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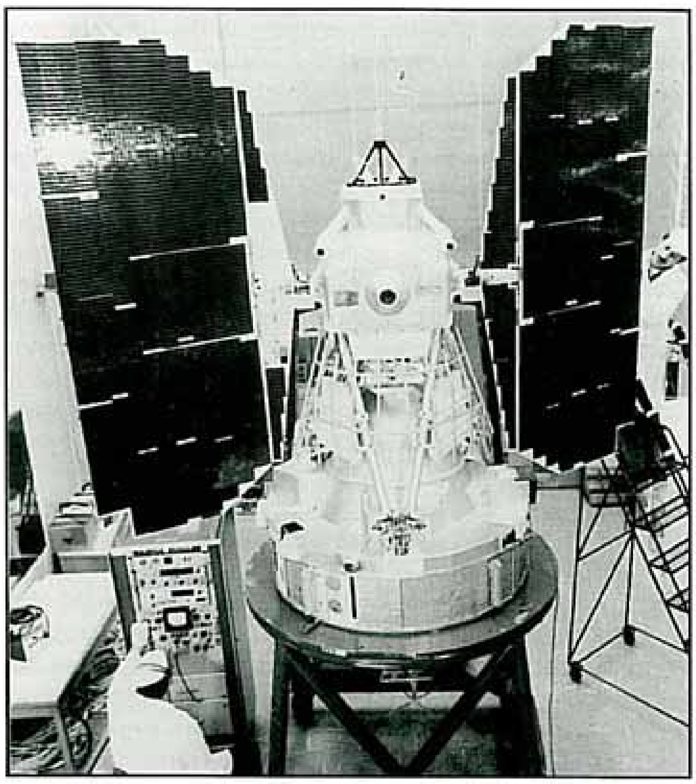
An Eye In The Sky

It's Cost Effective

Often times, on the ground you cannot see territory quite as well as you can see from up high," says Western Irrigation District's (WID) Theo Owel. As an alternative to obtaining the most costly and dated aerial photographs, the WID has started utilizing "remote-sensing" imagery, i.e. imagery obtained from satellites.

The main attractiveness of satellite imagery is the low cost, states Owel. This low-cost feature means that imagery can be updated annually or more frequently if special projects so require. Other advantages include: the image can be utilized for many different analyses, easy reproduction and potential incorporation into GIS applications.

"There are a number of special considerations associated with this approach. First of all, the raw data (obtained from RadarSat International) requires geo-referencing by an outside consultant. Due to the complexity, and the related high cost of computer software, it is not likely that this process will ever be undertaken in-house. However, it is



Satellite being put through final testing before being launched to gather satellite imagery.

anticipated that this outside contract will be relatively inexpensive for second and subsequent updates," states Owel.

"Another drawback," states Owel "is the resolution of the imagery. Of the two options available (imagery from the Landsat satellite or Spot satellite) the best resolution available is 20m for multispectral (color) imagery. Panchromatic imagery is available at 10m resolution, but this black and white imagery does not allow for the detailed interpretation that we require." "While this resolution of satellite imagery is not as good as is available with conventional aerial photography, it will allow the review and area calculations with sufficient accuracy. We also anticipate that the image accuracy will improve substantially in the very near future, perhaps to 5m or better," he adds.

A concern for some time is the availability of software required to handle the satellite imagery (i.e. view, analyze, perform calculations). "We have reviewed different options, and we have found a product (MapInfo ver.3.0) that will satisfy our needs, at a price that is surprisingly low (less than $2000.00)," states Owel.

After initial start-up costs of approximately $5000.00 to purchase software and baseline information, the costs for annual updates are estimated to be in the order of $6000.00.

"The main objective of the acquisition of new imagery is to determine 'who is irrigating, where, and how many acres'," he states.

The essence of satellite imagery is the fact that any surface feature on earth reflects a certain amount of sunlight, both visible light with wavelengths in the range of 0.4-0.7 μm as well as infrared with longer wavelengths in the range of 0.7-3.0 μm. These reflections are recorded by sensors aboard the satellite. The amount and intensity of the reflection in the various wavelengths is indicative of the nature and type of the surface feature. For example: because water absorbs infrared very strongly (and therefore reflects very little), water bodies like reservoirs and lakes show black on infrared imagery. On the other hand, lush green vegetation reflects infrared very strongly, which shows as very intense red on the imagery. Unhealthy vegetation reflects far less infrared, and shows more like a pink image.

Due to a large number of factors that all have some impact on the make-up of the image, a certain amount of ground-truthing is required before definite statements can be made on the basis of the imagery. This ground-truthing happens after certain assumptions are made based on initial analysis of the imagery. The field investigations can then be used to fine-tune the image model. Because irrigated fields receive a consistent and uniform amount of water (resulting in even crop growth) the imagery will show these fields as a uniform, bright red. One of the better indicators on the imagery is the centre pivot. These fields will show as very precise circles, in a very bright and intense red. The spectral make-up of these areas can then be used to "train" the computer: the computer can be instructed to look for all parcels with the same color make-up, those parcels are then labelled as having a high-probability of being irrigated. Ditchriders are provided with these details for field reconnaissance.

"The first imagery we obtained was recorded on July 27, 1994. The initial analysis has been completed, and we are in the midst of field truthing the details. We now have ordered imagery for 1995 and on the basis of recommendations from our ditchriders we have ordered data which is recorded earlier in the season. The reason: hay crops were cut before the end of July, which means that most of the plant material (which is crucial for the reflection of the sun's radiation) was gone. The field will therefore not yield the bright red image which is normally indicative of irrigation!" says Owel.

The following steps form the process to compare field practices with the current assessment roll:

1. Acquisition of raw data from Radarsat International.
2. Geo-referencing the data to the UTM coordinate system.
3. Analysis of the imagery to determine irrigated areas. Outline irrigated areas on computer (polygons).
4. Perform computer assisted comparison of assessment records with polygon map, and highlight all mismatched records meeting certain criteria.
5. Analysis of selected parcels via ground truthing (field inspections); review of ditchrider reports, landowner contact, etc.
6. Correction of deficiencies in assessment roll.

"Ultimately, all parcels which are being irrigated are to be backed-up with the right type of irrigation contract. We have been finding a number of parcels where the actual irrigated area is larger than the area on contract. Quite often the farmer will not have realized that his expanding irrigation set-up has outgrown his contract. Another circumstance we are encountering, is where a farmer irrigates a field, he has no contract, and supports this practice because he has other areas under contract he doesn't irrigate. The Board of Directors of the Western Irrigation District has directed that all these discrepancies between the assessment roll and the actual field practices are to be corrected. With the use of satellite imagery we hope to identify and quantify all these, considerably faster and easier than without 'help from above'," concludes Owel.

For more information contact Theo Owel, Western Irrigation District, 201 Pine Road, Strathmore, Alberta, Canada T1P 1C1. Telephone (403) 934-3542. ■

Langemann Gate Being Marketed

It started with a great idea for Peter Langemann, the man of many talents. For a long time he toyed with the idea that there had to be some way of mechanizing a farm turnout gate on a canal so that no matter what volume of water was flowing in the canal, a set amount of water would be diverted through the turnout. He set to work on the design throughout the winter of 1992 and built the first models.

The gate was designed on the basis of what he calls "a feed forward principle." "That is to say, that my electronically-controlled gate imitates the variations in water level on the upstream side of it. If the water level goes up the gate goes up the same corresponding amount and vice versa. This simply means there is always a constant head above the gate and therefore a constant flow over it." In 1993, the first prototype Langemann constant flow gates were field tested in the St. Mary River Irrigation District (SMRID). Results were very positive. The self-taught inventor gave his invention and his patent rights to the SMRID who, in turn, has contracted to Aqua Systems 2000 Inc. (AS2I) to build and market the gate.

"The patented design has gained recognition and acceptance due to its simplicity, overshot technology, control capabilities and low power requirements," says Gerald Robinson a partner in AS2I. The gate is designed to fit into the stoplog guides or onto the face of an existing structure and can be installed when the canal is in operation. Installation is completed within three to four hours.

Each gate is engineered to fit a new or existing structure and comprises of: double-hinged gate leaves, a rigid frame with side plates and a drive mechanism powered by a battery and solar panel. The gate functions as a vertical adjustable weir with a water level sensing and control system that works in either flow control or level control mode. The gate provides positive linear movement in either direction in increments as small as 3.0 mm.

It's the ideal solution for those sites where grid power is not readily available. The design of the gate provides a unique distribution of water pressures afforded by the gate configuration and the use of low friction operating components allow for low power requirements. "A battery and a solar charging system can operate very large gates" says Robinson.

In the spring of 1995, the Bow River Irrigation District purchased a large Langemann Gate (5.0 m wide by 1.3 m depth) and installed it on their "B" system. The gate is

Hydraulic Hi-hoe lowers Langemann Gate into existing concrete structure on BRID's Lateral B. Note: canal is in operation.

located on a structure downstream of three closed gravity pipelines and a lateral tailout from another irrigation block. "Handling excess water from the systems was very difficult before the Langemann Gate was installed," says Emil Johnson, district water master. "Now any surges are directed by the gate down the drain. It has proven itself in providing steady downstream flow control," concludes Johnson.

The high-tech gate has solved another water management problem on the SMRID's large Lethbridge Lateral where it bifurcates flow into the Northeast (14.55 m^3/s) and North Laterals (10.6 m^3/s). Water supervisors Gary Miler, Maurice Madsen and Keith Preddy had one of the most difficult control sites to operate in the entire western block. A rather complex set of hydraulic conditions come into play at various flow settings which results in site attendance requirements that are excessive whenever a flow change is made. "With the installation of the Langemann Gate in the North Lateral, controlled flow can be maintained. What was a very time consuming and complexing situation has now turned into a normal operating situation," says Keith Preddy.

"Practical irrigation applications for the Langemann Gate," says Robinson, "include check structures, turnouts, spillways and reservoir control structures. It has a lot of potential applications in industrial and municipal areas as well. The overshot configuration promotes safety in that it provides free movement of floating debris allowing it to pass through the structure and avoids the collection of trash in front," concludes Robinson.

For more information contact Gerald Robinson or Ken Craig at Aqua Systems 2000 Inc., 1606 Lakeside Road, Lethbridge, Alberta, Canada T1K 3G8. Telephone (403) 327-8381. ■

Management Practices For Good Surface Water Quality

This article is the second in a two-part series of articles on surface water quality. The first article appeared in the previous issue of the Water Hauler's Bulletin.

Elevated levels of certain constituents in surface water can have deleterious effects on agricultural production, the environment, animals and humans. These constituents include salts, nitrogen, phosphorus, coliform bacteria and trace elements. Deleterious effects of these constituents, factors that lead to elevated constituent levels, and practices producers can use to minimize or prevent the buildup of elevated constituent levels are discussed.

Salinity and Dissolved Solids

Excess salts, sodium and other dissolved solids can have serious effects on agricultural production. High salt concentrations in soils interfere with the extraction of water by plants. This causes plants to suffer from moisture stress, and results in reduced crop yields. Excess sodium in soils reduces the permeability of soil to water, air and roots. High levels of salts and sodium may be toxic to some crops. High total dissolved solid concentrations in water may adversely affect taste and can reduce livestock productivity.

Southern Alberta's semi-arid climate results in relatively high salt concentrations in some soils and much of the groundwater. Most of the salts are very soluble and can become further concentrated where groundwater discharges at the soil surface. Surface runoff can move salts from the soil surface into streams and lakes. Irrigation waters drawn from water sources with high salt levels will cause irrigated crop yields to decline.

Producers can minimize the buildup and spread of soil salinity by avoiding over-irrigation, and ensuring irrigated soils have sufficient drainage.

Nitrate-Nitrogen and Phosphate-Phosphorus

Nitrate-nitrogen has been implicated in two major health problems, blue-baby syndrome (methaemoglobinaemia) and stomach cancer. Phosphate-phosphorus is not commonly toxic to man, animals or fish. Excessive amounts of nitrogen and phosphorus added to water bodies promote noxious aquatic weed and algae growth and premature aging of lakes and streams, a process called eutrophication. Phosphate-phosphorus is often the nutrient that promotes accelerated eutrophication, which restricts the use of surface waters for fisheries, recreation, industry and drinking. Excessive plant growth can deplete oxygen concentrations and result in fish kills.

Nitrate-nitrogen is highly water soluble and therefore very mobile. Potential agricultural sources of nitrate-nitrogen contamination include nitrogen fertilizers, runoff from feedlots and manure storage facilities, and overloading of land with manure. Phosphate-phosphorus is transported to surface waters as soluble phosphate-phosphorus in runoff and particulate phosphate-phosphorus from eroding surface soil, streambanks and channel beds. Potential agricultural sources include phosphorus fertilizers and manure applications to cultivated land. Canadian water quality guidelines have not been established for phosphate-phosphorus. Maximum desirable concentrations of phosphate-phosphorus to prevent accelerated eutrophication in flowing water, in lakes and reservoirs and for water flowing into lakes and reservoirs have been established by the U.S. Environmental Protection Agency.

Producers can take steps to avoid losses of nitrate-nitrogen and phosphate-phosphorus in surface runoff. Nutrient applications from fertilizers and manure should not exceed crop nutrient requirements. Proper timing and placement of fertilizers help minimize the potential for nutrient losses. Conservation tillage leaves crop residues in place to protect the soil surface from wind and water erosion. Cover crops also hold the soil in place. Grassed waterways and vegetative filter strips around streams and ponds slow runoff, allowing soil sediments to settle out before reaching surface waters. Runoff around feedlots should be diverted away from surface waters. Manure applied to fields should be incorporated, if possible, to reduce the potential for nutrient losses from runoff. If incorporation is not possible, manure should be applied to fields with growing crops or crop residues. Fields receiving manure should be rotated to avoid nutrient buildup. Manure should not be applied to frozen or snow-covered land. Applying manure to wet soils should also be avoided to minimize soil compaction, runoff and nutrient leaching.

Coliform Bacteria

Total and faecal coliform bacteria are indicators of the potential occurrence of disease-causing organisms such as hepatitis and salmonella. Sources of total and faecal coliforms in surface waters are faeces and urine from livestock, humans and wild animals, including the waste products of living farm animals. Water contamination caused by animal wastes is due to high manure application rates to soil, runoff from feedlots or manure storage piles, spillage of manure into surface waters, and defecation and urination of animals in surface waters.

Many factors can contribute to high coliform counts in surface waters, and farmers can adopt management practices that ensure they are not adding to the problem. Good manure management practices are essential. Manure buildup in any one area of a pasture can be prevented by maintaining stocking rates appropriate for the pasture size. Highly productive forage can be maintained on pasture land to slow runoff and to utilize nutrients. A rotational system of grazing can be used to prevent overgrazing and soil

Manure should be applied at rates that do not exceed crop nutrient requirements.

erosion. Feeders and waterers can be located a reasonable distance from ponds and streams, and moved to new locations before livestock wear paths by repeated trampling. Areas that become barren of plant cover are susceptible to possible contaminated runoff. Livestock access to ponds and streams can be limited by fencing. Shade can be provided in summer to reduce the need for animals to enter water for heat relief.

Trace Elements

Many trace elements are biologically beneficial at very low concentrations, but toxic or otherwise detrimental to the health of organisms and plants at low to moderate concentrations. Trace elements occur in nature at low concentrations, and their concentrations in different natural environments vary widely. Point and nonpoint sources, which contribute trace elements to surface waters, result primarily from human activities. The first modern pesticides were metals, specifically arsenic and mercury. Mercury was used until 1985, and arsenic is still applied in limited quantities. Metals do not degrade in the environment, but tend to accumulate. They may be changed chemically after they are added to the environment, but once added they do not disappear. Contributions of trace elements to the environment include atmospheric pollutants, sewage sludge, irrigation water, pesticides and fertilizers. Farm and home items that can contribute trace elements to the environment when discarded include motor oil, fuels, antifreeze, paints, wood preservatives, batteries, computers and smoke detectors. Improper disposal of these items can cause serious environmental contamination.

Producers can minimize the risk of environmental contamination by applying pesticides and fertilizers only at recommended rates. Recycling and proper disposal of used or left-over chemicals and other toxic items can also prevent environmental contamination.

For more information contact Graeme Greenlee, Resource Conservation Section, Irrigation Branch, Alberta Agriculture, Food and Rural Development, Agriculture Centre, Lethbridge, Alberta, Canada T1J 4C7. Telephone (403) 381-5893. ■

A Geographic Information System for the Eastern Irrigation District

Editors Note:

This is the last of a three-part series regarding the GIS of the Eastern Irrigation District.

Part 3:

Implementing a GIS, Value of Partnerships

There is much more to implementing a GIS than simply purchasing the software. The software selection and purchase kicked-off the massive data collection effort that actually forms the GIS. In the past year, the following activities have been completed:

• Aerial Photography Data Collected

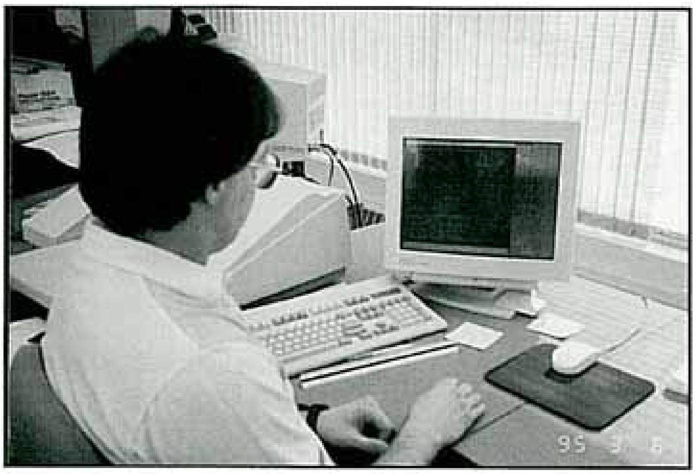
The EID arranged for a new fly-over for its administrative region. This area includes 1.5 million acres of land, of which the irrigated areas account for some 270,000 acres. The photographs were taken in false color infrared to show vegetative growth and irrigation patterns. In advance of the aerial photography a complete ground control for the project was established. This process ensured the 80% overlap of flight lines, combined with an airborne geographical positioning system, could be used to generate 1.0-metre contours and to ensure that the scanning of the photos themselves could be corrected for the orthogonal project of the earth. Hard copy prints of the photos were also produced. The EID contracted Stewart Weir Land Data Inc. to complete this portion of the project.

• Converting Photos Into Data

In addition to obtaining the aerial photographic information, the EID also contracted Stewart Weir to convert the aerial photographs into digital images. This was accomplished by scanning the photos and subjecting them to analysis to develop contours on the basis of a 1.0-metre resolution. Each photo was provided to the EID as an individual computer file.

• Pushing the Technology

During the software evaluation stage of the GIS project, the EID recognized that the PAMAP GIS had the most potential to deal with digital images, even though PAMAP's actual experience with images was minimal in comparison with the EID project. Taking the digital data produced by Stewart Weir and bringing it into PAMAP involved a close cooperation between the EID and EPS's programmers. Handling the large file sizes was a particular challenge.



Mark Porter operates geographic information package on 486 Dell computer.

• Implementing the GIS Components

The EID's task now began in earnest. The first component of the GIS involved combining nine individual digital files together for each township (the EID region covers 75 such townships). Once the township photos had been combined, the contours were overlayed on a vector level. The combination of the raster (the digital photo data) and the vector data (the contour data) forms the backdrop for the entire GIS.

The EID also arranged to purchase data relative to oil and gas operations in the region from Canex. This information, including wellsites, pipelines, access roads, etc. was merged into each of the township maps that had been produced.

The aerial photos were put to immediate use in providing a visual positioning for the location of the entire irrigation network, canals, drains and reservoirs. This time-consuming task was completed on a township-by-township basis. The high quality of the photo data has provided the EID with a very detailed and up-to-date map of the entire irrigation infrastructure.

Parcel mapping data, including surveyed blocks, right-of-way plans, lot plans and registered plans was purchased from the Alberta Government and combined into the township maps. The overall accuracy of the data has been confirmed through visual comparisons of the locations of canals, roads, etc. to the parcel mapping data. This provides a high level of confidence to the applicability of the next phases of the EID's GIS Project.

• Next Phases of Implementation

The next phase of the project involves a review of the irrigation assessment. This comparison of current records to aerial photographs will indicate areas where the assessment does not reflect the actual on-the-ground irrigation operations.

Future components of the project include adding all of the canal system technical data including turnout locations, canal design elements by reach, data related to road crossings, structure locations and sizes, annual canal maintenance records, pesticide operations, locations of wetland and wildlife projects, emergency response plans, etc. These elements will be phased into the GIS based on the priority of their need for integration.

"By approaching our information needs on a regional basis, we have been able to design a full featured GIS that meets our needs and the needs of many others in the region," says assistant manager Earl Wilson, P. Eng. "By involving other organizations, such as Pan Canadian, in our discussions, we have been able to develop funding partners that have made this GIS system a real bargain in the long-term." The total costs of implementation to date are estimated to be around $350,000. Pan Canadian has shared in this cost as a data collection exercise. For their contribution they obtain a copy of the aerial photography, the contours, the irrigation network location and the irrigation assessment. By having both organizations work from the same data, future land use conflicts will be reduced, resulting in cost savings, concludes Wilson.

For further information or a demonstration of the EID's GIS system, please contact Mark Porter, Eastern Irrigation District, P.O. Bag 8, 550 Industrial Road, Brooks, Alberta, Canada T1R 1B2. Telephone (403) 362-1400 or Fax (403) 362-6206. ■

Alberta Irrigation Projects Association Annual Conference '95

The Alberta Irrigation Projects Association (AIPA) will be holding its annual conference November 19-21 at the Lethbridge Lodge Hotel. Conference chairman, Kent Bullock, says this year's theme is "The Value of Water – Beyond Measure." The conference is limited to the number of delegates it can accommodate. For more information please contact conference secretary Verna Lees at telephone (403) 328-3063. ■

Scheduling Irrigations Using A Home-Based Computer Model

Scheduling irrigations to ensure that growing season soil moisture is adequate for crop growth is always a challenge. A new tool to help in irrigation scheduling is being tested by the irrigation branch of Alberta Agriculture, Food and Rural Development. The model **(LRSIMM)** was originally developed at the Lethbridge Research Station by Agriculture and Agri-Food Canada. It estimates daily crop water use and suggests timing and amounts for irrigations using soil and moisture condition information, daily weather data and inherent crop water use co-efficients.

"The software has been developed to help producers optimize their input and production levels," says Gregg Dill, irrigation specialist with the irrigation branch of Alberta Agriculture, Food and Rural Development. "It can be especially helpful to those irrigators with larger operations and many systems and fields to manage," he says. Nonetheless, the model may also be useful to water managers in irrigation districts who may wish to get a better forecast of potential water demands on either a block-by-block or overall district basis.

Two producers who used and tested the model during the 1994 irrigation season made the following comments:

"The model confirmed the need to irrigate within two to three days of the irrigation management technician recommendation. This is well within the accuracy required for good irrigation management considering the range of conditions that exist in a field."

"My confidence in the model's predictions grew during the irrigation season. However, it should not be used as the only decision making tool. It is still essential that periodic field soil sampling be done to confirm predicted soil moisture levels."

The first time the model is used, information about the field to be "computer monitored" needs to be entered into the model. This includes such parameters as: type of crop being grown as well as soil texture-related factors such as water holding capacity, allowable moisture depletion and initial soil moisture depletion. Soil moisture samples should be taken and analyzed to determine these values although they can be estimated manually by hand texturing taught through the AIM (Alberta Irrigation Management) Program.

Daily recordings of weather data, including maximum and minimum air temperatures, solar radiation, wind and rainfall, are required to be entered at least every week. Precipitation and temperature information can be collected relatively inexpensively at the local farm level. Solar radiation and wind data require more expensive equipment to collect but this data is usually available, and usually valid locally, from a meterological monitoring site located within an acceptable distance (100 km) from the field. Along with entering the summary of daily weather data, the amount of any irrigations applied and associated dates are required to be entered into the computer program.

Consumptive moisture use is calculated for the crop based on the date (which relates to crop growth stage), the weather data and the soil moisture information provided. The resulting soil moisture level is then calculated. Once the soil moisture level is calculated, the date of the next irrigation is predicted from long-term consumptive use data.

An example of the weekly LRSIMM report and IRRIGATION report are shown in Table 1 and Table 2. These reports are produced for each field monitored through the model. A field may be defined for each crop, soil type, moisture conditions or different irrigation management. Up to ten fields can be monitored within the model at any one time.

Table 1. Weekly weather and crop use report

Table 1. Weekly weather and crop use report

LRSIMM REPORT for: Lethbridge to Jun 23

FIELD 3: PEAS REGION: Lethbridge BEGINNING DATE: May 1

JULIAN DAY (no.)	CALENDAR DATE	MAX TEMP (C)	MIN TEMP (C)	SOLAR RADIATION (kj/m2)	WIND (km/day)	RAIN and IRRIGATION (mm)	CROP USE (mm)
168	Jun 17	20.0	4.2	30101	234	0.0	4.1
169	Jun 18	22.6	4.0	25347	234	9.0	3.5
170	Jun 19	21.7	3.8	32192	427	0.0	5.7
171	Jun 20	25.8	4.5	30180	197	0.0	5.0
172	Jun 21	25.0	10.8	31190	240	53.0	5.5
173	Jun 22	28.4	9.8	27940	196	0.0	5.8
174	Jun 23	29.1	14.6	26497	291	0.0	6.2
					Weekly Totals	62.0	35.7
					Season Totals	153.0	153.3

Table 2. Weekly irrigation report

IRRIGATION REPORT for: Lethbridge

CROP or FIELD	REPORT DATE	SOIL MOISTURE DEPLETION TO-DATE (mm)	ALLOWABLE (mm)	REMAIN (mm)	IRRIGATIONS LAST	NEXT	AMOUNT (mm)
PEAS	Jun 23	65	96	31	Jun 21	Jun 30	96

The **LRSIMM** report (Table 1) includes the input weather data which can be checked for errors and corrected as required. Weekly and seasonal totals for rain and irrigation as well as crop use are included to provide an overview of the moisture/crop use balance.

The IRRIGATION report (Table 2) provides the soil moisture depletion information to date and recommends the date of the next irrigation. The recommended amount of the irrigation is based on the allowable soil moisture depletion provided as input during model initialization.

An evaluation of the performance of the model is shown in Figure 1. **LRSIMM** results, AIM estimates and neutron probe moisture readings are plotted and can be compared. Bryan Smith, AIM technologist with the irrigation branch in Lethbridge notes, "The model tends to predict higher consumptive use later in the season and consequently can encourage one or more additional irrigations that were considered and confirmed as unnecessary by the AIM technician using neutron probe moisture measurements." Gregg Dill adds, "Fortunately this situation usually occurs after the end of a normal irrigation season. However, the model may not be too far off, even at the end of the season, for a high-yielding crop. Irrigations were predicted most successfully for top producing fields." Because the model tends to more closely represent high production levels, it can also be used to evaluate situations where optimum production levels are not being achieved and to determine if an assessment of other system aspects or cultural practices needs to be carried out. "It can also be noted," says Dill "that the soil moisture dropped below 50 per cent available in July due to irrigation system shortcomings. The model is also useful to identify such limitations."

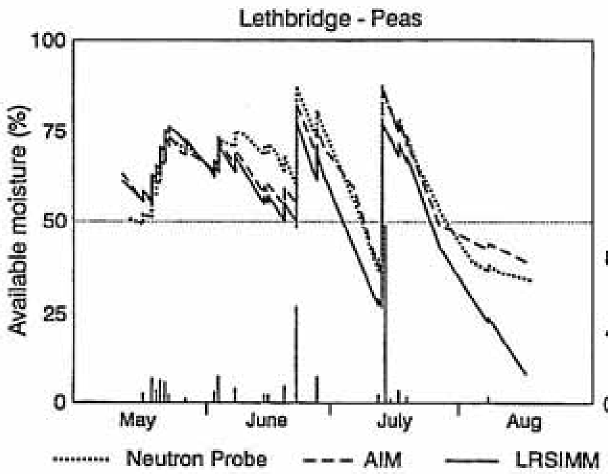
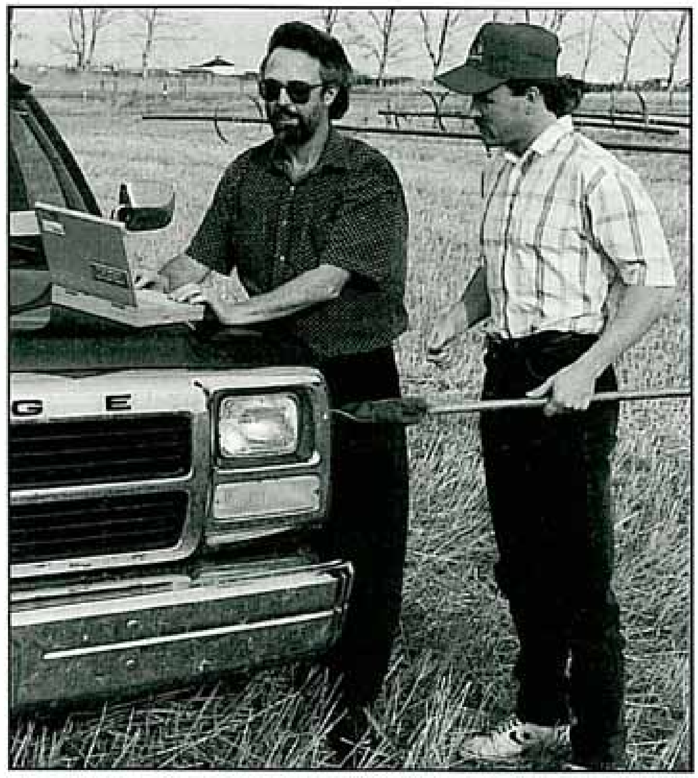


Figure 1. Comparison of LRSIMM soil moisture predictions vs. conventional field measurements.

The **LRSIMM** model is being "field-tested" again this year by many more irrigators across southern Alberta in order to refine its ability to serve as a beneficial tool, helping irrigators achieve more cost-effective and high-yielding production levels. An expanding network of meteorological or agro-climatic data collection stations, supported by the irrigation branch, Agriculture & Agri-Food Canada and Environment Canada, provides the base of weather information. Soon, regular reporting of such weather information could be available through such electronic information services as the Internet.

For more information, contact Gregg Dill, Irrigation Specialist, Alberta Agriculture, Food & Rural Development, Agriculture Centre, Lethbridge, Alberta, Canada T1J 4C7. Telephone (403) 381-5136. ■



Gregg Dill (l) and Bryan Smith verify the LRSIMM soil moisture predictions vs. actual soil probe sampling.

THE WATER HAULER'S BULLETIN

Designed to provide the operation and management personnel of Irrigation Districts with items of interest in their line of work. Comments are welcome. Please contact Duncan Lloyd, editor, at Area Code (403) 381-5539, Lethbridge.

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