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The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water research and development as well as the building of a sustainable water research capacity in South Africa.

Updated irrigation design manual towards optimum water use in the agricultural sector

Large areas of South Africa are subject to hot and dry climatic conditions, high evaporation and a low and intermittent rainfall, where optimal crop production is not possible without the addition of plant-available water by means of irrigation. A recently completed Water Research Commission (WRC) project reviewed and updated the South African irrigation design manual and irrigation user manuals. The manuals serve as a reference guide for crop producers for the planning, choice installation, management and maintenance of an irrigation system, and have already proven to be a valuable addition to crop producers' knowledge arsenal towards more crop per drop irrigation strategies.

Background



The water requirements of irrigated agriculture in South Africa are estimated at 56% of the total annual water requirements of 22 045 million m³ surface and groundwater (WRC, 2010). Although the contribution of irrigation to total agricultural production varies according to crop type, most of this water is used for commercial food production.

It is, therefore, important that technology transfer takes place to communicate information on improved water use efficiency to all stakeholders in the irrigation sector, including the suppliers of irrigation equipment and management services as they play an important role in water management at the farm and field level.

Currently, the main sources of locally relevant information for the design and management of irrigation systems are the Irrigation Design Manual and the Irrigation Users' Manual, both published by the Agricultural Research Council (ARC). The Design Manual was first published in 1996 and updated in 2003, while the Users' Manual was first published in 2002.

An opportunity to influence irrigation water use efficiency across a wide spectrum of stakeholders has been identified in the urgent need for the revision and updating of both these manuals, which are used extensively for training of irrigation designers and managers in South Africa.

The two irrigation manuals are well-known and widely used in the South African irrigation sector, especially the Design Manual, which is used by most of the tertiary education institutions as a textbook for irrigation courses as the industry standard. The irrigation industry consists of the manufacturers or suppliers of equipment, retail outlets, irrigation design professionals, and irrigation installation and/or maintenance contractors, serving the agricultural sector, which consists of more than 30 000 farmers irrigating around 1.2 million hectares of land in South Africa.

The South African irrigation design manual and irrigation user manuals

It is of utmost importance that the manuals are kept up to date with the latest information and developments in the irrigation industry as effective knowledge sharing is necessary for the effective use of water by everybody

involved in irrigation. According to the ARC, approximately 400 manuals are sold annually.

A new edition will also lead to existing users replacing their outdated copies (it is estimated that there are approximately 5 000 copies of the Design Manual and 2 000 copies of the User's Manual in circulation). Thus, the proposed project will have a positive long-term effect especially since it aims to meet some objectives of the National Water Resource Strategy.

The main objective of the project was to come up with comprehensive, current and user-friendly irrigation design and irrigation user manuals.

The specific objectives were:

1. To update and improve the South African Irrigation Design Manual (IDM) to ensure that current best practices are employed in the design process which will help safeguard the irrigation industry amid the current over exploitation of South Africa in the design process and the decrease in energy availability and the subsequent rise in energy costs.
2. To update and improve the South African Irrigation User Manual (IUM) in order to assist both commercial and subsistence irrigation farmers as well as irrigation scheme managers in the quest to meet the stated goals in National Water Resource Strategy 2 of improved water use efficiency by providing quality and relevant information about current trends and the latest technological developments in the irrigation industry.

Approach used

The Irrigation Design Manual consists of nineteen chapters of highly technical material while the Irrigation User's Manual consists of thirteen chapters of information pertinent to users in the irrigation sector. Users include commercial and subsistence farmers as well as irrigation schemes. To comprehensively update the manuals, the following processes were followed:

1. Review
2. Update
3. Rewrite

The results of each process, followed sequentially, fed into, and formed the basis for the next process.

1) Review

The focus of the review process was to identify existing errors, challenge the existing material, identify knowledge gaps and omissions and make recommendations for

improvements. In order to accomplish the review process, a series of consultative workshops countrywide were undertaken whereby, amongst others, representatives and individuals from the following were invited:

- South African Irrigation Institute
- South African Institute of Agricultural Engineers
- Academics from local universities
- Practicing consultants
- Commercial farmers
- Industry experts

During the review process nineteen chapters from the Irrigation Design Manual were reviewed while thirteen chapters from the "Irrigation User's Manual" were reviewed.

2) Update

During the updating process a comprehensive literature research study was undertaken guided by the outputs of the review process. Both current local and overseas irrigation design and user irrigation practices were systematically analysed and assessed to ascertain the best approaches that could be applied in the South African situation. The investigative process did not solely concentrate on available literature but also encompasses inputs from irrigation equipment suppliers, industry experts as well as recognised designers and users. A large emphasis of the research was on encouraging the sustainable use of both water and energy within the irrigation sector.

In addition to the body of knowledge that was gathered, relevant design and user examples were included to explicitly explain the complexities, intricacies, inter dependencies, and implications of the gathered technical data. The examples emphasise on current design norms and the application of the latest technological advancements in equipment against a background of diminishing resource base of water and energy supplies.

A major thrust of these examples was to illustrate the need for effectiveness and efficiency in irrigation design and water usage in agriculture.

3) Rewrite

The final stage was to compile the chapters in each manual in a logical format with appropriate explanative diagrams, photographs, graphs, tables and figures that promotes effective knowledge dissemination and enhances the skills levels in the agricultural water use sector.

Outcomes

In both manuals, there were renaming, restructuring and addition of new chapters. The review and update of the Irrigation Design Manual resulted in new chapters being introduced. These include: Documentation and drawings (Chapter 18), Feasibility studies (chapter 19), Greenhouse irrigation systems (chapter 14) and Terminology, conversion tables, design norms and overview of design software (chapter 20).

In turn, the review and update of the Irrigation User's Manual resulted in the introduction of the following new chapters: Greenhouse irrigation systems (chapter 13) and Terminology, conversion tables, design norms and overview of scheduling software (chapter 16).

The new manuals have major changes that include (but are not limited to) a shift from system efficiency to accounting for water losses, to water balancing and water accounting using. In the design manual, a water framework is used to show exactly where water losses are taking place for open channel hydraulics and bulk water supply.

The introduction of greenhouse irrigation systems, as a completely new chapter, strengthens the two manuals. An irrigation system designed for greenhouse applications are done on the same principles as micro and drip irrigation with a few adaptations to more frequent and intensive irrigation strategies. However, the technologies used in these systems are more varied with diverse equipment and

application techniques.

One of the key improvements to the manuals include a complete section on variable speed drives (VSDs). A VSD is a device that can vary the speed of a normally fixed speed motor. It is a type of adjustable-speed drive used in electro-mechanical drive systems to control the motor speed and torque by varying input alternating current frequency and voltage. Typically, a VSD system consists of a variable frequency power supply which uses solid state components to produce a pulse-width modulated current that varies the power and frequency supplied to the motor. This enables accurate control of the motor speed over a broad range. Their main advantage is that they are energy efficient. They also reduce noise generation and wear on mechanical components such as belts and bearings.

Conclusions

The review and update resulted in two comprehensive manuals. The final deliverable is compiled in three volumes, i.e. Volume A (the Main Report), Volume B (the Irrigation Design Manual) and Volume C (the Irrigation User Manual). The two reviewed and updated manuals are now more understandable as effective tools for both the designer and the user.

There is a strong relation between the two manuals to allow for cross referencing.

Related report

Irrigation Design Manual (**WRC Report No. TT 819/1/20**) and Irrigation User's Manual (**WRC Report no. TT 819/2/20**). For more information, contact WRC Executive Manager, Dr Sylvester Mpandeli, at sylvesterm@wrc.org.za