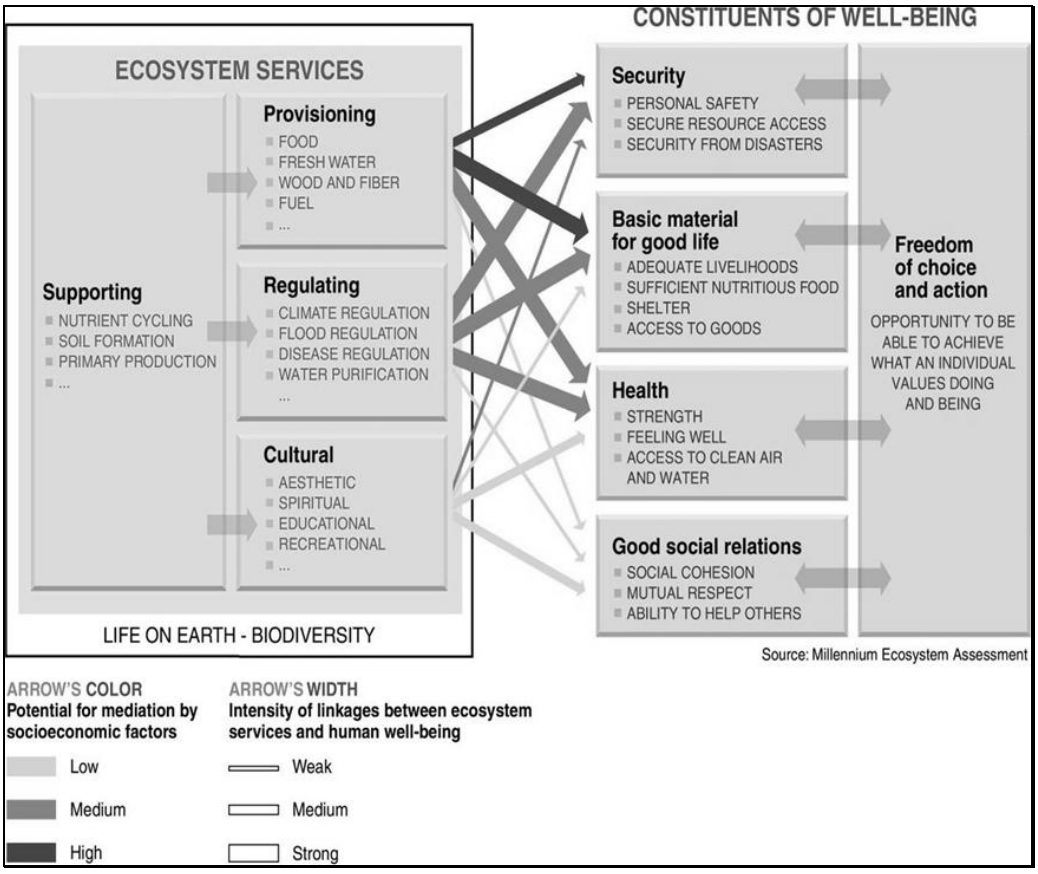
This paper focuses on the ecosystem based approach (EBA) to improve environmental decision making in the city of Onkaparinga (CO), South Australia by recognizing and classifying the major ecosystem services. It tries to answer the following questions- what are the current state of the ecosystem services in the CO? What are the key drivers causing changes in ES and how can we incorporate EBA in decision making? To address these questions, first, it elaborates on the ecosystem based approach by identifying and classifying ES in the CO. Second, it provides an insight into the key environmental issues which are important for the CO council. It is expected that identifying the currently obtainable benefits will support the CO in making decisions from unintended loss of any ecosystem which can contribute for economic and social welfare of growing population in the council area.

Ecosystem Based Approach and Environmental Decision Making

Ecosystem Services

The concept of ES was first coined in the 1980s but gained much attention by the environmentalists, economists and policy makers after the works of Costanza et al. [8] and ‘Daily’s ‘Nature’s Service’ in 1997. Both discussed the significance of ecosystems in societal development [32], [46]. Daily [17,p.3] defines ES ‘as the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfil human life. On the other hand, Costanza et al. [8, p. 253] define ES as ‘the benefits human derive, directly or indirectly, from ecosystem functions’. Following Daily’s concept MEA [32] defines ES ‘the benefits obtained from ecosystems’. In general ES are, therefore, the result of interactions among environmental characteristics, structure and process of these biotic and abiotic components that directly or indirectly contribute to humanity [14], [15], [17], [43], [37]. Here this paper has taken into account uses the broader definition provided by MEA because of its universal acceptance and it is consistent with any other definitions existing in the literature.

Besides scientific and ethical ground of conserving biodiversity and environment, ES tries to link ecology and economy [8] and sees nature as a stock of multiple 'consumptive and non-consumptive goods and services' [17], [28]. Valuation (tangible and intangible) of different ecosystems is the centre of the view. The total economic value (all ecosystem are valued) conceptual framework views ecosystem goods and services as the flows of benefits and costs provided by the stock of natural capital [16], [29], [42]. Hence, the importance of making explicit value of multiple ES that ecosystem performs, and assessing this value within a framework help not only protect the degraded ecosystem but also help for improved decision making [16]. TEEB [41] is the result of global valuation of ecosystems and in a recent study of de Groot et al. [16] also developed an Ecosystem Service Value Database with more than 1350 value estimates.



Source: [32], p. 7

Fig. 1: *Ecosystem services and their relationship with human well-being*

Classification of Ecosystem Services

Classification of ES provides a platform for addressing and recognizing the current and potential ecosystems to deliver ES and understand their relationship. Moreover, it

provides the necessary information about the actual uses and services and future and potential benefits of landscape. This also creates a clear picture on how improving one service affect another service on the same and neighbouring landscape [19].

A number of studies [17], [19], [22], [32], [38], [41], [44] identify and classify the variety of ES provided by the main ecosystems worldwide, across different spatio-temporal scales. Yet, there are insignificant studies that identify and understand the dynamics of ES in local and regional level, which often represent the practical scales at which management strategies are designed and implemented [33]. However, most studies [33], [34], [38], [43] have used the classification of MEA because of its universal acceptance in academia, policy making and other related fields. UNEP [44, p.54] refers that MEA analysis provides better reflection of 'real world biological, geophysical, social and economic interactions and allows for a more holistic analysis of these interactions'. Here, this study also emphasises the primacy of the classification of MEA and identifies the ES in the CO based on the MEA framework. MEA [32] classifies ES in four broad categories (Table 1) on the basis of the function of ecosystems.

Table 1: *Categories of ecosystem services and related services*

Types of Services	**Services**
Provisioning services	Food, Fibre, Genetic resources, Bio-chemicals/ natural medicines, Ornamental resources, Fresh water
Regulating Services	Air quality, Climate regulation, Water regulation, Erosion regulation, Disease regulation, Pest regulation, Pollination
Cultural services	Cultural diversity, Spiritual and religious values, Recreation and ecotourism, Aesthetic values, Knowledge systems, Educational values
Supporting services	Soil formation, Photosynthesis, Primary production, Water cycling

Source: Millennium Ecosystem services, 2005:33

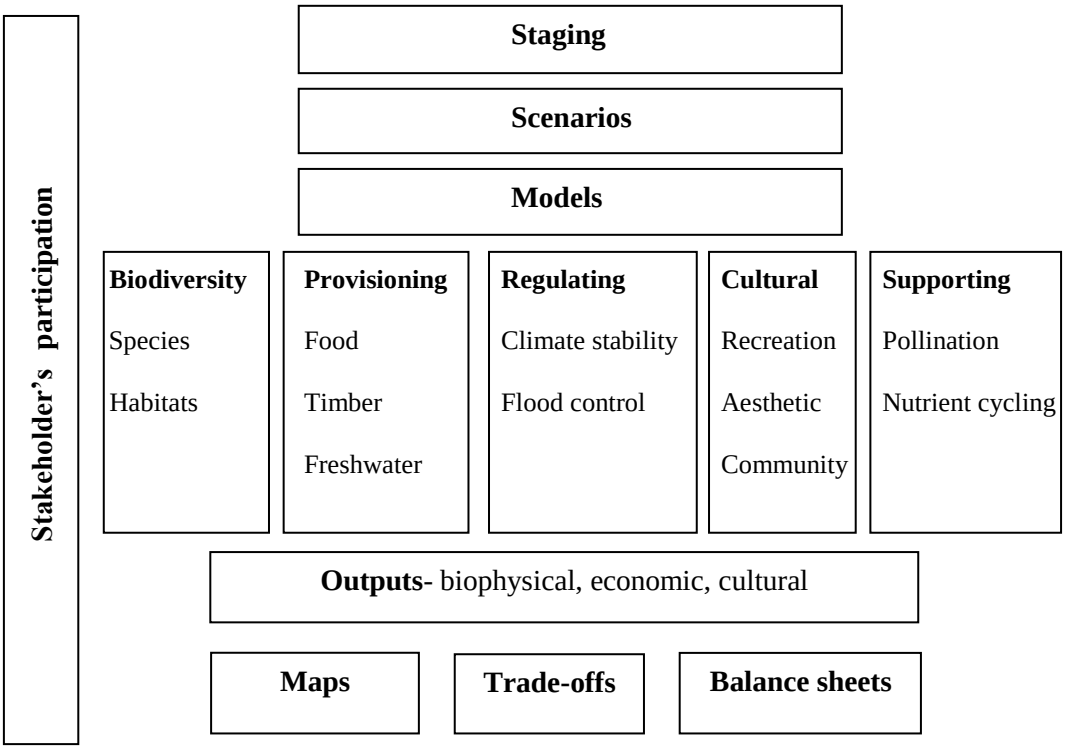
However, classification of MEA is criticized for its generalized view, not to address its universality and context dependency, double counting of benefits (particularly relevant for supporting and regulating functions), relationship between categories of services and ecological process and function [18], [44], and narrow and unclear functional relationship (which is presented in crisscrossing arrows in various strength) between nature and human well-being [21].

Ecosystem Based Approach in Decision Making

An EBA is a holistic or systematic approach that puts ES at the centre of the development and policy making by integrating social, economic and ecological dimension of natural resource [37]. World Resource Institute (2008) describes EBA as framework by which ES are integrated into public and private decision-making [44]. An EBA helps to -

- identify and classify the benefits that people derive from ecosystems. It also includes market and non-market, use and non-use, tangible and non-tangible benefits.
- explain consumers and producers of ES for maintenance and improvement of ecosystems for human well-being.
- describe and communicate benefits derived from natural and modified ecosystems to wide range of stakeholders.

There is no concrete model to incorporate EBA in decision making. Cooter et al.[13], Daily et al.[15], de Groot et al. [17], Fisher et al. [22], and Sandhu[36] have provided different models showing how to incorporate the approach into policy making. However, although classification of ES varies, the pathway of incorporating ES follows almost similar way and every model starts with identifying and classifying the ES. Figure 2 shows a basic understanding of how ES can be incorporated into decision.



Source: [15], p. 23

Fig. 2: *A process of integrating ecosystem services into decisions*

The initial stage requires a working classification of all relevant types of ecosystems. Once the classification is established the set of services provided by particular ecosystems needs to be identified. The third stage involves the matching of services and/or

combination of services with tangible and intangible benefit outcomes utilized or appreciated by human society. The final stage is concerned with valuation of final outcome benefits provided by each ecosystem. Here, this study will not focus all the stages of the EBA, it intends to identify and classify the possible ecosystems in the study area in accordance with the classification of MEA.

Methodology

To identify the potential ES in the CO, this study is based on existing knowledge regarding the current management, exploitation and conservation values of the CO and used this knowledge to identify and classify the ES delivered by these natural and semi natural assets, and the drivers of changes in the ecosystem. Moreover, an extensive observation survey was done for two months from June and July in 2013. By observation survey it was possible to make a list of ES. Finally, to finalize the ES, the sustainability officer of the city council and two consultants of a project titled 'Assessing natural assets and ecosystems in the city of Onkaparinga' with collaboration of the CO and Flinders University, Adelaide, Australia were consulted to get expert opinion. Moreover, different literatures and documents are used as secondary sources.

Description of the study area

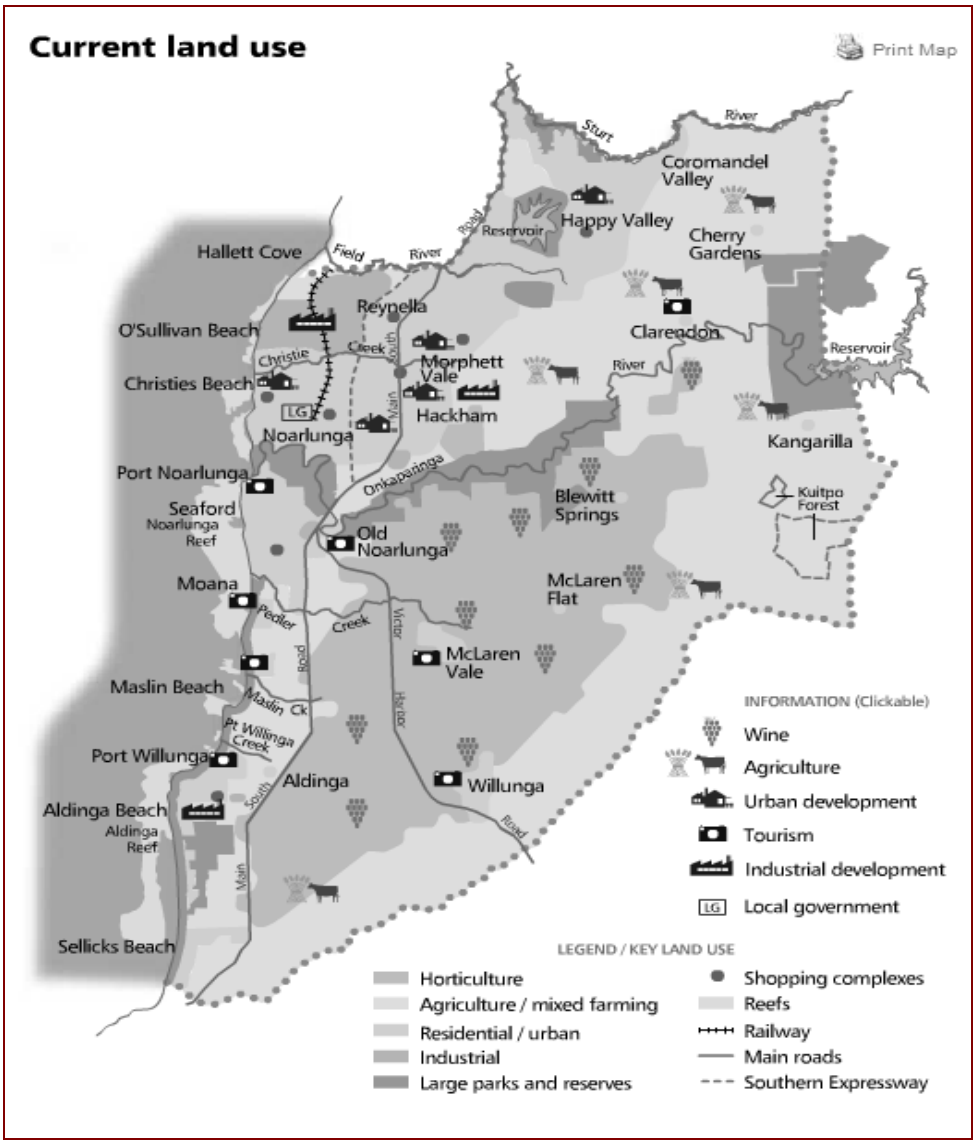
The study area (Fig. 3) is located approximately 50 km south of Adelaide, South Australia. The landscape of CO is highly diverse, covering an area of 51,800 ha at the southern end of the Adelaide and Mt Lofty Ranges region. Western boundary of CO comprises of 31 km coastline including open beaches, reefs, dunes and cliff to the foothills of the Southern Mt Lofty ranges in the east and south. The northern boundary is defined by Sturt and Field rivers. Currently the CO is important for offering variety of ES including agricultural production, biodiversity conservation and other intangible ES, such as carbon sequestration, climate regulation, soil protection and decreased water runoff in the hilly areas, cultural services.

Ecosystem Services in the City of Onkaparinga

The ES supplied in the CO is characterised by the framework of MEA. The MEA classified ES in four broad categories as provisioning, regulating, cultural and supporting services. Moreover, research into ecosystem services requires the identification of beneficiaries, the way they use the service, and their spatio-temporal scale in order to translate a function into service [33]. Here, this study classifies ES in the CO by considering ES provider (landscape); types of benefits; ES beneficiaries; threats and drivers to the ecosystem within the City council boundary depending on the present condition of the landscape (Table 2). Cooter et al.,[12] points 'valuing the benefits we receive from nature, and identifying the beneficiaries, allows for a more complete assessment of the social, environmental, and economic impacts of a given management action or policy decision leading to maximize benefits and fewer unintended consequences'.

Provisioning services

Provisioning services are defined as the material benefits that human derive from ecosystems, such as fresh water, raw materials, food. The landscape of CO provides a number of goods and services that are directly and indirectly related to human well-being. The major provisioning services come from the vast agricultural rural landscapes (76% of the total area). The major agricultural activity in the CO is viticulture, livestock farming, and horticulture. Currently, there are 70 wineries and 250 private grape productions



Source: [10]

Fig. 3: *The study area*

vineyards which are involved in producing 50,000-70,000 tonnes of grapes per year from 7,388 hectares of land [12]. This region not only meets the local demand but also supplies to the international wine market. This area also produces meat, cheese and milk. Fresh food products (honey, bakery, vegetables, etc.) and fruits (Almonds, olive) are produced and marketed in the local and regional markets. Long coastal and marine areas are the source of fish, etc.

Onkaparinga River is the centre of the water supply which created different catchment areas. Other significant riverine systems in the region include Christie Creek, Peddler Creek, Maslin Creek, Pt. Willunga Creek, Washpool and Sellicks creek [11]. In the early days, the rivers were used for residential and irrigation purpose.

Forest and vegetation cover in the CO are diversified in nature and characteristics. Major forest and vegetation includes grassy and grassy woodland, heathland and coastal, shrub land, riparian and, wetland [10]. These areas are important for providing fibre, raw materials, grazing, etc.

Regulating service

Ecosystem provides diverse range of regulating services which includes climate regulation, hazard regulation, pollination, water purification, pest and disease control, etc. The CO climate change report [5] mentions that in 2002, 3.2 million tons of carbon was stored in the Mount Lofty ranges, woodland conservation parks, farmland, and coastal and marine areas contains the high amount of carbon storage. Coastal dunes, cliffs, forest areas also play vital role for coastal protection, water regulation, erosion control, water regulation [1].

Pollination plays a vital role for the production of crops. This is required for the production of almonds, olives and other cross pollinated crops in the region. However, practice of monoculture decreases pollination which is necessary for production of some food crops [33], [38].

Soil quality regulation has pivotal role in maintaining organic and mineral nutrients in soil. Viticulture has long been concerned with the soil health because the quality and flavour in wine are influenced by the organic and mineral compositions of the soil [24]. Soils and topography of McLaren vale-Willunga basin are particularly suited for viticulture [40].

Cultural Services

The CO provides vast number of cultural ES which have shaped the local lifestyle and has contributed towards social and economic well-being of the society. Scenic coastal areas, Mount lofty region, McLaren Vale-Willunga wine region, Onkaparinga river national park, Aldinga Scrub, Tour Down under festival, Sea and vine festival, Almond Blossom festival, Kaurna dreaming tracks, walking trails, bicycle trails and many more at the landscape level are providing different types of cultural services including tourism, cultural heritage, educational values, recreation aesthetic, and also fostering good social relationship. Willunga farmers market, Willunga Township and Port Willunga Beach are the top most cultural ES which are providing multifunctional benefits considering the socio-

ecological perspective. These cultural services have immense importance to develop sense of place, social activity, pleasure, and meeting people which have the potentiality to generate other form of capital called 'social capital' [20], [35] that works as social, economic and environmental development of the area. In another study of the CO finds beaches and foreshore open spaces were accessed by 85.7% in 2011 and 66.2 % felt that these open and coastal areas meet the in family recreation and leisure activities [11]. Moreover, the tourism sector provides $326 million in direct economic activity and $ 130 million in value adding to the local economy, creating nearly 4000 tourism related jobs in the CO.

Supporting Services

Supporting services are fundamentally different from other ES and very useful and are required for producing and sustaining other ES. Supporting services are necessary for other services to generate goods and services and the functions of these services are strictly ecological. This service provides the basic physical structure for functioning of the other three services. The services include nutrient cycling, soil formation, primary production, heat regulation, habitat provision, water cycling, etc.

Barbier et al. [1] shows in their study on coastal and estuarine ecosystems, that coral reef, salt marshes, mangrove, sea bed grass, beach sands, dunes and cliffs provide goods and services in the context of Caribbean Sea. The CO has long coastal areas and supporting for water regulation, primary production, erosion, nutrient cycling. The coastal areas are important for maintaining the food chain and web. Increased agricultural production requires soil nutrient cycle. The CO has fertile land for agricultural production which depends on soil nutrient cycling.

Environmental Issues in the City of Onkaparinga

The present CO, according to Australian Bureau of Statistics (2011) is the largest council in SA by population (164,896), is growing at about 1% p.a. [9]. It is, and will continue to, rapidly change in terms of infrastructure and services due to population growth. This growth will impact social, economic and environmental sustainability of the city of Onkaparinga and beyond. Expansion of population in peri-urban areas both in quantum and spatially will impact land, water and energy allocation, and strengthen environmental pressure through impacts on air and water quality, biodiversity and other ES as well as incurring opportunity costs related to high-value agricultural land.

Historically, this region has experienced massive change in its landscape. The Kaurna people managed this landscape for 45-55000 years ago [39], [30] but massive changes occurred after European settlement in 1836. The current landscape situation is resulted by replacement of induced forest and species and gradual conversion of other land cover for agriculture, urban and coastal development [30], [39], [40].

Across Adelaide, among 725 native plants and 177 species of birds, 140 (19%) are locally extinct and another 393 (54%) are rare or threatened. In the CO, only 9% of the total native vegetation is remaining throughout the council [9].

Despite growing recognition of their values, the future of the CO's forest, agricultural and coastal areas remains at risk. The city has a substantial planned growth with

approximately 20,000 dwelling planned for new development and potentially new residents in the next 20 years [10]. To meet the demand of the dwelling high rate of real estate expansion is going on the high value agricultural areas, in the coastal areas living the coastal cliffs, coastal vegetation at risk.

Wine-grape production is rapidly increasing over the last 10 years which has importance for local, regional and national economies. However, commercial practice of viticulture in a form of monoculture which depends on high agrochemical input to pest control disease and weed problems.

Table 2: *Ecosystem services in the City of Onkaparinga*

Ecosystem goods or services	**Ecosystem service providers**	**Beneficiaries**			**Threats or drivers of change**
		Local	Regional	International	
Provisioning services					
Wheat	Agricultural land	X	X		Decrease in soil fertility, Expansion of other agricultural product, overexploitation
Wine	Vineyards	X	X	X	Decrease in soil fertility, pest and diseases control, residential expansion
Fruits	Orchards	X	X		
Fish	Coastal and marine areas/Onkaparinga river	X	X		Climate change, habitat destruction, change of food web
Vegetables	Home gardens, commercial vegetable fields, Organic vegetable fields, Nurseries	X	X		Weeds
Meat, Cheese, Milk	Livestock	X	X		
Grazing	Grassland and grassy woodland	X			
Timber	Heathland forest	X	X		
Ornamental resources					
Fresh water	Onkaparinga river, water reservoirs in Happy valley, and Willunga	X			
Genetic resources	Native forest and vegetation	X	X		Native vegetation clearance, extinct and threatened species

Regulating services					
Air quality regulation		X	X		
Climate regulation	Forest, agricultural land, coastal landscape	X	X	X	Climate change
Water regulation	Coastal area	X			
Water Supply	Onkaparinga river, reservoirs, water treatment plants	X			Climate change, increase in salinity,
Erosion regulation	Grassland, grassy woodland, coastal cliffs and dunes, coastal forest	X			Commercial agricultural, grazing, coastal development
Refugia	Aldinga Scrub, Onkaparinga river recreation park, National park, and 48 sites for conservation.	X	X	X	Proper maintenance, stakeholder awareness
Disease regulation					
Pest regulation	Native insects and pests	X			Loss of biodiversity
Pollination	Native bees	X			Loss of biodiversity
Cultural services					
Aesthetic	Farmland, coastal landscapes, Mt. Lofty Zones	X	X		Proper maintenance, promotion of these place
Recreation and ecotourism	Coastal areas, Mot Lofty zones, Sellicks Hills, Farm land, Willunga farmers market, sea and vine festival, almond blossom festival etc.	X	X	X	Proper maintenance
Spiritual and religious and historical	Aboriginal history and important place, wash pool, early European settlement	X	X		Proper maintenance
Knowledge and education	Coastal, Marine, Forest, agriculture al landscape	X	X	X	

Supporting services		
Soil formation	X	Fertilizer
Biological control	X	Loss of biodiversity
Mineralization of plant nutrients	X	Agricultural and residential development
Nitrogen fixation	X	Intensive farming and agricultural
Water cycling	X	

This reliance on the chemical reduces environmental suitability including soil fertility, pollination, and biological pest and disease control methods, increases soil erosion, water and soil contamination, etc. [24], [38].

The CO is prone to be affected by climate change. Increasing sea level rise might increase coastal flooding, affect dunes and cliffs. Moreover, the intensity of the flooding in the Onkaparinga river is likely to be increased. The climate change report of the CO [5] identifies that Aldinga, Christie Beach and Sellicks beach will be the most affected with the sea level rise by 2070.

Discussion

This study identifies ES and threats/drivers of change at local scale in the CO. This is a prerequisite for implementing EBA. Once ES, spatial scale, and their threats are identified, these can be integrated in current policy framework for decision making. This information will enable the incorporation of ecological knowledge about multiple ecosystem services of the CO into decision making. Quantification and economic valuation of ES would be more useful for policy makers and land managers than qualitative analysis. However, the knowledge gap on the importance of different services across the CO landscape needs to be filled before a good quantification is possible. This study represents the first step.

Ecosystem scale is very important while identifying and classifying ES and taking it into the policy context because generation of ES depends on spatial and temporal variability. The ES providers, beneficiaries and management, all are scale depended [47]. To manage and utilize each benefit of ES, policy makers needs to understand the scale dependency nature of ecosystem because valuation of ES at the global scale are unable to meet the need for the policy context of local scale. Thus, identification and separation of the ES and utilization of their benefits need to be assessed to their corresponding scales [47].

Classification of ES is necessary because it works as useful tool for prioritising and identifying the policy problem in relation to synergies and trade-offs among different ES. Trade-off arises when a single service is increased at the expense of others. Globally, most ecosystems are decreased for increasing the provisioning services and this is true for

the CO. The provisioning service such as agricultural and residential are being enhanced, on the other hand regulating and supporting and cultural services are being decreased in the context of the CO. This assumption is supported by Bennett's [3] result in context of Canadian peri-urban agricultural landscape which is similar to the CO. The expense of services can cause reduction in biodiversity threatening the conservation values area and diminish the possibilities of supplying diversifies economic activities thus ultimately impact on local human well-being.

However, the ES are at the community level and their relationship between tangible and intangible factors are largely synergetic. More synergies can be enhanced by using 'habitat modification techniques'. Sandhu et al. [38] and Gordon et al. [24] in their studies on organic farming in arable lands, demonstrates that floral and mulch supplementation resources in viticulture, can extensively increase regulating land supporting services, such as, pest control, soil nutrients, better pollination, honey extraction as well as biodiversity.

There are many biodiversity conservation rules and regulations that do exist in the local, regional and national level. The EBA encourages providing incentives and benefits in maintaining biodiversity and practices for conservation to the community which are widely practiced in different countries in New Zealand for wetland management, in EU countries for forest and agricultural conservation, even in Australia in the form of 'payment for ecosystem'. However, present conservation activities in CO scarcely contribute to the welfare of people living in the protected area like Aldinga scrub or maintaining water quality of Onkaparinga River or protecting indigenous trees in homestead level, apart from those who are involved in the tourism sectors and farmers. There are scarce incentives for local population to maintain an adequate level of management of these landscapes.

The CO is experiencing massive infrastructural development and state government and local government both are investing in those infrastructures. But such kind of investment requires assessing not the stocks and flows of ES but also their dynamic and variability [43]. This information can then be used to make decisions about natural assets in the CO for better management and protection using the EBA.

In the Table 2, the paper tries to incorporate all types of ecosystem goods and services generated by the CO. Identification of ES in any level of governance is particularly difficult because ES processes and assets are not linked with any particular category, they are critically linked and generally across all categories. Decision making becomes difficult when it needs to be considered the complex process in one hand and demand and values, on the other hand which requires scientific, technical, quantitative and qualitative analysis. However, this study provides a generalized classification on the basis of practical experiences. This essay can be useful starting point for future investigation. A proper database of ES can create opportunity for more cost effective analysis that greatly enhance more balanced decision making [16] regarding sustainable use and allocation of natural resources.

Conclusion

The CO is a cultural land and hot spot of biodiversity [40] and provides different ES. Despite their ecological and social recognition, these landscapes are currently under risk of degradation and loss mainly due to disappearance of the management activities on which their survival depends. The land scapes have historically provided range of ES to the society but these ES are being changed due to population increase, high development activities, agricultural expansion and climate change.

The framework on ES approach is used in this study to identify ES demand and supply at the local governance level which is useful tool to identify and describe the ES provided by the landscape and the main threats and drivers that conflict regarding ecosystem demand. This information allows incorporating the ecological knowledge about multiple ES in decision making.

References

1. Barbier E.D., Hacker D.S., Kennedy C., Koch W.E., Siter A., and Silman R.B., 2011, The value of estuarine and coastal ecosystem services, *Ecological Monographs*, 81(2), 169-193.
2. Bateman J.I., Harwood A.R., Mace G.M., Watson R.T., Abson D.J., Andrews B., Binner A., Crow A., Day H.B., Dugdale S., Fezzi C.,Foden J. and Hadley D., 2013, Bringing ecosystem services into economic decision making: land use in the United Kingdom, *Science*, 341, 45-50.
3. Bennett E.M., Peterson G.D. and Gordon L.J., 2009, Understanding relationships among multiple ecosystem services, Ecology *Letters*, 12, 1344-1404.
4. BoydJ. and Banzhaf S., 2007, What is ecosystems services? The need for environmental accounting, *Ecological Economics*, 63, 616- 626.
5. Caton B., Climate change impact in the coastal areas, The city of Onkaparinga, 2007,Available:http//:*www.onkaparinga.sa.gov.au/.../impact_of_climate_change_report.pdf* r (May 25, 2013).
6. Chan K.M.A., Shaw M.R., Cameron D.R., Underwood E.C., and Daily G.C., 2006, Conservation planning for ecosystem services, *Plos Biology*, 4(11 e 379), Available:http//: www. plosbiology.org (April 26, 2013).
7. Costanza R., 2008, Ecosystem services: multiple classification systems are needed, *Biological Conservation*, 4, 350- 352.
8. Costanza R., d'Arge R., deGroot R., Farber S., Grasso M., Hannon B., Limburg K., Naeem S., O'Neil R.V., Paruelo J., Raskin R.G., Sutton P. and van den Belt M., 1997, The value of the world's ecosystem services and natural capital, *Nature*, 387, 253-260.
9. City of Onkaparinga,Native Vegetation: native vegetation strategy 2010-14,Available: http//:www.onkaparingacity.com/custom/files/docs/draft_native_vegetation_strategy_20102014pdf (May 22, 2013)
10. City of Onkaparinga, Community Initiative in the city of Onkaparinga 2008-2028, 2007,Available:http//:www.*onkaparingacity.com/custom/files/docs/community_plan_2028.pdf* (May 22, 2013)
11. City of Onkaparinga, Development plan of the city of Onkaparinga,2008, Available: http//:*www.onkaparingacity.com/.../planning...plan/development_plan_review....*

    (May 22, 2013)

12. City of Onkaparinga, Sustainable wine making, 2013, Available: http//:www.mclarenvale.info/sustainable-winegrowing/overview (September 12, 2013)
13. Cooter E.J., Rea A., Bruins R., Schwede D. and Dennis R., 2012, The role of the atmosphere in the provision of ecosystem services, *Science of the Total Environment*, 1-12
14. Daily G.C., 1997,"Nature's Services: Societal Dependence on Natural Ecosystems", Inland Press, Washington DC
15. Daily G.C., Polaski S., Goldstein J., Kareiva P.M., Mooney H.A., Pejchar L., Ricketts T.H., Salzman J. andShallenberger R., 2009, Ecosystem services in decision making:time to deliver, *Frontiers Ecological Environment*, 7, 21-28
16. De Groot R., Brander L., Ploeg S.V.D., Costanza R., Bernard F., Braat L., Christie M., Crossman, Ghermand A., Hein L., Hussain S., Kumar P., Mcvittie A., Portela R., Rodriguez C.L., Brink P.T. and Beukering P.V., 2012, Global estimates of the value of ecosystems and their services in monetary units, *Ecosystem Services*, 1, 50-61.
17. De Groot R., Wilson M.A., and Boumans R.M.J., 2002, A typology for the classification, description and valuation of ecosystem functions, goods and services, *Ecological Economics*, 41, 393-408.
18. Farley J., and Costanza R., 2010, Payment for ecosystem services; from local to global, *Ecological Economics*, 69, 2060-20.
19. *EU, 'Mapping and assessment of ecosystem and related services, technical report, European Union Commission, 2013.*

    *Available:*http//:www.*ec.europa.eu/ecosystem_assessment/pdf/MAESWorkingPaper2013.pd* (September 10, 2014).
20. Fukuyama F., 2001, Social capital, civil society and development,*Third World Quarterly*, 11(1), 7-20.
21. Fish R.D., 2011, Environmental decision making and an ecosystems approach: some challenges from the perspective of social science, *Progress in Physical Geography*, 35(5), 671- 680.
22. Fisher B., Turner R.K. and Morling P., 2009, Defining and classifying ecosystem services for decision making, ,*Ecological Economics*, 68(3), 643-653.
23. Fisher B. and Turner R.K., 2008, Ecosystem services: classification for valuation, *Biology Conservation*, 141(5), 1167-1179.
24. Gordon O.S., Jacometh M., Tomkins J. and Wratten., 2013, Viticulture can be modified to provide multicultural ecosystem services, in Wratten et al. (ed) "Ecosystem services in Agricultural land and urban landscapes" , Wiley-Blackwell, UK, p. 45-55.
25. Hancock J., 2010, The case for an ecosystem service approach to decision making: an overview, *Science Horizons*, 3(2), 188-196.
26. Hauck J., Gorg C., Varjopuro R., Ratamaki O. and Jax K., 2013, Benefits and limitations of the ecosystem services concept in in environmental policy and decision making: some stakeholder perspectives',*Environmental Science and Policy,25*, 13-21.
27. Hein I., van Koppen K., de Groot R.S. and van Ierland E. C., 2006, Spatial scales , stakeholder and the valuation of ecosystem services, *Ecological Economics*, 57, 209-228.
28. Hussain T.A.M. andTschirhart J., 2013, Economic/ ecological trade-offs among ecosystems services and biodiversity conservation, *Ecological Economics*, 93, 116-129.
29. KavalP. and Baskaran R., 2013, Key ideas and concepts from economic for understanding the roles and value of ecosystem services, in Wratten et al. (ed) "Ecosystem services in Agricultural land and urban landscapes", Wiley-Blackwell, UK, p.28-42.
30. Linn R., 1991,"Cradle of adversity; a history of the Wuilllunga District", National Library of Australia.

31. Max Neef., Elizaldaand Hopenhayn M., 1991, Development and human needs, in Max- Neef M (ed.) "Human scale development: conception, application and further reflections", The Apex Press, New York.
32. MEA., 2005, "Ecosystem and Human well-being: synthesis" Millennium ecosystem services, Washington *DC.*
33. Ordonez M.A., BugterR., Seoane S.S., de Luis E. and Calvo E., 2013, Temporal changes in socio-ecological systems and their impact on ecosystem services at different governance scale: a case of Heathlands, *Ecosystems*, 16, 756-782.
34. Plieninger T., Ferranto S., Huntsinger L., Kelly M. and GetzC., 2012, Appreciation, Use and management of biodiversity and ecosystem services in California's working landscape, Environmental Management, 50, 427-440.
35. Putnam R., 1995, Bowling alone: America's declining social capital, *Journal of democracy*, 6(1), 65-78.
36. Sandhu H. Forthcoming, 'Ecosystem services valuation framework and economic impact of alternative forest management under different climate scenarios' unpublished report, School of Environment, Flinders University, Australia.
37. Sandhu H., Wrattten S.D., Cullen R. and Costanza R., 2013, "Ecosystem services in Agricultural land and urban landscapes", Wiley-Blackwell, UK.
38. Sandhu H., Wratten S.D. and Cullen R., 2010, Organic agriculture and ecosystem service, Environmental Science and Policy, 13(1), 1-7.
39. Santich B., 1998, "McLaren vale: sea and vine", Wakefield Press, South Australia.
40. Stuart R.E., 2005,A problem of settlement: the continuing evolution of a cultural landscape: cultural landscape change on the Willunga Plains from 1840, Unpublished B Arch. Research report, Department of Archaeology, Flinders University of South Australia.
41. TEEB., The economics of ecosystems and biodiversity for national and international policy makers, 2010 TEEB (online), Available: http///;www.teebweb.org(May 22, 2013).
42. Turner K.R., and Daily G.C., 2008,The ecosystem services framework and natural capital conservation,*Environmental Resource Economics*, 39, 25-35.
43. UK NEA., UK National Ecosystem assessment: synthesis of the key findings, UNEP-WCMC, 2011, Cambridge (online), Available: http///:www.uknea-wcmc.org/Resources/tabid/82/Default.aspx(March10, 2013).
44. UNEP, Ecosystems and human well-being: a framework for assessment, Available: http//: www.unep.org/maweb/documents/document.300.aspx.pdf (May 22, 2013).
45. Wallace K.J., 2007, Classification of ecosystem services:problems and solutions, *Biology Conservation*, 139, 235- 346.
46. Washington H.,2012, "Human dependence on natur*e",* Routledge, UK
47. Whitten S.M. and Coggan A., 2013, Market based instruments and Ecosystem services, cities' in Wratten et al. (ed.) "Ecosystem services in Agricultural land and urban landscapes" , Wiley-Blackwell, UK pp. 178-196.
48. Zhang Y., Holzapel, C. and Yuan, X., 2013, Scale dependent ecosystem services, in Wratten et al. (ed.) "Ecosystem services in Agricultural land and urban landscapes", Wiley-Blackwell, UK pp. 107-118.