The socio-economic impact of irrigation development — A South African experience*

MF Viljoen
Department of Agricultural Economics, University of the Orange Free State, PO Box 339, Bloemfontein 9300, South Africa.

Abstract

A study was conducted to determine *ex post* the socio-economic impact of irrigation development for the Vaalharts irrigation scheme which was started in 1936. By making use of a multi-criteria interrelationship approach and by comparing the Vaalharts area with a control area, it was possible to determine the impact of irrigation development on various socio-economic variables and social welfare aims. The main conclusion was that irrigation development had a major positive effect on most of the social welfare aims considered.

Introduction

Over the years the building of dams for irrigation and other purposes has taken up large amounts of government funds at the expense of certain other development projects. As time passed, the competition for funds became stronger, the sites for dams scarcer and more remote from development points and the building costs of dams more expensive. Under these circumstances it became necessary for authorities involved in government projects to compete more strongly for funds than before. The need therefore developed to show not only the financial benefits that will accrue from new development projects (as has been done before), but also to show the broader socio-economic benefits.

To get a normative indication of the extent of the socio-economic benefits that ensued from an actual irrigation project, the Department of Water Affairs contracted the University of the Orange Free State to undertake such a research project.

The Vaalharts irrigation scheme, which is situated between the Vaal and the Harts Rivers, approximately in the centre of the country (see Map 1), and which is also the largest irrigation scheme in the Republic of South Africa (32 000 ha), served as the focal point of the research project. Development in this area was to be compared with development in the Plooysburg area which served as control area. The control area is situated not too distantly from Vaalharts (see Map 1), with similar soil and climatic conditions but without irrigation development. Table 1 shows some facts about the magisterial districts in which Vaalharts and Plooysburg are situated.

Methodology

The approach followed in the study can be described as a multi-criteria interrelationship approach. In short this means that different criteria were used to measure the changes in the various socio-economic components and that the interrelationships amongst the socio-economic components were determined (Leistritz and Murdock, 1981). In comparison with a social cost-benefit analysis (see for example Hansen, 1978) this approach aims only to determine and quantify certain social benefits, but not the cost that was incurred.

The welfare economic theory (Ritson, 1977) served as the base for the study. This theory provided the necessary guidelines to identify social welfare aims and socio-economic impacts, to measure the various impacts and to integrate the results.

Fig. 1 is a schematic presentation of the welfare economic model, showing that the production factors (which are always relatively scarce) must be allocated to different economic and other activities in order to serve the various social welfare aims. Although each economic activity makes contributions to various welfare aims, the promotion of some is more direct. For instance increased food production, a direct impact of irrigation development, may also enhance national health (and indirect impact) if it, for example, leads to better feeding of the population. In the case of irrigation development the following welfare aims were considered to be more directly affected:

- increased food production;
- stabilised food production;
- independence of food imports;
- earning of foreign currency;
- creation of existence opportunities to farmers;
- creation of job opportunities;
- regional development;
- geographical distribution of welfare;
- establishment of viable rural communities; and
- countering depopulation of rural areas.

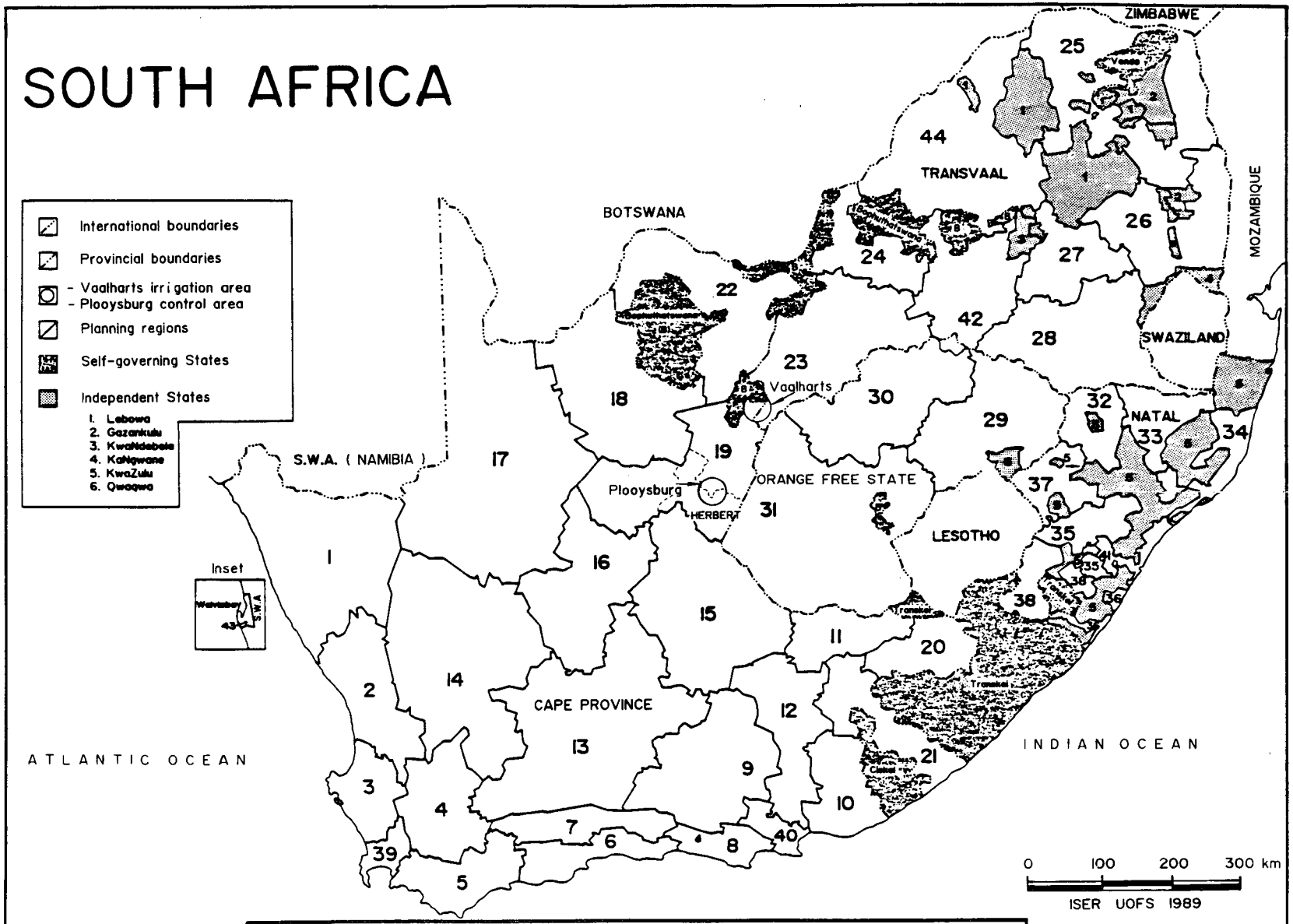
TABLE 1
SELECTED CHARACTERISTICS OF THE HARTSWATER AND HERBERT MAGISTERIAL DISTRICTS*

	Hartswater	Herbert
Area (ha)	74 074	766 600
Degree of longitude (east)	25	24
Degree of latitude (south)	27	29
Average yearly rainfall (mm)	442	315
Average yearly maximum temperature (°C)	26,6	27,4
Average yearly minimum temperature (°C)	10,5	10,0
Average yearly temperature (°C)	18,5	18,7
Irrigation soil type	Hutton	Hutton

*Vaalharts is situated in the Hartswater magisterial district and Plooysburg in the Herbert magisterial district.

*Revised paper. Originally presented at the Sixth IWRA World Congress on Water Resources, Ottowa, Canada. 29 May - 3 June 1988.
Received 22 February 1989

ISSN 0378-4738 = Water SA Vol. 16. No. 1 January 1990



MAP 1 RESEARCH AREA

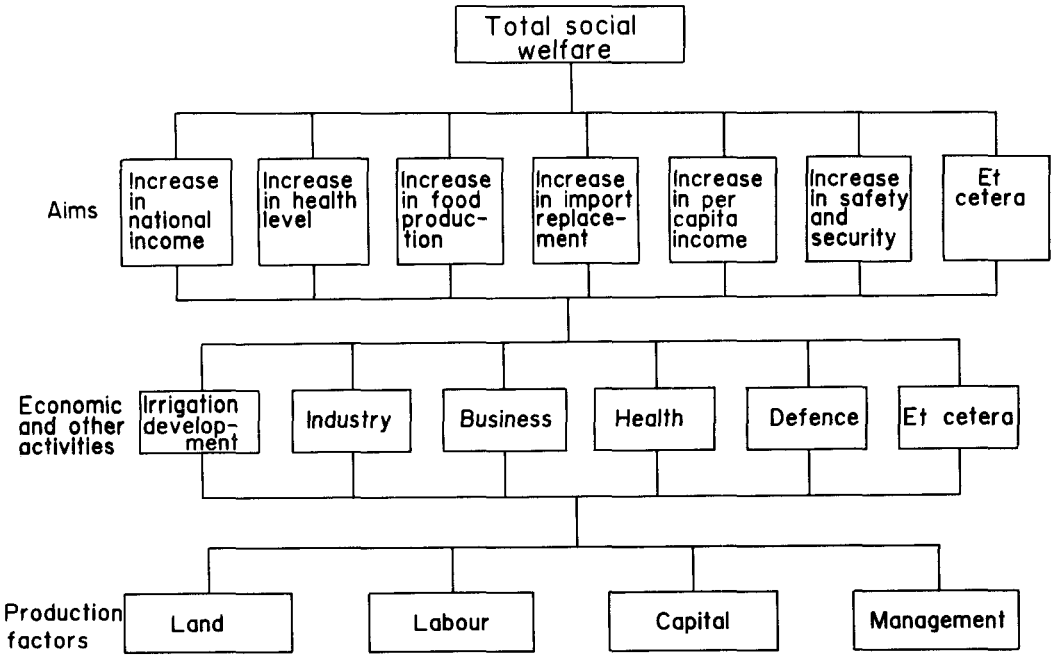


Figure 1
Welfare economic model.

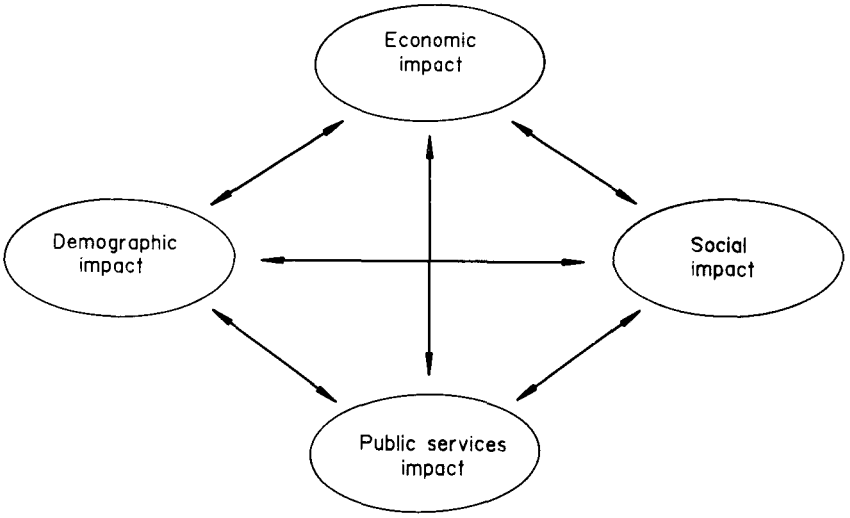


Figure 2
The interaction of impacts.

Measuring the impact of irrigation development is related to the extent to which it promotes the mentioned welfare aims. In practice the most efficient way of measuring would probably be to classify the impacts into types such as economic, social, demographic and public services, then to determine the impacts within each class after which the total impact could be established within an integrated framework. Fig. 2 shows the interaction amonst the different types of impacts in the process of development. As a result of the initial economic impact (which is more often the instigator in development projects), the other impacts follow and interact to promote integrated growth and development.

For meaningful measurement of the impacts it is first of all necessary to consider a few fundamental factors.

Viewpoint from which measurement is undertaken

It is important that evaluation should be undertaken from the viewpoint of the national economy. If this is not done, it will be difficult to compare one project with another within a social welfare framework. This implies that special care must be taken for the possible cancelling and double counting of impacts as well as the measuring units used. For the evaluation of certain economic impacts, for example, it may be necessary to use shadow prices rather than current prices.

The geographical area that is applicable

Theoretically the correct geographical area for which impacts ought to be determined is the total country. In practice this is very difficult to achieve and determination of the impact therefore focuses on the primary impact area, i.e. the irrigation area and the immediate hinterland.

The extent to which indirect impacts are to be included

The ideal approach would be to include all identifiable backward and forward linkage effects, the so-called indirect or secondary effects or second and higher-order effects. Once again this is difficult to achieve so that impact assessment concentrates on the direct or primary first-order effects.

The before-and-after approach against the with-and-without approach

In this study the theoretically better with-and-without approach is followed by comparing the Vaalharts irrigation area with the Plooysburg control area over a period of fifty years.

With this fundamental basis the measurement was done as follows. The impacts were first categorised into economic impacts, socio-demographic impacts and public service impacts. In each category various theories were applied and indicators were used to determine the impacts. Theories that were used to measure the economic impacts are the stages theory of regional growth, the locality theory, the shift and share analysis, the central place theory and the economic base theory (Viljoen *et al.,* 1989).

In establishing the socio-demographic impacts, aspects that were analysed included demographic tendencies, the social characteristics of the population and social development. The public service impact was derived by determining investment, job creation and services rendered by the public sector.

Various methods were used to obtain the necessary data, namely scrutiny of official data, completion of questionnaires by personal interviews with irrigation farmers, at businesses, households and other service-rendering institutions in the Vaalharts area, group discussions, correspondence and telephone requests. Data processing was done manually and by computer.

After the various impacts had been established an endeavour was made to integrate them within a social welfare framework and to link the impacts with the various social welfare aims.

Results

Economic impact

Each of the five theories applied gives another perspective on the economic impact.

The stages theory of regional growth of Hoover and Fischer (Parr, 1970) states that the primary sector (agriculture and mining) dominates during the first phase of development. During the following developmental phases the secondary (industries) and tertiary (finance, business and services) sectors will dominate. In applying this theory to the Vaalharts irrigation area it was found that although all these phases of regional growth could be identified during the fifty years of the existence of Vaalharts, the primary sector with intensive irrigation dominates in all phases, for instance during the last half of the period under consideration when the secondary and tertiary sectors expanded, the contribution of agriculture to the total Gross Geographical Product (GGP) for the Hartswater magisterial district was still around fifty per cent. In 1960 it was 52 per cent, in 1970 48 per cent and in 1980 53 per cent. Comparable percentages for the secondary and tertiary sectors over the same period were respectively 5, 7 and 10 per cent and 44, 44 and 37 per cent (Viljoen *et al.,* 1989).

The locality theory (Leistritz and Murdock, 1981) gives insight into the development of different economic enterpises over a period of time. For Vaalharts it showed that a considerable number of enterprises in both the business and industrial sectors (input supply and output processing) were established and that the Vaalharts Agricultural Cooperative had played a major role in various developments, for example the processing of agricultural products, manufacturing of implements and rendering of agricultural extension services to its members.

In order to ascertain the factors and contribution to growth in the irrigation area, a shift and share analysis (Perloff and Dodds, 1963) was applied. This analysis demonstrated that growth in the Vaalharts area over a period was dominated by its comparative advantage for irrigation development, thus for a specific enterprise. The composition of its businesses was, however not as favourable for a high economic growth rate as the average of the country, better than the average of the development region in which it is situated.

Applying the community economic base theory (Tiebout, 1962), the economic base of the irrigation area could be determined and the relative importance of the different sectors in the process of economic growth could be established and quantified. The dominant role played by the agricultural sector was confirmed. Agriculture provides almost half of the job opportunities in the irrigation area and makes a major contribution to the area's income multiplier of 3,37 in 1985.

The central place theory (Christaller, 1966) was used to determine the relative functional importance of towns in the irrigation area and to establish the linkages with the other towns in the development region and with the regional centre, Kimberley. It was found that the towns in the Vaalharts area developed to meaningful second-order towns which also supply certain services, e.g. education, business and medical services to other towns in the vicinity. Fig. 3 is a presentation of the applied model.

Socio-demographic impact

The socio-demographic impact refers to the impact of irrigation development on the size, composition and distribution of the population and on certain other demographic characteristics. In the Vaalharts area (Hartswater district) the total population increased from 2 764 in 1936 to 28 874 in 1980, that is by 945 per cent, while it increased from only 14 862 to 18 278 (23 per cent) in the control area (Herbert district) over the same period (Table 2). For Vaalharts the increase in the white, black and coloured populations over this period was respectively 1 197, 795 and 1 764 per cent compared compared to a decrease in the white population of 35 per cent and an increase in the black and coloured populations of only 10 and 227 per cent for the control area. Comparing the age distribution and education level of the white population also showed a more favourable situation for Vaalharts in that the population tends to be younger (median age 27,3 years for Vaalharts as aginst 32,1 years for the control area) and better educated (43 per cent standard ten and higher for Vaalharts as against 37 per cent for the control area) typifying a more vigorous community.

Development within the socio-cultural domain showed a rich variety of activities on organisational, sport and recreational levels

which contributed to a relatively high quality of life. In the towns of Hartswater and Jan Kempdorp an Afrikaanse Sakekamer, a Women's Agricultural Society, a Round Table, Rapportryers, a Garden Club, a Development Society, Voortrekker Movement, Landsdiens Movement and various sport clubs exist for instance. An evaluation of the reasons why people chose to move to Vaalharts, besides the desire for a better job, revealed the view that inhabitants rated the living conditions and general quality of life quite high. Almost 90 per cent of the white households that were surveyed rated the living conditions in Vaalharts as favourable to very favourable.

The black and coloured populations living in the rural areas who are primarily dependent on farming for an income, increased by almost 700 per cent (from 2 244 to 15 858) in the Vaalharts area between 1936 and 1980, in comparison with only 36 per cent (from 9 130 to 12 374) in the control area. This also shows the greater ability of the irrigation area to provide job opportunities.

Public service impact

In endeavouring to quantify the public service impact an assessment was made of the investment and job creation of central, regional and local authorities in Vaalharts. Table 3 gives an overview. A wide spectrum of government services was supplied to initiate, support and guide the development process through the various phases. Referring to irrigation development in particular, the initial role of the government as the primary initiator of irrigation development through its establishment of the basic irrigation

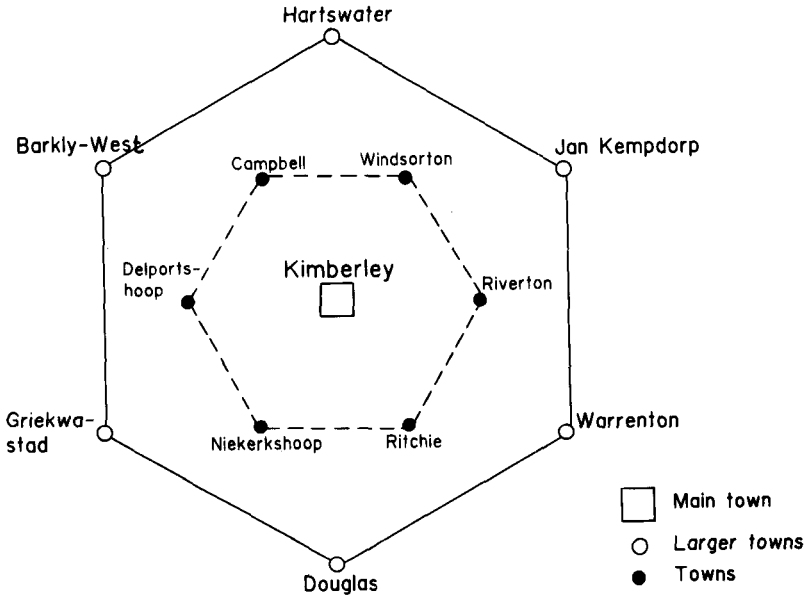


Figure 3
Distribution of towns in Development Region 19 according to the market principle of Christaller (1966).

TABLE 2
POPULATION IN THE HARTSWATER AND HERBERT MAGISTERIAL DISTRICTS, 1936 AND 1980.

District	Year	Whites	Blacks	Coloureds	Asian	Total
Hartswater	1936	490	2 047	225	3	2 764
(Vaalharts)	1980	6 355	18 319	4 195	5	28 874
Herbert	1936	3 937	7 731	3 189	5	14 862
(Control area)	1980	2 547	.8 521	10 442	57	18 278

Sources: South Africa (Republic). Department of Statistics (1976). *Population of South Africa: 1904-1970.* Report No. 02-05-12. Government Printer. Pretoria.

South Africa (Republic). Central Statistical Services (1985). *Population Census 1980. Geographical Distribution of the Population with an Overview for 1951-1980.* Report No. 02-80-13. Government Printer. Pretoria.

TABLE 3
PUBLIC INSTITUTIONS IN THE HARTSWATER MAGISTERIAL DISTRICT, 1985.

Name of institution	Date started/ erected	Present employment (1985)	Investment in land and buildings at replacement value (R'000)
Hartswater			
South African Police	1933	37	100
Dept of Posts and Telecommunications	1945	91	99
Voorspoed Primary School	1946	8	*
South African Transport Services	1947	19	304
Hartswater Primary School	1947	24	*
Magistrate's office	1949	11	*
Hartswater High School	1953	20	*
Connie Vorster Memorial Hospital	1955	81	250
Municipality	1960	99	324
Development Board	1973	6	250
Municipal clinic	1980	4	104
Jan Kempdorp			
South African Transport Services	1913	11	288
Dept of Water Affairs	1934	500	*
Dept of Posts and Telecommunications	1938	46	154
Agricultural Experimental Station	1938	121	3 601
Vaalharts High School	1941	22	*
South African Police	1942	18	80
South African Defence Force	1943	403	2 565
Andalusia Primary School	1944	25	*
Ganspan Primary School	1945	11	*
Hartsvallei Primary School	1950	4	*
Jan Kempdorp Hospital	1953	59	870
Eskom	1954	61	433
Noord-Kaapland Agricultural School	1957	45	*
Vaalharts Divisional Council	1960	82	389
Dept of Agricultural Extension	1965	18	120
Municipality	1967	124	270
Municipal clinic	1973	5	80
Development Council**	1973	18	39
Andalusia Old Age Home	1981	31	503
TOTAL		**2 004**	**10 823**

*Information not available
**As per 1985

infrastructure changed after a period of time to that of supporter of irrigation and irrigation development. Government functions that were prominent during the latter phase, besides the traditional government services, were those of maintenance and control of the irrigation infrastructure, and water allocation as well as research and extension services rendered through the agricultural experimental station.

Contribution to social welfare aims

Evaluating the contribution of irrigation development to the different social welfare aims showed a very positive effect as the comparison between Vaalharts and the control area will demonstrate.

Creation of job opportunities

The population in the Vaalharts irrigation area increased from 2 764 in 1936 to 24 174 in 1985 (after reaching a peak of 28 874 in 1980). By 1985 15 900 jobs were available in the Vaalharts irrigation area, with agriculture supplying 7 900 jobs directly and the rest indirectly. In the control area the number of additional jobs created since the beginning of Vaalharts was relatively small: a total increase of approximately 1 000 jobs over the fifty-year period.

Increase in food production

Vaalharts has made a substantial contribution to food production over a period. For example, from 1970 to 1980 684 000 t of wheat, 311 000 t of maize, 215 000 t of peanuts and 197 000 t of lucerne were produced in an area that had been used previously for extensive livestock farming only.

Stabilising food production

A comparison of maize and wheat production at Vaalharts with that at Plooysburg during the period 1971 to 1980, showed that besides much higher yields for Vaalharts in comparison with Plooysburg, the per hectare yields were more stable over a period. The standard deviation was 2,75 for Vaalharts and 3,50 for Plooysburg.

Independence of food imports and earning of foreign currency

Although the volume of agricultural products yielded by the Vaalharts area is only a small part of that of the RSA (for most products it is substantially higher than that of the control area, see Table 4), it did make contributions to savings in food imports and earning of foreign currency. If a particular product is imported or exported, the contribution of Vaalharts is considered to be equal to the import or export values of the relevant production at Vaalharts.

Existence opportunities for farmers

By 1955 1 180 farmers were settled at Vaalharts. The number increased to 1 400 in 1970, after which it started to decrease, reaching a figure of 600 in 1985. This decrease was mainly caused by economic circumstances (the so-called price-cost squeeze that has been effective since 1975) which forced farmers to increase their farm sizes in order to maintain an income high enough to live on. Despite this decline since 1970 it can be stated that the irrigation project did contribute substantially over a period in creating existence opportunities for farmers. In the control area the number of farmers decreased from 610 in 1936 to 300 in 1985.

Countering depopulation of rural areas

The total population in the Vaalharts area (rural and non-rural) increased from 2 764 in 1936 to 28 874 in 1980, that is, by 945 per cent. In the control area the population increased from 14 872 to only 18 278 (23 per cent) over the same period. Vaalharts had thus been more successful in countering depopulation than Plooysburg.

Establishing a vital community

Confirmation for this aim is found in the fact that the development of the irrigation sector at Vaalharts not only promotes the establishment of a relatively strong economy (the contribution of all economic sectors to the gross geographical product increased by 2 870 per cent for Vaalharts during the period 1960 to 1980 while it increased by only 540 per cent for the control area), it also led to the establishment of a community with a broad spectrum of social and cultural activities and with a satisfactory quality of life.

Enhancing regional development and geographical distribution of welfare

The indicators used in evaluating the previous three welfare aims are also applicable. They already proved that Vaalharts made a much larger contribution to regional development than Plooysburg. If one considers that almost the total volume of the agricultural production of Vaalharts and one-third of the production and services of its secondary and tertiary sectors are exported to markets outside the development region in which it is situated, it is a substantial earner of income not only for the irrigation area but also for the total development region. Business with its immediate neighbour Bophuthatswana, an independent black homeland adjacent to Vaalharts, but also situated in the same development region, amounts to almost 40 per cent of the total yearly sales. Not only is Vaalharts thus an important source of income and job creation in the total region, but it also puts the region in a more competitive position with other regions and makes an important contribution towards the promotion of regional development and geographical distribution of welfare from a national point of view.

Unfolding and integration of impacts

A summary of the unfolding and integration of the different types of impacts is given in Fig. 4.

The construction work, started by the government in 1936, was completed in 1961 and led to increased job creation and income.

TABLE 4
GROSS INCOME (R) OF CROPS PRODUCED IN THE HARTSWATER AND HERBERT MAGISTERIAL DISTRICTS, 1973, 1975 AND 1976

	1973		1975		1976	
	Hartswater	Herbert	Hartswater	Herbert	Hartswater	Herbert
Maize	745 894	50 061	1 713 814	95 435	1 503 113	145 705
Grain sorghum	36 996	509	14 378	6 823	7 489	2 373
Peanuts	2 081 138	23 297	4 258 475	47 669	1 840 749	112 119
Sunflower seed	14 811	0	24 491	0	6 168	70 514
Acre beans	1 570	0	1 930	0	461	0
Dry beans	2 128	528	198 998	0	5 863	293
Wheat	2 861 233	897 551	4 426 633	875 113	5 103 348	1 069 986
Hay	875 493	351 109	230 299	49 864	139 158	105 268
Cotton	1 431 719	167 175	4 990 215	528 373	1 208 233	244 184
Potatoes	61 845	86 339	905 567	1 265 613	305 364	1 674 997
Other	442 152	640 289	998 016	757 355	743 004	699 504
Total	8 554 979	2 216 858	17 762 816	3 626 345	10 864 950	4 124 943

Source: South Africa (Republic). Department of Agricultural Economics and Marketing. Regional accounts by districts, Pretoria.

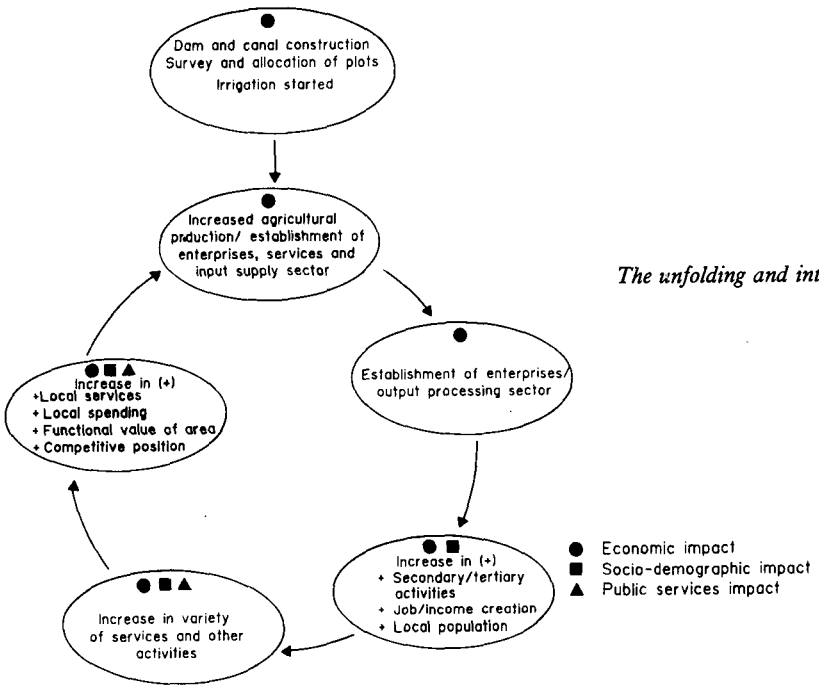


Figure 4
The unfolding and integration of socio-economic impacts.

With the increased agricultural output that resulted, the foundation was laid for the economic impact out of which the socio-demographic and public service impact would arise. The establishment of the Vaalharts Agricultural Cooperative in 1944 and other enterprises in the input-supply and output-processing sectors afterwards, broadened the economic impact. This also led to increased job creation and local spending which expanded the economic base of the irrigation area.

The settlement of farmers and their families after the completion of the inital construction phase not only laid the cornerstone for the socio-demographic impact, but also stimulated the demand for services and facilities in the tertiary sector, which led to an expansion in the existing business and other services. This gave permanency to the integration of the initial economic and socio-demographic impact. Organised social community activities culminated in a variety of ecclesiastical, educational and recreational organisations. The increase in population and increased business and other tertiary activities needed an expansion and diversification in the supply of services by the public sector. With this development the integration of the public service impact was formalised.

From this discussion it may seem as if the unfolding and integration of impacts took place in a sequential manner. In practice the economic impact may be the instigator more often but stages could be identified in the development process where it would unfold simultaneously with the socio-demographic and public service impacts.

Acknowledgement

The author expresses his thanks to Messrs NJ Oosthuizen and RB van der Merwe of the Institute for Social and Economic Research who were co-researchers in this study.

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