

An Assessment of Tradeoffs between Water Productivity and Equity¹

- *Krishna C. Prasad² and Malcolm Watson³*

1. Introduction

The ministerial declaration of the third World Water Forum underscored that “water is a primary pillar of sustainable development, and that, consequently, the efficient and fair management of water resources is essential”⁴. Along the same discourse, the National Water Act of South Africa, 1998 highlights “efficiency” and “equity” as two major cornerstones of the new vision for water resources development and management.

‘Equity’, focusing on the distributional standpoint, is interpreted from two different but complementary dimensions: (a) Accessibility, and (b) Socio-economic returns. ‘Accessibility’, in accordance to the theory of distributive justice, involves entitlement for using water and physical and economic ability of the water users to make productive use of the entitled water resources. The socio-economic return, taking the outcome point of view, relates to the distribution of socio-economic benefits from the water use among stakeholders.

‘Efficiency’ commonly refers to improved acquisition, allocation, distribution, and frugal use of water subsequently contributing to the enhancement of water productivity.

Water is a major input in a water-related production system. Efficiency is closely tied to the value of the water in relation to its maximum potential in combination with other complementing inputs. Equity, on the other hand, depends on how ‘accessibility’ and ‘returns’ from water resources are distributed among various water users. Thus, equity may or may not necessarily help improve efficiency and eventually productivity or vice versa. Accordingly:

- Are there tradeoffs between efficiency and equity?
- What are the water productivity and equity conditions?
- What are the water management options for minimizing such tradeoffs, if any, so that Efficiency and Equity objectives are not compromised?

These are the three main questions this paper attempts to address. Findings are based on empirical research undertaken in the Olifants River basin of South Africa, but may be applicable in other similar situations. Efforts have been made to identify the water management options that promote both equity and productivity.

2. Reviewing ‘equity’

The notion of equity is diverse, complex, and contextual (Bakker 2000, Boelens 1998, Lauderdale 1998, USDC 1994, Young and McColl 2002). Accordingly, several actors often use the concept of equity in their own political struggle, according to their own ideology and interests as backed by their social, economic, and political power. It can be interpreted in any one or all the three different temporal contexts, namely: ‘historical’, ‘contemporary’, and

¹ Paper presented at the 11th SA National Hydrology Symposium, 3-5 September, Port Elizabeth, South Africa. This paper expresses the views of the authors and not those of DWAF or IWMI. Permission to present this paper is gratefully acknowledged.

² Ph. D. Fellow, International Water Management Institute and University of Colorado, USA.

³ Senior Specialist: Systems Analysis. Department of Water Affairs and Forestry, South Africa.

⁴ <http://www.siyassa.org.eg/esiyassa/AHRAM/2003/4/1/ECON1.HTM>

‘successive’ contexts depending upon policy objectives, individual’s preferences, availability of information, perceptions, and comparative advantages.

In South Africa, the objective of redressing past inequities relates to the ‘historical’ context whereby corrective measures are to be taken for the previously disadvantaged. Similarly, the objective of fulfilling water needs of the aspirant users at the desired locations refers to the ‘contemporary’ context. Likewise, maintaining intergenerational equity by making the use of water in a manner that does not offset the same opportunity for the future generations (or loss of resource) relates to ‘successive’ context.

The notion of equity in the context of allocation and use of scarce water resources has varied interpretations and it can be examined from at least four different viewpoints:

- *Equity in Physical and Economic Access to Water Resources*
- *Equity in Distribution of Socio-economic Impacts*
- *Equity in Cost Sharing*
- *Equity in Extent of Water Use*

It is important to mention here that in all of the above-discussed notions of equity, at least four more elements emerge very frequently: the relative positions of women, resource poor, previously disadvantaged, and new users including emerging farmers which are also captured in the various legal and policy documents of South Africa. These documents emphasize the need to look at equity in relation to access to the desired quantity, quality, and reliability of water resources; access to safe and clean drinking water and sanitation services; and access to direct or indirect benefits from water resource use, including cooperation from others.

Despite all the diversity and complexity associated with the notion equity, an attempt has been to assess equity in section 5.

3. Productivity: what does it mean?

Various legislations of South Africa highlight the objectives of ‘efficiency’ and ‘beneficiation’, and provide direction for making various water uses efficient, optimal, socially and economically beneficial to all users, contribute to socio-economic development, and address peoples’ needs without endangering the resource quality and sustainability. Productivity of water generally refers to the total value a water user or a society derives from a consumptive, non-consumptive, or multiple use of water. Non-consumptive use of water enables its successive use provided there are users downstream. This increases its total value every time it is reused. Consumptive water use, on the contrary, lacks this prospect.

Multiple water use signifies a condition where the same amount of water is put to several beneficial uses at the same time or location. Clearly, the total value of a multiple and non-consumptive water use is likely to be higher than a single consumptive use compared to others. The notion of ‘productivity of water’ seeks to capture the total value of water considering all these uses.

How is productivity different than efficiency?

The concept of efficiency is often brought in the discussion of productivity and used interchangeably. In water resources management, efficiency has several objective connotations depending upon specific purposes of the related activities, resource investment, and intended outputs. Efficiency, which invariably is measured against the outputs, can be interpreted in terms of any one of them or in combinations.

Let us say there are three alternative sets of activities, which could lead to three different levels of quantifiable outputs, unit cost⁵, employment generation and employment per unit of output. In comparing relative merits of these three activities against the existing condition, one can assess efficiency in different ways. Four kinds of efficiencies can be calculated using each of these variables and one an aggregated one, product or sum of all efficiencies.

Commonly, four different approaches are considered while assessing efficiency. An additional (derived) approach can be to use combinations of these efficiencies depending upon the variables of interest.

Target-based approach - Under this approach, usually there is an upper limit to the intended or potential output, which is taken as the base to assess the existing condition. It is a typical approach taken in water resources engineering calculations, e.g. designed or potential versus prevailing water acquisition conditions. The targeted/potential and existing conditions are assessed in terms of the same units and hence they must be measurable.

Performance-based approach – This refers to how well the directed activities and resources transform into intended and or potential outputs. The underlying notion is that the more efficient a water system or a related activity is, the more economic benefits (in the form of intended outputs) will accrue from it. The directed resources and activities are assessed against the intended outputs/benefits with little or no consideration to the input side.

Cost-based approach - This approach is commonly used in an economic context. It examines whether similar results could have been achieved by other means, at a lower cost (total, average, or marginal), and in the same time. It is biased toward the input side. The output side is considered very much predetermined and rigid.

Input-output approach - In purely economic terms, it denotes the amount of output compared to input. The higher is the ratio, the more is the efficiency. This concept requires estimating both input and output in same units. Therefore, both inputs and outputs must be measurable.

Depending upon which one of the above approaches one takes to assess efficiency, the interpretations of efficiency may vary. Measurability of benefits is core to the above approaches. However, the water use accrues more than just the tangible and accurately measurable benefits. Further, there can be consumptive, non-consumptive, or multiple uses. The issue of water quality before and after each use is an additional concern. It is difficult to capture all these characteristics by using the concepts in the approaches discussed above. Also, water may be one of many inputs. Though efficient use of water is closely tied to its productivity, and hence to the total social and economic returns, the extent of returns will depend on a combination of other complementing inputs in addition to water. Thus, the concept of efficiency falls short of capturing the total value of water. More accurately, efficiency signifies effective acquisition, allocation, distribution, and frugal use of water subsequently contributing to enhancement of the total value of water or productivity of water.

Water productivity, somewhat differently, intends to signify the total socio-economic returns from the use of water. Water use is measured in terms of the volume whereas the returns are often calculated in terms of benefits (tangible) converted in monetary terms, say Rands per cubic meter of water (discussed later).

⁵ Assuming that the average and marginal costs are the same in this example.

The Olifants Basin is a principal sub-catchment of the Limpopo River. It rises in the north of South Africa (in the province of Mpumalanga) and flows north-east (through Northern Province) into Mozambique (Figure 1). In South Africa, significant mining, industrial and agricultural activities (including intensive irrigation schemes) are concentrated within the catchment, so it is of considerable importance for the country's economy. In compliance with the National Water Act (1998) and National Water Resources Strategy (NWRS), it is planned to establish a Catchment Management Agency to manage the water (DWAF, 2002). This Agency will be responsible for managing water resources to the point where the Olifants River flows into Mozambique. The Letaba River, a major tributary that rises in South Africa but joins the Olifants in Mozambique, will not be included in the Olifants Water Management Area. Accordingly, most studies to date including this one have excluded the Letaba River.



Several available reports exhibit very varying pictures of the existing water use pattern in the Olifants river basin in South Africa. Efforts made here are mainly to illustrate an analysis of equity and productivity and not to validate the water use situation in the basin.

- Water use Authorization and Registration and Management system (WARMS) database, June 2003 (being updated),
- National Water Resources Strategy of South Africa (NWRS), July 2002,
- Olifants CMA proposal, 2002, and
- Water Situation Assessment Model 3.003.

Each of them has varying categorizations of water use as compared to that in the Act (1998) and water use situations depicted by them vary as well. The water use information available from WARMS, though under process of being verified and updated, are based on the information provided by the end-users and has been used here for analysis purpose. The summary of sectoral water use is presented in the chart below.

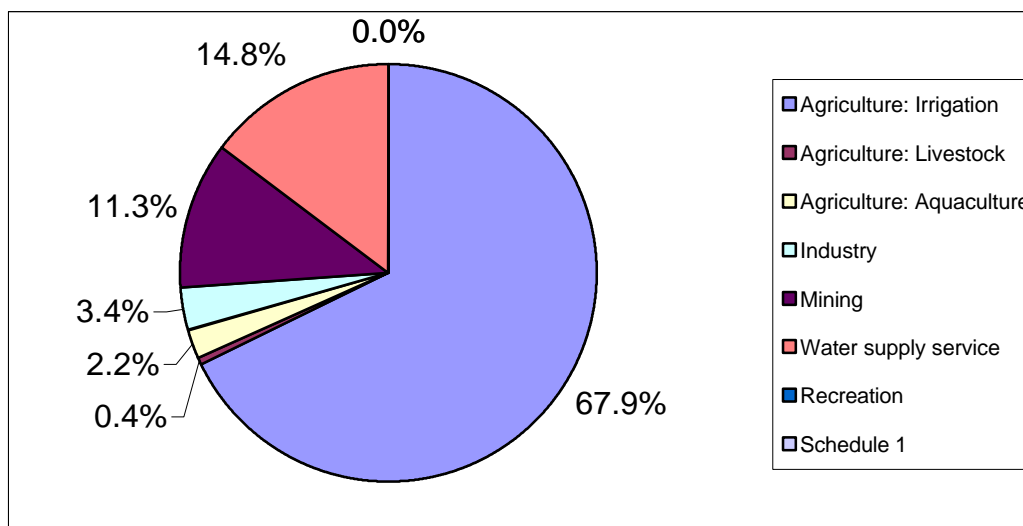


Chart 1: Sectoral Water Use in Olifants (2002)

5. Assessing Equity

As discussed above, the job of assessing equity will depend upon which one of the four viewpoints one takes as well as the availability of information. An appraisal of these alternative approaches follows.

5.1 Measuring Equity in Access to Water Resources

It can be assessed in terms of entitlement to use water (Entitlement) and ability to access the entitlements (Accessibility). The accessibility to entitled water can be facilitated or restricted by at least two factors, i.e. physical infrastructures (Physical Accessibility) and associated financial costs (Affordability) to be able to benefit from the entitlement. Physical accessibility can be in terms of accessibility to drinking water, sanitation, and other productive uses and it depends upon the sufficiency of infrastructure to be able to deliver water to the needed locations. Affordability relates to income and potential economic benefit from the use of water. The indicators helpful for measuring these variables eventually defining equity are given in the following table.

Table 1: Indicators of Equity in Access

Socio-economic Objective	Variables		Indicators
Equity	Entitlement		Proportion of water users with defined water rights
	Accessibility	Physical Accessibility	Proportion of households with access to water within a reasonable distance (say 200m)
			Intensity of water controlling network in catchment area
		Affordability	Income level
			Expected minimum economic benefit from a productive use

The first two indicators are self-explanatory. Information on these two indicators is still being compiled under the initiatives of WARMS and relevant water services sections of the DWAF.

The intensity of water controlling infrastructure can be estimated in terms of the proportion of controlled water supplies.

For income level, several methods can be used (Woolard 2002). It can either be in absolute terms (e.g. per household income) or as income inequality. Gini Coefficient, which ranges from 0 to 1, respectively implies absolute equality to absolute inequality. Alternatively, one can examine the shares in total income of groups of households arranged in order of income level. Also, one may choose to consider the expenditure shares of households by decile, in which households are ranked on adult equivalent expenditure and then divided into 10 groups with equal numbers of households in each group. The use of Theil-T index allows one to decompose inequality into within group and between group components (ibid). A wealth of information on income level is readily available.

The minimum economic benefit from a water use depends upon the type of use, volume, his/her complementing resource base to make the best use of water, including knowledge and skill, and several other factors making its quantification impractical and conceivably redundant.

5.2 Measuring Equity in Distribution of Socio-economic Impacts

As reviewed before, it involves both positive and negative impacts of water allocation and use, encompassing both tangible and intangible effects either in the short run or long run. Interpreting equity from this viewpoint makes it almost impossible to measure, as the interpretation of socio-economic impacts can be very subjective, context specific, temporal, influenced by individual's background and preferences, power structure, and so forth (Briscoe 1996).

5.3 Measuring Equity in Cost Sharing

With this viewpoint, first one needs to agree on one of the previously described three principles in relation to cost sharing: same charges; ability-to-pay principle; and benefit principle. Even the National Water Act (1998) indicates a mix of the latter two principles. In addition, the objective of redressing past inequities makes it more unreasonable to follow any one of these principles, even if the relevant information is available.

5.4 Measuring Equity in Extent of Water Use

This is a relatively simpler approach one can take in South African context. Various water uses and users are being compiled under the WARMS initiatives. Nevertheless, the process is not yet complete to be able to make reliable inferences. However, the available information on various users and uses (under the process of verification and rectification) in combination with other relevant socio-economic information can greatly facilitate (and hence is used in) this analysis.

5.5 Adopted Methodology

Based on the previous discussions and guided by the concept of "Equity in Extent of Water Use", the intention is to analyze who uses how much water and where to be able to capture the skewness⁶ in water use distribution. Efforts are made here to make use of already available information.

Economic Information System, 2002 (EIS) maintained and being upgraded by the DWAF is an important initiative for capturing comprehensive socio-economic information, which aims to aid the planning processes related to water resources development and management. Besides others, it captures the Gross Geographic Product (GGP) by various sectors and labor statistics – the information of interest here.

⁶ Skewness of a distribution characterizes the degree of asymmetry of a distribution around its mean.

GDP is the Gross Domestic Product (GDP) by geographic area. GDP is the total value, at factor cost, of final goods and services produced within the country during the given year, by local as well as foreign firms. Figures are discounted for inflation in order to show only real changes in production. The figures provided are at 1997 prices. The GDP is the most important measure of the level of economic activities in a geographic area. The growth in the GDP is known as the economic growth rate.

Labor statistics consist of information on those employed in the formal and informal sectors, and the unemployed. The labor distribution provides information on the sectoral distribution of formal economic activities⁷, as do the GDP figures.

The existing categorizations of available socio-economic information do not match with the previously discussed sectors of water uses. Four modified categories based on their mutual affinity have been considered for grouping GDP, labor statistics, and water uses for analysis.

Table 2: Sectoral Categorization of Economic and Water Use Sectors

Modified Sectors	Existing Economic Sectors in EIS 2000	Water Uses Sectors in WARMS
Agriculture	Agriculture	Agriculture: Irrigation Agriculture: Livestock Agriculture: Aquaculture
Industry	Manufacturing Construction Trade Transport Business and Financial Services	Industry Recreation
Mining	Mining	Mining
Water Supply Service	Electricity, Water and Gas Community Services Other	Water supply service Schedule 1

In addition, the data are compiled by magisterial districts or other administrative boundaries that do not follow hydrological boundaries such as quaternaries. Estimates of disaggregated information at quaternary level have been made by computing area densities of GDP and Employment by modified sectors and then by multiplying back with the quaternary areas. EIS-reported growth rates were taken as the basis for estimating employment figures for 2002 (see table below). The GDP figures are projections for 2002 based on 1997 fixed prices.

Table 3: Employment Growth Rate from 1980-1994 (EIS 2000)

Sector	% growth
Agriculture	-3.69%
Industry	1.82%
Mining	3.62%
Water Supply Service	2.62%

5.6 Equity Scenario in Olifants River Basin

In order to assess the equity scenario, skewness in three sets of information were computed across the quaternaries:

- skewness in sectoral water uses per unit area to reflect variation in water use by spatial location,
- skewness in water use per unit employment in each sector – water use volume per unit employment - to reflect affinity toward employment generation, and

⁷ Refer to the EIS 2002 model for full description of the sectors.

- skewness in sectoral water productivities estimates (explained in later section) – Rand/m³ - to reflect socioeconomic benefits to the society in terms of GGP.

Further, the three sets of skewness were averaged to get a combined skewness in sectoral water use across various quaternaries. It is important to note here that by averaging, one inadvertently gives same weights to all the three sets of skewness. It means that all three considerations (spatially equitable use of water, employment generation and improving productivity) are being considered equally important. However, one can assign different weights to the three sets of skewness or consider additional ones depending upon the interest and preferences of the stakeholders.

Sectoral equity coefficients in the river basin (water use per unit area, employment and GGP) were computed by using the following equation. The equation gives a positive value in the range of 0 to 1, 1 being the most equitable condition, and zero the worst.

$$\text{Sectoral Equity Coefficient} = e^{-\text{Absolute [Combined skewness]}}$$

A combination of skewness in all sectors has been used to compute an aggregated and overall basin level water equity coefficient. The overall water equity coefficient of the river basin was calculated using the same equation but with the average of the skewness in each of the sectors. Here again, instead of averaging, one can assign different weights depending upon the relative priority given to different sectors. The results are presented in the chart below.

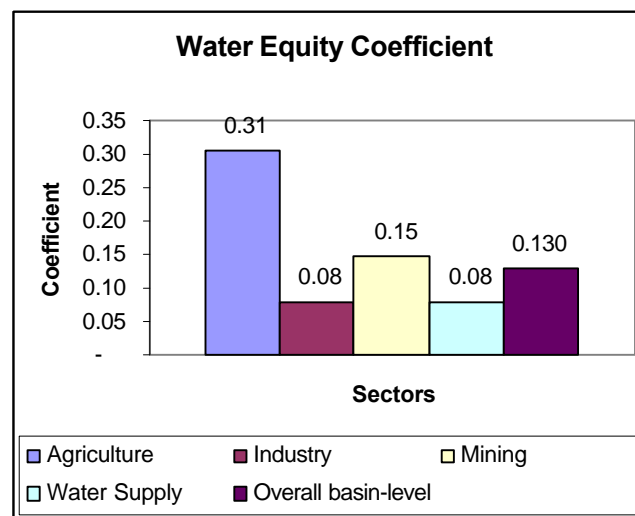


Chart 2: Water Equity Coefficients

6. Assessing Productivity

Following the Dublin conference⁸, the productivity of water is generally interpreted in the context of management of water as an economic resource. Two approaches are commonly used for assessing the productivity of water: Value-based and Cost-based.

6.1 Value-based Approach

This approach views productivity of water in terms of the value of its use. In economic terms, it reflects the maximum amount a user would be willing to pay for a specific use of water. For normal economic goods, which are exchanged between buyers and sellers under a specified set of conditions, this value can be measured by estimating the area under the demand curve.

⁸ <http://www.wmo.ch/web/homs/documents/english/icwedece.html>.

Since markets for water either typically don't exist or are highly imperfect, it is not simple to determine what this value is for different users of water (Briscoe 1996). Given this limitation, a range of methods is used to estimate the value of water in different end uses. These methods include (ibid, p5):

- Estimating demand curves and integrating areas under them: examining market-like transactions;
- Estimating production functions and simulating the loss of output which would result from the use of one unit less of water;
- Estimating the costs of providing water if an existing source were not to be available; and
- Asking with carefully structured "contingent valuation" questions about how much users value the resource.

The value-based approach has been criticized mainly on the ground that the value of water varies widely depending on factors such as the use to which it is put; the income, individual's preferences, and other characteristics of the user; the location at which it is available; season and time; quality and reliability of the supply; "value" of wastewater treatment; or the "value" of environmental quality (Briscoe 1996).

6.2 Cost-based Approach

Under this approach, the value of water is approximated in terms of financial cost associated with making it available in the desired quantity and quality. It may take into account two kinds of cost: Use cost and Opportunity cost.

Use Cost: The use cost can be interpreted in three ways: (a) "historical costs", (b) replacement cost, and (c) marginal cost. Historical cost refers to the costs⁹ that had been incurred in the past to make the resource available. The replacement cost is the cost that would be incurred for making the resource available in the present context. Both of these costs are average costs. The marginal cost refers to the cost that will have to be incurred if the system needs to be expanded to produce another cubic meter of water. Where cost curves are relatively flat, the distinction between the former (average costs) and the latter (marginal costs) is unimportant. Costs fall when there are economies of scale and marginal costs are less than average costs.

Opportunity cost: This encompasses the notion of lost benefits if the resource is not made available. It is related to value in a non-transitive way and difficult to estimate. It requires a systems approach and a number of assumptions about real impacts and responses to these. It depends upon the characteristics of the resource user, (e.g. high value user versus low value user), the intensity of water stress in the basin, alternative options for fulfilling the need, and costs associated with arising conflicts due to competition.

6.3 Productivity Assessment in Olifants River Basin

Considering the data availability, a practical and perhaps reasonably informative way of assessing value of water is to evaluate its economic contribution in the sector it is being used. The GGP provides a reliable picture of how much a particular sector is contributing to the global economy considering primary, secondary and tertiary sectors, which in turn indicates how much socio-economic contribution the water use in a particular sector is making to the society. It also takes care of the effects on primary and secondary sectors, a concern raised by Hassan (2003). Nevertheless, it must be realized that water is a constraint of productivity, not a driving force. Accordingly, the GGP must not solely be attributed to water use.

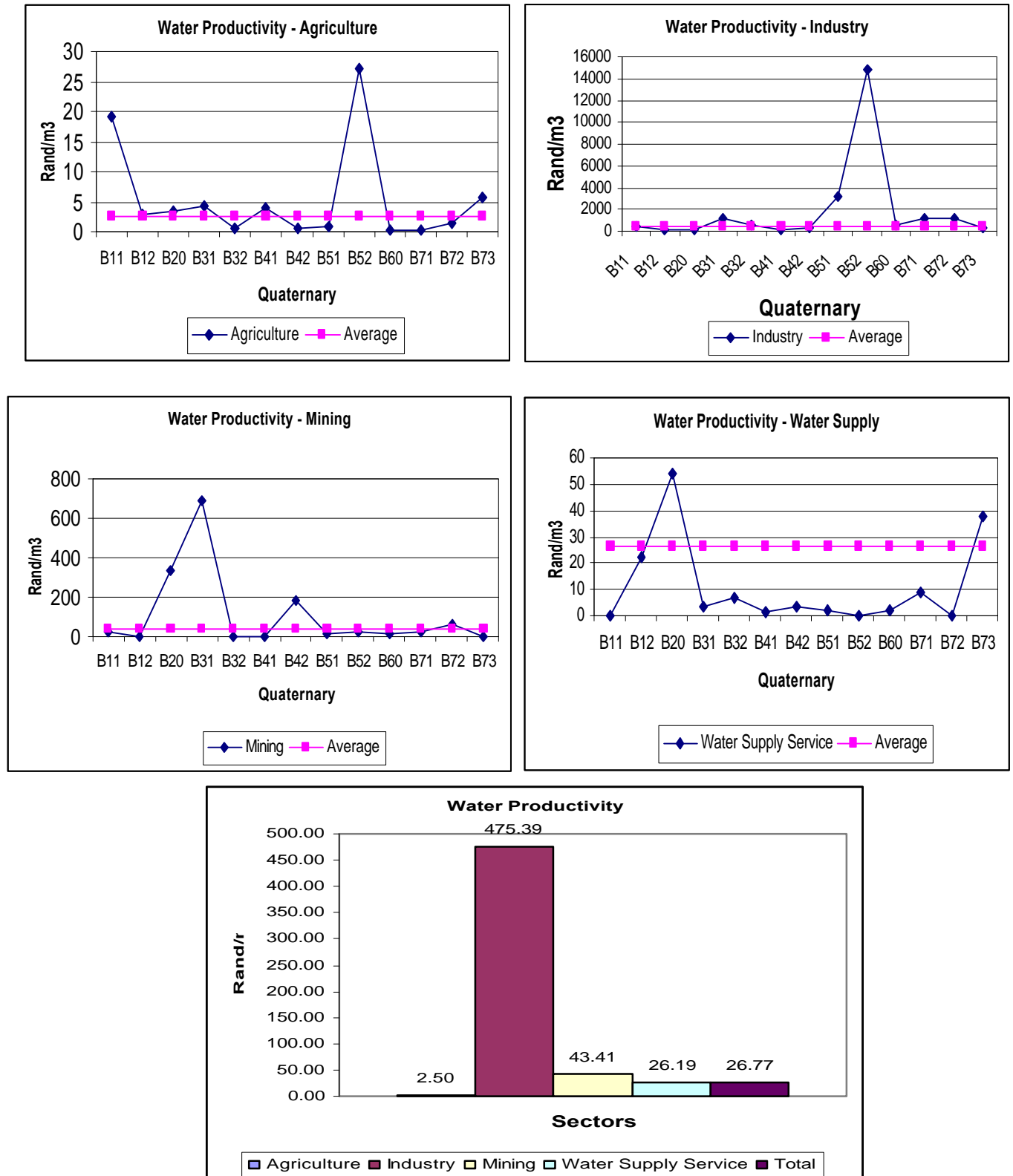
GGP data are readily available for South Africa and many other countries. Taking this very approach the water productivity figures in each of the modified sectors were computed by

⁹ Which are often heavily distorted by government interventions.

dividing the GGP by the water use. Results of the productivity computations are presented in the following graphs.

As seen from the graphs, the industry sector contributes the most in terms of GGP to the society per unit volume of water use. The mining and water supply sectors are the second and third respectively. The agriculture sector is the lowest contributor.

Figure 2: Results of Water Productivity Computations



7. Tradeoffs between equity and productivity

The Pearson product moment correlation coefficient¹⁰ of the two data sets, sectoral equity coefficients and water productivity, gives us a value of -0.462. Empirically, it suggests that there is a strong mutual influence in the two sets of information in the negative direction. In other words, it implies a significant tradeoff between equity and productivity. However, the proof of mutual causality is a subject for further analysis.

Comparison of the estimates of equity and productivity reveals several other insights (see chart 3):

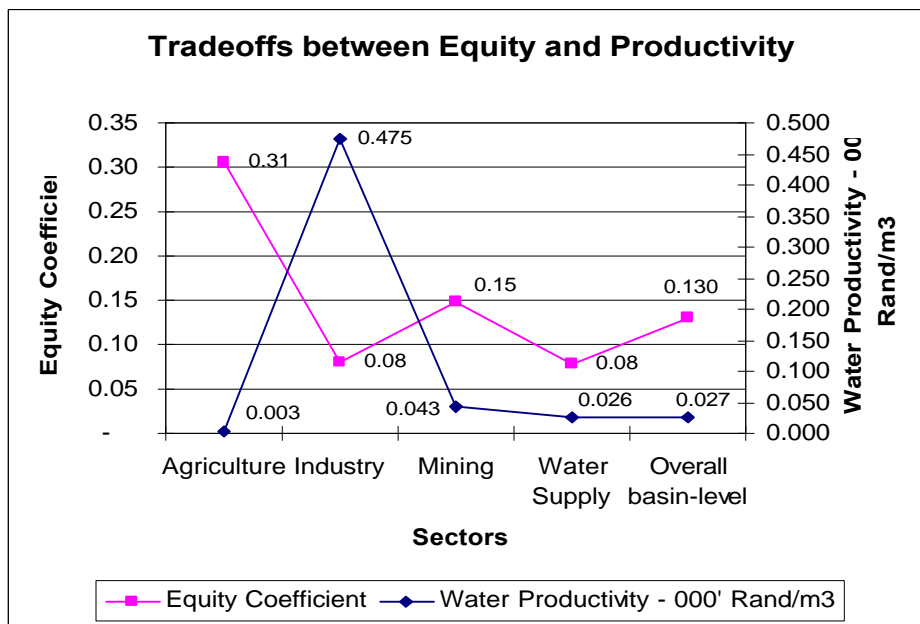


Chart 3: Tradeoffs between equity and productivity

- The agricultural sector has the highest equity in water use but has the least water productivity. In other words, as per the criteria considered, water use in agriculture is most equitably distributed (spatially) across various quaternaries in the river basin, per unit catchment area, employment generation, and water productivity. But on the other hand, the water use contributes the least toward socio-economic benefits to the society.
- The industrial sector has the highest water productivity but also has the highest inequity in water use, very similar to that of the water supply sector.
- There are tradeoffs in terms of equity and water productivity if one allocated water from one sector to another.

The comparison also highlights some strategic options toward reconciling equity and productivity:

- Promotion of water use in the agricultural sector can be a promising means to improve spatial equity in terms of GGP, employment and water use.

¹⁰ A dimensionless index that ranges from -1.0 to 1.0 reflects the extent of a linear relationship between two data sets.

- Industry sector needs to be considered with priority if the intention is to improve water productivity but not equity.
- Comparatively dismal water productivity in the agriculture sector indicates the need to examine its productivity improvement possibilities compared to its potential.

8. Conclusions and limitations

Besides portraying the equity and water productivity conditions across the thirteen quaternaries in the river basin, the findings of this study endorse the hypothesis that there are tradeoffs in equity and water productivity objectives. The overall equity coefficient of the river basin comes out to be 0.13 ($\ll 1$), implying that there is much scope for improving equity conditions in the basin. It also indicates that there is an urgent need for improving water productivity in the agricultural sector, which consumes more than 70% of available water if allowed for by its potential. It points out that the industrial sector is the largest contributor in terms of GGP and hence water productivity, whereas agriculture sector is the best in terms of promoting spatial equity in the society.

The methodology adopted here for assessing equity and water productivity in a river basin provides several valuable insights of the current conditions helping to highlight possible strategic actions. The inferences are very much dependent on the authenticity of the available data and aggregation and interpretation of the objectives of water resources management in a given context. Though the weights assigned to various objective parameters of computations were equal in this paper, they can readily be adapted to match the aspirations of the stakeholders. Much of the information used here was not available at the quaternary level as desired and hence was approximated. Such approximations are prone to inducing errors in the results and in the interpretation of the results.

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Annex 1: Sectoral Water Use in Olifants (2002)

Quat.	Sectors	Vol - m³	Quat. Totals (m³)	Quat.	Sectors	Vol - m³	Quat. Totals (m³)
B11	Agriculture: Irrigation	28,039,670	121,901,430	B51	Agriculture: Irrigation	56,213,223	71,028,960
	Agriculture: Livestock	670,041			Agriculture: Livestock	45,748	
	Agriculture: Aquaculture	-			Agriculture: Aquaculture	-	
	Industry	6,253,749			Industry	142,400	
	Mining	86,895,970			Mining	732,284	
	Water supply service	42,000			Water supply service	13,870,000	
	Recreation	-			Recreation	-	
	Schedule 1	-			Schedule 1	25,305	
B12	Agriculture: Irrigation	34,700,508	69,826,882	B52	Agriculture: Irrigation	5,180,230	6,323,180
	Agriculture: Livestock	107,184			Agriculture: Livestock	-	
	Agriculture: Aquaculture	-			Agriculture: Aquaculture	-	
	Industry	2,735,717			Industry	98,300	
	Mining	21,611,540			Mining	1,001,580	
	Water supply service	10,671,933			Water supply service	43,070	
	Recreation	-			Recreation	-	
	Schedule 1	-			Schedule 1	-	
B20	Agriculture: Irrigation	126,061,858	185,219,863	B60	Agriculture: Irrigation	118,455,511	126,349,047
	Agriculture: Livestock	3,276,405			Agriculture: Livestock	133,400	
	Agriculture: Aquaculture	335,280			Agriculture: Aquaculture	3,000	
	Industry	27,628,137			Industry	566,550	
	Mining	2,603,358			Mining	572,870	
	Water supply service	25,314,825			Water supply service	6,617,351	
	Recreation	-			Recreation	365	
	Schedule 1	-			Schedule 1	-	
B31	Agriculture: Irrigation	78,549,944	107,867,658	B71	Agriculture: Irrigation	118,455,511	121,862,123
	Agriculture: Livestock	273,838			Agriculture: Livestock	1,500	
	Agriculture: Aquaculture	797,778			Agriculture: Aquaculture	-	
	Industry	1,352,148			Industry	323,600	
	Mining	415,240			Mining	720,000	
	Water supply service	26,249,150			Water supply service	2,361,512	
	Recreation	500			Recreation	-	
	Schedule 1	229,060			Schedule 1	-	
B32	Agriculture: Irrigation	233,751,095	244,177,076	B72	Agriculture: Irrigation	48,077,227	150,536,481
	Agriculture: Livestock	780,091			Agriculture: Livestock	91,327	
	Agriculture: Aquaculture	-			Agriculture: Aquaculture	-	
	Industry	2,429,426			Industry	493,105	
	Mining	-			Mining	2,924,279	
	Water supply service	6,873,984			Water supply service	98,950,543	
	Recreation	-			Recreation	-	
	Schedule 1	342,480			Schedule 1	-	
B41	Agriculture: Irrigation	48,948,047	109,119,007	B73	Agriculture: Irrigation	13,858,010	15,626,949
	Agriculture: Livestock	133,940			Agriculture: Livestock	32,890	
	Agriculture: Aquaculture	418,733			Agriculture: Aquaculture	-	
	Industry	3,869,890			Industry	1,447,882	
	Mining	41,937,886			Mining	-	
	Water supply service	13,765,496			Water supply service	288,167	
	Recreation	-			Recreation	-	
	Schedule 1	45,015			Schedule 1	-	
B42	Agriculture: Irrigation	52,710,376	88,891,584	Olifants	Agriculture: Irrigation	963,001,210	67.88%
	Agriculture: Livestock	20,325			Agriculture: Livestock	5,566,689	0.39%
	Agriculture: Aquaculture	29,712,523			Agriculture: Aquaculture	31,267,314	2.20%
	Industry	785,639			Industry	48,126,543	3.39%
	Mining	676,350			Mining	160,091,356	11.28%
	Water supply service	4,678,708			Water supply service	209,726,739	14.78%
	Recreation	304,399			Recreation	305,264	0.02%
	Schedule 1	3,264			Schedule 1	645,124	0.05%
					Total	1,418,730,240	

Annex 2: Available and Estimated Socio-economic Data for Olifants

Quat .	Modified sectors	Water Use Vol - m3	Area in Km2	Pop. (est. 2002, WSAM)	GGP (000' /Km2) projected for 2002	Employment 1994-per km2	Total GGP in 000' Rands	Employment (1994)	Empl. Est 2002
B11	Agriculture	28,709,711	4,714	240,242	116.42	0.86	548,807	4,070	3,013
	Industry	6,253,749			499.45	1.90	2,354,397	8,946	10,337
	Mining	86,895,970			369.12	3.51	1,740,025	16,551	21,999
	Water Supply Service	42,000			882.44	2.16	4,159,840	10,182	12,521
B12	Agriculture	34,807,692	2,391	117,878	40.29	0.96	96,327	2,284	1,691
	Industry	2,735,717			142.99	1.04	341,895	2,482	2,868
	Mining	21,611,540			23.70	0.35	56,671	829	1,102
	Water Supply Service	10,671,933			98.48	1.05	235,476	2,510	3,086
B20	Agriculture	129,673,543	4,356	297,992	104.05	1.50	453,258	6,547	4,846
	Industry	27,628,137			639.30	7.63	2,784,769	33,220	38,389
	Mining	2,603,358			199.26	2.00	867,987	8,731	11,605
	Water Supply Service	25,314,825			313.56	3.96	1,365,889	17,260	21,225
B31	Agriculture	79,621,560	6,148	378,425	53.79	0.90	330,705	5,519	4,085
	Industry	1,352,648			261.31	4.31	1,606,520	26,482	30,603
	Mining	415,240			46.64	0.62	286,719	3,804	5,057
	Water Supply Service	26,478,210			14.76	3.90	90,717	23,948	29,450
B32	Agriculture	234,531,186	5,094	265,408	31.92	1.67	162,601	8,513	6,301
	Industry	2,429,426			255.33	6.03	1,300,668	30,703	35,480
	Mining	-			1.64	0.38	8,329	1,929	2,563
	Water Supply Service	7,216,464			9.45	4.13	48,155	21,043	25,878
B41	Agriculture	49,500,720	5,043	170,062	38.39	0.64	193,608	3,217	2,381
	Industry	3,869,890			76.34	0.80	384,997	4,050	4,680
	Mining	41,937,886			20.42	0.34	102,988	1,713	2,277
	Water Supply Service	13,810,511			3.99	0.49	20,104	2,484	3,055
B42	Agriculture	82,443,224	2,093	26,721	18.81	0.72	39,360	1,499	1,109
	Industry	1,090,038			158.40	0.68	331,541	1,432	1,655
	Mining	676,350			58.37	0.27	122,175	564	750
	Water Supply Service	4,681,972			7.09	0.47	14,831	988	1,214
B51	Agriculture	56,258,971	6,170	323,383	9.05	0.65	55,845	4,018	2,974
	Industry	142,400			72.47	2.01	447,130	12,405	14,335
	Mining	732,284			1.57	0.11	9,664	683	908
	Water Supply Service	13,895,305			4.41	3.73	27,189	23,040	28,333
B52	Agriculture	5,180,230	3,558	373,940	39.48	1.09	140,460	3,874	2,868
	Industry	98,300			407.91	1.81	1,451,346	6,450	7,453
	Mining	1,001,580			7.44	0.10	26,477	353	470
	Water Supply Service	43,070			29.57	2.44	105,195	8,671	10,664
B60	Agriculture	118,591,911	2,842	38,109	14.25	1.34	40,486	3,799	2,812
	Industry	566,915			104.50	6.07	296,980	17,240	19,923
	Mining	572,870			3.71	0.52	10,555	1,464	1,947
	Water Supply Service	6,617,351			5.03	4.91	14,287	13,964	17,172
B71	Agriculture	118,457,011	3,038	138,665	14.74	1.35	44,783	4,092	3,029
	Industry	323,600			123.68	3.91	375,741	11,873	13,721
	Mining	720,000			5.85	1.01	17,758	3,072	4,083
	Water Supply Service	2,361,512			7.01	8.11	21,303	24,642	30,303
B72	Agriculture	48,168,554	4,464	159,932	13.88	1.93	61,982	8,603	6,368
	Industry	493,105			133.43	15.47	595,628	69,063	79,809
	Mining	2,924,279			39.64	27.21	176,953	121,457	161,439
	Water Supply Service	98,950,543			2.04	30.95	9,112	138,178	169,923
B73	Agriculture	13,890,900	4,652	43,377	16.81	0.59	78,213	2,722	2,015
	Industry	1,447,882			69.97	1.55	325,483	7,199	8,320
	Mining	-			1.50	0.28	6,987	1,306	1,736
	Water Supply Service	288,167			2.32	1.90	10,789	8,852	10,886
Olifants	Agriculture	999,835,213	54,563	2,574,133	45.84	1.36	2,501,022	74,013	54,780
	Industry	48,431,807			421.97	5.40	23,024,163	294,627	340,468
	Mining	160,091,356			127.36	4.57	6,949,150	249,621	331,792
	Water Supply Service	210,371,863			100.96	6.88	5,508,836	375,241	461,449