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Developing Basement Aquifers to Generate Economic Benefits: A Case Study from Southeast Zimbabwe

D. K. WAUGHRAY and C. J. LOVELL
Institute of Hydrology, Wallingford, Oxon U.K.
and
E. MAZHANGARA
Lowveld Research Station, Chiredzi, Zimbabwe

Summary. — Shallow basement aquifers are present throughout much of sub-Saharan Africa, but due to their variability and complexity the groundwater they contain often remains underdeveloped. As a consequence, productivity in many rural areas underlain by these aquifers continues to be low. A research program in southeast Zimbabwe was designed to increase access to this groundwater for domestic and productive use. The results suggest that by providing water for the household and for small-scale community vegetable gardens, a stream of financial and economic benefits can rapidly be generated for project participants. This benefit stream, though relatively small, is reliable and accrues particularly to women in the household. Critically, the financial benefits are being re-invested to promote diversification into other income-generating activities. These findings may have implications for the future development of water resources from basement geologies throughout sub-Saharan Africa. © 1998 Elsevier Science Ltd. All rights reserved

Key words — sub-Saharan Africa, Zimbabwe, basement aquifers, rural water supply, collector wells, income generation

1. INTRODUCTION

This paper analyzes the improvements to the rural economy in parts of Masvingo Province, southeast Zimbabwe, which resulted from the creation of splash-irrigated community vegetable gardens around collector wells. These wells were installed as part of a pilot project to examine new approaches for improving water and food security in dryland areas of sub-Saharan Africa underlain by crystalline basement aquifers. Although the original objective of the project was technical, after five years of implementation the pilot project provided a stream of economic benefits for participating communities through the productive use of groundwater. Thus, the research described here is presented in the wider context of the role groundwater could play in generating economic benefits for farms and households in dryland production systems in sub-Saharan Africa, based on the findings of a pilot project in Zimbabwe.

The paper outlines the background research which led to the pilot project; it presents the key findings of the project and a comparative survey on the benefits generated by a standard borehole in the area; and it concludes with a short discussion of the findings.

2. BACKGROUND

Rural livelihoods in sub-Saharan Africa are becoming increasingly dependent on cash-based income flows, both from farm and non-farm sources. Generating reliable and diverse income opportunities is recognized as a key objective for initiating sustainable rural development (Scoones, 1996). In most cases, however, rural incomes have to be generated from the existing natural resource base. As most natural resources in dryland areas are treated as common property

resources, income-generating initiatives, community-based decision making and natural resource management all have to form part of the same nexus which must shape any successful approach for encouraging sustainable rural development (Cleaver and Schreiber, 1994).

Water is often seen as *the* critical natural resource constraint on dryland production systems in sub-Saharan Africa (Cleaver and Schreiber, 1994). Unfortunately, the variability and unreliability of rainfall makes the sustainable development of water resources difficult (Griffiths, 1972). Exploiting groundwater can often provide a buffer against such unreliable rainfall, and is the primary source of water for many rural communities. But, the present use of groundwater in areas underlain by crystalline basement rocks, which comprise a significant part of the geology of sub-Saharan Africa (Wright, 1992), often remains low. This is because aquifers in this geology occur in the weathered overburden (regolith), which has low permeability and in the fractured bedrock underneath, which has a low storage capacity. These factors combine to provide low yields for boreholes (Butterworth *et al.*, 1995). For example, in a recent World Bank drought relief program, of the new boreholes drilled in Masvingo Province, southeast Zimbabwe (an area typical of those underlain by shallow basement aquifers), 47% were found to be either dry or low yielding. Consequently, groundwater usage in the region is only about 4% of annual average recharge (Lovell *et al.*, 1996).

Technical research in southeast Zimbabwe assessed the potential for collector wells to abstract water from these basement aquifers. A collector well is a large diameter, shallow well whose yield is enhanced by radial drilling at the base to a distance of up to 30 m in several directions (see Figure 1).

The collector wells gave a safe daily yield of between 10 and 40 $m^3 d^{-1}$ per day when used with two hand pumps; a high-yielding hand pump borehole in the same area would give 7 $m^3 d^{-1}$ of water per day. (Lovell *et al.*, 1996).

Improving the use of basement groundwater is not just a technical issue, however. It is also a question of adjusting water supply policies. Rural water supply programs in sub-Saharan Africa have generally been developed to help meet wider social policy objectives such as the improved provision of drinking water and sanitation facilities. While these social objectives are undoubtedly important, a formal link in rural water supply program design has rarely been made between sustainable rural development and the *productive* uses rural communities can attach to water resources.

When water can be supplied in a rural dryland location it is likely to be put to many different uses, irrespective of the purpose of the original

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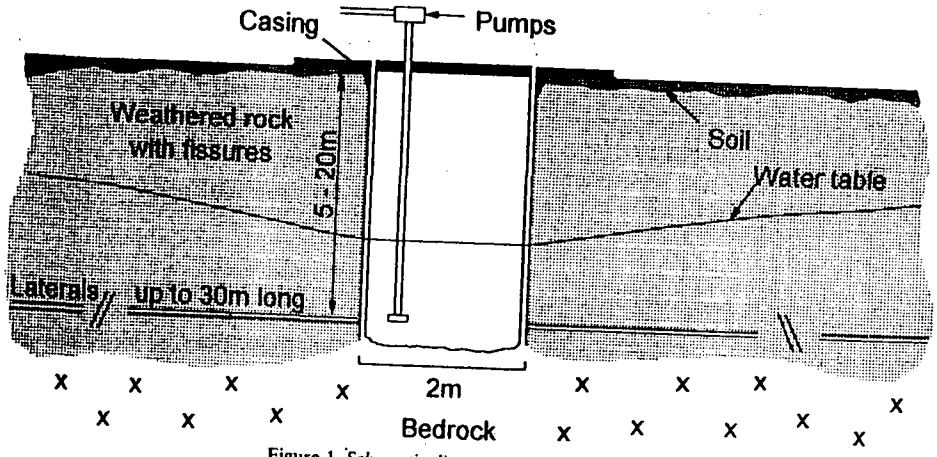

Figure 1. *Schematic diagram of a collector well.*

project. Drinking, cleaning, livestock watering, food processing, brick making — research in water-scarce areas has shown that people have multiple and innovative uses for limited water supplies (Meinzen-Dick and Jackson, 1996). Importantly, these diverse water-related production activities are usually undertaken and managed by women. As a result they can also play a significant role in generating and diversifying household income flows and investment strategies. These activities, however, have often been viewed by water resource professionals as being unimportant and are regularly overlooked.

Due to the public service nature of rural water supply programs, the operating and maintenance costs of water supply projects in sub-Saharan Africa have usually been met by national public sector agencies or parastatal organizations. The ownership and rights to manage the water supply infrastructure have often remained outside the recipient community. Consequently, the potential for user communities to even "informally" utilize the different productive capacities of the water supplied to them has rarely been fully realized.

The trial yields of the collector wells in Zimbabwe were shown to be sufficient to irrigate a garden of approximately 0.5 ha as well as to supply a part of the domestic water requirements for a surrounding community (Lovell *et al.*, 1996). It was envisaged, therefore, that if the collector wells could be implemented with an onus on community self-management, and could deliver a reliable input to a women-based farming system such as a vegetable garden, then the productivity gains to be had could be large and the benefits likely to be re-invested in the household. Due to the widespread presence of basement aquifers and the insecurity of rural livelihoods in the communal lands of southeast Zimbabwe, this region was selected as the location for a collector well and vegetable garden pilot project.

Project designers also recognized, however, that the particular institutional and management needs of women farmers would also have to be addressed in project design. Women have resource endowments and risk management strategies different from male farmers in sub-Saharan Africa. They often have limited access to productive land and institutional credit. As a result, women farmers require specific and distinct plots of land to enhance their tennurial security and labor and management strategies unlike those used by men farmers. In addition, more group or community-focused activities are required of women than of men (Cleaver and Schreiber, 1994). Baseline surveys in the communal areas of southeast Zimbabwe supported these findings. They found that women were effectively the heads for over a quarter of households in the region, that they made up the greater part of the farm family labor force and that vegetable cultivation was one of the most important of womens' farming activities in the region (Brown and Dube, 1994).

Accordingly, a pilot project involving a series of *self-managed* collector wells and *community-based* vegetable gardens was designed. The gardens were envisaged for use particularly during the early dry season when the opportunity cost of women's labor is at its lowest

Seven water points and half-hectare community vegetable garden schemes were subsequently established during 1991–95 in the Zaka and Chivi districts of Masvingo Province, southeast Zimbabwe (see Figure 2). Two further schemes were constructed by the nongovernment organization (NGO) Plan International, to the east of the pilot project sites. The pilot project ended in October, 1996, though monitoring of the schemes continued.

The high degree of community management and self-maintenance which existed in the pilot schemes resulted from the emphasis on community training and institution building during the implementation process. Lovell *et al.* (1996) report on this in depth. A particular focus of the research was the assessment of the economic, institutional and social impact of the schemes. A 1993–94 baseline survey involved interviews of 180 households (Brown and Dube, 1994) and in September 1995, 169 households in a return survey (Waughray *et al.*, 1996).[1] The survey included participative monitoring of each scheme's agro-economic performance (Mazhangara, Mtetwa and Dube, 1995). We quantified the non-market based benefits of the schemes, especially the reliability of the water supply, (Waughray, Moran and Lovell, 1997), and assessed the wider impacts of the scheme on the rural production system (Waughray *et al.*, 1997a). Section 3 presents the key findings of these surveys.

3. RESULTS

(a) *Membership and management of the community vegetable gardens*

By 1996, 545 households were members of the seven garden schemes. Membership of each garden ranged from 46 to 134 families, with an average of 78 members per scheme (Waughray *et*

al., 1997a). Members came from the surrounding community and were comprised of people from more than one village. Methods of membership selection varied between the schemes, with the supply of labor to help construct the well and garden, or the payment of an entry fee, being the most common. Of garden members surveyed, 80% said that the main decision maker and most labor for the community garden came from women. The average amount of time women spent working in the scheme gardens was about 11 hours per week over an average 10-month growing season. During this period, they grew, harvested, consumed or sold vegetables (such as cabbage, onions and tomatoes).

Each community garden was enclosed by a chain-link fence and a locked gate, usually with the well outside. Within the fence the gardens were divided up into plots. The average plot size was six square meters. The predominant irrigation method in the gardens was surface irrigation, whereby water was carried to the plots in buckets and tipped onto the soil surface. Irrigation schedules were usually rigid with a fixed number of buckets of water being applied to each bed each week regardless of the crop growth stage. A garden committee consisting of several members of the scheme managed the project at each site. It held regular garden meetings and made decisions regarding water scheduling, seed purchases, maintenance requirements and the use of water both within the garden and between garden and non-garden members.

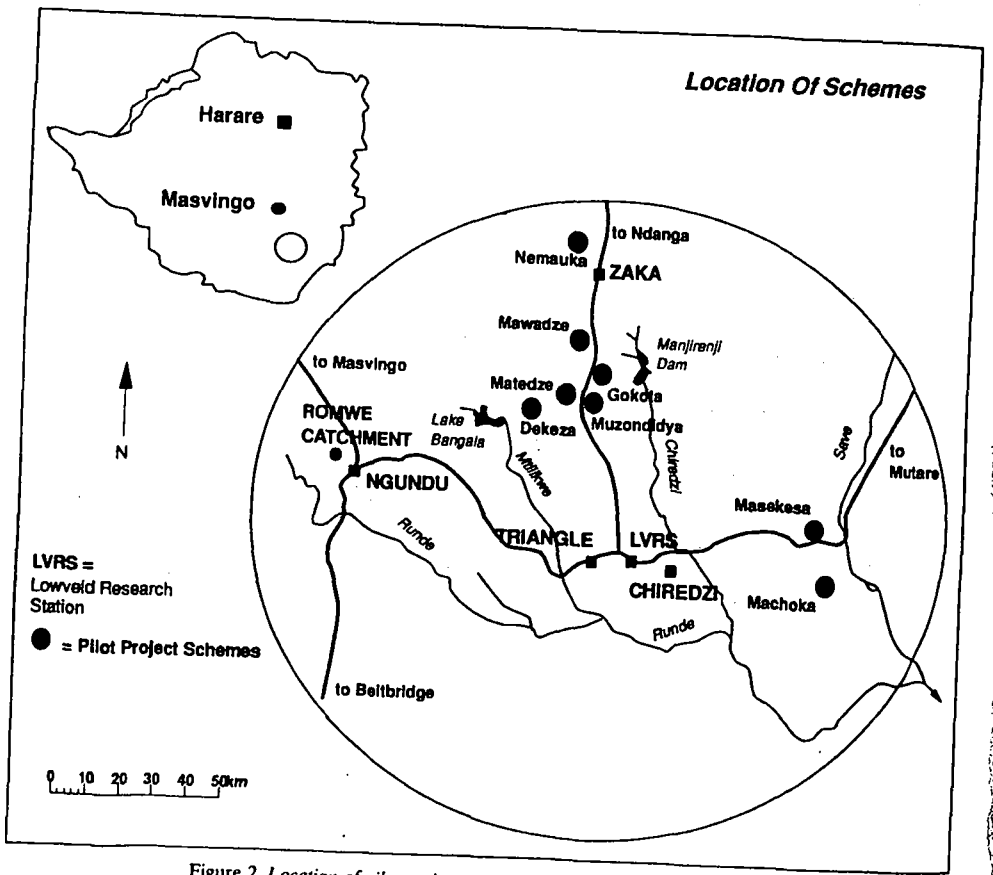

Figure 2. *Location of pilot project collector well and garden schemes.*

(b) *Increased productivity of vegetable garden systems*

Yields for the 1995 growing season averaged 386 kg of produce per member — equivalent to about 58 tons per hectare. Internal rates of financial return for the gardens ranged from 11–15% across the schemes (calculated using garden gate prices and including the imputed value of vegetables taken by members for home consumption, but not the opportunity costs of labor) (Mazhangara, Mtetwa and Dube, 1995). There was some variability in financial performance from scheme to scheme and a few marked fluctuations in the performance of individual schemes from year to year, but generally returns recorded at all schemes increased over the period of monitoring.

Average gross financial margins for the 1995 winter season across the schemes were US$8350 per hectare, US$38 per member and US$1.3 per labor day.[2] By comparison, traditional stream bank vegetable gardens have been recorded as giving an average gross financial margin per hectare of US$398 for winter vegetables, or US$6.9 per member (Meinzen-Dick, Sullins and Makombe, 1994).

(c) *Improved security of vegetable cultivation*

Before the project, the scarcity period for vegetables at the scheme sites lasted from March to January, peaking in September (the end of the dry season) with approximately 4–4.5 days a week occurring without vegetables being consumed by households. With the schemes, the scarcity period for vegetables was reduced to between July and December, with the end of the dry season remaining the peak month of scarcity. During peak scarcity, however, only 1–1.5 days a week went by without vegetables being consumed. Thus, the schemes supplied fresh vegetables over a longer period, and yielded an excess for drying that lasted throughout the remaining scarce period. The introduction of the schemes also lowered the risk for non-members of not being able to obtain fresh vegetables throughout the dry season when a particular source failed (for example due to drought or pests).

(d) *Improved security of domestic water supply*

At least 911 households were obtaining their domestic water requirements from the pilot project schemes by 1996, using approximately 110 liters per household per day. Overall, 50% of members and 39% of non-members said they obtained all their domestic water from the collector well. Water shortages, cited as the main problem by previously sampled households, dropped to being the fourth most pressing problem after shortages of livestock, cereal crops and money (Waughray *et al.*, 1996).

The average distance members walked to the schemes to collect domestic water was approximately 1000 m. This ranged from 100 to 3000 m. For non-members this distance was further, averaging 1500 m and ranging from 100 to 3500 m. Interestingly, the average distances to next best or alternative water sources (borehole, hand dug well, stream) were much lower — approximately 460 m for members and 600 m for non-members respectively (Waughray *et al.*, 1996). The longer distances women chose to walk to the schemes for domestic water supported the hypothesis that the wells were not seen as a time saving intervention, but as a *reliable* water source. Indeed, those surveyed consistently mentioned the reliability of the wells as a key benefit of the schemes, above that of closeness (Waughray *et al.*, 1996).

Enhanced reliability was partly due to more effective exploitation of the regolith groundwater by the laterals (see Figure 1), but also because the regolith provided a more reliable groundwater supply than the bedrock, and because there were two relatively new pumps and therefore the communities had a stronger motive and a cash flow from garden sales to repair and maintain the wells themselves. The strong degree of community involvement in operation and maintenance meant that the rate of water supplied by the pilot project wells never dropped below 10 $m^3 d^{-1}$ per day, not even at the height of the dry season (Lovell *et al.*, 1996). This contrasts with the many other boreholes in the area which were much more seasonal in nature and which were not as quickly repaired when broken.

Indeed, the reliability of the wells was emphasized by the fact that, on average, a further 22% of respondents said they also relied on the schemes for domestic water when their nearest other water source was broken. This figure varied from 3–54% across schemes (Waughray *et al.*, 1996). It is not clear whether "broken" in this context meant a mechanical failure in a pump, or a seasonally dry period for the water source. Towards the end of the dry season, however, the wells experienced surges of use by people who for most of the year were dependent on other water sources. This indicated their wider import-

ance in water security terms for the catchments in which they were placed.

(e) *Implementation costs*

The capital costs for implementing a collector well and a half-hectare garden averaged US$11600. This compared to US$7400 for a single handpump borehole, implemented as part of a drought relief program (Lovell *et al.*, 1994, 1995, 1996). Thus, when evaluated simply as a water supply scheme the capital costs to implement a water point and community garden scheme properly were higher than those incurred by siting and sinking a single borehole. The average capital cost per hectare of implementing a comparable smallholder irrigation scheme (where river water is pumped to canals and siphons, due to the constraints on developing sufficient groundwater) was US$5300. To implement a traditional dambo garden (where buckets of water are drawn from shallow dug wells), capital costs have been identified as US$750 per hectare (Lovell *et al.*, 1996).

The higher capital costs for the pilot project schemes resulted from two factors: a need for more specialized drilling equipment, and the use of facilitators to encourage the emergence of viable micro-level institutions to operate and manage each scheme. Thus, the corollary of the high capital costs has been that the *recurrent* costs for the collector well schemes to the implementing agency have been close to zero. Waughray *et al.* (1997b) examine this issue in depth.

(f) *Ability to generate income*

Data generated from the pilot project schemes also indicated the potential of the vegetable gardens for generating income. The period of vegetable sales lasted for an average 6.5 months across the schemes (Waughray *et al.*, 1996). Produce was sold by each garden member, either in bundles to neighbors or in nearby townships. Block purchases of vegetable harvests by local market traders also occurred. Average gross financial earnings obtained per member surveyed from selling some produce during the 1995 growing season was US$27.8 (Waughray *et al.*, 1996).

The income levels generated between the schemes were related to the length of the growing and selling seasons. These depended on many variables, such as the number of members in the garden, marketing strategies, pest control, extension advice, effectiveness of collective decision making and locational aspects. At the most successful scheme, average gross financial earnings per member for 1995 were US$82; at the least successful scheme (where crops were only grown for two months due to a pest attack), average gross financial earnings per member in 1995 were US$8.3.

It was difficult to obtain accurate data on household incomes against which to compare the US$27.8 average gross financial earning per household for the pilot schemes. A national survey for 1989–90 stated that total gross national average income per household was US$602. Of this, off-farm income accounted for 15.6%, or US$93.4 (MLARR, 1990). Corbett (1994) cited by Scoones (1996) estimated that 50% of households in the pilot project area in 1990 had annual incomes below US$166, and under 10% of households had incomes above US$498. No quantitative information was obtained on the value of remittances, although they were considered an important source of income. Moreover, none of these figures take into account the extreme uncertainty or gender bias attached to annual, monthly and even weekly household income flows to rural households in the region.

(g) *Distribution of income earning opportunities*

It is important to note not only the financial value of the income generated by the schemes, but also the *number* of people who were able to participate in the cash earning activity. This is critical if the impact of the scheme on economic welfare at each site is to be assessed in terms of equity as well as an overall improvement in economic welfare. One hundred garden members surveyed across all of the schemes were asked from which four activities (sale of scheme garden vegetables, remittances, sale of rainfed crops, beer brewing) they regularly received cash. Table 1 presents their aggregated replies.

Seventy-seven percent of garden members surveyed obtained an income from the pilot project schemes. Household surveys also indicated that, of those who joined each community garden, 49% were among the least wealthy in the community (Waughray *et al.*, 1996). For those women with maybe no other access to cash, materials or productive resources for income-generating activities, obtaining a steady seasonal income from the schemes had greatly lowered elements of risk and income insecurity in the household decision making and planning process. This was reflected in a sharp

Table 1. *Most regular cash sources for 100 sampled scheme members*

Source of cash	Number who regularly obtain cash from this source
Sale of scheme garden vegetables	77
Remittances	59
Sale of rainfed crops	41
Beer brewing	36

Source: Waughray *et al.* (1997a).

increase in both the perceived value of the plots and in their actual purchase prices. A comment typical of many garden members was, "if I gave up my plot I'd be giving up my future."

(h) *Group management of income*

An important aspect of the cash-generating capabilities of the schemes was the extent to which they generated income flows which were reliable enough to allow the opportunity for savings and reinvestments in other non-farm activities. A good indication of this capability was the revival and blossoming of "revolving fund" arrangements among scheme members.

A revolving fund or *kukandirana* (Scoones, 1996) is a traditional Zimbabwean savings club operated and managed by a group of friends or colleagues. Each member of the group puts an equal amount into a fund each week or month. The fund is given to one member to spend provided the others in the group feel the purchases are justifiable. Each member takes a turn to spend the fund — hence the term "revolving" fund. Where investment facilities are limited and where there is a high marginal utility attached to ready cash, membership of a revolving fund is a rational, risk-reducing exercise. It becomes possible only when members feel that they and their colleagues can rely on a steady income flow with which to participate. Such clubs usually follow on from reasonable harvests.

Although the drought meant that most such clubs collapsed after 1988, research in 1994 found that 16% of a sample of households in the area were members of a savings club (Scoones, 1996). By comparison, surveys found that by the end of the 1996 growing season, 69% of garden members sampled were involved in scheme-related revolving funds (Waughray *et al.*, 1997a). Membership of these funds ranged from seven to 40, averaging at 11. Of the sample surveyed, only one fund existed before the schemes started, and that had expanded from 10 to 33 members. Lump sum amounts obtained individually by fund members from "their turns" ranged from US$10 to US$24 during the 1996 vegetable selling season.

The spending pattern of revolving fund income seemed to change over time. At a scheme established in 1995, many revolving funds were being used for dealing with immediate household expenditures, such as the payment of school fees or uniforms, and the purchase of utensils and basic household needs. At the first site, however, established in 1991, savings clubs had become geared toward saving to buy livestock, inputs for other income-generating initiatives and for "emergencies," with less emphasis on the immediate household necessities apart from the recurrent cost of school fees.

Although knowledge of revolving funds is widespread in southern Zimbabwe, it appeared that members of the pilot project schemes had a better opportunity to re-start savings clubs through the reliable and widespread income flows generated by the wells and vegetable gardens. The length of the garden's selling period appeared critical to the amount of group savings that could be collected. It seemed that those clubs which had longer periods over which money was collected attracted more members and could afford to rely on a lower weekly contribution. As the community garden schemes progress it will be interesting to note both the further development of the revolving funds themselves and the subsequent increase or otherwise in the range of income generating activities for women, based on the capital purchases derived from these funds.

(i) *Diversification of household production*

Results from participative exercises indicated that over 200 other household-based projects were started as a direct result of the benefits accrued from the seven schemes (Waughray *et al.*, 1997a). These initiatives ranged from small livestock or fruit tree schemes through to pottery, knitting and buying and selling (of second hand clothes). Cash inputs to start these

new activities ranged from US$4 to US$44 per year. Other inputs provided by the pilot schemes included water and vegetable fodder. Outputs from these activities (gross financial margins at farm gate prices not including opportunity costs of labor) ranged from US$10 to US$262 per year. There were also numerous examples of *group* initiatives that had started as a result of the pilot project (Waughray *et al.*, 1997a). The schemes were also the catalyst for positive changes in the surrounding farming systems. Typically, some income generated from the sale of vegetables was used to pay for more inputs for rainfed crops such as seed purchases, more hired labor, and the purchase of other rainfed farming inputs such as chemicals, hoes and replacement parts for ploughs and cultivators. Some non-members bought and resold the garden vegetables and were hired as laborers for the gardens, and on the garden members' rainfed fields (Waughray *et al.*, 1997a).

4. INCOME GENERATION AT A STANDARD BOREHOLE

It is important to try and separate the impact of the pilot project schemes from any other factors that may have encouraged the improvement in water-related production activities in the area over the last few years. For example, the series of good rains which have improved rainfed farm yields since the 1991–92 drought could have helped in the re-starting of some livestock and vegetable garden projects. Therefore, a control survey at another location where a standard borehole had been implemented, and about which nothing was known *a priori*, was undertaken (Waughray *et al.*, 1997a).

Of the 20 respondents interviewed at this site, 14 reported that they were also involved in vegetable gardens either at a nearby dam or on the banks of a river. These households grew vegetables for an average seven months per year. Eleven households sold some of their produce for an average three months per year. The average income earned from these gardens was US$15.9 per annum. Of the 11 respondents who sold some vegetables, four were also members of a revolving fund. The money saved was used to buy household utensils. Several other savings clubs had not re-started following the end of the drought. Eight of the respondents said they bought vegetables from other gardens (either co-operative or private gardens) during the dry season. These households spent on average US$5.4 each on fresh vegetables during this period. There was, however, a noticeable lack of other livelihood projects in the area when compared to the pilot project sites. Yet 18 of the 20 respondents said they wanted to start new projects. Of these, 13 said a lack of money was the key constraint. When this point was explored further, the respondents said that the main constraint to initiating and sustaining group projects was the problem of *unequal* cash distribution within the community. In essence, there were never enough people with money at the same time to allow group projects to take off. Seven of the 20 respondents said a lack of a water was also a major constraint.

The borehole at this site had been implemented solely as a domestic water supply point. No institutions had been encouraged to help organize the potential multiple uses of the water it provided. The community felt that the water point belonged to the state and that when broken, it was up to the state to fix it. Consequently, the water point was an unreliable source of water, both technically and institutionally, and it was perceived to be risky to plan any water-related productive activities around it. Any financial or economic benefits the water point could generate for the community were therefore viewed as haphazard. Thus, despite a latent demand (as indicated by the fact that some people were cultivating vegetables elsewhere), the potential to start water related projects around the borehole remained constrained. This site provided a good example of the degree of productive potential which can exist within rural dryland communities, but which is often not capitalized on by water points due to the design, the implementation process and the general policy objectives of the water supply program under which they are delivered.

5. DISCUSSION AND CONCLUSIONS

The pilot research project has shown that collector wells can exploit the water resource potential of the regolith in basement aquifers successfully, and that they can abstract enough water to meet both the domestic and small-scale irrigation requirements of surrounding communities. Both water and fresh vegetable security for the participating households in the region increased substantially under this project.

The research has also shown that a wide portfolio of economic benefits can be gained from such community-based, "productive" water point schemes. The design of the project meant that the benefits from the project accrued particularly to women. As a result, a great deal of income from the project was reinvested in the household. Investments occurred either in necessary capital or recurrent costs (pots and pans, school fees), or in income diversification activities (small livestock projects, buying and selling activities). The accessibility and reliability, as well as the size, of the income flow to the scheme participants seemed critical to the success of these activities.

As a better record is built up over several seasons, more sophisticated analyses will be carried out to ascertain the most significant variables that influence income levels at the schemes. Disseminating this kind of information could further improve the financial performance of ongoing and future collector well and garden schemes in dryland areas, as and when they are implemented.

The findings of this research project so far are also proving particularly relevant to those public sector institutions in Zimbabwe responsible for rural water supply and management. By recognizing the connection that exists between generating and diversifying rural incomes, encouraging community-based institutions for decision making and the common property nature of natural resources in the region, the schemes have initiated community-based management systems for groundwater. The schemes help create capacity for local-level management of the collector well and the community garden scheme generated a rapid, tangible and reliable benefit stream (water, vegetables, cash) to the mostly resource-poor participants. Though relatively small to the outsider, this benefit stream has provided an economic incentive for the community to sustain and evolve its involvement in local-level water resource management. Integral to the project's success, therefore, has been the high degree of emphasis placed on active community participation and institution building.

There are still many issues that require further investigation. Property rights governing land, water and other natural resources affected by the scheme, and the relationships between new organizational structures for the water point and existing traditional and modern institutions can affect significantly the successful management of the water points. More emphasis needs to be given to wealth and equity issues surrounding scheme membership and the impact of subsequent activities. The long-term sustainability of water use within these schemes, particularly within the context of the high degree of variability in rainfall, also needs to be investigated. Similarly, the extent to which the research findings at the pilot scale are repeatable and can be transferred to the regional scale also have to be established. The environmental and economic ramifications at the regional scale must also be researched as the project progresses.

The research suggests, however, that there is significant potential for productive water points and community garden schemes to provide income generation and diversification opportunities in those regions of sub-Saharan Africa underlain by shallow basement aquifers through complementing, rather than replacing, rainfed farming practices. Evidence indicates that they could also provide the initial incentive for community-based water resource management strategies. It is hoped that the development and expansion of the research both in Zimbabwe and in several other countries will provide enough data and evidence upon which to base a confident case for recommending the replication of similar productive water point and garden schemes as an option for sustainable rural development in these areas.

NOTES

1. The surveys elicited replies from both "members" and "non-members" of the community garden schemes. A member was taken to be a representative of a household from one of the villages in the area who joined and remained part of one of the community garden schemes. Each scheme member was taken to represent a different household within the area. A non-member was taken to be a representative of a household from one of the villages in the area who did not join one of the collector well/community garden schemes. Each non-member was taken to represent a different household within the area which did not participate directly in the community garden.

2. All financial figures quoted in this paper were converted to a 1996 Z$ equivalent. The multiplier is based on Zimbabwean Central Statistical Office figures and takes 1990 as the base year. The 1996 Z$ figures were then converted to a 1996 US$ equivalent using a conversion rate of US$1 = Z$10.06.

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The Demographic Crisis in the Former Soviet Union: Introduction

CHARLES BECKER
University of Colorado, Boulder and Denver, CO, U.S.A.
and
DAVID BLOOM*
Harvard University, Cambridge, MA, U.S.A.

1. INTRODUCTION

During 1990–95 countries of the former Soviet Union and of Eastern Europe experienced an extraordinary demographic crisis, most notably a startling fall in life expectancy. In Russia alone, life expectancy fell by 6 years, from 70 in 1989 to 64 in 1995, which represented an estimated 1.3 to 1.7 million premature deaths. These deaths were disproportionately concentrated among prime age men. The magnitude of this crisis, along with its peculiar demographic structure, has inspired many researchers to compare these deaths to casualties of war. This special issue of *World Development* is devoted to understanding the structure, causes, and consequences of this demographic crisis.

Available data provide clear evidence of the immediate causes of the sudden rise in death rates. In Russia, during 1989–94 there was a 50% increase in deaths from cardiovascular disease; external causes of death, such as accidents, injuries, poisoning and violence, increased by 150%; and there was a dramatic rise in deaths from preventable diseases such as tuberculosis, bronchitis, pneumonia and dysentery. While the proximate causes of the mortality increase are unambiguous, much work has been done to try to understand its underlying causes. The correlation of the crisis with the demise of the Soviet system has led many investigators to suggest that the economic transition, with its accompanying political and economic instability (including a sharp drop in real incomes), was a major causal factor. Increases in psychosocial stress and the loss of social capital believed to be associated with the transition are often cited, as are the undoubtedly related excesses in alcohol consumption. The increasingly inefficient medical infrastructure, caused partially by the decline in state health care expenditures, is also believed to have a significant negative impact on life expectancy. Other possible causes include poor nutrition, the long-term effects of smoking, and environmental degradation.

In an effort to understand better the crisis, its magnitude, nature, origins and consequences, the Harvard Institute for International Development hosted a conference in January 1998 on "The Mortality Crisis in Post-Soviet Societies." The conference brought together an international, multidisciplinary group of participants whose background spanned medical, demographic, economic and sociological training. This special issue consists of a collection of the papers presented at this conference, of which several were presented at a preliminary workshop held in early 1997 at the University of Colorado's Institute of Behavioral Science.

The papers in this issue fall into three categories. The papers in the first category describe the crisis in terms of its magnitude and composition, those in the second examine its

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