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An assessment of the feasible application of environmental valuation methods on Rand Water open-space

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Abstract

Rand Water has contracted University of South Africa (UNISA) to develop a monetary valuation method for its open spaces and its inherent ecological functions. This article begins by reviewing existing contemporary definitions for open space in South Africa and then identifies the key characteristics thereof. Open Spaces in the Gauteng urban environment is in a crisis and factors such as open space coverage standards, sale of open space, crime and the impact of the apartheid legacy are briefly examined. Rand Water's open space contributes to the total open space stock of Gauteng province. Any shortage of open space and threats to the sustainable management and expansion of the open space network of the province therefore has a direct bearing on how Rand Water views and manages its open space resources.

Environmental resource economics provides economists and environmentalists with various instruments to place a monetary value on the environment. The available valuation instruments are briefly reviewed and questionnaires are developed from this to determine whether it can be applied by Rand Water staff to obtain values at a minimal cost, in a short space of time, and whether it assesses the various use and non-use values.

Keywords: Open Space, environmental valuation, environmental resource economics, use value, non-use value, consumptive use value, non-consumptive use value, indirect use value, existence value, option value, production function approach, restoration cost method, replacement cost method, travel cost method, hedonic pricing method, contingent valuation method, damage cost avoided method, defensive expenditure method, Rand Water

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Abstrak

Rand Water het die Universiteit van Suid-Afrika (UNISA) ingekontraheer om 'n waarderingmetode te ontwikkel vir sy oopruimtes en inherente ekologiese funksies. Hierdie artikel begin dus met 'n oorsig van huidige kontemporêre definisies van oop ruimtes in Suid-Afrika en identifiseer dan die hoof eienskappe daarvan. Oopruimtes in die Gauteng stedelike omgewing is in 'n krisis en faktore soos oopruimte dekkingstandaarde, verkoop van oopruimtes, misdaad, en die impak van die apartheid nalatingskap word kortweg ondersoek. Rand Water se oopruimtes dra by tot die totale oopruimte voorraad van die Gauteng Provinsie. Enige tekort van oop ruimtes en bedreigings tot die volhoubare bestuur en uitbreiding van die oopruimte netwerk van die provinsie het dus 'n direkte uitwerking op hoe Rand Water sy oopruimte bates beskou en bestuur.

Omgewings-hulpbronekonomie voorsien ekonome en omgewingskundiges met verskeie instrumente om 'n ekonomiese waarde van die omgewing te bepaal. Die beskikbare waarderinginstrumente word kortliks ondersoek en vraelyste is ooreenkomstig ontwikkel om te bepaal of Rand Water personeel dit kan toepas teen minimale koste, oor 'n kort tydperk, en of die metodes die verskillende gebruiks- en nie-gebruiks waardes kan bepaal.

Slutelwoorde: Omgewings-hulpbronekonomie, oopruimtes, ekologiese funksies, omgewings-valuasie, omgewings-valuasie metode, omgewings waarde, produksiefunksie benadering, skade-onkostevermeidingsmetode, restourasiekosstemetode, vervangingskosstemetode, reiskostemetode, hedoniese-prysbepalingsmetode, kontingente-valuasietemete

1. Background

Rand Water is similar to other government utilities in being under pressure to provide goods and services at an affordable rate and of regulated quality. This means that there is a constant review of operational costs with reference to its core functions as an efficiency exercise. Rand Water owns several portions of land as part of its estates portfolio and is responsible for their management and maintenance. The question may therefore be asked whether these open spaces perform a function of any economic value that can be aligned with or complement Rand Water's core business. If these open spaces are not providing value, it would not be strategically sensible to retain them as non-performing assets. However, if the economic value of these open spaces could be clearly defined, this would enable objective decisions to be made that would more likely be in favour of its retention.

Rand Water has therefore contracted UNISA, through tender, to develop a valuation method for its private open space network. This article aims to review existing environmental valuation methods to establish the most suitable methods within the Rand Water context. The article briefly addresses current definitions of open space and the challenges faced by open spaces, and explore the possible interventions that environmental resource economics or the

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property valuation profession can provide. The article aims to establish a valuation methodology that can be applied to estimate the value of open spaces and ecosystems.

The Rand Water context and its terms of reference for this article will form the basis of selecting and developing suitable valuation methods.

The context of Rand Water and its open spaces may be delineated as follows:

- Rand Water's open space network is to a certain degree accessible and can be used for recreation and leisure use by its own staff.
- Public harvesting of natural resources on these open spaces is very limited and can be accounted for in valuation methods.
- Commercial agriculture, including crop production and grazing, is not practised on the Rand Water open spaces. Some of the open spaces do have agricultural potential and agricultural resource value; however, agricultural resource economics will not form part of this study.
- An estimated 95% of Rand Water's open spaces are located in close proximity to or in view of urban areas, meaning that they could provide a stream of environmental services to these areas, which is an important aspect in valuation studies.

2. Introduction

2.1 Defining open space

It is important to have a good understanding of the term 'open space' and what it encompasses in the context of this article. A review of current local definitions is necessary before any particular definition is adopted.

- Mogale City Urban Open Space Project (Mogale City Local Municipality, 2003):

Any undeveloped vegetated land within and beyond the urban edge, belonging to any of the following six open space categories: ecological, social, institutional, heritage, agricultural and prospective (degraded land).

- Cape MOSS (Chittenden Nicks de Villiers, 2000):

Open space is principally the unbuilt component inside the urban edge that serves a variety of purposes and functions.

- Durban MOSS (Durban Metropolitan Council, 1999):

Two types of open space were identified for the DMOSS:

- Urban open spaces

... the human made or legally designated places and areas within the DMA that are developed for community use. They include parks, sports fields, agricultural fields, streets, town squares, road reserves, servitudes for services such as electricity transmission line, dams, private gardens.

- Natural open spaces

... the remaining undisturbed natural and undeveloped areas within the DMA. They are the areas that contain the core terrestrial, freshwater, estuarine and marine ecosystems. These ecosystems include land cover types such as grasslands, forests, beaches, estuaries, rivers, wetlands.

Instead of drafting a new definition for open space, this article summarises the key characteristics of open space that contextualise it for this environmental valuation study. Open space is therefore regarded as the following:

- Public or private land within or outside the 'urban edge' that is mostly vegetated and may contain water bodies such as rivers, dams, wetlands or estuaries.
- Land that is undeveloped and in a natural state or has been landscaped to function as an aesthetic area and/or recreational facility and/or sporting facility.
- Land that is purposefully and in most cases legally set aside for conservation or zoned as 'open space', 'agricultural' land or 'undetermined'.

These criteria may not be all-encompassing and may not be suitable for all scenarios but nonetheless set a reference framework for this study.

2.2 The open space 'crisis'

Open space in South Africa is increasingly under pressure as urban areas expand in density. While some may feel that open space plays an important role in a developing country such as South Africa, others argue that open space is a luxury in a situation where housing and basic infrastructure provision are high priorities which should take precedence in the context of limited resources. The general

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sentiment among environmentalists and parks managers is that open space is necessary for the long-term sustainability of cities.

The benefits of open spaces have been well researched and include the following in the urban context:

- Open space offers opportunities for active and passive recreation, which in turn reduces destructive and antisocial behaviour, builds family cohesiveness, promotes good psychological and physical well-being, and produces 'upstream' savings in health services owing to increased physical activity through recreation.
- Open space and recreation facilities are significant economic generators as they promote spending on leisure travel, sport and recreation equipment, draw tourism, and act as employment generators.
- Open space is often a place of learning, especially where the natural environment is introduced in an interactive manner, and it enhances people's understanding of their natural environment and environmental issues.
- Open space maintains ecosystems and preserves biodiversity, protects endangered fauna and flora species, and provides ecosystem services such as clean water and air (Naidoo, 2003: 2-11; PricewaterhouseCoopers, 2003: 4).

While most of these benefits appear obvious and necessary for sustainable development, the question has to be asked whether present management practice recognises these benefits.

Most metropolitan and larger local municipalities now have open space planning regimes in place, such as a Metropolitan/Municipal Open Space System (MOSS) and open space framework, which inform planners of the status of open space in terms of size, connectivity, quantity, and relationship with surrounding land uses. These planning instruments have not always been present in South Africa and were mostly initiated through *Local Agenda 21*, after the United Nations Conference on Sustainable Development held in Rio de Janeiro in 1992 (Durban Metropolitan Council, 1999).

South Africa's open space coverage standards have lagged behind international averages in that the old Transvaal province proposed 1.2 Ha per 1000 population, whereas international standards for open space coverage range from 6 to 8 Ha per 1000 (City of Tshwane Metropolitan Municipality, 2005). Depending on the density of an urban population, the international open space

coverage standards translated into approximately 10% of a city in the 1960's (Doell, 1963: 22) while it is presently at 14% according to Harnik (2000). An increase in the open space coverage standards has been evident over the past five decades since Doell (1963: 19) stated that the standard at that time was coverage of 7 acres (2.8 Ha) per 1000 population for American cities, while the current average according to Harnik (2000) is 6.8 Ha per 1000 population. These targets include social and ecological open space. It makes sense to provide social open space on the basis of an area-per-population standard, but the same rule cannot be justified for ecological open space. Ecological open space allocation should be based on criteria such as ecological processes, species diversity, and sensitivity of ecosystem functions, which after a thorough assessment can be expressed in percentage sustainable representation per bioregion.

The World Conservation Union set an international conservation target of 10% in February 1992 at the IVth World Congress on National Parks and Protected Areas in Caracas. It was later realised that such a target would conserve only an estimated 50% of species (GDACE, 2005). The IUCN has therefore set a new target to stop all loss of biodiversity by 2010 in Europe (Göteborg European Council, 2001), which means that each country has to adjust its conservation targets to its specific bioregion characteristics instead of a one-size-fits-all target, to prevent any further biodiversity loss.

The Gauteng Department of Agriculture, Conservation and Environment has set itself conservation targets of more than 30% since less than 1% of Gauteng province, within the urban edge, is currently formally conserved (GDACE, 2005). These targets are set to influence both open space provision in Gauteng province at local government level and privately owned land. Land use applications reviewed through the EIA process will be subject to decision-making tools such as the C-Plan 2 to ensure that conservation targets are reached, with specific reference to ecological open space.

The fact that allocation of open space targets and standards has increased over time means that knowledge about the implications of development impacts and lack of open space provision has increased. There are, however, a number of challenges that need to be considered which are likely to impact on the allocation of open space and its quality in Gauteng province.

The incidence of crime and perceptions around it are influencing people's willingness to use open spaces for recreation. Properties located close to open spaces pay a higher premium on household insurance due to the risk perception. Municipalities have in certain

instances sold off high-risk open spaces where incidents of rape and housebreaking have occurred. This may have been encouraged by community police forums and political pressure. Fencing and controlled access, security lighting and integrated land uses are often viable solutions to crime in parks and need to be explored before the irreversible sale and development of open space is considered.

South Africa's previous government planned and enforced segregated communities, where people of colour were disadvantaged in the provision of basic services. The provision of open space in these old affected townships was also inadequate and was generally characterised by sparsely allocated small park stands within dense residential developments. South African local government is now challenged to provide sufficient open spaces for these communities.

One may ask how these problems relate to the Rand Water case. Rand Water's open space contributes to the total open space stock of Gauteng province. Any shortage of open space and threats to the sustainable management and expansion of the open space network of the province therefore has a direct bearing on how Rand Water views and manages its open space resources. This context will also assist with the valuing of the Rand Water open space stock.

2.3 Environmental resource economics as management intervention

Sustainability is both an ecological and an economic problem. In the early eighties it was realised that for science to make any progress with regard to the understanding of sustainable development, an integrated and interdisciplinary approach would be needed (Perman, Ma, McGilvray & Common, 2003: 8). Economists realised that economic development and welfare were dependent on the availability of resources and the ability of the environment to sustain human existence. Environmentalists realised that poverty, as the absence of welfare, was an environmentally destructive socio-economic problem that could to some extent be addressed with economic instruments (Dasgupta, 1997: 18).

Environmental resource economics developed, with these realisations, as an economics discipline. This is evident in that the majority of research work in this field is performed by economists. It was within this economics frame of reference that it was recognised that environmental resources were abused and neglected because market systems failed to attach appropriate values to them. This market

failure was a result of poorly defined property rights such as clean air (if nobody owns it, everybody can abuse it), failure to cost external effects or consequences of development on the environment, and failure to recognise environmental services and goods as an input in production (Perman, *et al.*, 2003: 124-126).

The realisation that markets had failed to attach a value to a resource or an external effect led to the development of valuation instruments. The fact that these resources had no price did not mean that they had no value. Perman *et al.* (2003: 11) argue that if well-being is affected by the presence or absence of a resource, then it must have a value, whether positive or negative.

The environmental valuation techniques have not been without controversy, as questions of ethics, validity and accuracy often emerge in the literature. Gen (2004: xviii) poses the question whether utilitarian ethics should be allowed to influence environmental policy. Non-economists reason that decisions about the future of environmental resources should not be based on monetary values, as attached values would only reflect society's current understanding of their importance. A case in point is the severe destruction of wetlands over the past century; only recently has their importance been realised. Such valuations may therefore discount the expectation of future growth in knowledge relevant to the implications of development (Perman *et al.*, 2003: 402). This brings to the fore the importance of the precautionary principle when evaluating environmental resources, and the fact that decisions about their future should be based on a suite of factors and not just monetary value alone.

In a recent study done to determine the value of grasslands in South Africa, De Witt & Blignaut (2006: 4) state that environmental valuation is not an elementary calculation that will produce stable, absolute values that can be traded off against development. They argue that economic valuation is not an absolute science but is rather reductionist and overlooks the value of a system in its totality.

The economic component of environmental considerations remains an important factor, despite the shortcomings in the environmental valuation studies. Sub-section 2(4)(i) of the South African National Environmental Management Act (NEMA), Act 107 of 1998 states as follows: "The social, economic and environmental impacts of activities, including disadvantages and benefits, must be considered, assessed and evaluated, and decisions must be appropriate in the light of such consideration and assessment."

It should be realised that environmental valuation is a fairly new and rapidly expanding field (Perman *et al.*, 2003: 399). The identification of many of the shortcomings in the methods has resulted in improvement and refinement. The results obtained from valuation studies are used as a guide to inform decisions and can be a valuable educational tool to inform decision makers about the 'value' of the natural environment. Decisions about the future of open spaces and ecosystems should not be based solely on the results of a valuation but should consider social, economic and environmental factors as given in the national environmental management principles of NEMA.

3. Total economic value

It is necessary to understand the various values that comprise the total economic value of an open space and its ecosystem functions before the methods that value them are discussed. Figure 1 gives a breakdown of the various values associated with open spaces.

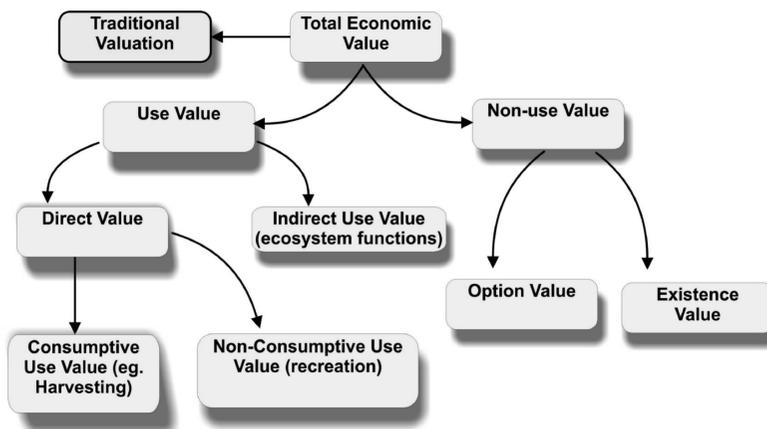


Figure 1: Conventional classification of the values of environmental amenities
Source: Turpie Joubert Van Zyl Harding & Leiman 2001: 11

Ecosystems and open spaces differ from each other in terms of size, quality and types of ecological services and functions. Not all the various values associated with open space are applicable to each and every open space or environmental resource. In some cases the value may be of such insignificance that it is not feasible to perform a valuation on it. The valuer needs to use his or her own discretion when evaluating an open space to determine which values are relevant.

3.1 Traditional valuation

Municipalities are occasionally faced with the decision to sell open space. This may be because a developer has approached such municipality and indicated his or her willingness to purchase. The municipality's response to such an offer will depend on the policies, strategies and by-laws in place relating to open space management. A property valuation is required in the event that a municipality decides to sell open space. A property valuer, who is normally a municipal official, performs a valuation. Factors such as availability of services, accessibility, improvements on the property, zoning and size, and regional sales data are used to obtain a value. This results in an often very low monetary valuation for the open space in relation to, say, residential or business property. The traditional property valuation method does not consider value-adding factors such as the flow of environmental services including water purification, climate amelioration, nutrient cycling, carbon sequestration and biodiversity sustenance, and therefore overlooks potentially value adding benefits.

The purchaser would in most cases transform the open space and would not be willing to pay for 'benefits' lost to society. If the benefits that open spaces provide to the larger community were factored into its price, then it is most likely that no sale would be concluded and the open space would be preserved for the community who benefits from its services. Such an approach would also warrant that the purchaser pay for the loss of these services provided to a community, where a sale is approved and proceeds, or alternatively that the cost of the loss be compensated for in the price.

Fortunately the development or transformation of open spaces is a listed activity (activity number 20) in terms of sections 24 and 24 D of the South African National Environmental Management Act, Act 107 of 1998. The sale and development of open space will be more difficult with these regulations in place.

Unfortunately professional property valuers are not trained to recognise environmental goods and services in the holistic value of a property. Research and development into open space valuation therefore presents an opportunity for the integration of environmental valuation methods in the property valuation profession, which will certainly give more recognition to the importance of environmental goods and services.

3.2 Use values

3.2.1 Consumptive use value

This value is obtained from the economic benefits associated with the direct harvesting of goods from an open space. This may include a wide variety of goods such as building material, food, flowers and medicinal plants (Turpie *et al.*, 2001: 12). This value is not constant as it is affected by the market value of the harvested goods and the ability of the open space to supply the goods in a sustainable stream. This method is mostly applied to renewable resources or biotic populations that can regenerate, such as fauna and flora. Goods such as minerals are non-renewable and harvesting them is not a desirable or sustainable practice in open spaces and is for the purpose of this study excluded. Harvesting of minerals in open spaces is in most cases an illegal activity prohibited by municipal by-laws. The value of mineral stock in an open space would only be considered during a cost benefit analysis where mining is considered as an alternative use.

If the sustainability threshold is exceeded, then the volume of goods and flow of services supplied declines and subsequently their value. It is therefore important to ensure that the consumptive use value is not based on volumes that are not sustainably harvested, which would give inflated values at first but would be likely to depreciate over a short space of time. Sustainable harvesting, however, gives realistic values which appreciate in time provided the market demand remains constant. The question the valuer should ask is whether the level of current use is affecting future availability. The resource can be used indefinitely if harvest is equal to or less than the natural reproduction rate, and if the ecological systems that support reproduction are preserved (Perman *et al.*, 2003: 18).

Consumptive use value is applicable only where goods are legally harvested, such as communal land where harvesting rights are granted. A nature reserve will most often not permit harvesting, and a consumptive use value will not be applicable. The production function method is used to gauge consumptive use value (see section 4.1.1).

3.2.2 Non-consumptive use value

Non-consumptive use value implies, as the name suggests, that the value is obtained from the use of an open space that does not involve harvesting or collecting any goods (Turpie *et al.*, 2001:

12). Activities such as recreational use and tourism add value to an open space as people are willing to spend money to use such recreation opportunities. People spend money on travelling costs to get to these open spaces, food and beverages and sometimes accommodation. If not well managed, non-consumptive use can have a negative impact on the use value. An example is the value of a wilderness area, which lies in the perceived absence of people and the sense of exclusivity, for which people are willing to pay a premium (Perman *et al.*, 2003: 127). Such an area would not be a great escape if it were crowded and noisy. Overuse could also directly impact on the quality of the facility through abuse of the amenity infrastructure, trampling of pathways, and unmanageable littering. Such overuse would result in a depreciation of the open space's non-consumptive use value. This value is also often reflected in nearby property prices and is alternatively referred to as hedonic value or pricing (see section 4.2.2).

3.2.3 Indirect use value

Indirect use value is the economic benefits that urban society obtains from the ecological services and functions that open spaces provide (Turpie *et al.*, 2001). These functions may include those shown in Table 1.

Table 1: Some environmental services and functions that open spaces may provide

• Water supply and purification	• Climate amelioration
• Sound and nuisance control	• Flood and erosion control
• Carbon sequestration	• Soil formation and nutrient cycling
• Pollination	• Refuges for biodiversity

Source: Adapted from Turpie *et al.* 2001: 12

The challenge in obtaining a value for these ecological services is that they are communal and free from market influences. There are, however, indirect methods which can be used to determine a value for ecological services. A change in the quality of an environmental service, such as increased air pollution, reduces property values of the affected area, while improvement results in an appreciation of the property values. These changes can be measured to value the change.

The cost of replacing an ecological service with an artificial substitute can also be used as a proxy to infer a value for it. A wetland has

water purification and storm-water retention properties which can be mimicked by engineering infrastructure such as water purification plants and storm-water retention systems. The cost of developing infrastructure to treat and manage the same quantity of water as the wetland would serve as the value indicator (see section 4.1.2).

3.3 Non-use values: Option and existence values

Option value refers to the value that people place on reserving the option to use a resource in the future (Turpie *et al.*, 2001: 12). This optional use value could be either a use or a non-use value. This is normally expressed as a person's or community's willingness to pay to guarantee the availability of the open space for future use (Perman *et al.*, 2003: 402). There is also the quasi-option value which is expressed as a person's willingness to pay to avoid the irreversible loss of an open space or ecological service, considering the risk that the advancement of knowledge could in future prove that such loss had been catastrophic and ill-informed (Perman *et al.*, 2003: 402). An example would be the relative ignorance 50 years ago concerning the implications of wetland destruction, which led to the loss of a significant number of wetlands. This has resulted in the adoption of the precautionary principle whenever the holistic impact of a particular action is unknown. This could alternatively be expressed as a person's willingness to pay to avoid unknown risks. With option and quasi-option use value there is no certainty or there is incomplete knowledge about the future conditions of an open space or ecological service (Perman *et al.*, 2003: 402).

The comfortable knowledge of the existence of a resource can be referred to as existence value. Contribution to the conservation of far-off places such as rain forests or paleontological important sites could be measured to determine this value. This value, however, need not be applicable to far-off resources only, as willingness to pay for the conservation of any resource could be interpreted as existence value. Unlike option and quasi-option value, there is complete certainty with existence value about the future conditions of an open space and ecological services (Perman *et al.*, 2003: 402).

A farm portion with unique landscape and biodiversity features in close proximity to urban development can have the option to be developed as a residential township or to be preserved as a protected nature reserve. The value attached to the property will remain an option value until it is formally protected, where after it will assume an existence value. Once it is legally protected, alternative options are restricted by legislation.

4. Valuation methods

Methods employed in previous studies for the valuation of open spaces and ecosystems are the same methods generally applied to value environmental resources. These methods can be broadly categorised into three categories, namely market value approaches, surrogate market approaches and simulated market approaches (Turpie *et al.*, 2001: 16).

Market value approaches use market-related pricing of goods and services used to establish a value, for example based on the net value of harvested cut flowers. The market value approach may apply to use and non-use values. There may for example be an option on a particular portion of land to harvest wild flowers and this 'option value' can be determined by using a market value approach based on the market value of the wild flowers in question.

Surrogate market approaches, also referred to as revealed preference approaches examine the economic trends in a particular situation and how an environmental resource influences these trends. A well-maintained and attractive open space will positively influence property values, which are then translated into a net benefit or premium and ultimately expressed as a value. In contrast, a poorly maintained open space will adversely affect property values and could be seen as a cost to the property market for not maintaining such open space in good order.

Simulated market approaches use surveys or questionnaires to obtain the perceived value or 'willingness to pay' for a service or amenity or to conserve a particular area. Mean values are then calculated from these surveys and multiplied by the number of affected households to obtain a value. This method is also valuable to test user responses to hypothetical scenarios such as the possible sale of park land or the impact of maintenance standards and crime on usage and ultimately value.

4.1 Market value approaches

4.1.1 Production function approach

This method is used to determine the net annual value of goods and services produced by an open space or ecosystem. It therefore values the consumptive use of open space goods.

The annual use value = $Q \times (P-C)$, where Q is the quantity of goods produced, P is the market price at which the goods are sold, and C

is the cost of harvesting, processing, transporting and marketing the goods. A net present value of the open space is then obtained by converting the annual use value (annual use = $Q \times (P-C)$) into a rand value per hectare (R/Ha). Therefore, if the total annual use value of an open space is say R350,000 from flower harvesting and the property measures 10Ha, then the net present value would be R35,000 per Ha (Turpie *et al.*, 2001: 17).

This valuation method may not be often applied in the valuation of open spaces since the harvesting of fauna and flora is prohibited by most municipal by-laws, except for fishing in certain locations. It would be unethical to attach a use value to an open space based on products which have been illegally obtained. It would be the same as to say that the Kruger National Park is worth x based on the street value of its elephant tusks and rhino horns, while it is illegal to trade in these bio-products. Numerous indigenous plant species are under threat due to unscrupulous harvesting for medicinal use. This valuation method could become valuable if the free-for-all situation could be changed into a sustainable harvesting programme that is monitored.

The market value approach is also used to value agricultural or forestry land in support of normal property valuation techniques and this is where the method originated.

4.1.2 Restoration cost or replacement cost method

This method is usually used to value ecosystem functions and departs from the hypothesis that the value of the ecosystem is equal to its replacement cost or restoration cost. The replacement cost refers to the replacement of ecosystem functions with artificial structures and systems that will replicate the ecosystem function, such as water purification and retention (Turpie *et al.*, 2001: 18). However, not all ecosystems can realistically be replaced or replicated by artificial structures and systems, making its use rather limited. An approach with the replacement cost method for wetlands would be to obtain engineering costs for the construction of water purification plants per mega-litre treating capacity and to use the total water treatment output of the wetland over a certain time period to obtain a value for the ecological function

Use of the restoration cost method could be based on a hypothetical scenario postulating that the environmental service has been lost or damaged and needs to be restored through rehabilitation practice, which is difficult to calculate. The restoration cost method

is often used in lawsuits to determine actual damage caused by illegal activities or negligence, or to determine the negative environmental economic implications of a current production method.

The restoration cost method could employ landscape development costs including earthworks, irrigation, soft and hard landscape materials, and design and project management costs as proxy for value of developed open spaces. The application of the restoration cost method in valuing natural areas is far more complicated, as the restoration of sensitive environments to their original status, for example fynbos vegetation, wetlands or Bankenveld, is extremely difficult if not impossible at present. A number of species cannot be commercially cultivated and re-established in an area for example the common Sugarbush tree or *Protea caffra*. The restoration cost method would therefore be difficult to apply as the costs of complete restoration are unknown. It would therefore be advisable that the cost to restore an area as close as possible to its original status be used so that natural systems can continue with the restoration process. One could then attempt to value the 'benefits lost over time' where there is no alternative to an incomplete restoration. This could include the loss of benefits over time up to the estimated point of complete restoration. Lost benefits could include reduced levels of bio-diversity, reduced visitation rates and reduced efficiency in water and air purification. The lost benefits approach would most likely employ methods such as damage cost avoided, and replacement cost methods to form a multi-tier valuation approach with the restoration cost method.

4.1.3 Damage costs avoided

Wetlands play an important role in flood attenuation due to their good water retention capacity. The absence of wetlands increases the risk of flash floods and resultant flooding of adjacent properties. It is possible, with the assistance of hydrologists for instance, to delineate the areas along a water course that would be affected by floods if no wetland were present. The possible damages, linked to a probability analysis, are then calculated based on the value of affected infrastructure within the demarcated flood zone. Such probable damage cost or reparation cost is then assumed as the measure of value (Turpie *et al.*, 2001: 18).

The damage cost avoided method is normally used to argue for the retention of certain ecosystems and their beneficial functions that support human settlements.

4.1.4 Defensive expenditure method

The defensive expenditure method uses the cost of preventing damage opposed to the cost of repairing damage as a proxy for value (Turpie *et al.*, 2001: 18). The control of alien invaders, for instance on agricultural land, ensures that the land remains productive and economically active. The cost of removing invaders and regular follow-up programmes to minimise re-growth is for example compared to the net benefits of the programme such as increased water resource availability and bio-diversity preservation. If the programme's economic benefits outweigh the input costs then it has a positive value. This method is often used in Cost Benefit Analysis. The maintenance of coastal wetlands and estuaries has also proven effective in controlling the force of tidal waves and storms to prevent damage to infrastructure, and this damage avoidance cost or defensive expenditure is used as proxy for value (Turpie *et al.*, 2001: 18).

4.2 Surrogate market / Revealed preference approaches

4.2.1 Travel cost method

The travel cost method is primarily used to value recreational and tourism attractions that are visited frequently. Data obtained from this method can be helpful to determine what visitors would be willing to pay as an entrance fee, based on the visitors' consumer surplus. The method therefore values non-consumptive use of an open space. It is based on the idea that the value visitors place on environmental amenity services is reflected in their willingness to spend money to experience such services (Perman *et al.*, 2003: 411). People spend money on transport to get to the facility, refreshments, time and often entrance fees. These costs are then used as proxy to determine value and therefore reveal spending patterns which are influenced by an attraction such as a park. A substantial amount of data is needed to obtain objective surveys, which include the number of visitors, distance travelled, mode of transport, socio-economic background, time spent at site and value of visitor's time. The travel cost method does entail some limitations and controversies, however, which need to be kept in mind when considering its application:

- One question is whether the opportunity cost of recreational time should be considered at all – in other words, whether the time spent on recreation should be valued against time that could alternatively have been spent on business.

- Visitors to these amenities and attractions often do not travel specifically to visit such locations but their journey forms part of a number of visits to multiple locations. This makes the travel cost method somewhat more complex to use. The apportionment of travel costs to each trip is not feasible, and the responses of respondents who visited more than the study area during the survey should be removed from the survey.
- Other visitors that live close-by may have travelled by foot or bicycle, which requires more extensive questionnaires to determine the value placed on the amenity by visitors. These values have probably been captured in adjacent properties, and the hedonic pricing method is then needed to determine this. If hedonic pricing is also used on the same environmental resource, then visitors from surveyed properties should be excluded from the TCM survey to avoid overestimation (Turpie *et al.*, 2001: 19; Perman *et al.*, 2003: 415-417)

4.2.2 Hedonic pricing

Property prices are often positively affected by the presence of green open spaces, lakes and areas with attractive natural scenery. The hedonic pricing method calculates the value added to private property due to the presence of an open space and uses this value to determine the total value of an open space. This calculation is based on the estimated increase in property value (often given by estate agents and sales data) due to the presence of an open space. The estimated increase is then averaged and multiplied by the number of the relevant properties (Van Zyl, Leiman & Jansen, 2004: 16-18).

As an example, a park positively influences approximately 420 property values by 8%. The mean property value for the area is R1,000,000 per property. A premium of approximately R80,000 per property is calculated and multiplied by 420 properties, which gives a total value of R33,600,000.

This method is, however, difficult to apply in areas where there is a limited market for properties, such as informal housing and other low income areas, or in rural areas where open space is more abundant and less of a value-adding factor.

4.3 Simulated market/ Stated preference approaches: The contingent valuation method (CVM)

This method tests people's willingness to pay (WTP) for the use or presence of an open space or their willingness to accept compensation (WTA) for the loss of an open space. It is sometimes referred to as a stated preference method, whereas methods such as the TCM and hedonic valuation methods are revealed preference methods (Perman *et al.*, 2003: 420). It is called contingent valuation because the valuation is contingent on a hypothetical scenario put to respondents (Perman *et al.*, 2003: 420). This is normally determined through interviews and using open-ended questions, referendums, dichotomous choices (yes or no), bidding games, trade-off games, ranking techniques, costless choice options or the priority evaluator technique (Turpie *et al.*, 2001: 20). The survey is also dependent on socio-economic data to construct a demand curve for net social values (Perman *et al.*, 2003: 424).

The survey questionnaire should present, by way of a programme or policy, ways to improve or protect an environmental asset from a clearly defined environmental impact. Respondents are then asked about their WTP for such a programme or policy. The payment vehicle is normally presented as some sort of tax payment and the respondent 'votes' either for or against it. This form of survey is sometimes named a 'referendum model' (Perman *et al.*, 2003: 424). The respondent's WTP is tested by offering a choice of amounts that he or she would be willing to pay. The respondent then responds with a yes or no answer (dichotomous choice format). It is also important that the survey make provision for respondents to indicate that where the stated amounts are not within their WTP or where they are objecting to the payment vehicle, their 'no' vote is correctly interpreted.

This method is subject to several biases that make its application controversial and subject to criticism. Some of biases are the following:

- Strategic biases whereby respondents believe they could influence decisions by over- or underestimating willingness to pay
- Embedded biases whereby respondents do not give realistic answers in relation to their current financial constraints, budgets and needs

- Interviewer bias, information bias, starting-point bias and hypothetical bias, which can influence the respondent's answers and subsequently the results of the survey

The biases can be largely eliminated if the survey design is done correctly and tested before implementation.

In a CVM survey, the median is normally used to calculate total WTP as it is less affected by outliers. The total WTP is the median figure times the size of the relevant population.

The method bases its findings on hypothetical questions instead of observed, actual, behaviour (Perman *et al.*, 2003: 420). It is also very costly and time-consuming to execute as it requires several interviewers, detailed and tested site-specific surveys, data enumerators and statisticians. The method is also criticised for having been developed solely for First World economies, with the assumption of generally well-educated respondents and its subsequent (perceived) irrelevance in Third World applications. If the survey is not well designed it can produce insensitivities in terms of price and scope. Price insensitivity relates to WTP which statistically appears not to be influenced by the income levels of respondents, and scope sensitivity relates to statistical insensitivity to differing conservation targets hypothetically presented to respondents (Perman *et al.*, 2003: 427,429). An example of price insensitivity is where respondents' WTP does not appear to be influenced by their household income, where in practice it should. An example of scope insensitivity is where respondents' WTP does not change where different conservation targets are presented, e.g. 1000 Ha, 2000 Ha or 5000 Ha set aside for conservation, where in practice there should be a correlation.

Past experience has shown that respondents generally protest against WTA, as they refuse to accept any compensation for stated loss of a public good, and they would rather pay for its preservation, hence the predominant use of WTP (Perman *et al.*, 2003: 429). Socio-economic factors, education levels and moral values differ in Third World countries, however, and these respondents may be more inclined to WTA than WTP.

Respondents may also deny responsibility for conservation and generally vote 'no' for any WTP as they believe it to be a function of the state, for which they are already taxed. They may also feel that environmental problems should be the responsibility of those who caused them, or that those who stand to benefit the most from an environmental improvement should pay for it. The CVM assumes that the respondent has some sort of responsibility towards the environment

and therefore asks WTP questions. This may, however, not always be legally and constitutionally enforceable, especially with site-specific problems. The survey design needs to explore these dynamics and this should include briefing the respondent on his or her obligations, if any. It may be that a respondent has no obligation to the problem but would feel morally obliged to make a contribution (Perman *et al.*, 2003: 431-432).

CVM offers the benefit of valuing both use and non-use values, while the other instruments available can value only use-value. CVM has also been granted admissible by USA courts, the *Exxon Valdez* oil spill case being particularly well known (Perman *et al.*, 2003: 434).

5. Which environmental values need to be assessed?

Environmental amenities may not always have all the values represented. It is therefore important to determine which values are applicable and then which valuation method is most appropriate to determine the value. It may also be true that a particular value is not prominent enough to justify its valuation, considering factors such as budget and time restrictions.

The types of values were discussed in sections 3.1 to 3.3.

Table 2: Environmental values and suitable methods used to determine valuation

Type of value	Valuation Methods						
	Production function	Restoration and replacement	Damage cost	Defensive expenditure	Travel cost	Hedonic pricing	Contingent
Consumptive use	√√	√	√	√	√	√	√√
Non-consumptive use	√	√	√	√	√√	√√	√√
Indirect use	X	√√	√√	√√	X	√√	√
Option and existence value	x	x	x	x	x	x	√√

Source: Adapted from Turpie *et al.* 2001: 15

6. Application of the environmental valuation techniques

6.1 Production function approach

The production function approach, as stated earlier in section 4.1.1, simply entails calculating the annual use value = $Q \times (P-C)$, where Q is the quantity of goods produced, P is the market price at which the goods are sold, and C is the cost of harvesting, processing, transporting and marketing the goods. A net present value of the open space is then obtained by converting the annual use value into a rand value per hectare.

This method requires the following data:

- 6.1.1 The size of the environmental amenity in Ha
- 6.1.2 The products harvested
- 6.1.3 The quantity of products harvested over time
- 6.1.4 The market value or price of the products
- 6.1.5 The cost of harvesting the products.

6.2 Restoration and replacement cost

Before any costing is done, it is necessary to assess the environmental service that is provided in terms of the following:

- 6.2.1 The types of services provided (i.e. water purification, erosion control)
- 6.2.2 How the services are provided (water retention through wetland vegetation)
- 6.2.3 To whom they are provided (residential area x)
- 6.2.4 The measured levels at which the services are provided (2 megalitres per day).

The second step is to identify the least expensive alternative means of providing the identified service or services to the designated area. The third step is to determine the cost of the alternative means of providing the service or services. Finally it is necessary to determine whether the public would be willing to accept the substitute or replacement service in place of the ecosystem service (King & Mazzotta, 2006: 1).

6.3 Damage cost avoided

The initial step of the damage cost avoided method also requires a thorough assessment of the services provided, as described in 6.2.1 to 6.2.4.

The second step is to estimate the potential physical damage to property, either annually or over a realistic time period. The final step is to calculate either the rand value of potential property damage, or the amount that people spend to prevent such damage (King & Mazzotta, 2006: 1).

6.4 Defensive expenditure method

This method is simply the costing of existing programmes aimed at sustaining the integrity of an environmental service.

6.5 Travel cost method

Zonal boundaries are drawn up with each zone representing an average distance from the environmental amenity. AA tariffs or SARS tariffs can be used based on vehicle capacity to determine cost per kilometre. The travel cost per kilometre is multiplied by the distance travelled to give a total travel cost per respondent.

The analyst then estimates a demand curve by determining the relationship between visitation rate and travel costs per zone. The statistical or functional form of the demand curve is chosen on the basis of best fit and applied to the data. This could either be linear, semilog or loglinear (Turpie *et al.*, 2001: 48). The demand curve explains the change in visitation numbers as the cost of travelling in relation to distance increases or decreases. Price is therefore a dependent variable. Factors such as income level may to a lesser degree also be a dependent variable, and factors such as race may be statistically independent of the visitation rates.

Consumer surplus is then calculated for visitors from each zone. Consumer surplus is the difference between the market price of a commodity, say R1,00, and what an individual is prepared to pay, say R3,00, with a resulting surplus of R2,00. In the TCM application, consumer surplus simply means the difference between what the person has paid in travel cost to visit the amenity and the cut-off point where no more visits are likely. This cut off point is where it simply becomes too expensive to travel to the amenity. The surplus is therefore the additional travelling cost (distance, time and mode of transport cost) a visitor is willing to pay to visit the amenity up to the point of resistance. The consumer surplus is a handy indicator where

access fees are under consideration. Say for instance a game reserve needs to increase entrance fees, but does not wish to do so to the extent that visitation numbers will be severely compromised. The consumer surplus will then in such a case give a good indication up to what point entrance fees can be increased where it will simply become too expensive to visit such reserve.

The consumer surplus for each zone is then summed to give the total recreational use value.

6.6 Hedonic pricing (calculation of influence of environmental amenities on property prices)

This method is dependent on sales data of properties in the survey area or, if this is not available, on the input of experienced estate agents or property valuers.

Sales data is used to determine the premium, if any, on property values due to close proximity to an attractive environmental amenity. Some of the benefits that properties get from such close proximity are easy access to recreational opportunities, scenic views, and sometimes serenity. These benefits contribute to property demand and the subsequent rise in values.

The average price of properties located in the area but not directly next to or close to the environmental amenity is calculated using sales data or inputs from estate agents. The premium (or discount) is then calculated for properties located next to or in close proximity to the environmental amenity by comparing their sales data with the average of the area. Supposing the average for the area is R1,000,000 per property, and the average value of properties that seem to benefit from proximity to the environmental amenity is R1,150,000, then the average premium is 15%.

The influence of the environmental amenity on property value is the total premium multiplied by the total number of properties.

Table 3: Property price increase due to proximity to environmental amenity

Number of affected properties	Average value of affected properties	Total value of affected properties	Premium	Value due to environmental amenity
31	R1 150 000	R36 650 000	15%	R4 650 000

Source: Adapted from Van Zyl *et al.* 2004: 18

6.7 Contingent valuation method

CVM elicits people's WTP for an environmental programme in a constructed hypothetical scenario. It therefore requires the development of a questionnaire.

The following describes a scenario and presents an example of a CVM questionnaire based on it. This questionnaire must be done one-on-one with the respondent by trained interviewers.

The Mogale City Local Municipality and private individuals own land towards the west of the Walter Sisulu Botanical Gardens. It has been realised that this land contains unique biodiversity and geological features worthy of conservation. However, the land is under development pressure and these unique features may be lost if no intervention takes place. This land also forms part of the hunting ground of the Botanical Gardens' resident pair of Black Eagles. The Municipality, in partnership with the South African National Biodiversity Institute, wishes to purchase the remaining portions of land worthy of conservation but is in need of a one-off dedicated tax contribution to make possible the purchasing of land, erection of game fencing and launch of conservation programmes. The purpose of this questionnaire is for you to vote on your willingness to contribute and the amount you wish to contribute. It is important to note that the tax contribution is voluntary and will exclusively be applied for the purposes stated above.

The median total WTP is then calculated and multiplied by the total relevant population. This will present the economic value of the environmental amenity.

7. Selection of the appropriate valuation methods for Rand Water open space

Each of the valuation methods has its specific area of application and is somewhat limited in wider applications. Some of the methods are outright unsuitable for application at Rand Water and were eliminated from the onset based on consensus by the research project team.

The production function approach was eliminated as there are limited opportunities for harvesting of natural goods from Rand Water's open spaces. Rand Water's infrastructure is listed as National Key Points with resultant high security and access control levels. This inaccessibility limits harvesting and therefore the feasible application of the production function approach. The presence or not of harvestable goods is irrelevant because of this factor.

Limited accessibility also affects the application of the Travel Cost Method as well as the Contingent Valuation Methods as both methods are mostly applied where there are accessible environmental and recreational services and infrastructure. Both methods also rely on high user numbers to obtain representative interviewees, which is also unlikely in the Rand Water case. Contingent Valuation methods use taxes as a payment vehicle to determine WTP. Rand Water cannot implement taxes in any form as it is not a statutory revenue collector. Rand Water's recreation facilities are mostly used by its employees who often stay in close proximity to these facilities. This will result in insignificant travel costs when applying the Travel Cost Method.

As part of the participatory action research approach, a meeting was held on 22 November 2006 where selected Rand Water employees were asked to assist with the selection of appropriate valuation methods for the Government entity's open spaces. Participants were given an overview presentation on the values associated with open space and the methods used to value it. The participants were also offered an opportunity to perform the Replacement Cost Method on an open space located at the Rand Water Estates Nursery, for them to be familiarised with the application of the methods.

Some of the general conditions needed for the successful application of the methods were converted into a questionnaire that would enable the selection of the most appropriate methods. Within the context of Rand Water's open space, respondents reviewed these criteria and answered Yes, Maybe/sometimes or No. One point have been allocated for a Yes answer, 0.5 points for a Maybe/sometimes answer and 0 points for a No answer. The results for each answer are summed, then divided by the number of questions for each method and percentage suitability is then allocated. Twelve respondents completed the questionnaire.

The results of these questionnaires are presented as follows:

7.1 Replacement Cost Method

General condition or criteria to be met	Choose an appropriate answer and mark with X		
	Yes	Maybe / Sometimes	No
Is there an environmental service such as water purification nutrient cycling carbon sequestration and water storage and storm water attenuation?	12	0	0

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Can this environmental service be readily quantified? i.e. volumes of water purified volumes of carbon sequestrated volumes of water stored metric volume of soil preserved.	6	4	2
Can this environmental service be replaced or replicated with engineering infrastructure such as a water purification plant to purify water or storm water infrastructure to manage surface water runoff?	6	5	1
Are there costing guidelines available for such engineering infrastructure? i.e. Professional Institutes Project Costing Guidelines.	6	3	3

The replacement cost method received a rated suitability of 74% based on the assessed results. Rand Water has a number of wetland areas within its open space stock and this method is particularly suitable for use on wetlands and waterways, which is perhaps the reason for its reasonably high suitability score.

7.2 Restoration Cost Method

General condition or criteria to be met	Choose an appropriate answer and mark with X		
	Yes	Maybe / Sometimes	No
Can this open space park or ecosystem function be restored to its original state or as close to its original state as possible if it is hypothetically lost by either pollution or illegal development?	8	3	1
Can the status of the environmental service be determined prior to the impact? i.e. species diversity ecosystem functions etc. In other words are there records of the ecosystem functions park infrastructure and bio-diversity of all Rand Water open spaces?	5	4	3
Are there costing guidelines available for such restoration/ rehabilitation work? i.e. landscape contractor costs plant material and/or specialist studies.	10	1	1

The restoration cost method is relatively easy to apply and is perhaps closer to what horticulturists and estate managers may apply in their work environments, as it is essentially based on project costing. This method was also applied in a practical session prior to the completion of this questionnaire that may have contributed to the relatively high suitability rating of 75%.

7.3 Damage Cost Avoided

General condition or criteria to be met	Choose an appropriate answer and mark with X		
	Yes	Maybe / Sometimes	No
Is there any property infrastructure natural resource or quality of life (health) that will suffer measurable and likely damage if the environmental service discontinues? <i>i.e.</i> Deterioration of water quality on health and tourism value increase in peak storm water volumes that causes flooding air quality reduction impacting on health.	10	1	1
Can the probability of such damage be determined?	9	3	0
Can the extent of such probable damage be quantified?	4	7	1

A suitability rating of 79% indicates that it is evident that respondents feel that the Rand Water open spaces and ecological services perform an important damage avoidance function. One has to view Rand Water open spaces in relation to its core function, which is to provide water, and how these open spaces and their inherent ecological services contribute to the protection and maintenance of this key infrastructure. The many wetlands and open spaces also act as a buffer between Rand Water operations and surrounding land uses. The absence of these buffers may also increase the risk of probable damage should there be floods or infrastructure failure.

7.4 Defensive Expenditure Method

General condition or criteria to be met	Choose an appropriate answer and mark with X		
	Yes	Maybe / Sometimes	No
Are there any proactive measures to sustain the ability of an environmental resource to prevent any damage? <i>i.e.</i> An alien invader eradication programme to avoid erosion and sustenance of agricultural potential or estuary maintenance to avoid storm damage or fire control?	12	0	0
Is the cost of such proactive measures available?	7	3	2

Respondents all agreed that there were programmes in place to maintain the integrity of Rand Water's open spaces, its environmental services and its operations. Rand Water supports eradication programmes as part of the 'Work for Water' programme which aims to

reduce alien plant invaders from water catchment and river areas. Such programmes can be valued against the cost or consequences of not controlling such plants within the context of South Africa as a water scarce country. The 'Water Wise' gardening campaign of Rand Water can also be valued using the same method. A suitability rating of 85% was calculated.

7.5 Hedonic Pricing

General condition or criteria to be met	Choose an appropriate answer and mark with X		
	Yes	Maybe / Sometimes	No
Are there any properties in close proximity to the environmental resource that may benefit from it in terms of view serenity recreation and leisure activities?	9	2	1
Is the environmental resource in question relatively unique and in relative short supply? In other words is there a demand for such environmental resource in the survey area to the extent that it influences property values?	4	7	1
Are the properties that may be benefiting from such environmental resource relatively tradable on the open market and in relative demand?	1	9	2
Are there any sales statistics that can be analysed or property valuers or experienced estate agents that can be interviewed regarding the affected properties?	5	4	3

The Hedonic Pricing method only achieved a suitability rating of 50%. Although most respondents agreed that there were properties in close proximity to environmental resources that may benefit from them, it was clear however that they may not necessarily affect property values. The reason for this is evident in the questionnaire results where benefiting properties are mostly those located within Rand Water's Estates, which being staff housing and workplaces is not tradable on the open market. This method may therefore only be suitable where surrounding private properties are benefiting from the Rand Water open space in terms of a view or benefit from its non-consumptive and indirect use values.

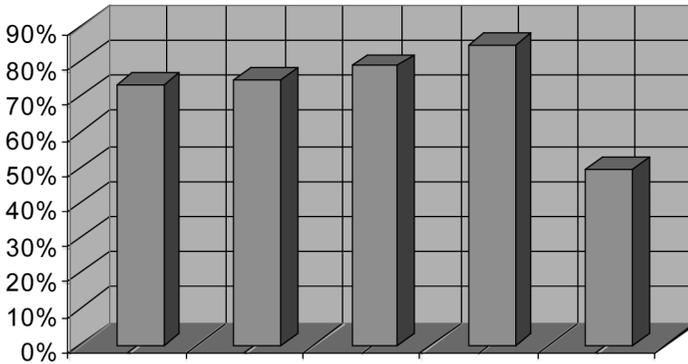


Figure 2: Percentage suitability rating for the application of valuation methods on Rand Water's open space

8. Conclusion

Open spaces and their inherent environmental services play an important role in the urban environment. There are however numerous challenges in achieving an equilibrium between sufficient open space allocation and urban development. Among these challenges is the need to densify cities in the wake of urbanisation and urgent housing needs, crime in parks, ignorance about the implications of development on sensitive environments, and restrictive budget allocations for parks management functions.

The nature of these challenges rather favours a reduction in the number and extent of park coverage, considering its economic argument that open spaces are not generators of income. Open space allocation is after all not a core municipal service. The question is then asked whether there is economic sense in providing open spaces within the urban environment.

Rand Water is asking the same questions about its open space network. Is there an economic case for keeping and maintaining these open spaces considering that this government entity's core function is to provide water? How do these open spaces and their environmental services complement the operations of Rand Water and contribute to its work, environmental, social and legal environment?

The recent three decades have seen the development of environmental valuation techniques under the wing of environmental

resource economics. Economists have realised that there has been market failures in that the economic benefits of the environment is not accounted for in economies. This effective discounting of the environment has led to abuse and a skewed favour towards development, at the expense of sustainability. These valuation methods have been developed to assist economists, and to a lesser degree environmentalists, in determining the economic value of the stream of benefits offered by the environment. Economists realised that the economy is operating within the environment and is reliant thereon, as a destroyed environment cannot support life, without which there is no economy.

This paradigm sets the stage for the assessment of the feasible application of environmental valuation techniques within the Rand Water context. Different methods are employed to value different environmental services and not all methods are therefore applicable in each scenario. Rand Water's open spaces are set within a unique environment characterised by limited accessibility. This excludability factor has a significant impact on the application of a number of valuation methods which relies on vast numbers of respondents to obtain efficient data. The Travel Cost Method as well as the Contingent Valuation Method acquires its data through questionnaires from a wide range of interested and affected parties, which are largely absent from Rand Water open space. The Hedonic pricing method is reliant on sales data of tradable private property which may benefit from its proximity to an open space or its environmental services. Although there are private properties that may benefit from Rand Water open space, this is fairly limited. The majority of residential areas that are benefiting directly from these parks and open spaces are owned by Rand Water and provided for its employees. These properties are therefore not tradable on the open market and sales data is non-existent. The application of the Hedonic Pricing Method is therefore limited.

The exclusion of these methods means that the values these methods have been designed to determine (non-consumptive use, option and existence values) are excluded as well. The total economic value may therefore not be attainable with the limited suite of methods available. There is therefore a need to develop specific methods that will fill this gap to ensure that valuations reflect the total economic value of the Rand Water open spaces. The standard suite of available methods is also limited in valuing the impact of the environment on human health, productivity and behaviour. Available methods also offer limited scope in valuing carbon sequestration, and there is vast scope for further research in this field.

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