Environmental offsets and other market approaches with specific reference to the Olifants River (East) and Berg River

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Abstract

Biodiversity offsets for a river create the incentive for cooperation amongst stakeholders with benefits to the environment. Because of the isolation paradox supporting institutions need to be created to facilitate cooperation. Environmental pollution caused by mining activity is a problem in the Olifants River (East) in South Africa. The catchment surface is fractured by mining activities and water is drained into underground aquifers, after which it seeps into streams. Mines have been permitted to release nutrients in the streams during periods of high flow, which is called the "controlled release scheme". A main problem is the effluent leakage from old disused mines during times when river flow is low and not sufficient dilution of nutrients is possible. DWAF (Department of Water Affairs and Forestry) has accepted ownership of these mines but they may not have the technology (which is expensive) to desalinate the effluent. In an offsetting arrangement, incentives can be provided to existing mines to desalinate water from these defunct mines by allowing them to discharge a given amount in the Olifants when the water flow is sufficiently high. The above arrangement will cost the taxpayer nothing while discharge during low flow periods is reduced. A discussion was held with stakeholders of the Olifants River Forum during 2006 and support was received for some of these policy options. It is shown how offsets can mitigate negative effects of dam construction. It is further proposed that tradable pollution permits be adopted which are subject to a rule that discharges in the river are only allowed when flow is sufficiently high and that trades may only occur within certain parameters.

Keywords: environmental offsets; pollution permits; Olifants River (East)

1. Introduction

Pollution in South African rivers is a concern and this issue has been a national news item in recent times. In spite of its importance it is not always clear how it should be tackled. In this contribution the emphasis is on market approaches and the involvement of stakeholders. Some aspects of environmental pollution will be studied in the Olifants River (East), with a view to suggest policy options and brief comments will be made about the Berg River in the Western

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Cape. The Olifants River rises to the east of Johannesburg and flows north-east through the provinces of Mpumalanga and Limpopo into Mozambique. Approximately 3.4 million people live in the Olifants River Catchment and a considerable proportion of South Africa's mining, power generation and agricultural activities are concentrated here (McCartney *et al*., 2004). The catchment also encompasses important tourist destinations (such as the Kruger National Park). It is estimated that activities within the Olifants River Water Management Area (WMA) generate 6% of the GDP of South Africa.

The urban population in the Berg River WMA is estimated at 3.5 million. About 12% of the GDP of South Africa originates from the Berg WMA. The fruit farming sector in the Western Cape is highly labour intensive and provides livelihoods to many. Pollution problems in the Berg River are less severe than two years ago, but if it is not brought under control, South Africa's fruit and vegetable exports to the EU and USA would be at risk (Myburgh, 2007).

The Loskop Dam in the Olifants River Catchment is the centre of the coal mining and power generation industries (Eskom) in South Africa. These industries generate saline effluent, part of which is discharged into the river system. According to Van Stryp (2006) pollution is bad while several mining operations are currently technically breaking the law due to the Department of Water Affairs and Forestry's (DWAF's) lack of capacity to enforce quality standards (Lodewijks, 2006). Water quality deteriorates if the level of Loskop Dam falls and with lower flow in the river the dilution capacity of the system is compromised. According to Coetzee (2006) the main problem in the Loskop Dam is the effluent leak from old disused mines.

Mines act as a collector of groundwater. The catchment surface is fractured from mining, runoff decreases and water is drained into underground aquifers, and then seeps into streams (Lodewijks, 2006). The Klein Olifants River is an example of pollution by contaminated underground water that originates from mines. Mines pollute water due to the reaction of water with minerals. During the wet period in 1995/6 many mines filled up with water, and started spilling. Desalination plants had to be built because coalmines need to get rid of this water. The quality of the water originating from coalmines is a critical factor (Lodewijks, 2006) while mines near Witbank are accused of polluting the underground water (Pretorius, 2006).

Water quality affects agricultural crops such as tobacco and citrus negatively in the Loskop area (Pretorius, 2006). This has a negative impact on export of

some agricultural products that are chemically tested. Prinsloo (2006) also considers algae a problem in this area as filters are clogged.

2. Economic theoretical considerations

It is suggested in this contribution that economic measures may be used to complement the Controlled Release Scheme of DWAF. Two economic policies are suggested, namely transferable pollution permits and environmental offsets. Transferable pollution permits are a well known mechanism but the problem is that the pollution market in catchments differs from the traditional pollution markets and that rules and safeguards need to be adopted. DWAF so far had concerns with transferable pollution permits but it will be shown that these concerns can be incorporated in the rules of the program. Environmental offsets are also well known in wetland conservation but so far this is a relatively unknown tool in river management. As these techniques are suggested in the recommendations, some theoretical considerations are given.

2.1 A separate instrument is needed for each policy goal

Young and McColl (2005) adopt the Tinberger Principle namely that a separate instrument be used for each policy goal. While a market in water trades promotes efficiency in water use it is not designed to improve other bio-diversity objectives such as water quality. Specific approaches will be discussed to reduce pollution or promote bio-diversity in the spirit of this Principle.

2.2 The isolation paradox explains the need for institutions in off-set arrangements

In order to justify the creation of institutions to deal with biodiversity problems it is important to understand why institutions are needed. Economists have traditionally diagnosed environmental problems as market failures. The markets do not transmit appropriate incentives needed to achieve efficiency. Some have called for government to tax or regulate externalities. Others have argued that allocative inefficiency is caused by incomplete property rights and therefore privatization is the appropriate policy response. The latter group contend that government failure is more pervasive. The merits of these approaches will not be debated here.

The insistence on individual action or none at all can leave every one isolated and ineffective (Randall & Taylor, 2000). This class of issues are called isolation paradoxes. Some economists contend that the law has evolved over time to deal with the isolation paradox problem without government

interference (Pasour, 1990). Examples are downstream fishermen in England formed an association and have taken upstream polluters to task while class action court cases in the USA are common in environmental pollution. For instance citizens of LA have claimed compensation from air polluters in a class action court case. No single citizen in LA may have enough funds to take the polluter(s) to court and even if the person has the funds he/she does not have the incentive as others will free ride on the outcome.

American law therefore created the institution of class action cases through which many victims can enlist and take offenders to court. This example also explains the scale effect that a large amount of money is involved. The cost to upgrade a river may be significant as it may do little good to only improve a small section of the river. A river can only be upgraded if a considerable number of independent land owners can be encouraged to cooperate with each other and with public land agencies. For many kinds of ecosystems (wetlands and rivers), protection of biodiversity requires large areas of contiguous habitat. This is the classic isolation paradox (Randall & Taylor, 2000).

The creation of bio-diversity offsets for a river creates the incentive for cooperation amongst stakeholders which may be mines, developers, environmental groups, farmers and public land agencies. Supporting institutions need to be created to facilitate cooperation. Situations are often unique but it is proposed that opportunities for enhancing the environment be sought through a partnership between government and stakeholders.

3. Some market related policies which may impact on the environment in catchments

3.1 Water trades and the environment

Water trading may have benefits for the environment for instance trades from upstream to downstream improve stream flow. That is a person upstream sells his water rights and stops irrigation. Both the quality and quantity of water are important for bio-diversity. Both these dimensions may improve with trade as the farmer upstream stops applying fertiliser while the greater stream flow has a dilution effect. Trades in the opposite direction will have a negative effect on the environment and are not approved in the Western USA and South Africa should follow the same approach. All the water trades so far observed in South Africa are from up to down stream (Boegoeberg to Kakamas along the Orange River and from above the gorge to below the gorge along the Crocodile River) but as these trades were from non-users (non irrigators who own water use entitlement) to users (farmers near the river

without sufficient water) there was no environmental impact. At present (2008), there is opposition to trade of non-exercised user rights in the Berg River and Crocodile River. When trade takes place between users (irrigators) in future the positive environmental impacts will be as discussed above. There are salination problems in the Lower Berg River and some suggested that trading from down to up in this river should be considered.

Although trading may have environmental impacts as discussed, water trading promotes efficiency in water use and does not have a specific environmental objective. Negative impacts on the environment are avoided by the legal protection of the Reserve in the National Water Act of 1998 and by authorities through licenses.

3.2 Environmental fund

If an environmental fund is established then water in rivers may be purchased for this purpose. Several rivers in South Africa are in deficit (not sufficient water is provided for the Ecological Reserve) at present such as the Crocodile (East) and the Olifants River (East). The Ecological Reserve is protected by law but as these rivers are under stress it is a challenging task to reconcile water demand with available water without reducing water allocated to current users. It has been suggested by Van Niekerk (2006) that a fund be created which can be used to buy out water rights. The fund could be used to influence both the quantity and quality of water. Water rights may be purchased from farmers in areas where irrigation leads to salination (for instance in the Great Fish River) or where water quality is adversely affected by fertilization.

A possible source for such a fund may be tax on water used by farmers and the forestry sector (financed through catchment management charges). The fund could be financed through the selling of "biodiversity credits" on either a national and/or international scale. Politicians and businesses may benefit from a positive attitude to the environment as it may mean votes and also profits for instance the cover of Newsweek (2006) reads, "Going Green How Big Business Learned to Love the Environment".

A lucrative source for funding in South Africa is rural property developers and possibly mines who want to improve their social image. It may be possible if these users of the environment make contributions to such a fund that this gesture will improve their chances when they apply for concessions to expand. Often these developers do not pay for concessions which are worth a significant monetary value and which entail a transfer of wealth from society

to developers. If environmental rents are extracted by developers then these contributions will not be a tax on new investment and not be a disincentive to create jobs. Connor and Young (2003) propose that these contributions be tax deductible (as other donations to worthy causes) in order to provide added incentive to contributors.

If a fund is set up for biodiversity purposes, safeguards need to be put in place that this money is used for biodiversity purposes, and not for other objectives. Preferably the fund should be administered by a non profit organization (De Wit, 2006).

3.3 Transferable pollution permits

The optimum discharge tax is conceptually indicated by the intersection of two functions. The first function shows as more is polluted the marginal cost of damage increases (marginal cost of one additional unit of pollution released). The second function shows that as more pollution is eliminated the marginal cost of elimination increases (marginal cost of one additional unit of pollution controlled) (Lodewijks, 2002). Marginal cost functions are opportunity cost functions which are by definition subjective and not observable. It is thus not possible to calculate an optimum discharge tax using econometric tools to a high degree of accuracy. The optimum discharge tax will also vary along the river as is the case with water prices in different water markets along a river, making estimation of the optimum tax impossible. It is thus suggested that a pollution trading market be created to discover the rent of the pollution permit.

3.4 Wetland offsets can reduce pollution in a river

The concept of wetland offsets will be introduced briefly to show that this arrangement has a scientific foundation and that it could be adopted to provide incentives to stakeholders to reduce pollution in the Olifants River Catchment. A market for bio-diversity credits has developed in 20 states in the USA where wetlands have been constructed by some developers who then sell an offset right to others who want to drain wetlands (Randall & Taylor, 2000).

There are two approaches at the centre of offset management namely ecological proxies (area or habitat function) or the use of economic values of bio-diversity. Bio-diversity has no market value but a technique such as willingness to pay (WTP) has been used to impute a monetary value to such a good. In some instances such as the eradication of alien vegetation it may be easier to attach a monetary value (opportunity cost of the Government doing it).

In South Africa biodiversity offsets have been proposed by the Institute of National Resources (INR) (Dickens, 2006) and in the Western Cape (De Wit, 2006). De Wit (2006) provides guidelines for a framework wherein offsets can be recommended. Bio-diversity offsets do not replace the responsibility to make onsite offsets. Bio-diversity offsets are conservative actions to compensate for the residual unavoidable harm to bio-diversity caused by development projects, so as to ensure no net loss of bio-diversity. For more information on these trading schemes the reader is referred to Randall and Taylor (2000), Bjornlund (2003), De Wit (2006) and Dickens (2006).

In this contribution the concept of biodiversity offsets as applied to wetlands is further explored in streams. In the latter cases the approach was to expand the offset beyond water and to include land in the riparian zone (which also results directly in biodiversity protection). Land and water users who adopt sustainable best management practices should be able to earn biodiversity credits in this way.

Incentives may be provided through markets to stakeholders to improve biodiversity in streams. It is suggested that credits be earned if rivers are upgraded from say a D to an A river. It is up to responsible authorities to decide how many credits can be earned by improving the classification of a river reach. It is envisaged that would be investors in a river banking scheme will propose to upgrade a river. These investors will look at rivers where they can make the biggest improvement for a given outlay. Authorities should also guide investors in terms of rivers where biodiversity is threatened. An off-setting arrangement from river to river may also be considered, whereby users who want to degrade the class in a river have to off-set the degradation by increasing the class of another river by the same magnitude or using a mitigation ratio.

It is further suggested that these credits be convertible to wetland credits. In wetland offsets the currency used to make offsets is the size of land involved (Randall & Taylor, 2000). In a river offset system the water surface area (and riparian zone) that is improved may be considered for trading. The fact that surface area in a river (which may include the riparian zone) is different from the surface area in a wetland will be accounted for by a different exchange rate (conversion factor). A different mitigation ratio may be applied as for wetlands or it may be decided that such a ratio may not be relevant to rivers.

In this contribution the mitigation offset system applied to wetlands is also suggested for rivers while exchange rates (conversion rates) may be used by the responsible authorities in order to link these markets. It will be up to

entrepreneurs to improve the classification of a river or a section in a river. This may involve buying out farmers in a highly sensitive area, improving water quality, improving habitat services, storm water mitigation etc. as prescribed by the relevant authorities. The concept of "no net loss" to biodiversity may thus be applied to biodiversity in wetlands and rivers bringing all together in one market. In the above approach it is assumed that polluters to the stream are fined in accordance with damages and that they do not earn credits from reducing pollution.

It is suggested that current efforts to promote bio-diversity in wetlands be supported by efforts to enhance it in rivers. It should be considered that market approaches used to promote wetland bio-diversity be linked to proposed efforts in rivers.

4. Tradable pollution permits and the Controlled Release Scheme in the Olifants River (East)

The current approach to reduce pollution in the Olifants River is the "Controlled Release Scheme". Markets can also be used to provide incentives to stakeholders to reduce pollution. Various options are available that can be used in a complementary fashion. These will be discussed.

4.1 Controlled release scheme

Presently pollution levels from mines can be brought to the required level by using the assimilative capacity of streams/rivers. A "controlled release scheme" is currently in place that controls the releases of effluent into rivers and dams. During high flow periods, when the assimilative capacity of the system is high, discharges are possible. Golder Africa Associates monitors the discharge scheme. Although this discharge system is the cheaper method, during low river flow sufficient dilution of salts (pollutants) is not possible. If the mines had not put in a desalination plant, they would not have been able to continue with operations as no discharge was possible during the recent period up to 2006 of low flow of the Olifants River (Lodewijks, 2006).

During high stream flow the release of pollutants may not exceed required quality levels but during low flows, assimilative capacity will be too low to absorb pollutants. The challenge of this approach would be the low flow periods that can be of a long duration in South Africa. For instance, during the period 2001 to 2006 it was too dry to release any pollutants into the Olifants Catchment (Lodewijks, 2006). It is an open question whether buying water use entitlements from agriculture and/or transfers from other catchments can be

used to increase the assimilative capacity of streams in dry periods. The cost and availability of sufficient water at the required time may cause such an approach non-viable.

4.2 Discharge taxes

In terms of Chapter 3 of the National Water Act (NWA) No. 36, the water needs for the effective functioning of aquatic ecosystems must be protected. Ecological sustainability refers to water (quantity and quality) required to protect the aquatic ecosystems of the water resources and ensure their sustainability. Waste is defined in terms of Section 1 (1) (xxiii) of the NWA. The calculation of charges will be based on the registered discharge waste load of salinity and phosphorus, as representing the two most widespread water quality problems in South Africa. The salt load will be estimated using electrical conductivity. Phosphorus (as the limiting nutrient for freshwater eutrophication) will be estimated using soluble phosphorus (phosphate) (DWAF, 2006).

DWAF is developing a Waste Discharge Charge System aimed at incentivising polluters to reduce discharge levels. This "polluter pays principle" should become operative in 2008 (Havenga, 2006). This system will distinguish between point and non-point sources. At present, discharges in the Olifants Catchment are not taxed. It is recommended that polluters should pay a discharge tax which must be enforced as they use water from the river in a similar way as abstracting users of water who pay water rates.

4.3 Tradable discharge permits

In a permit discharge-trading market the market price of permits will be determined by the intersection of two marginal cost functions (marginal cost of one additional unit of pollution released and marginal cost of one additional unit of pollution controlled). In a water market the market discovers the optimum price of water and participants in the market face the opportunity cost of this price. It is recommended that the same principle should be followed in discharges of pollution and that the optimum price be discovered in a pollution trading market. If polluters also have to pay a discharge tax then this tax will reduce the market price.

Lodewijks (2002) recommended a discharge permit trading system but the following problems have been raised by DWAF and others at the time (Lodewijks, 2006). Discharges are only possible when river flow is sufficient, while the following must be considered; spatial location of mines relative to

one another, and the river network which will drain the effluent into the dams. DWAF had concerns about trading monopolies and that it may affect small stakeholders negatively.

It is important that DWAF's concerns and other concerns be considered and possibly be incorporated as potential recommended rules of such a trading program. All markets have rules, for instance the Stock Exchange has opening and closing hours. A market for discharge permits will also have rules. As pollutants can only be discharged in rivers during high flow times, it is important that this rule be adopted in a permit-trading program.

Another rule in a permit-trading program may be that trade may only take place within well-defined reaches of the river. A water market has similar constraints to minimise externalities. In a water market, trade can only take place from up stream to down stream while in a pollution permit trading program, trade should go the other way as down stream trade increases the concentration of the pollutant at a down stream point.

The Olifants River Forum Stakeholder Workshop near Witbank was attended during 2006 (for list of stakeholders see Olifants River Forum, 2006). Gunter (2006), one of the representatives of the mines who participated, indicated that mines are definitely interested in tradable discharge permits but thought that it may not be possible in future to obtain them from DWAF. The alternative of building desalination plants is expensive. The cost of the plant near Witbank visited is about R300 million (US$ 42 million) (Gunter, 2006). Not all this cost is fixed as the reservoir where the pollutants solidify, fill up after 15 years after which time a new site must be established and the old one is thus abandoned. Variable costs can be saved using discharges and the mines prefer this method.

The rule that discharge is only permitted during high flow is also adopted in the Hunter River Salinity Trading Program in Australia (HRSTS, undated). Reason for the adoption of the Australian program is because of conflict between primary producers (livestock and irrigation farmers) and mining. Credits in the Australian program are initially allocated free to license holders based on environmental performance. Two hundred credits are auctioned every two years to replace those retired. New credits have a lifespan of 10 years and a total of 1000 credits are permitted. Auction proceeds are used to pay scheme operating cost (environmental and compliance monitoring cost). Targets are set at 900 microsiemens/cm but it may vary along reaches. Options for industry are to purchase more credits and/or to implement cleaner technologies.

5. Environmental offsets

5.1 Offsets can provide incentives to reduce pollution in a river

According to Coetzee (2006) the pollution in the Loskop Dam in the Olifants River is serious. He further is of the opinion that the main source is the leakage from abandoned old mines (pre-1956) during low flow periods. DWAF has accepted ownership of these abandoned mines. Before the promulgation of Water Act of 1956 an agreement was reached between DWAF and the Chamber of Mines that the liabilities with respect to water pollution of all mines that had ceased production before 1956 would lie with DWAF (Lodewijks, 2002:36, 37).

In an offsetting arrangement, incentives can be provided to existing mines to desalinate these defunct mines and in return the existing mines could be provided a concession to discharge a given amount in the Olifants River when the water flow is sufficiently high.

The problem with the defunct mines is that they leak pollutants all the time including during the period when river flow is low. The negative environmental impact is reduced with this off-set arrangement as the pollution during low flow periods is reduced and pollutant is discharged when flow is sufficiently high. Lodewijks (2006) supports such an approach. Other offsets may be considered as the researcher can not be prescriptive regarding which offset to use as the arrangement must be attractive to parties concerned (mines and DWAF). The mines have the technology to desalinate polluted water and have already invested hundreds of millions Rand in this. DWAF may not have the technology while a major part of the significant investment is of a fixed nature. The above arrangement will cost the taxpayer nothing and will promote a more desirable outcome.

5.2 Offsets to mitigate negative environmental impacts of dams

The promotion of water markets in South Africa will reduce the pressure on the construction of new dams. However, the demand for increased storable water is great in South Africa due to increased urbanization and demand from the mining sector. For instance, it is estimated that urban demand will double in the Lower Olifants River Catchment during the next decade (McCartney *et al*., 2004). South Africa has a fast growing urban population which is entirely different from countries such as the USA and Australia as well as Europe. Environmentalists in these countries are concerned about the environmental impact of dams.

It appears that in China where urbanisation is also high, dams are being built often over-riding local opposition. This conclusion is drawn from TV coverage of the alleged one million people displaced by the building of the Three Gorges Dam in China and from a personal visit to China. It is suggested if dams are contemplated in South Africa and if impacts are negative in sensitive ecological areas that offsets be considered to mitigate negative environmental impacts. It may be possible to negotiate with the builders of a dam to eradicate alien vegetation over a stretch in the river or to make other offsets in return for waiving opposition to the construction. If offsets are seen to have scientific international foundation then it is possible to strengthen their institutions and to inform stakeholders that such arrangements are possible. If stakeholders are not aware that these offsets are possible then many developments may not take place because of the opposition to such developments.

Several (potential) offsets in rivers in South Africa will be discussed. Two of the offsets are in the Olifants River Catchment (De Hoop Dam and Flag Boshielo Dam), while the agreement between the builders of a dam and environmentalists in KwaZulu-Natal can be seen as an offset arrangement. It appears as if these arrangements have taken place in a voluntary bargaining way between stakeholders.

(a) De Hoop Dam located on the Steelpoort River
The building of a dam in the Steelpoort River namely the De Hoop Dam has been approved subject to a final environmental audit (Havenga, 2006). The Kruger National Park has been opposed to the building of the dam initially. Management in the Kruger National Park now seems more supportive of the project given that the dam may play a role in augmenting flows particularly in dry periods. Gyedu-Ababio (2006) indicated that the Kruger National Park might waive concerns about the building of the De Hoop Dam in the Steelpoort River if the Park gets an allocation (say 5%) of the dam's capacity. This is not an official offer and it is not known whether it is intended as a serious statement but as a potential off-set such an arrangement should be pursued.

(b) Flag Boshielo Dam
Raising of the wall of the Flag Boshielo Dam increases yield by 18 million cubic meters but eight farms were inundated as a result. As part of an off-set the canal infrastructure of Previous Disadvantage Individual (PDI) farmers downstream of the dam is being upgraded as part of the deal.

(c) Newcastle Dam
Wetland offsets have similar ingredients to the offsetting arrangement in the construction of a dam in Newcastle in KwaZulu-Natal. The town of Newcastle in KwaZulu-Natal is building a dam for drinking water. It has been established that 18 ha will be damaged (flooded) by construction of the dam. In exchange for flooding 18 ha of a provincial reserve, the proponent purchased more than 1000 ha of the catchment area and set aside funds to manage the remaining area to control invasive plants. The 1000 ha will be handed over to KZN wildlife for conservation (De Wit, 2006).

(d) Boulder Creek, Colorado
In the Boulder Creek, projects were funded to increase stream flow as it increased the capacity of the stream for ammonia (Randall & Taylor, 2000). One source of the ammonia pollution was livestock and in the offsetting arrangement farmers were paid to fence livestock in the riparian zone.

5.3 Privatising the eradication of alien vegetation and offsets of wetlands

Mines have bio-diversity action plans in the Olifants River Catchment, for instance a wetlands mitigation program is used whereby a previously destroyed wetland can be rehabilitated in exchange for a concession elsewhere (Lodewijks, 2006). Mines intend to eradicate 2500 ha of alien vegetation that will yield 5 million cubic meters of water at a cost of R24.4 million or R4.9 per cubic meter. This appears to be the cheapest (best value) option for harvesting water (Rossouw, 2006). There are other plans to obtain 13 million cubic meters of water from eradicating alien vegetation at a cost of R117 million (Rossouw, 2006). These private ventures should be encouraged as they have positive social spin-offs.

A major environmental problem in rivers is that alien vegetation is a significant consumptive use of water. Alien vegetation is currently been eradicated under the Government's Working for Water (WfW) Programme. Alien vegetation is a major problem for instance in the highly stressed Lower Crocodile it is officially estimated that alien vegetation uses more water than the significant forestry sector in this basin (DWAF, 2004). Currently R50 million is spent annually in this Province for the eradication of this consumptive use which is insufficient (Comrie, 2006). An offsetting arrangement may be considered to provide incentives to private entrepreneurs to undertake this where state funding is clearly inadequate.

6. Water quality in the Berg River and the isolation paradox

Myburgh (2007) states that two years ago pollution levels in the Berg River were five to 24 times the EU's permitted maximum for food production. The key is to stop polluted matter from entering the river. This would necessitate cleaning up river banks, providing better sanitation for informal settlements and controlling the discharge of waste water from municipalities, wineries, intensive farms and industry (Myburgh, 2007). This would require a combined effort from the municipalities, the Province, the Department of Water Affairs and Forestry and industry. Heavy winter rains in 2007 have flushed out the river system giving some breathing space. South Africa's export competitors in the EU and USA have an incentive to cast doubt about the quality of South African fruit exports and it is instructive to bear in mind the massive recalls of Chinese products that failed to meet stringent health standards in their respective export markets. Farmers on the other hand are required to adhere to high quality standards, as rejection is possible for relative minor quality problems.

According to the Regional DWAF Office, part of the reason for this situation is that insufficient funds are made available to local governments to upgrade waste treatment facilities of municipalities. Water quality standards are monitored but DWAF cannot easily institute legal proceedings against another state agency. There is, however, currently a program underway to improve the quality of the Berg River and different role players are involved. There is pressure on municipalities and outcry from politicians. Developers have even promised financial assistance.

The DWAF is currently converting Irrigation Boards to Water Users Associations in catchments in South Africa. There appears no opposition to such a change in the Berg River from leading farmers visited during 2008. This conversion of the Berg River Irrigation Board to a Water User Association will bring in all stakeholders in one body and will assist in dealing with the pollution problems in the Berg River. Such a change is also in the spirit of the Isolation Paradox that supporting institutions need to be created to facilitate cooperation where all stake holders are represented. Role players have voluntary formed an association to deal with problems of common interest as in the Berg River but this may not always be the case and government may insist in providing institutions as in the case of water markets.

7. Concluding comments

Economists have traditionally diagnosed environmental problems as market failures and some have called for government to tax externalities while others have argued that inefficiency is caused by incomplete property rights and therefore privatization is the appropriate policy response. The latter group contend that government failure is more pervasive. The insistence on individual action or none at all can leave every one isolated and ineffective (isolation paradox) and institutions need to be created.

Institutions can be created in off-setting arrangements. Such an offsetting arrangement is discussed that can reduce pollution from abandoned old mines (pre-1956) during low flow periods in the Loskop Dam. In such an offsetting arrangement incentives can be provided to existing mines to desalinate these defunct mines and in return the existing mines could be provided a concession to discharge a given amount in the Olifants River when the water flow is sufficiently high. The problem with the defunct mines is that they leak pollutants all the time including during the period when river flow is low. The negative environmental impact is reduced with this off-set arrangement as the pollution during low flow periods is reduced and pollutant is discharged when flow is sufficiently high. Stakeholders in the Olifants River Forum supported such an approach.

In the USA formal markets have developed with trades (buyers and sellers) in trade-offs in wetlands with conversion rates. In this paper opportunities for specific trade-offs were proposed in a catchment. Trades proposed in this contribution are more site specific and it is not proposed that the good to be traded be converted to a good traded in another area through a conversion rate as in wetlands in the USA. However, innovative trades with conversion factors should be pursued – also in catchments – if they are supported by environmental groups.

If stakeholders are not aware that offsets are possible then many developments may not take place because of the opposition to such developments. The environment is often adversely affected by the building of dams and offsets can be used to mitigate these effects. Several case studies were discussed in this regard in this paper.

A discharge permit trading system was also proposed in the Olifants River. Amongst the rules that must be adopted in such a trading program is that discharges are only possible when river flow is sufficient. All markets are regulated and the concern of DWAF about such programmes could be

included as parameters within which such a programme should operate. The more constraints that are being placed on such a market the less "efficient" it will be so there is a trade-off between protection of some issues and flexibility of the market.

The Tinberger Principle is adopted in this paper namely that a separate instrument be used for each policy goal.

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