Agricultural Module

Data Sources: All data for the ag module came from data and information included in various places in the Russian Report. Some of these data were compiled by others from the Russian Report and came to us as part of the SWLRI report.

The ag module runs on three worksheets in the main Excel spreadsheet named "IraqWSM.inputdata.xls". The worksheet called "Ag 1" is organized by the 135 irrigation projects in Iraq, as reported in the Russian Report in Volume 3, Book 1, Appendix 7.1. These data include the 135 projects, the donums available for irrigated ag in 1980, and the donums actually irrigated in 1980. Rivers, governates and climate zone data came from Iraqi colleagues, and also from a map called "General Scheme of Water and Land Resources Development in Iraq (II stage), 1981," which also came from the Russian Report; or from Iraqi colleagues. That worksheet also includes data on irrigation intensity (use of the same crop land over two seasons) by governate, which came from Table 2.4, Volume 2, Book 2 of the Russian Report. That worksheet also has a place for changes to salinity at each project, but those data have not been found and entered yet.

The worksheet called "Ag 2" show gross irrigation levels required for Iraqi crops by zone, and by month. These data are all taken from ARDI electronic report: ARDI\ARDI SWLRI\SWLRI Final Report EXTRAS\Agriculture and Irrigation\Calculation Workbooks; these can also can be found in archive directory called "Ag module data' Data from those files were reorganized to fit into the crop categories shown in the file called "Ag data, ha by crop and governate, 1977-2005", also from the ARDI report, and also found in the directory called "Ag module data".

Worksheet "Ag 3" shows each crop expressed as a percentage of total crop yield, by governate. These data came from the Russian Report, Volume II, Book 1, Appendix 4.11, and can also be found in the the SWLRI directory described above and in the archive.

We also estimated changes in crop areas from 1996-2006. We used the crops expressed as a percentage of the total in 1977 to estimate the hectares by crop and governate in 1996-2006 using the COSIT total hectares for the years 1996-2006. These data may provide a base year from which future projections can be made. The user should be able to modify the totals for that base year depending on the user's perception of whether it is high or low. These data are available in the archive under the file name "Ag data, ha by crop and governate, 1977-1996," in the tab called "crop areas in 1996". The COSIT data are also available in the same file, in the tab called "1977-1996 wheat areas".

Model Structure:
The adopted model structure is based largely on the availability of supporting data and the ultimate needs of the project. In particular, the agricultural module was developed to answer the following question:

How do changes in the agricultural sector affect available surface water supplies and in turn, how do uncertainties in future surface water supplies impact deliveries for irrigation.

Potential changes to the agricultural system that are represented in the module include:

1. Total crop acreage,
2. Crop distribution among grain, industrial, vegetable, oil, and fodder crops,
3. Intensity of double cropping from winter to summer season, and
4. Irrigation efficiency.

In turn, model outputs include:

1. Desired irrigation diversions,
2. Actual irrigation diversions,
3. Irrigation shortfall,
4. Net irrigation (i.e., water consumed by crops),
5. Irrigation losses and return flows, and
6. Return flow salinity.

As with the rest of the model the agricultural module operates on a monthly timestep. Likewise, agricultural water demand is spatially distributed according to the 30 diversions coded into the surface water model. The demand for each diversion is unique to that diversion and time of year based on the best available data. To facilitate water planning on a meaningful basis the model allows the user to modify irrigation characteristics (see above) at three different levels:

1. Governate,
2. River, and
3. National.

Module outputs are likewise organized and displayed according to the desired management level.

The base calculations for this module are very simple. A schematic of the model structure is given below in Figure X. The model begins by reading data input in from the EXCEL spreadsheet. Inputs include total irrigated acreage, crop distributions, net irrigation consumption by crop, irrigation intensity (i.e., winter to summer cropping), and irrigation system efficiencies. The model then allows the user to adjust these inputs according to one of the three management levels. The desired water delivery for each diversion is calculated by the simple equation:

$$Irr_{net} = I\sum_{i=1}^{n} CA_i * D_i$$

$$Irr_{gross} = \frac{I_{net}}{\delta} - I_{net}$$

where Irr_{net} is the net irrigation (L^3/T), I is the irrigation intensity (1 for winter and some reduced percent for the summer season), CA_i is the crop area by crop i (L^2), and D_i is the crop demand (L/T). The gross irrigation Irr_{gross} (L^3/T) includes the system losses represented in the system efficiency factor δ .

Initially the module calculates a desired diversion that is the amount of water a particular diversion would want if there were no supply constraints. This value is passed to the surface water module where it an actual water diversion is calculated based on available supply and all water demands. Using the actual diversion from the surface water module the actual system losses, net irrigation, and irrigation shortfalls are calculated.

Note that system losses are simply calculated according to the relation

$$L = Irr_{gross} - Irr_{net}$$

This loss term is comprised of leakage from the conveyance system, water used to flush the soils, and other crop seepage lost below the root zone. Given the relatively shallow nature of the groundwater system and connection to the surface water system, it is assumed that all of these losses find their way back to the river. The point of return depends on whether the water returns by groundwater flow (returned directly to the river) or via a drain system.

Salinity of the return flow is determined by …..

While the calculation of the crop demand, return flows, etc is relatively simple, handling of the available data was a challenge. Specifically, data used in this model are associated with a number of different levels of aggregation. Gross crop acreages were available on the project level as were system efficiencies. Alternatively, irrigation intensities, and crop distributions, were available at the governate level. Finally, crop water use data were available only at the climate zone level. Furthermore, we wanted to allow the user to manipulate irrigation characteristics at three different management levels (governate, river, and national).

To handle the data requirements at these desperate levels of aggregation, a series of data transformation matrices were developed. Transform matrices were developed to work between the diversion-governate, diversion-river, diversion-zone, and governate-river levels. These transform matrices were developed from acreage data at the project level (135 projects) and indices which correlated each project with a diversion, governate, climate zone, and river. So each transform matrix is constructed based on data from the project level distributed according to the two desired levels (e.g., governate and diversion).

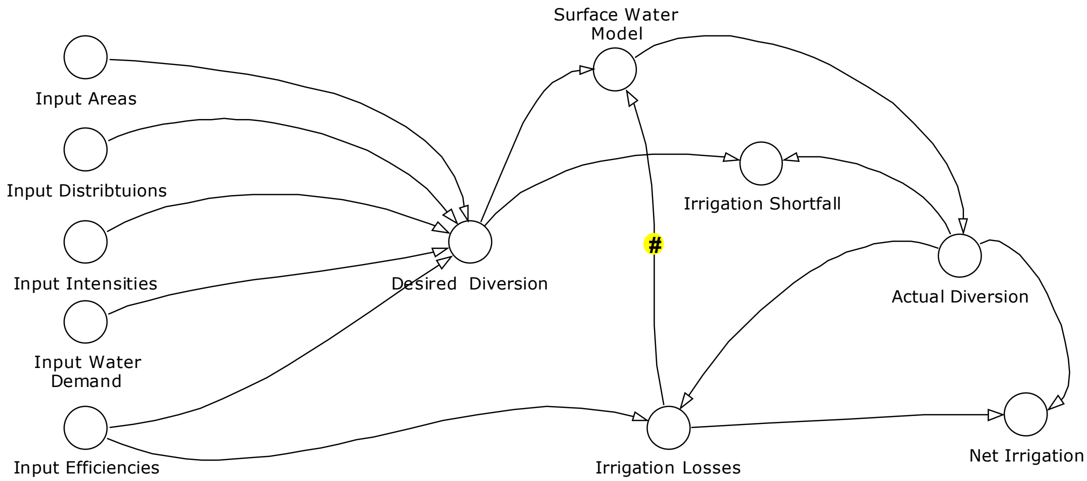

Figure X: Schematic of agricultural module.

Major Assumptions:

Assumptions in the model are largely driven by limitation in the available data. The model has been developed in a very general and modular manner such that as new data become available the model can easily be adjusted. Key limiting assumptions are as follows.

The first assumption involves the use of the irrigation intensities. The only data available simply give a rough proportion of the sum of summer and winter irrigated area to the total possible irrigable area. Thus it has been assumed that available crop area data correspond to winter croppings (when water use is at a minimum). The intensities are then used to calculate the percent of crop area that is irrigated during the summer season.

The second assumption involves the irrigation return flows. Given the lack of good groundwater data, we simply assume that all calculated irrigation losses are returned to the river. Further, all returns from a given diversion are assumed returned to a single point on the river (each project is likely to have its own return point which may or may not be in the same reach.

The third assumption involves the crop distributions used in the model. Such data is only available at the governate level. It is assumed that all projects within a given governate have identical crop distributions. This assumption is then used to distribute water demand calculations by diversion, river, and climate zone levels.

Finally, assumptions are made concerning the salinity of the return flows [to be added]

Next steps:

Find data on changes to salinity for each irrigation project and enter these data into worksheet “Ag 1”.

Generally improve identification of rivers, zones and diversions associated with irrigation projects, all shown in “Ag 1”.

Determine which “base year” to use as a starting point for future projections.