Accuracy: Irrigation Design Software and Google Earth

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Abstract. *In the past, an irrigation designer was reliant on the surveyors' data to provide an accurate digital terrain model.*

In many cases when the data was not available, the designer would proceed as if working on a flat surface or make vague assumptions about the terrain. Looking at the software tools available today, it is safe to conclude those days are over and irrigation designers can produce accurate designs at low cost.

By utilizing Google Earth, the irrigation designer can save a lot of time basing initial calculations and design decisions on very realistic survey data.

This presentation will be a comparison between the gain and loss of accuracy when designing irrigation on an undulated terrain assuming it is flat, using a Google Earth surface model and using an actual surveyed DTM. Analysis of the hydraulic results will prove that modern irrigation design software, using Google Earth, is invaluable.

Keywords. Irrigation Design Software, Digital terrain model simulation, Google Earth, Hydraulic calculations.

Irrigation design and elevation differences.

Any irrigation design project should be done based on accurate topographical terrain elevations.

Depending on the height differences in the terrain, a few survey coordinates could suffice. On steeper, complex areas the irrigation designer has to take special precaution to ensure the base survey model is appropriate and representative of the elevation detail. Ignoring this fact can result in inaccurate irrigation designs that:

- Do not produce the required pressure needs
- Are not economical
- Yields a sub standard production crop.

Making use of Google Earth (GE).

Google Earth is available in two license versions:

- A Free version with limited function.
- Google Earth Pro ($399 per year), which is intended for commercial use.

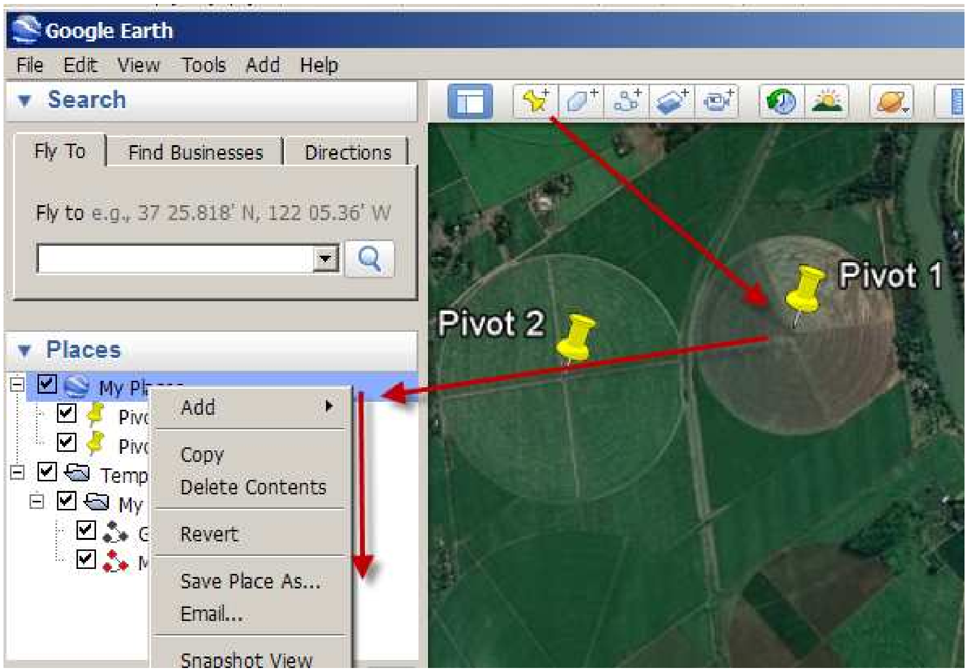
The free version was used in analyzing the data for this report.

Getting elevations from Google Earth.

There are various ways to get elevations from GE. Two basic methods are discussed in this paper.

1) Exporting KML files.

In GE the user can set place marks and then export the place marks as a KML file.



To create a KML file, do the following.

- Use the place mark button and position it.
- The place marks are added to the My Places group.
- Right click on My Places, use the Save Place As and create the KML file.
- Use an appropriate survey/cad/irrigation design program to import the KML file.

2) Using an independent program to communicate with GE to create and extract DTM points.

On larger designs, this will be the appropriate way of interacting with GE.

Software programs available these days are designed to send data to GE and also to receive information back from GE.

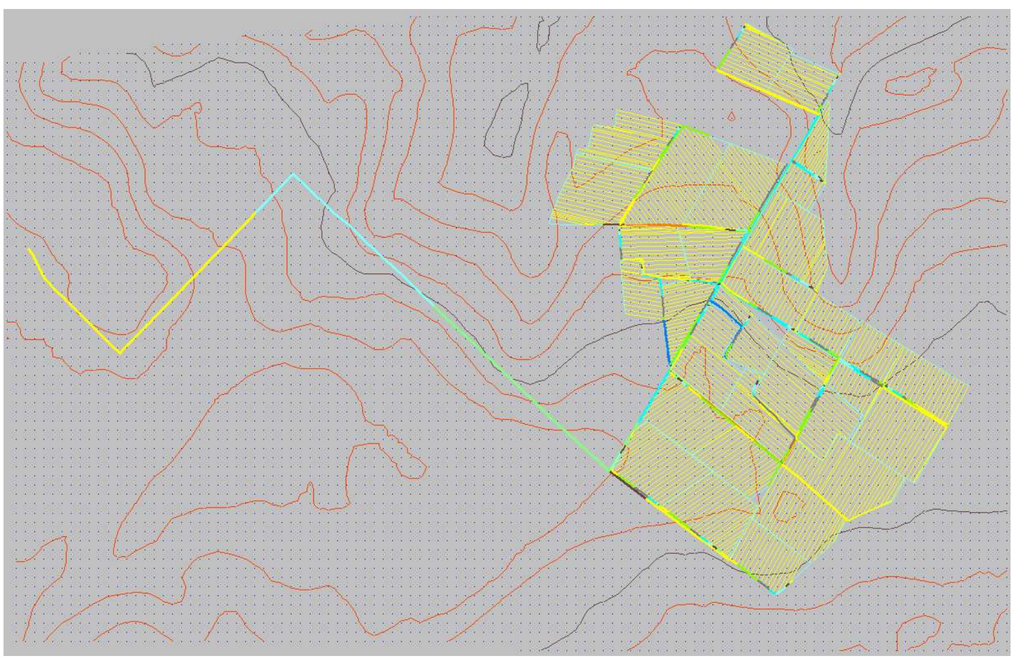
The following are the typical steps taken to set up a digital terrain model in an irrigation design software program.

- Open GE and position the screen over the proposed irrigation design area.
- Import the GE image as backdrop into the irrigation design software.

- On the image backdrop, define the area where the DTM is to be generated.
- Generate DTM points on a regular grid. These points would not have any defined elevations.
- Have the irrigation design software interact with GE and assign related elevations to the grid DTM points.
- Start doing the irrigation design on top of the new DTM.

GE image as back drop for the irrigation design.

Grid DTM data and contours used for the irrigation design.



Irrigation design.

With modern technology and software programs, designing an irrigation project should be doable, accurate and comprehensive. Many factors can affect the accuracy of the design. Working with incorrect topographical elevations should not be one of them. By using the methods described in the section (**Getting elevations from Google Earth**) above, the designer can produce a more accurate irrigation design rather than just making rough assumptions about the terrain.

- The following comparisons and findings were produced by using GE and the irrigation design software program called Irri-Maker.

Four different irrigation projects were analyzed. These projects were initially designed based on actual surveyed topographical data but for this paper, the designs were also placed onto a flat surface and also a GE produced DTM surface.

To determine how far off one could be by assuming a level surface, for each design the critical valve was identified and the pressure calculated. The same was done with the designs when placed onto the GE surface. The system pressure at the critical valve was calculated.

Using the same pipes the designs were then draped over the actual surveyed model and the pressure at the critical valve was re-calculated.

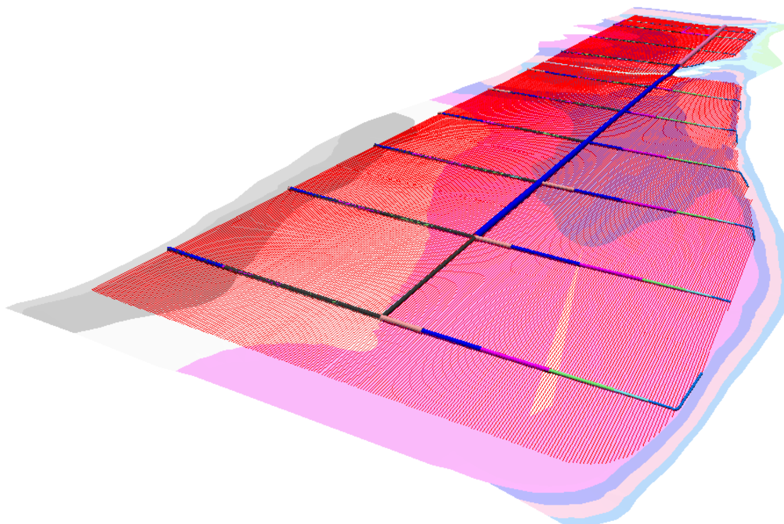
One would assume that the pressure differences between a flat surface and the actual surface would be quite great, especially on a terrain with high elevation differences. On the other hand, how acceptable would the pressure differences be when a design is done on a GE surface?

The following comparisons give an indication of the accuracies.

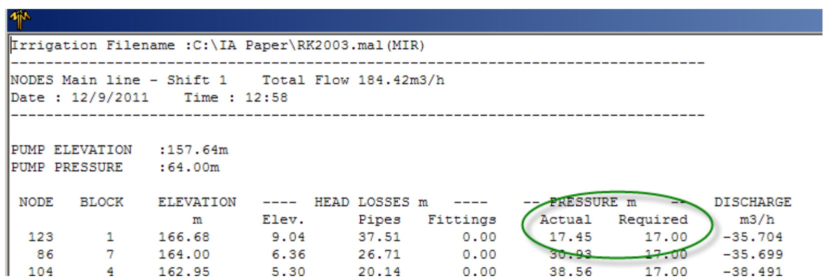
Project 1:

This project is on a fairly level terrain with slopes between 0 and 3% and the designer could easily assume it is flat enough to design without any elevation differences.

- A 3 dimensional view of the relative flat terrain and irrigation layout.



- Typical printout of the hydraulic results showing the actual and required pressures at the critical valve.



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Irrigation Filename :C:\IA Paper\RK2003.mal(MIR)
--------------------------------------------------------------------------------
NODES Main line - Shift 1    Total Flow 184.42m3/h
Date : 12/9/2011    Time : 12:58
--------------------------------------------------------------------------------

PUMP ELEVATION   :157.64m
PUMP PRESSURE    :64.00m

 NODE   BLOCK   ELEVATION   ----  HEAD LOSSES m   ----    -- PRESSURE m  --   DISCHARGE
                   m         Elev.     Pipes   Fittings    Actual  Required     m3/h
  123     1     166.68       9.04     37.51     0.00       17.45    17.00    -35.704
   86     7     164.00       6.36     26.71     0.00       30.93    17.00    -35.699
  104     4     162.95       5.30     20.14     0.00       38.56    17.00    -38.491
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The design for this project was run on a level DTM and a also DTM created from GE elevations. On each DTM model, the pipes for the design were optimized for velocity and pressure requirements. The 2 designs were then placed on the actual surveyed DTM model and without changing pipe diameters. Pressures at the critical valves were calculated.

Note that the pump pressure had to be adjusted upwards when the correct elevations were used.

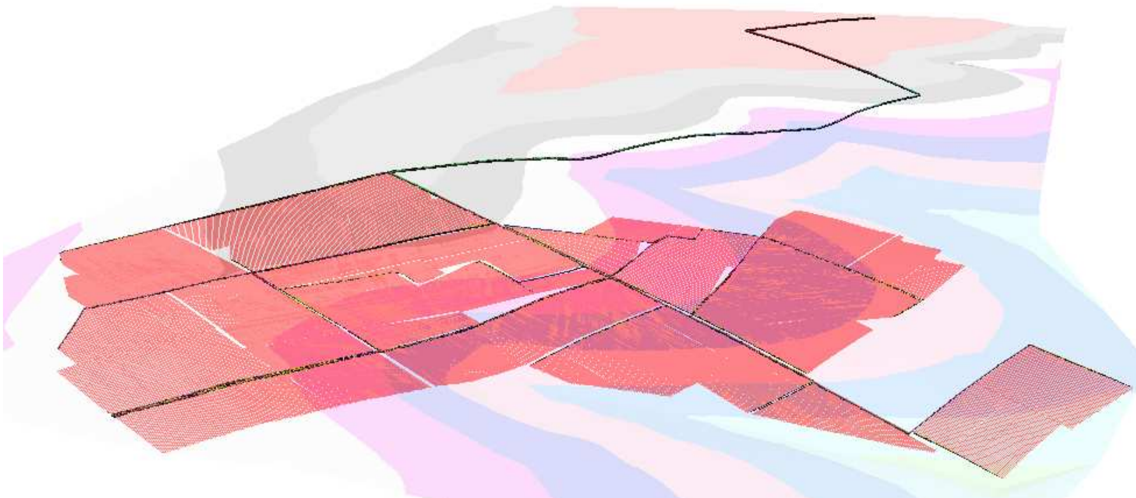
Results

The required pressure at the critical valve is 17m

Design / Surface	Pump Pressure (m)	Actual Valve pressure (m)	Difference (m)
Flat on Flat	55	19.45	+ 2.45
Flat on Actual	55	10.40	-6.60
GE on GE	64	17.79	+0.80
GE on Actual	64	19.45	+2.45

Project 2:

This project is on a steeper terrain and has slopes up to 6%.



Similar to the analysis of project 1, the irrigation design was placed on a flat surface and the pipe sizes and pump pressure calculated. The exact design was then draped over the actual survey data and the pressure at the critical value evaluated. The same was done with the design in relation to the GE model and actual model.

Results

The required pressure at the critical valve is 16m

Design / Surface	Pump Pressure (m)	Actual Valve pressure (m)	Difference (m)
Flat on Flat	40.5	16.01	+ 0.01
Flat on Actual	40.5	46.93	+20.93
GE on GE	16	16.30	+0.30
GE on Actual	16	21.19	+5.19

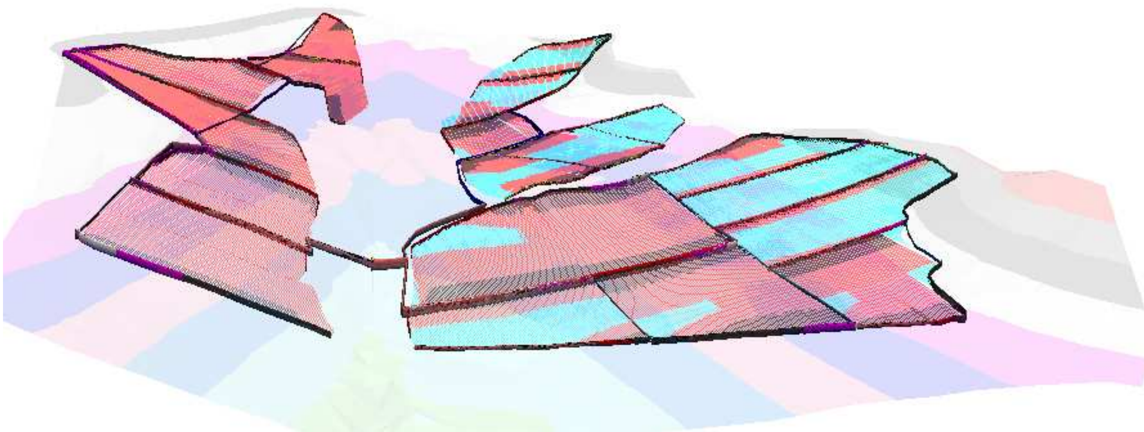
On this design the pump is at a higher elevation than the irrigation area. The presumed flat scenario does not take that into account and starts of with a pump pressure that is far too high.

The GE design however works on accurate elevations and is only off by 5 meters over the actual surface.

Project 3:

This project is on the steepest terrain and one would expect the differences to be huge.

3 Dimensional view of project 3.



Results

The required pressure at the critical valve is 15m

Design / Surface	Pump Pressure (m)	Actual Valve pressure (m)	Difference (m)
Flat on Flat	60	15.32	+ 0.32
Flat on Actual	60	15.08	- 34.50
GE on GE	63	15.10	+0.10
GE on Actual	63	18.08	+3.08

DTM grid size:

The results for the GE calculations were done on a DTM grid of 10x10 meters. As an additional check the area was also modeled with GE elevations at a 20x20 meter grid.

The critical node for GE on GE was 15.25m (as against 15.10) and when the design was draped onto the actual model the pressure went up to 18.26m. The difference is slightly more than that of the 10x10m grid but still quite accurate.

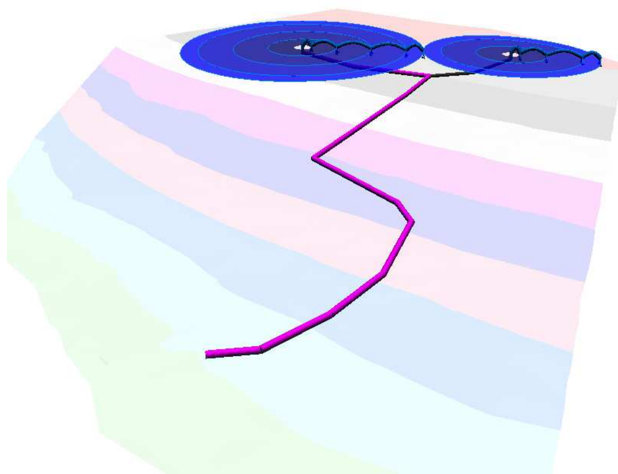
From the results it is clear that assuming such an area as flat is out of the question. Because of the actual elevation differences, an error of more than 35 meters is made.

The GE design is remarkably accurate and has a difference of only 3 meters at the critical valve when the design is placed on the actual survey.

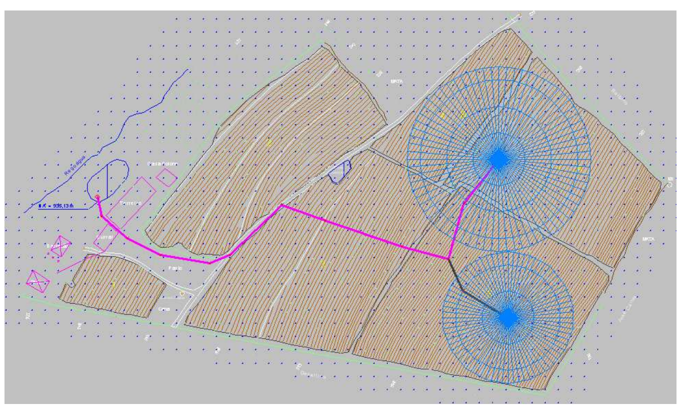
Project 4:

This project consists of a mainline running two pivots at an elevation higher than the pumping station.

3 Dimensional view of project 4.



Plan view of Project 4.



Results

The required pressure at the critical pivot is 20m

Design / Surface	Pump Pressure (m)	Actual Valve pressure (m)	Difference (m)
Flat on Flat	30	21.13	+ 1.13
Flat on Actual	57	21.37	- 27.0
GE on GE	51	20.84	+0.84
GE on Actual	51	16.62	-3.38

In this example the pump pressure for the flat model was totally wrong and had to be adjusted just to get the water to flow on the actual terrain.

Conclusion

Although the 4 examples in this test are by no means comprehensive and the results not scientifically accurate, a few general points have been proved.

- No irrigation design should be done without taking the topography into account.
- Designs done on elevations derived from Google Earth are fairly accurate. On average the pressures at the critical valve were off by an average of only 3 meters or about 4 psi.
- Irrigation design software programs are available that will interact with Google Earth and easily produce suitable terrain models.
- Google Earth can be used as an alternative to an actual survey when doing preliminary irrigation designs.
- Final irrigation designs must always be based on actual surveyed data.

It is not good practice to assume that an irrigation design done on a flat surface will yield acceptable answers in the field. With the software tools at the disposal of the modern irrigation designer, no design should be done without incorporating the correct topographical elevations.

References

Website related to Google Earth

- http://en.wikipedia.org/wiki/Google_Earth#Resolution_and_accuracy
- http://www2.jpl.nasa.gov/srtm/
- http://www.ciesin.org/documents/yuri_accuracy.pdf

Irrigation design software used in this article:

- http://www.irrimaker.com/

Other irrigation design software:

- http://www.irricad.com/
- http://www.wcadi.org/