Guantao Irrigation Calculator

hydrosolutions

User guide

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Title Picture: Winter wheat, Guantao County, spring 2019

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Acronyms and abbreviations

ET	Evapotranspiration
GW	Groundwater
GIWP	MWR General Institute of Water Resources and Hydropower Planning and Design
PET	Potential evapotranspiration

Acknowledgement

Various authors have contributed to the development of the Irrigation Calculator over the years, namely Dr. Sebastian Stoll, Jakob xxx, and Jules Henze. Thanks to comments and inputs from the entire project team, namely Dr. Haijing Wang, Dr. Tobias Siegfried, Dr. Silvan Ragettli, Prof. em. Wolfgang Kinzelbach, Dr. Ning Li, Dr. Yu Li, Dr. Lu Wang, Dr. Hou and Dr. Fei Chen, and from the project reviewers Prof. Armaury Tilmant, Prof. Timothy Foster and Prof. M. Pulido-Velasquez, the Irrigation Calculator was iteratively improved. The English version of the Irrigation Calculator was translated to Chinese by Dr. Haijing Wang.

1. What is the Guantao Irrigation Calculator?

The Guantao Irrigation Calculator is an on-line tool to estimate irrigation water demand and to monitor crop activity in Guantao County, Hebei Province, China. It has been developed in the Sino-Swiss research project "Rehabilitation and Management Strategy for Over-pumped Aquifers under a Changing Climate".

1.1 The method to calculate irrigation demand

The Guantao Irrigation Calculator implements the soil water balance following FAOs Irrigation and Drainage paper 56 (Allen et al., 1998). The method is briefly described below, for a detailed description the reader is referred to (Allen et al., 1998). A daily soil water balance is calculated following Eq. (1) (after eq. 85 in (Allen et al., 1998)). In the soil water balance, the water content in the root zone is expressed as the root zone depletion $D_{r,i}$, i.e. the water shortage relative to the field capacity (see Figure 1 for an illustration of the components of the soil water balance). Field capacity is the amount of water a soil can hold in the pores against gravity (see Figure 3 for an illustration of field capacity).

$$D_{r,i} = D_{r,i-1} - (P - RO)_i - CWD_i - CR_i + ET_{c,i} + DP_i \qquad (1)$$

where
- $D_{r,i}$ root zone depletion at the end of day i [mm]
- $D_{r,i-1}$ water content in the root zone at the end of day $i - 1$ [mm]
- P_i precipitation on day i [mm],
- RO_i runoff from the soil surface on day i [mm],
- CWD_i crop water deficit on day i that infiltrates the soil [mm],
- CR_i capillary rise from the groundwater table on day i [mm],
- $ET_{c,i}$ crop evapotranspiration on day i [mm],
- DP_i water loss out of the root zone by deep percolation on day i [mm].

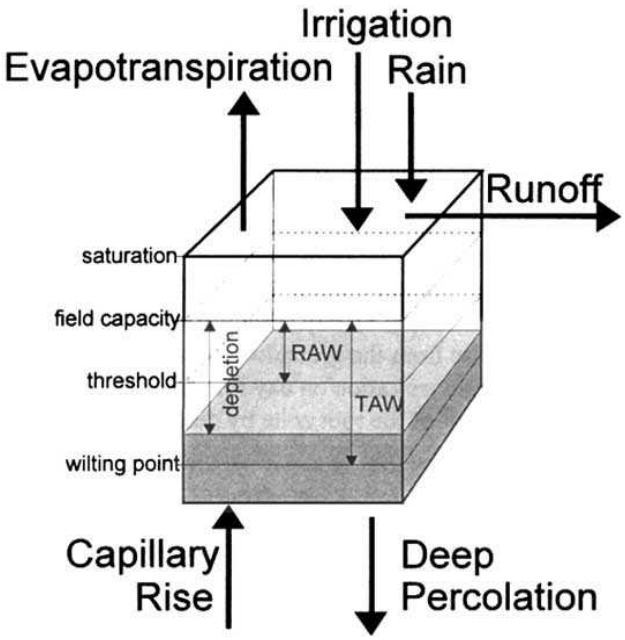

Figure 1: Components of the soil water balance. Picture from (Allen et al., 1998)*. The terms RAW & TAW are explained in the main text below.*

The total available water (TAW) is the amount of water available for a plant and depends on the daily root length (Eq. (2)).

$$TAW_i = 1000 \frac{mm}{m} \cdot (q_{FC} - q_{WP}) \cdot Z_{r,i} \quad (2)$$

with TAW_i the total available soil water in the root zone at day i [mm]
q_{FC} the water content at field capacity [m³/m³]
q_{WP} the water content at wilting point [m³/m³]
Z_r the rooting depth at day i [m]

The soil parameters q_{FC} and q_{WP} are given in Table 2 in Chapter 1.4.2 below. The readily available water (RAW) is the amount of water that can be used by the plant without experiencing water stress. The relationship between TAW and RAW is given in Eq. (3):

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$$RAW_i = p_{dry} \cdot TAW_i \quad (3)$$

Both, root length and the p_{dry} are default values provided by (Allen et al., 1998) and can be downloaded from the Irrigation Demand Calculator tab in the Guantao Irrigation Calculator (see Chapter 2.4.5 below for a detailed description of how to download the data).

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For Guantao county, the following assumptions were made:

- Runoff from the soil surface can be neglected due to the low slope of the fields in Guantao county, i.e. $RO_i = 0$.
- The groundwater table is at more than 5m depth and capillary rise from the groundwater can be neglected, i.e. $CR_i = 0$.

The Hebei irrigation norm lists crop irrigation demand for normal and dry years, i.e. for a 50% and 75% reliability. In the Guantao Irrigation Calculator, this was implemented by computing the 50% and 25% quantiles of the monthly precipitation between 2000 and 2019. The soil water balance is computed for normal and dry years respectively.

Daily reference evapotranspiration $ET_{0,i}$ is estimated using the Penman-Monteith equation provided in (Allen et al., 1998), based on monthly climate data. The single crop coefficient method is used, calculating daily crop Evapotranspiration $ET_{c,i}$ from the product of the reference Evapotranspiration and the crop coefficient $K_{c,i}$ (Eq. (4)).

$$ET_{c,i} = ET_{0,i} \cdot K_{c,i} \quad (4)$$

Default crop coefficients for four growth phases (initial phase, development phase, mid-season phase and late phase) are taken from (Allen et al., 1998) and adapted to local conditions based on literature data and interviews with local agriculture experts. Daily crop coefficients are derived from the typical planting date and duration of the growth phases of a crop (see Figure 2).

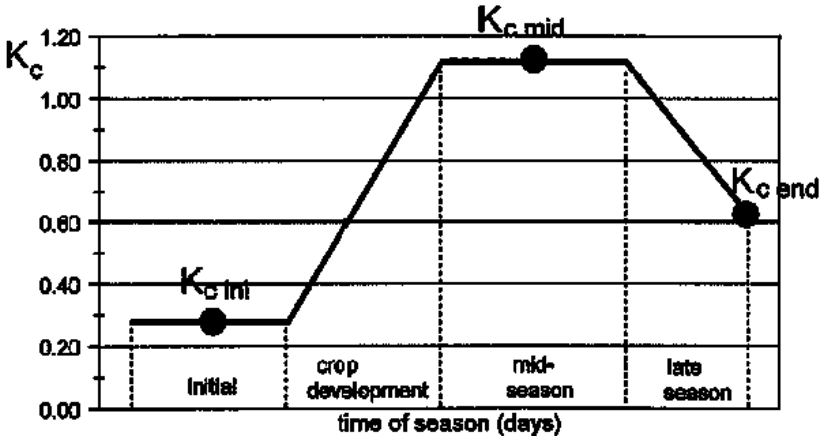

Figure 2: Visualization of an example of the daily crop coefficient. Picture from (Allen et al., 1998).

The coefficients and lengths of growth phases used can be downloaded from the Guantao Irrigation Calculator interface (see Chapter 2.4.5 on a description of how to do this).

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Deep percolation is estimated following (Allen et al., 1998).

Two alternative irrigation schedules are available to determine the crop water deficit CWD_i in the Guantao Irrigation Calculator: minimum irrigation and monthly irrigation. For the minimum irrigation schedule, the soil water content is filled up to threshold if the water content drops below the threshold, for the monthly irrigation schedule, the soil water content is filled up to field capacity at the end of each month or if the soil water content goes below the threshold. For an illustration of wilting point and field capacity see Figure 3. The monthly irrigation schedule is suited for all crops except winter wheat where minimum irrigation yields irrigation water demands which are closer to actual irrigation rates.

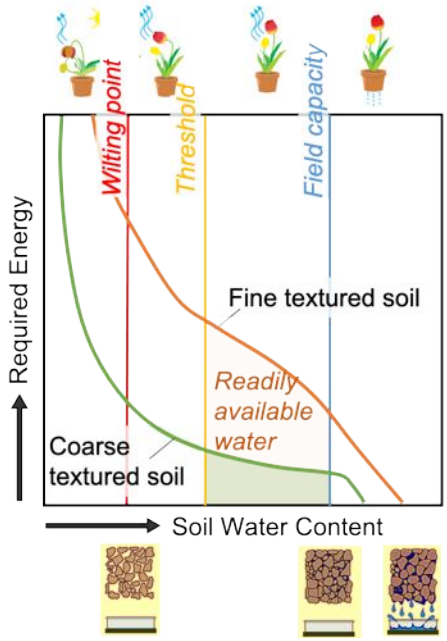

Figure 3: Relationship of soil water content and the energy the plant requires to take up water from the pores in the soil for coarse and fine textured soils. Field capacity describes the soil water content which can be held by the pores without deep drainage. Wilting point describes the soil water content below which the plant dies from water stress. The thresholddescribes the soil water content below which the plant starts to experience water stress.

The irrigation water demand per soil and crop IWD for day i is subsequently calculated by multiplying the crop water deficit from the soil water balance with correction factors for conveyance losses, irrigation methods and water source according to the Hebei irrigation norm (Hebei Quality and Technical Supervision Bureau, 2009) (Eq. (5)).

$$IWD_i = CWD_i \cdot \prod_{j=1}^{3} f_{corr,i} \tag{5}$$

An overview on the correction factors is given in Table 1. The irrigation water demand from the soil water balance described above is multiplied with the applicable correction factors.

Table 1: Correction factors for conveyance losses and irrigation methods as suggested by (Hebei Quality and Technical Supervision Bureau, 2009).

Category	Factor	Value
Correction for irrigation area [-]	Surface water, >30·10^4 mu	1.12
Correction for irrigation area [-]	Surface water, 1-30·10^4 mu	1.05
Correction for irrigation area [-]	Surface water, <1·10^4 mu	1.00
Correction for irrigation area [-]	Groudwater, > 200 mu	1.15
Correction for irrigation area [-]	Groundwater, 100-200 mu	1.07
Correction for irrigation area [-]	Groundwater, <100 mu	1.00
Factor for irrigation method [-]	Surface water, channel lining	0.92
Factor for irrigation method [-]	Surface water, flooding	1.00
Factor for irrigation method [-]	Groundwater, border irrigation	0.95
Factor for irrigation method [-]	Groundwater, pipe irrigation	0.88
Factor for irrigation method [-]	Groundwater, micro irrigation	0.50
Water source	Sufrace water	1.05
Water source	Groundwater	1.00

1.2 Validation of irrigation demand

The crop water demand computed by the Guantao Irrigation Calculator has been verified using literature values (Figure 4). It can be assumed that one irrigation event amounts to approximately 50 ± 10 mm. The Guantao Irrigation Calculator calculates crop water demands for winter wheat which are within the range of the literature values.

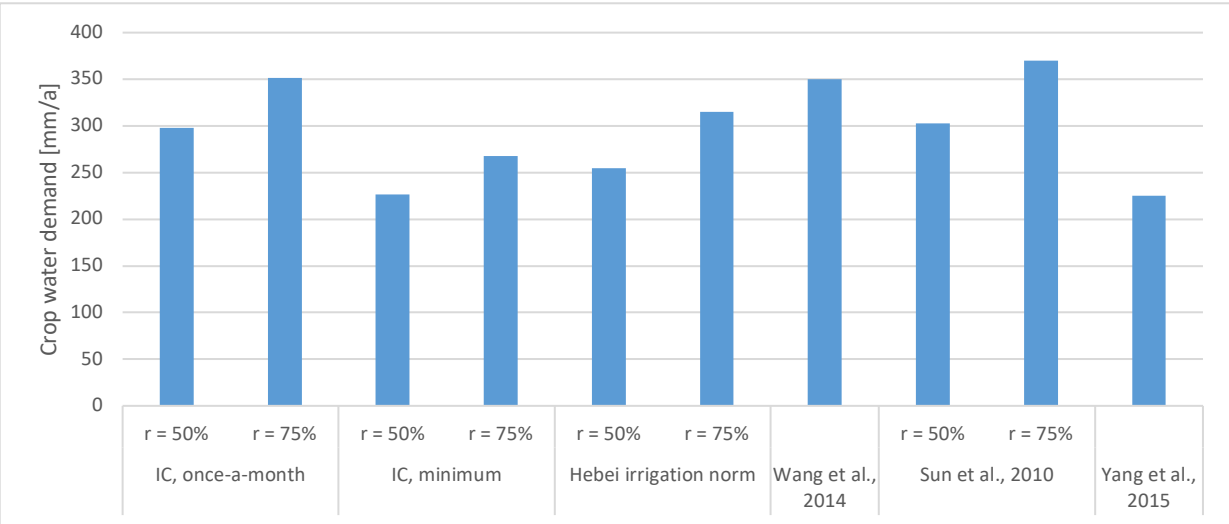

Figure 4: Comparison of irrigation water demand for winter wheat assuming flood irrigation with groundwater for 50% and 75% reliability (i.e. normal and dry year) for once-a-month-irrigation and minimum irrigation computed with the Guantao

Irrigation Calculator (IC). Also shown are the irrigation water demands in the Hebei irrigation norm and values from the literature: (Wang et al., 2014), (Sun et al., 2010), (Yang et al., 2015).

The focus of the literature is on the crop water demand of winter wheat since the winter wheat growth period falls outside of the precipitation period and is mainly responsible for the groundwater overdraft in agriculture. The crops for which sufficient literature has not been found have been compared to the Hebei Irrigation Norm.

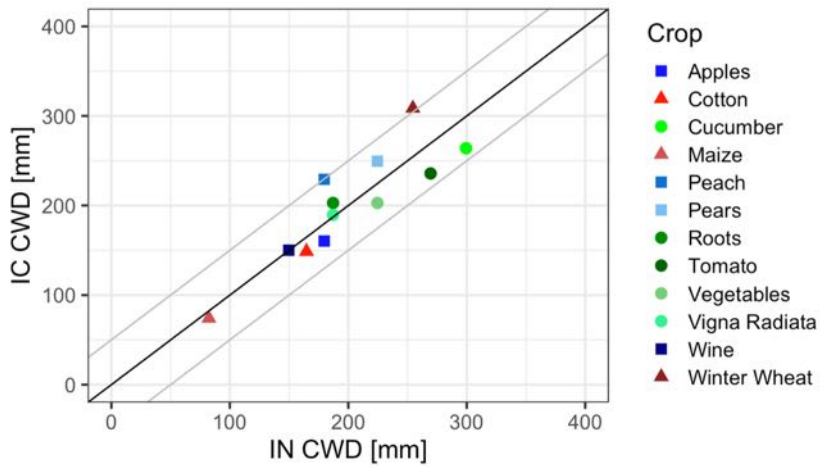

Figure 5: Crop water demand (CWD) calculated with the Guantao Irrigation Calculator (IC) and from the Hebei irrigation norm (IN) for different crop types. The data is for sandy soil, monthly irrigation scheme and normal precipitation.

1.3 The method to monitor crop activity

The crop activity is derived from maps of the Enhanced Vegetation Index (EVI) of the MODIS 16-Day Vegetation Indices MOD13Q1 (Didan, 2020a) and MYD13Q1 (Didan, 2020b). The EVI shows crop activity in a spatial resolution of 250 m by 250m. For a detailed description of the EVI product, the reader is referred to (Didan et al., 2015).

1.4 The data basis

1.4.1 Climate

The Guantao Irrigation Calculator uses the average monthly climate data between 2000-2019 from a meteo station in Guantao county as basis. The meteo data can be edited. The monthly average climate data of Guantao can be retrieved from the App by following the steps described in Chapter 2.4.3 below.

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The monthly climate data is distributed to daily values by applying the monthly average value to the day of the month. For precipitation, the number of wet days per month is available. The number of wet days per month are evenly distributed in the month and the monthly precipitation sum is applied to each wet day. The distribution of the precipitation events can be verified in the daily root zone depletion graph in the Irrigation Demand Calculator tab, Chapter 2.3.3 describes how to view the graph.

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1.4.2 Soil

The 3 soil types in the Hebei irrigation norm are sand, loam and clay (Hebei Quality and Technical Supervision Bureau, 2009). Default values for field capacity, threshold and wilting point are taken from (Schaake, 2000) and (Allen et al., 1998).

Table 2: Soil parameters used in the Guantao Irrigation Calculator.

Soil type	q_{FC}	q_{WP}

Sand	0.16	0.08
Loam	0.22	0.1
Clay	0.54	0.39

1.4.3 Crops

The Guantao Irrigation Calculator allows the calculation of the crop water deficit for the crop types present in the Hebei irrigation norm plus crop types that were additionally identified as relevant by the local authorities.

The default crop parameters (i.e. single crop coefficients and duration of phenological growth stages, planting date) from the FAO Irrigation and Drainage paper 56 were used as a basis for the Guantao Irrigation Calculator. The default parameters where subsequently adapted to local conditions following interviews with local specialist and the literature.

The list of crops and their parameters can be downloaded in the Irrigation Demand Calculator tab. The detailed procedure to do this is described in Chapter 2.4.5.

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2. How to use the Guantao Irrigation Calculator?

2.1 Prerequisites

The prerequisites for using the Guantao Irrigation Calculator are an up-to-date internet browser and access to the internet. The Guantao Irrigation Calculator is hosted in Europe as well as in China.

2.2 Access

The Guantao Irrigation Calculator is accessible from outside China on a Server hosted by hydrosolutions via AWS: https://app.hydrosolutions.ch/IrrigationCalc-Guantao2/ and from within China from a server in GIWP: https://www.gwm-handan.cn/Guantao2/.

2.3 Description of the features

The Guantao Irrigation Calculator is organised in 6 tabs which are described here below. Figure 6 shows the tabs in blue writing above the first horizontal line. The user can switch tabs by moving the pointer with the mouse on the text denoting the desired tab (a grey box will appear around the text) and then performing a left click. The procedure is described in detail in Chapter 2.4.2 below.

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The Guantao Irrigation Calculator is available in English and Chinese. To switch the language, the user can activate the respective language at the bottom left of each tab in the app. The procedure to switch the language is described in more detail in Chapter 2.4.1 below.

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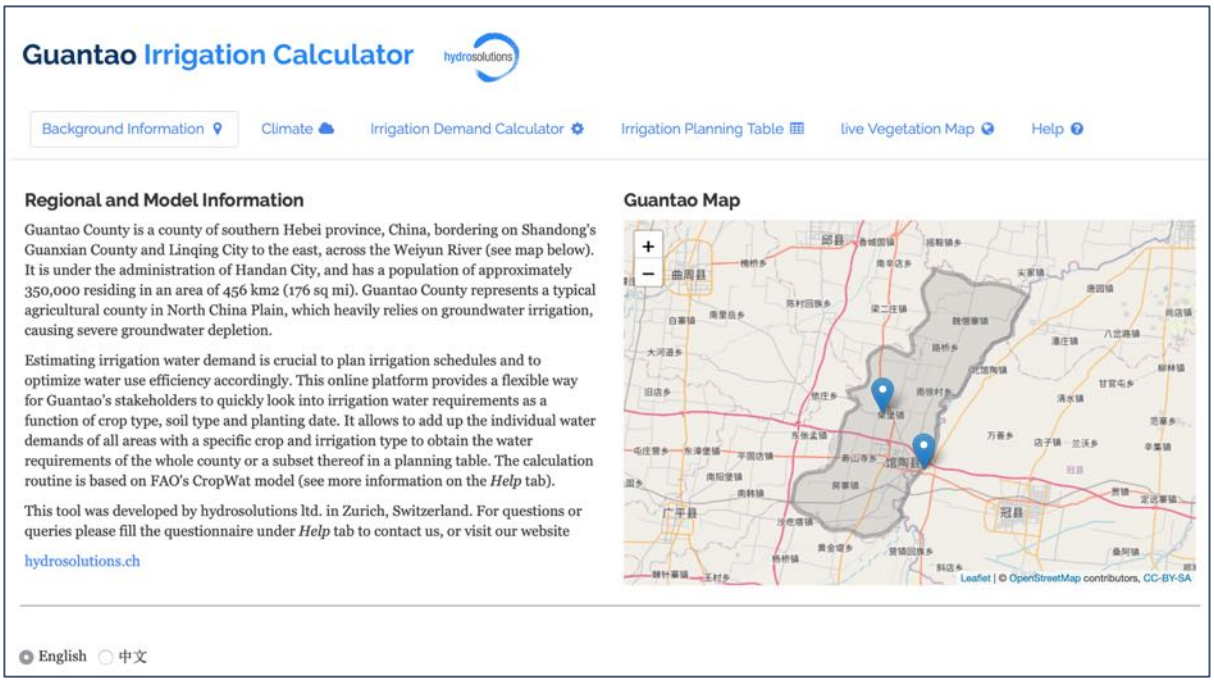

Figure 6: The Background Information tab appears when opening one of the links to the Guantao Irrigation Calculator.

2.3.1 The Background Information tab

The web-links in Chapter 2.2 above open by to the Background Information tab by default (Figure 6) which gives a brief summary of the project and a map with the locations of the available meteo data that is used as a basis for the calculation of the irrigation water demand.

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2.3.2 The Climate tab

The Climate tab shows the average monthly values of the Guantao meteo station data between 2000 and 2019. It further shows the reference ET (for short grass) calculated following (Allen et al., 1998) as described in Chapter 1.1 above.

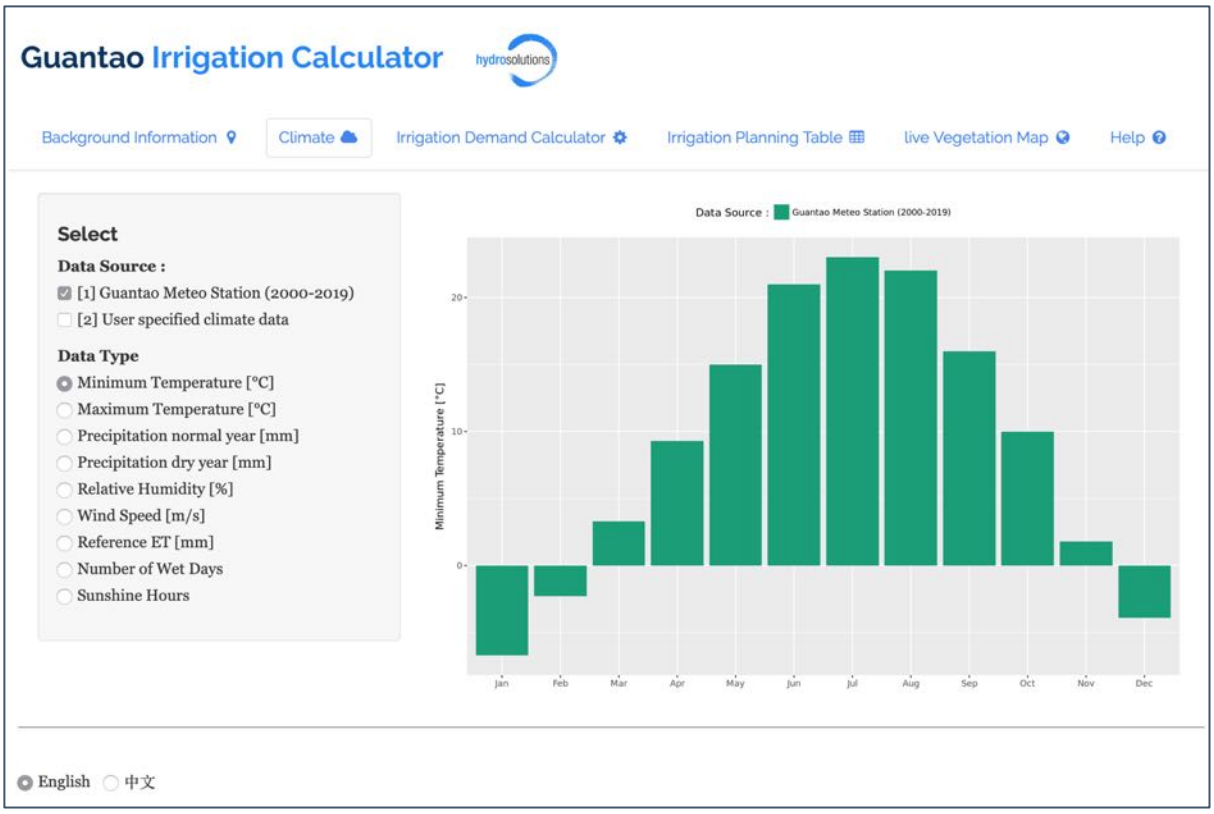

Figure 7: The climate tab visualizes the monthly average climate data at the Guantao meteo station.

The user can visualize data by moving the cursor on the circle next to the variable to display and by performing a left click in the circle.

The Guantao Irrigation Calculator offers the possibility to edit the meteo station data. This option is useful if the irrigation water demand under a different climate scenario is to be calculated. The climate data can be edited by activating the edit climate data pane by ticking the empty box next to [2] User specified climate data (Figure 8).

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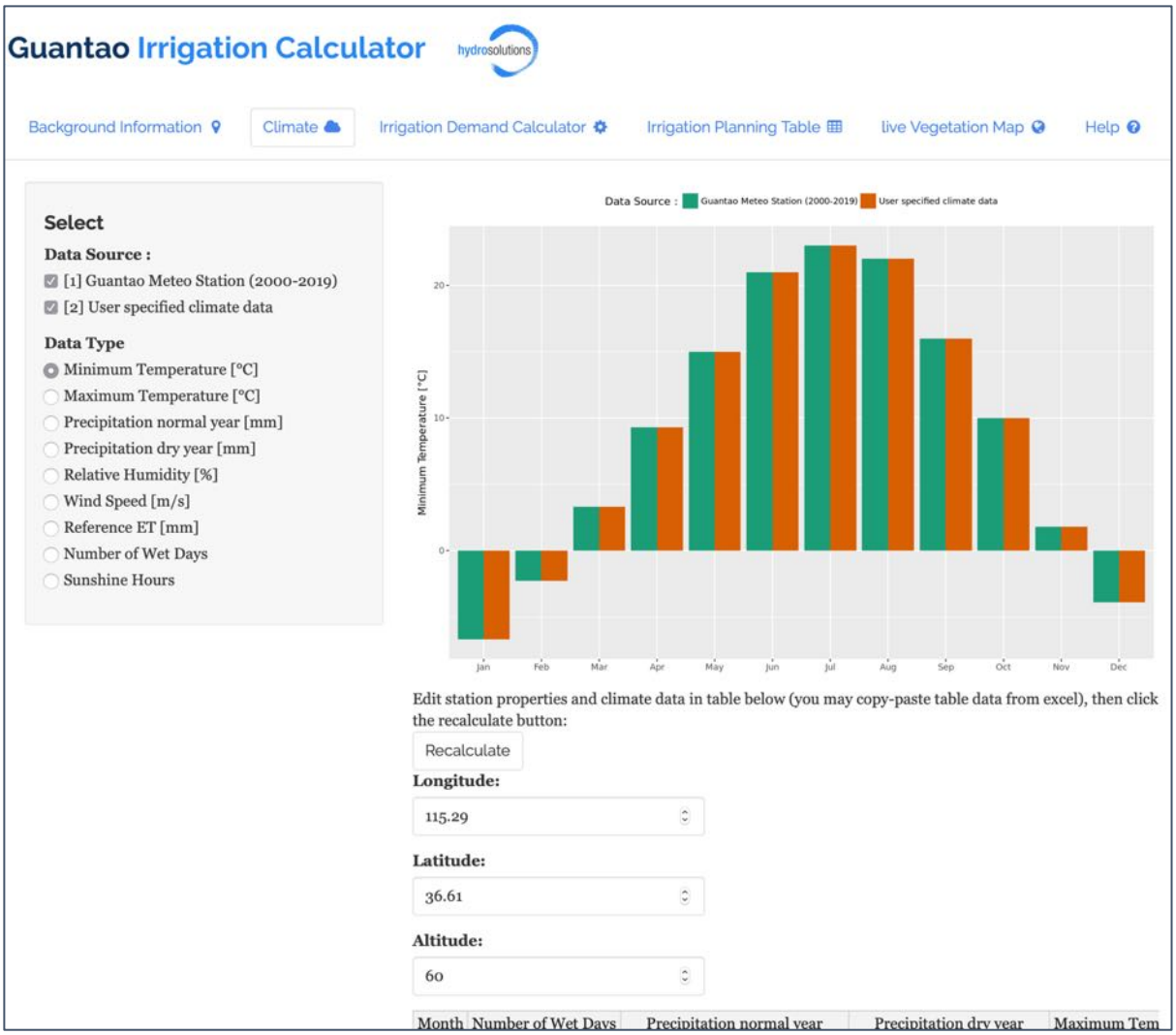

Figure 8: The upper part of the edit climate data pane that is activated by ticking [2] User specified climate data.

The default meteo station data is given in the table at the bottom of the page (Figure 9).

Month	Number of Wet Days	Precipitation normal year [mm]	Precipitation dry year [mm]	Maximum Tem
1	2.14	1.00	0.03	
2	3.75	8.10	3.13	
3	2.21	1.50	0.03	
4	4.50	15.00	10.03	
5	5.86	29.65	17.85	
6	8.43	65.45	32.50	
7	10.50	186.30	108.40	
8	8.57	123.50	44.60	
9	7.07	47.60	23.75	
10	5.43	13.55	6.53	
11	3.00	10.20	1.98	
12	2.29	3.70	0.33	

Figure 9: The editable climate data table in the edit climate data pane.

The data in the table can be edited directly by moving the cursor into a cell, performing a left click and conventional editing of the cell. Alternatively, data can be copied cell or column-wise from a spread sheet (e.g. MS Excel). The procedure to copy-paste climate data from a spread sheet to the Guantao Irrigation Calculator is described in detail in Chapter 2.4.4 below. After editing the climate data, the button Recalculate below the graph (Figure 10) needs to be pressed in order to recalculate

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the reference Evapotranspiration and to be able to select the edited, user specified climate data to calculate irrigation water demand.

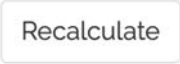

Figure 10: It is important to press the Recalculate button in order to write the changes in the climate data to the App.

2.3.3 The Irrigation Demand Calculator tab

The irrigation demand calculator tab allows the water resources planner to specify the land use for a given area in Guantao. Figure 11 shows a print screen of the tab. In the upper half of the grey box on the left, the user can select a number of parameters affecting the computation of the crop water deficit (i.e. the irrigation water demand prior to losses). In the middle part of the grey box, the variables can be selected for visualization in the plot at the top right of the pane. The action buttons in the lower part of the grey box will be described here below. The table shows the most important water balance components for the selected parameters. The Guantao Irrigation Calculator automatically updates the graph and the table every time a selection in the Select Parameters pane has been changed. In the following sections, the parts of the Irrigation Demand Calculator tab will be described in more detail.

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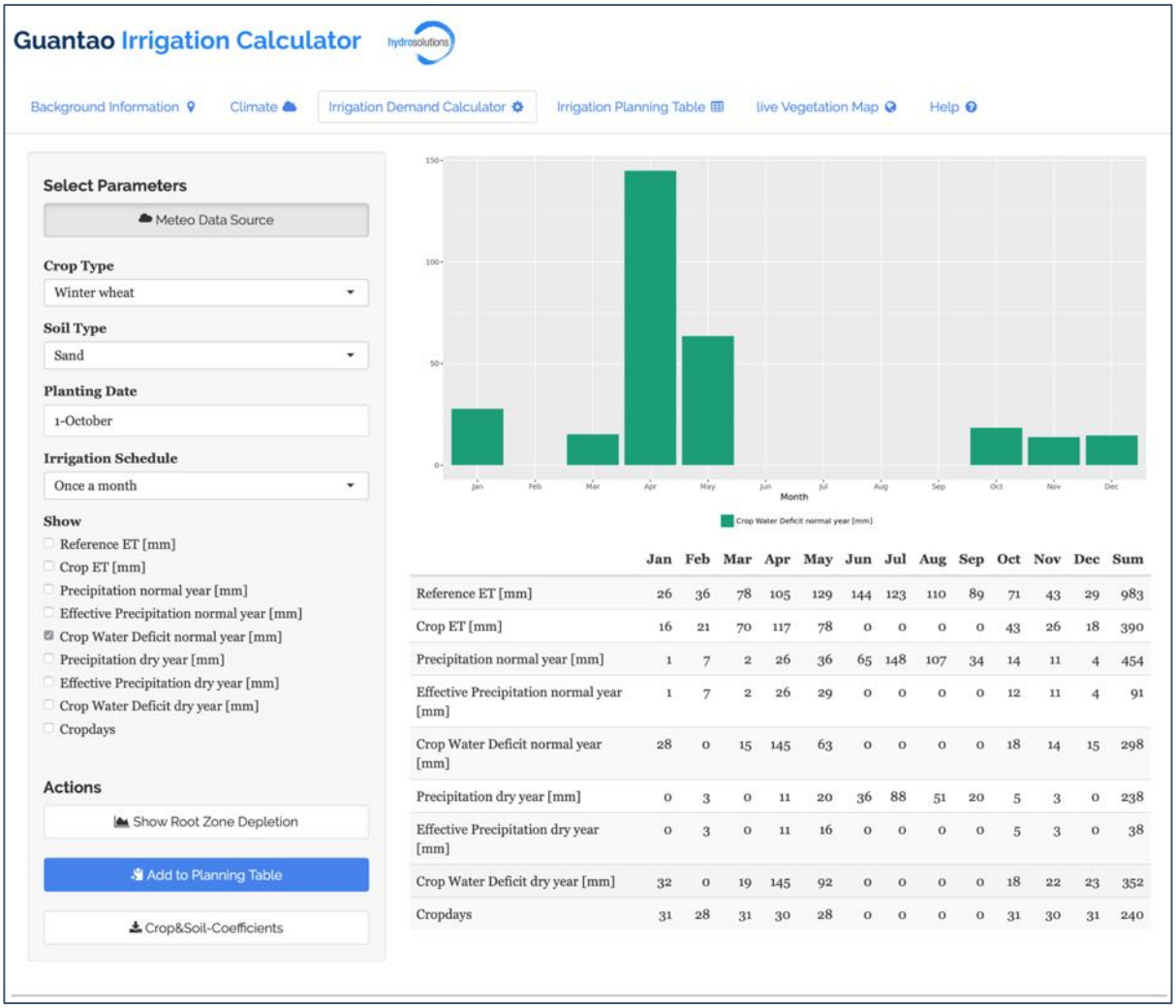

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Sum
Reference ET [mm]	26	36	78	105	129	144	123	110	89	71	43	29	983
Crop ET [mm]	16	21	70	117	78	0	0	0	0	43	26	18	390
Precipitation normal year [mm]	1	7	2	26	36	65	148	107	34	14	11	4	454
Effective Precipitation normal year [mm]	1	7	2	26	29	0	0	0	0	12	11	4	91
Crop Water Deficit normal year [mm]	28	0	15	145	63	0	0	0	0	18	14	15	298
Precipitation dry year [mm]	0	3	0	11	20	36	88	51	20	5	3	0	238
Effective Precipitation dry year [mm]	0	3	0	11	16	0	0	0	0	5	3	0	38
Crop Water Deficit dry year [mm]	32	0	19	145	92	0	0	0	0	18	22	23	352
Cropdays	31	28	31	30	28	0	0	0	0	31	30	31	240

Figure 11: Overview over the Irrigation Demand Calculator tab.

The Select Parameters

By default, the Guantao Irrigation Calculator uses the Guantao meteo station data to calculate the crop water deficit. If the user wishes to use a different climate data set, they can edit the climate data in the Climate tab following the instructions in Chapter 2.4.4 below and by subsequently selecting the User specified climate data after pressing the Meteo Data Source button.

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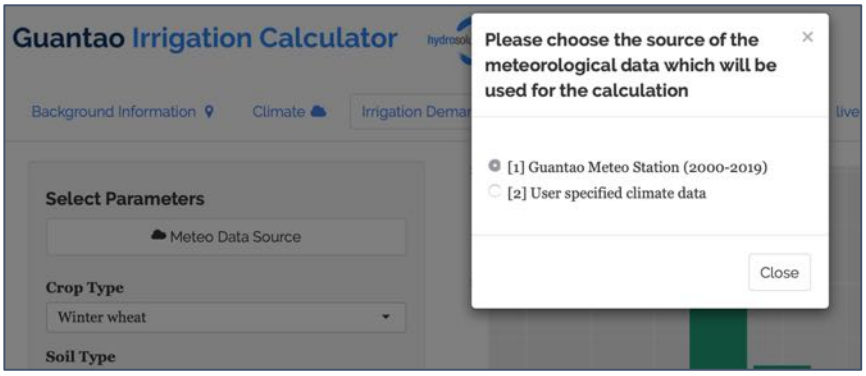

Figure 12: By pressing the Meteo Data Source button, the user can choose a different meteo data set to calculate the crop water deficit.

As a next step, the user can select a crop type in the drop-down menu Crop Type and a soil type in the Soil Type drop-down menu. More detail on the choice of crops and soils implemented in the Guantao Irrigation Calculator is given in Chapter 1.4.

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The planting date of the crop can be specified from the Planting Date pane by clicking on the date. A calendar window opens up where the planting date can be changed as described in Figure 13.

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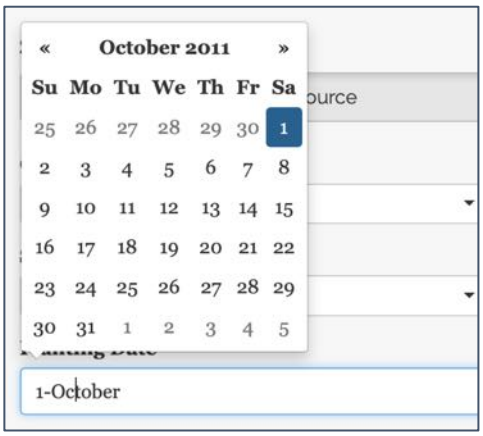

Figure 13: The planting date can be changed by performing a left-click in the date pane. The month can be changed by moving back in time by left-clicking << and forward in time by left-clicking >>. The day of the month can be selected by left-clicking on the day in the calendar pane. Please note that the year of the planting date is irrelevant to the calculation.

Please note that the year 2011 is indicated only as an example year and has no implication on the calculation of the irrigation water demand. The selection of the planting date is limited by a date range which can be viewed by downloading the Crop&Soil-Coefficients atht the bottom left of the App page (a detailed description of how to do this is given in Chapter 2.4.5).

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The last drop-down menu allows the selection of an irrigation schedule to apply to the crop. The user can choose between irrigation once a month (irrigation until field capacity at the end of the month or when water content goes below threshold) and minimum irrigation (irrigation until threshold when water content goes below threshold). An illustration of the irrigation method and its implementation is given in Chapter 1.1.

Under “Show”, the user can tick variables to visualize in the graph in the main pane. Several variables can be visualized at the same time.

The user can visualize the daily root zone depletion by performing a left click on the button labeled Show Root Zone Depletion. This opens a pop-up window (Figure 14) showing the development of the root zone depletion as well as the precipitation and irrigation events in a year with normal precipitation amounts.

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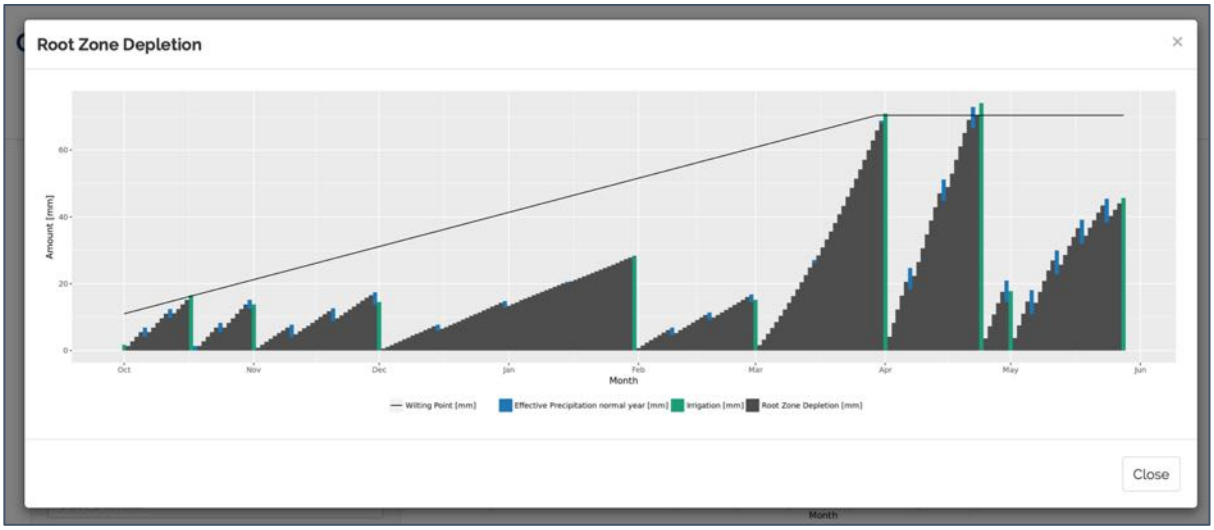

Figure 14: Daily root zone depletion for the example of winter wheat planted first of October and by applying the monthly irrigation scheme.

The crop can now be added to the Irrigation Planning Table by moving the cursor on the blue button Add to Planning Table and performing a left click. A new pop-up window will open (Figure 15) where the planting area, a number of losses and a label for the data set can be specified.

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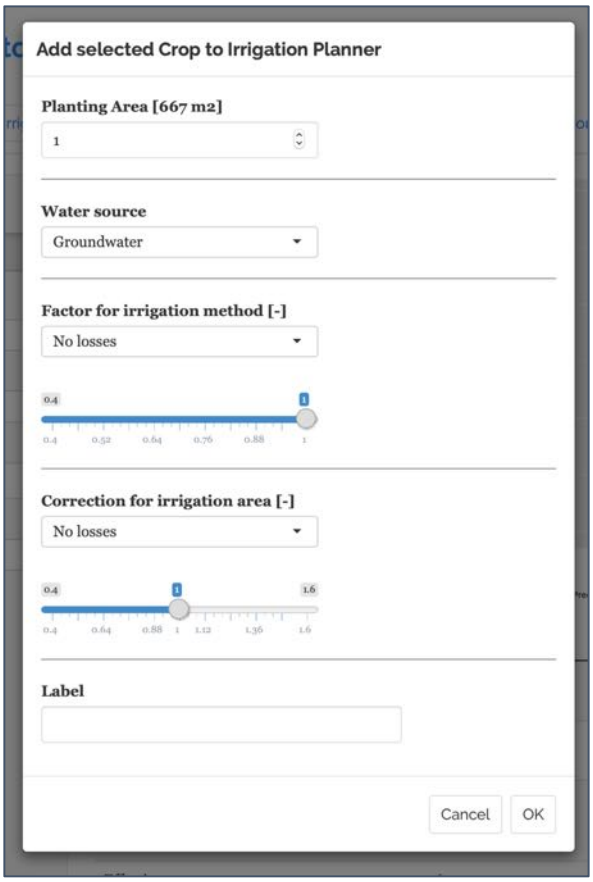

Figure 15: Pop-up window for specification of conveyance and irrigation losses.

The area is per default in units of 1 Chinese mu, equivalent to 667m^2. The correction factors for water source, irrigation method and irrigation that can be selected in the drop-down menu are according to the Hebei irrigation norm (Hebei Quality and Technical Supervision Bureau, 2009) and summarized in Table 1. A label can be specified by the user to simplify identification of the scenario in the Irrigation Planning Table. The default correction factors can be adapted manually by grabbing the slider with the cursor and moving it to the left or to the right. By clicking the OK button, the specified crop is added to the Irrigation Planning Table which is described in the following Chapter.

At the bottom of the page, the crop and soil parameters can be downloaded in an excel spread sheet by left-clicking on the button Crop&Soil-Coefficients. A detailed description of the excel spread sheet is given in Chapter 2.4.5.

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2.3.4 The Irrigation Planning Table

Figure 16 shows the empty Irrigation Planning Table, the default view of the tab. Crops can be added to the Irrigation Planning Table in the Irrigation Demand Calculator tab described in the previous Chapter.

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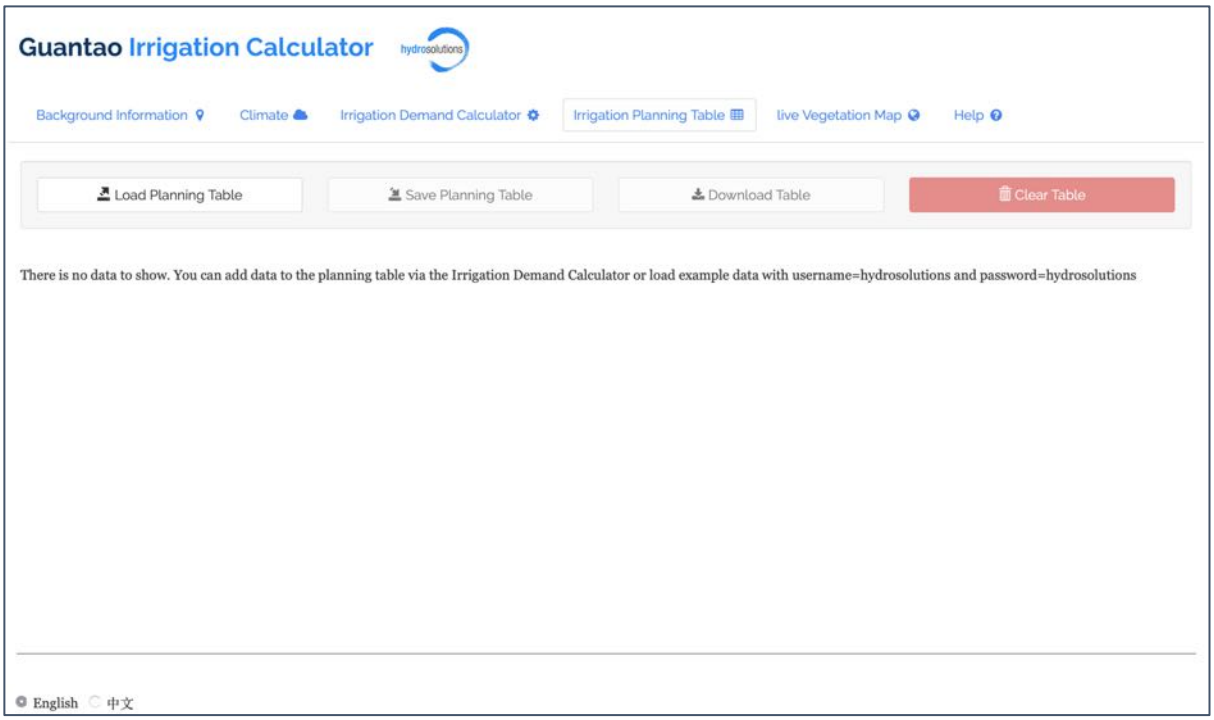

Figure 16: Default view of the empty Irrigation Planning Table.

A sample Irrigation Planning Table is given in Figure 17. The main pane of the Irrigation Planning Table tab shows the monthly Irrigation demand for a normal year whereas the table below the graph summarizes the annual irrigation demand for normal and dry years calculated from the Irrigation Calculator and using the Hebei irrigation norm.

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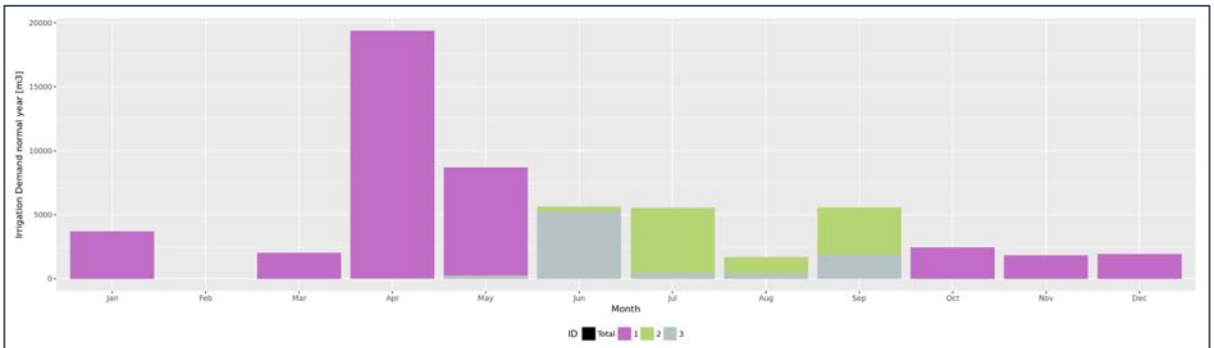

ID	Label	Crop	Area [667 m2]	Accumulated correction factor [-]	Soil	Planting Date	Irrigation Schedule	Irrigation Demand normal year [m3]	Irrigation Demand dry year [m3]	Irrigation Norm normal year [m3]	Irrigation Norm dry year [m3]	Actions	Show
1	A	Winter wheat	200	1	Sand	01-Oct	Once a month	39769.4	46908.4	34000	42000	Delete	☑
2	B	Summer maize	250	1	Sand	01-Jun	Once a month	10516.8	32153	13750	27500	Delete	☑
3	C	Cotton	75	1	Sand	01-Apr	Once a month	8238.4	16497.1	8250	11250	Delete	☑
			Total: 525	Volumetric Average: 1				Total: 58524.6	Total: 95558.5	Total: 56000	Total: 80750		

Figure 17: A sample Irrigation Planning Table.

By ticking the boxes on the left, the irrigation water demand of a given crop can be visualized in the graph. An entry can be removed by clicking the Delete button. To add a new crop, go to the Irrigation Demand Calculator tab and select the appropriate climate, crop and soil parameters and specify the area and the correction factors.

The Irrigation Planning Table can be emptied (red button Clear Table, Figure 18). Further, the Irrigation Planning Table can be downloaded as an excel spread sheet (button Download Table).

Figure 18: Activities available in the Irrigation Planning Table.

The excel file contains 3 sheets: A summary sheet that contains the data presented in the table of the Irrigation Planning Table tab and the monthly irrigation demand for normal and dry years.

A data bank for Irrigation Planning Tables is available in the back-end of the Guantao Irrigation Calculator which allows the user to save an Irrigation Planning Table and to retrieve it again at a later stage. A description of how to load an existing Planning Table from the data base, how to overwrite an existing Planning Table in the data base and how to save a new Planning Table to the data base is given in Chapters 2.4.6 and 2.4.7.

2.3.5 The live Vegetation Map

The Vegetation Map tab (Figure 19), shows the EVI of a selected region over time. The region to be displayed in the map on the right can be selected in the Map Control panel on the left. In the Archive, EVI maps of the past 4 years can be selected for visualization. The latest image is always at the top of the list.

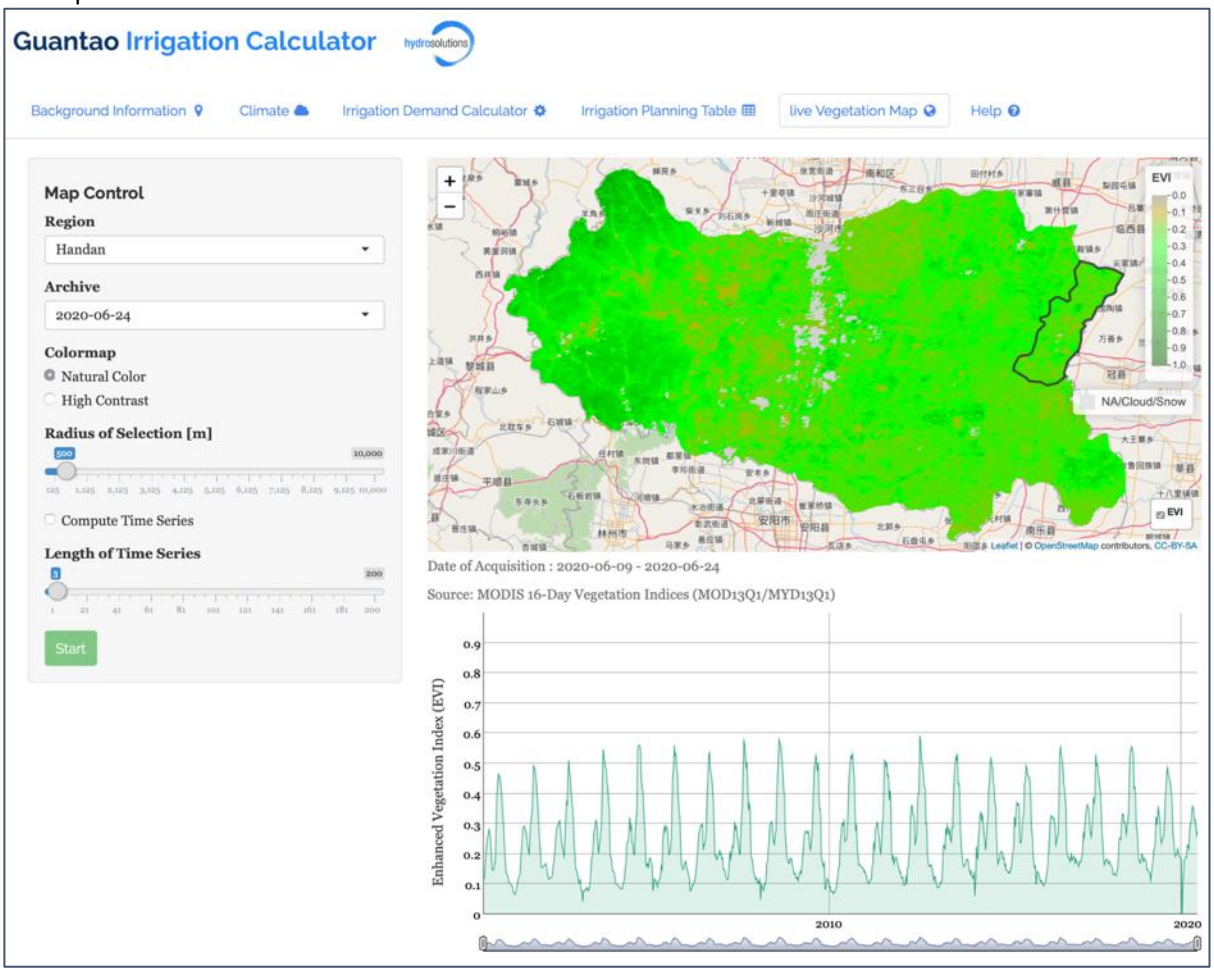

Figure 19: The live Vegetation Map tab. A high value of EVI indicates high plant activity. The EVI signal of the main growth season is visible as a peak of about 0.5. The smaller peak is mainly caused by the winter wheat planting area.

The EVI can be displayed in 2 different colour maps: Natural colour where the intensity of the green hue is an indicator for plant activity or the high contrast colour map where a larger number of colours in the map makes distinguishing between values of EVI easier.

By performing a left-click in the region of interest, the user can read the average value of EVI within a specified radius of selection.

By default, the time series of average EVI in the selected region is displayed below the map. By ticking the Compute Time Series box, specifying the length of the time series and clicking the Start button, the App calculates the time series of average EVI within the radius of selection. A box (Figure 20) will appear in the bottom right corner of your browser, showing the progress of the calculation.

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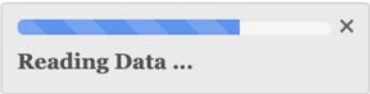

Figure 20: When requesting the calculation of the time series of EVI within the radius of selection, this box appears in the bottom right corner of your browser.

Attention, the Compute Time Series box must be ticked, otherwise the App will not start the computation. The Start button will appear in bright green colour. The calculation of the time series can be interrupted by pressing the Stop button which appears once a calculation is running.

2.3.6 The Help tab

A brief description of the input data and the methods used is given in the help tab (Figure 21).

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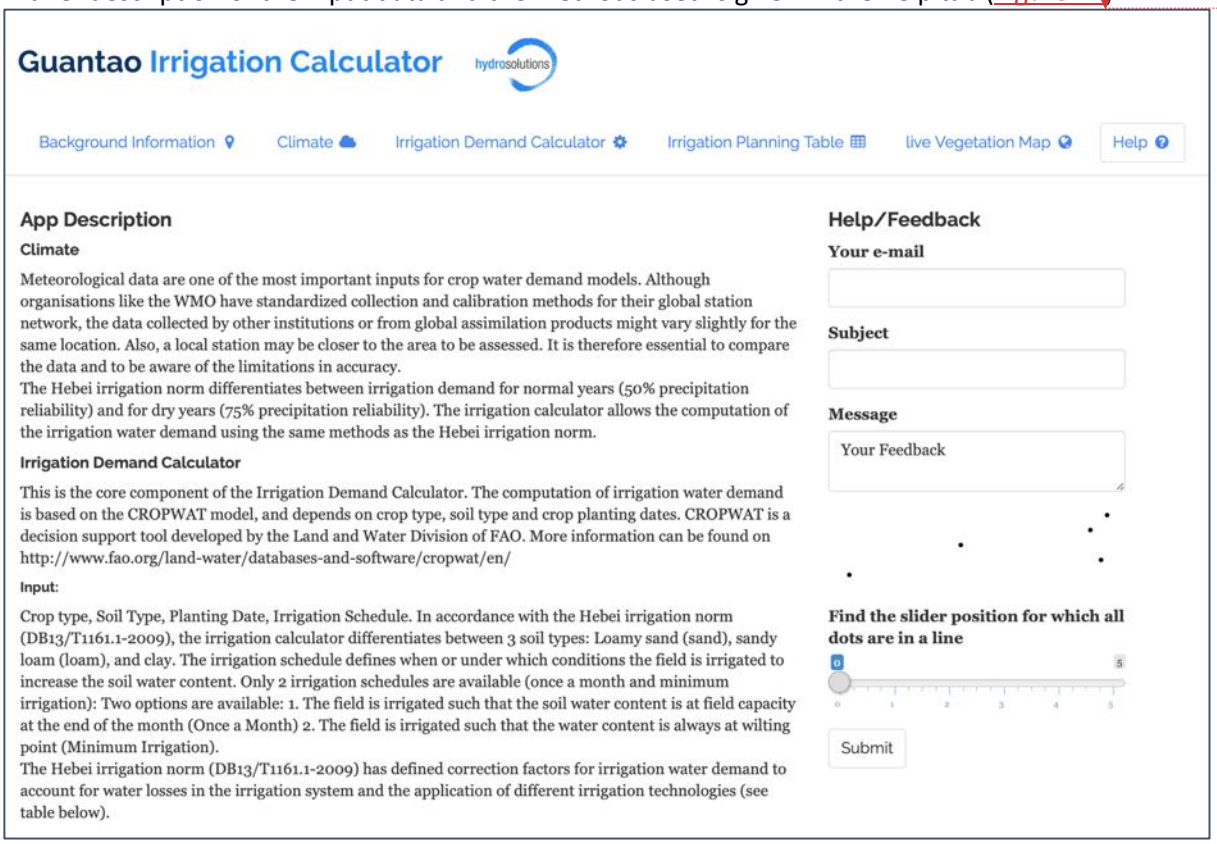

Figure 21: The help tab summarizes the method used to calculate the irrigation water demand.

Further, there is the possibility to send questions or feedback on the Guantao Irrigation Calculator to hydrosolutions Ltd.

2.4 Step-by-step guide to specific tasks

2.4.1 Changing the language

The Guantao Irrigation Calculator is available in English and in Chinese. The language can be changed by moving the cursor over the empty circle next to the language at the bottom left on any tab of the App and by selecting it with a left click (Figure 22). The Entire App will now appear in the selected language.

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Figure 22: The language can be changed by selecting the respective language at the bottom left of any tab.

2.4.2 Changing from one tab to another

On the App, move the pointer using your mouse to hover above the text describing the tab you would like to switch to. The tab will be highlighted with a grey box (Figure 23). Then perform a left click and the view will change to the chosen tab.

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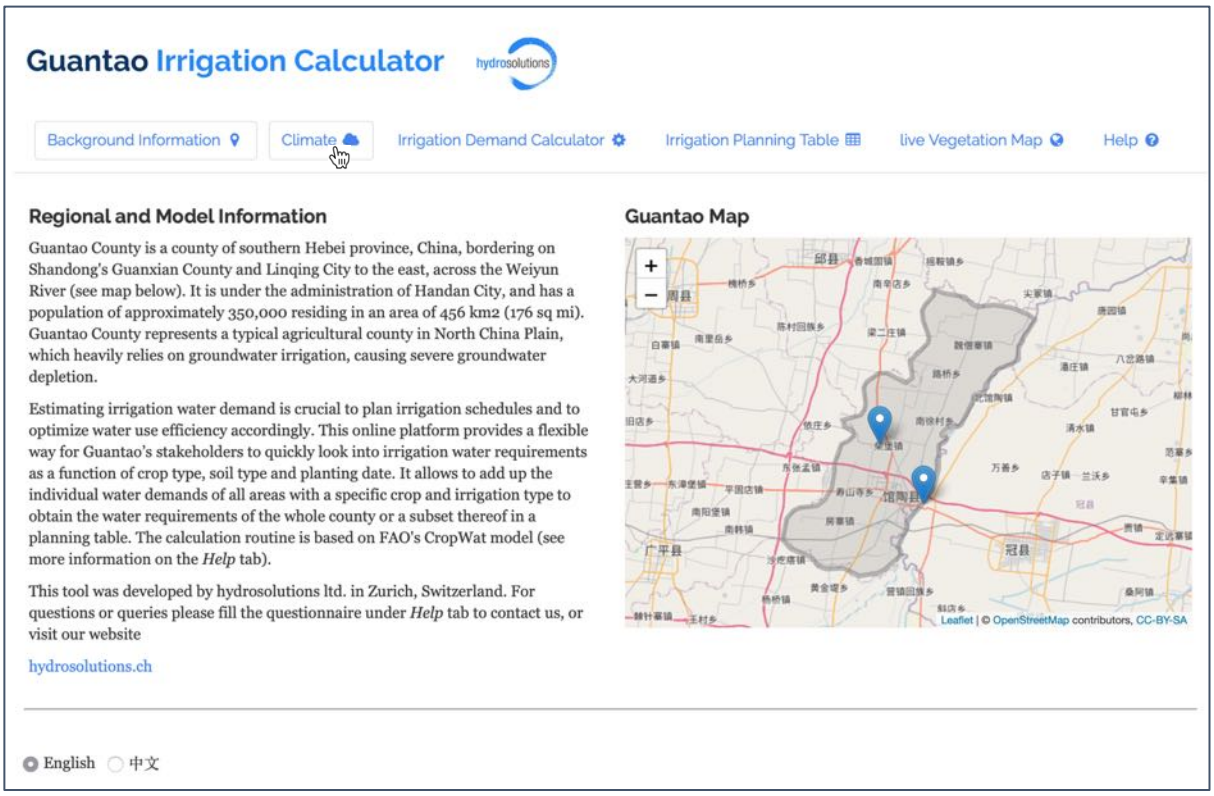

Figure 23: To switch a tab, move your pointer above the text describing the tab you'd like to visit and perform a left click.

2.4.3 How to obtain the climate data

In the Climate tab, in the grey box on the left, tick [2] User specified climate data by moving your pointer with the mouse on the empty box next to the text and performing a left click (Figure 24).

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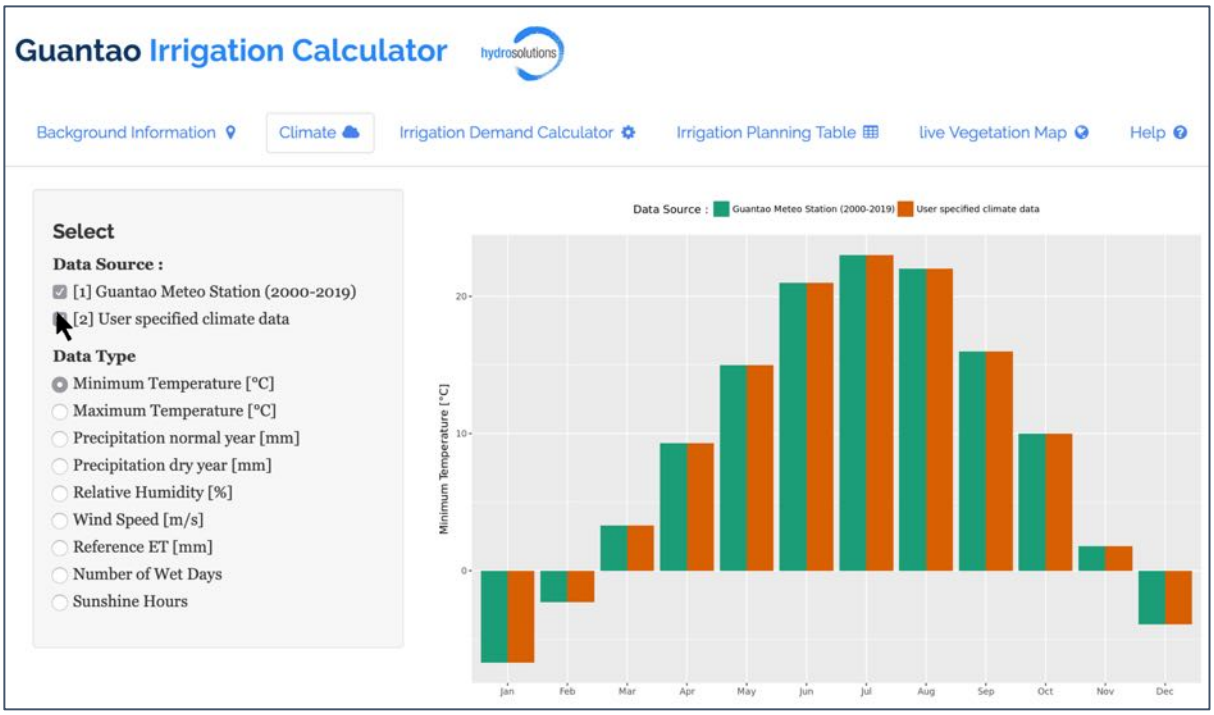

Figure 24: In order to obtain the Guantao meteo data, tick the box next to [2] User specified climate data.

Below the bar graph, the edit climate pane appears, containing the monthly average Guantao meteo station data in an editable table (Figure 25).

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Edit station properties and climate data in table below (you may copy-paste table data from excel), then click the recalculate button:

Recalculate

Longitude:

115.29

Latitude:

36.61

Altitude:

60

Month	Number of Wet Days	Precipitation normal year [mm]	Precipitation dry year [mm]	Maximum Tem
1	2.14	1.00	0.03	
2	3.75	8.10	3.13	
3	2.21	1.50	0.03	
4	4.50	15.00	10.03	
5	5.86	29.65	17.85	
6	8.43	65.45	32.50	
7	10.50	186.30	108.40	
8	8.57	123.50	44.60	
9	7.07	47.60	23.75	
10	5.43	13.55	6.53	
11	3.00	10.20	1.98	
12	2.29	3.70	0.33	

Figure 25: The edit climate data pane. Values in the table can be copy-pasted to and from a spread sheet (e.g. MS Excel).

Move your mouse to the cell containing the data you would like to copy and perform a left click. The cell will be highlighted in light blue (Figure 26).

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Month	Number of Wet Days
1	2.14
2	3.75
3	2.21
4	4.50
5	5.86

Figure 26: Select data in a cell by performing a left click in the cell.

The data in the cell can now be copied by simultaneously pressing the command and c buttons on your keyboard (Mac OS) or control and c buttons (MS Windows). Go to a spread sheet, select a cell to copy the value to and simultaneously press the command and v buttons on your keyboard (Mac OS) or control and v buttons (MS Windows).

The user can select several cells by holding the left-click and moving the cursor across the cells to be selected before releasing the left-click. Alternatively, an entire column of data can be selected by performing a left click on the column header.

Please note that the column header is not copied.

2.4.4 How to edit the climate data

In order to edit the climate data, the user can proceed as described in Chapter 2.4.3 above. Instead of copying the data from a selected cell, the user can edit the data in the selected cell using the keyboard.

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It is further possible to paste data cell- or column-wise from a spread sheet into the editable climate data table. In order to do this, the data cell or column in the spread sheet is selected and copied by simultaneously pressing the command and c buttons on your keyboard (Mac OS) or control and c button (MS Windows). The user then switches to the Guantao Irrigation Calculator App in the Browser window and performs a left click into the cell the data should be copied to. In the case of copying a column, the upper-most cell of the column can be selected. By simultaneously pressing the command and v buttons (Mac OS) or the control and v buttons (MS Windows), the data is pasted to the Guantao Irrigation Calculator App. In order to save the changes, the button Recalculate below the graph must be pressed.

2.4.5 How to obtain the crop parameters

A list of the crop types and their parameters for the calculation of the crop water demand can be obtained by clicking the Crop&Soil-Coefficients button (Figure 27).

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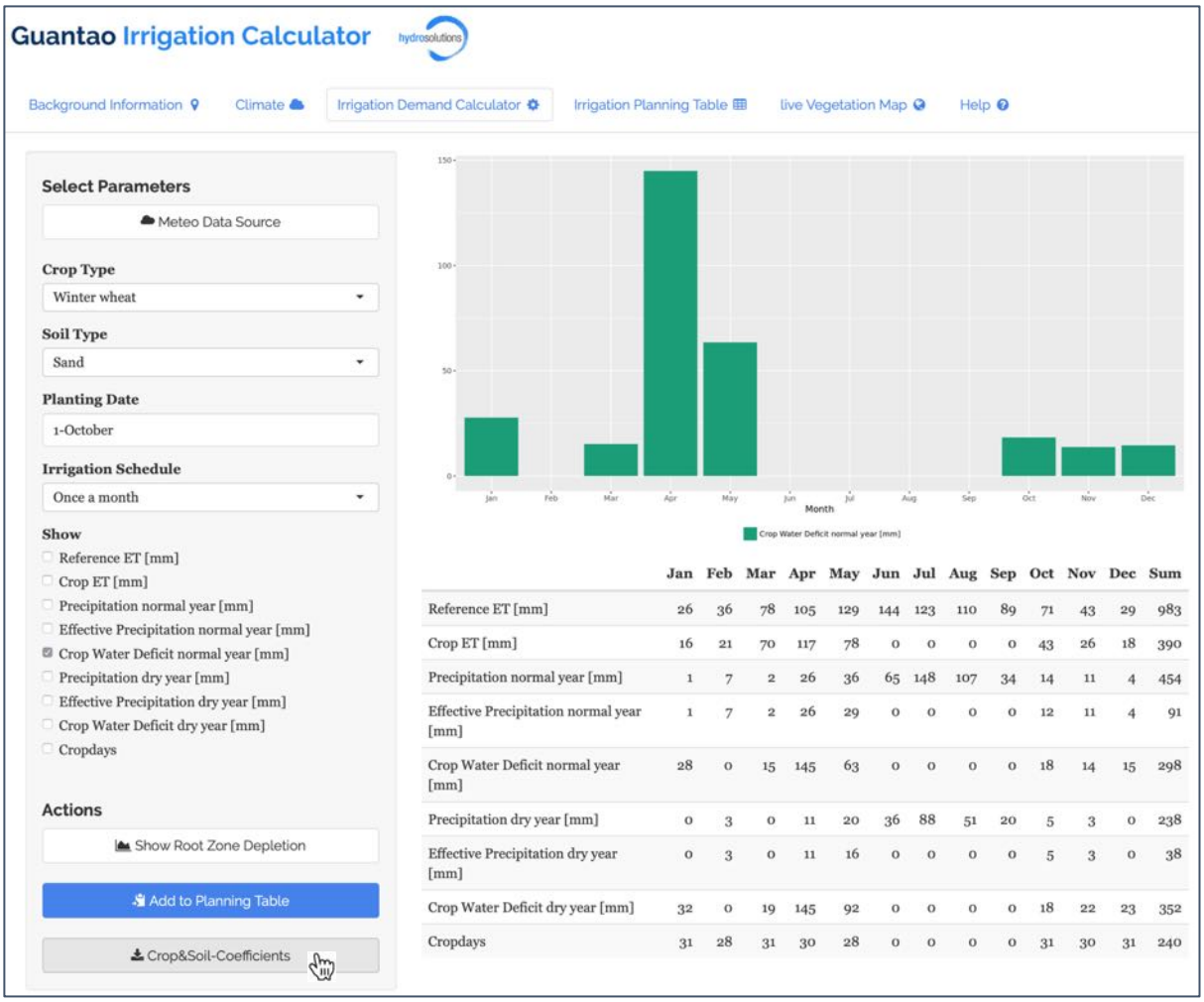

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Sum
Reference ET [mm]	26	36	78	105	129	144	123	110	89	71	43	29	983
Crop ET [mm]	16	21	70	117	78	0	0	0	0	43	26	18	390
Precipitation normal year [mm]	1	7	2	26	36	65	148	107	34	14	11	4	454
Effective Precipitation normal year [mm]	1	7	2	26	29	0	0	0	0	12	11	4	91
Crop Water Deficit normal year [mm]	28	0	15	145	63	0	0	0	0	18	14	15	298
Precipitation dry year [mm]	0	3	0	11	20	36	88	51	20	5	3	0	238
Effective Precipitation dry year [mm]	0	3	0	11	16	0	0	0	0	5	3	0	38
Crop Water Deficit dry year [mm]	32	0	19	145	92	0	0	0	0	18	22	23	352
Cropdays	31	28	31	30	28	0	0	0	0	31	30	31	240

Figure 27: To download a list with crop types and their parameters, move the cursor to the button Crop&Soil-Coefficients and left-click. The app will download an excel document containing the desired data to your computer.

The App will download an excel document to your computer containing the crop types implemented in the Guantao Irrigation Calculator as well as the following list of crop and soil parameters used for the soil water balance (Table 3):

Table 3: Description of the crop and soil parameters that can be downloaded from the Guantao Irrigation Calculator.

Name of parameter	Description of the parameter
DAYSINIT	Duration of initial growth phase in days
DAYSDEVELOP	Duration of the development phase in days
DAYSMID	Duration of the mid-season growth phase in days
DAYSLATE	Duration of the late-season stage in days
KCINIT	Crop coefficient during the initial growth phase [-]
KCMID	Crop coefficient during the mid-season stage [-]
KCEND	Crop coefficient in the late-season stage [-]
PDRY	Factor between the total available water and the readily available water [-]
ZROOTINIT	Initial root length at the beginning of the growth period [m]
ZROOTMAX	Maximum root length at the end of the growth period [m]
DATERANGESTART	Earliest possible planting date
DATERANGEEND	Latest possible planting date

Chapter 1.1 above describes how these parameters are used to calculate the irrigation water demand.
A note on the date range for the planting date: The Guantao Irrigation Calculator does not calculate the irrigation water demand for a specific year but for a given climate. For simplicity of implementation, the reference year of 2011 was chosen to indicate the planting date, the year, however, is irrelevant to the computation.

2.4.6 Loading an Irrigation Planning Table

In order to load a previously saved Planning Table from the data base, press the Load Planning Table button, enter username and password in the pop-up window and close the window with the OK button. If the specified Planning Table is available in the data base, it will be loaded to the Irrigation Planning Table tab.

2.4.7 Saving an Irrigation Planning Table

In order to save the Planning Table, press the Save Planning Table button in the Irrigation Planning Table tab (please note that the Irrigation Planning Table needs to have at least one entry to activate the Save Planning Table button). In a Pop-up window, the user can register a new user or overwrite an existing Irrigation Planning Table (Figure 28). Please note that a new user has to be specified for each separate Planning Table and it is good practice to generate a username which describes the Planning Table to be saved.

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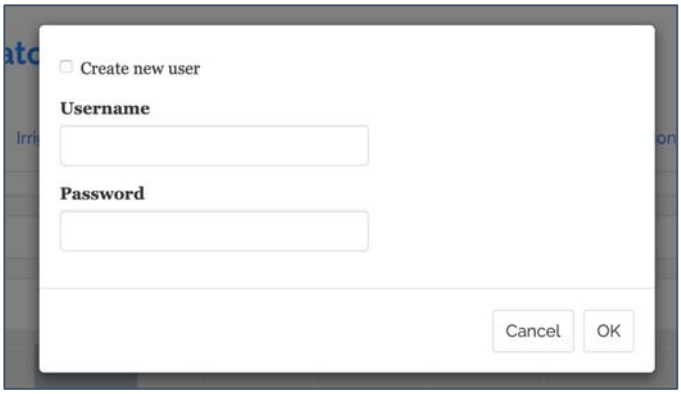

Figure 28: Pop-up window asking for username and password to save an Irrigation Planning Table in the data base.

Overwrite an Irrigation Planning Table in the data base

To overwrite an Irrigation Planning Table in the data base, enter username and password of said table and click the OK button.

Save a new Irrigation Planning Table

Figure 29 shows the window when Create new user is active. In addition to a new username and password, a valid email Address needs to be specified.

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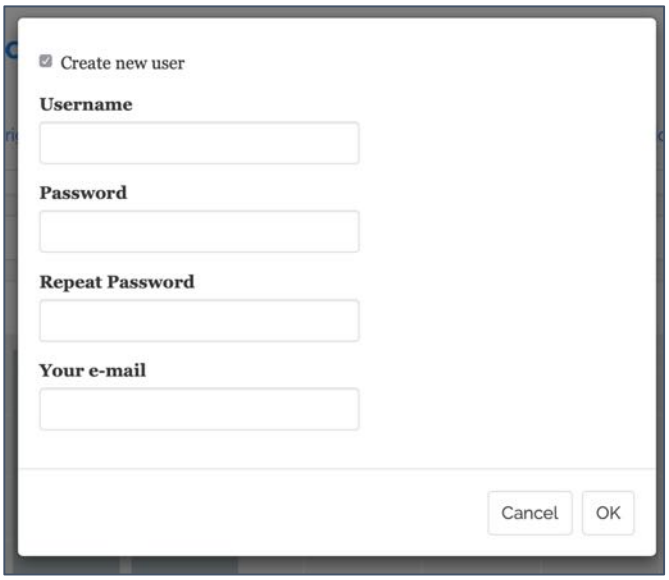

Figure 29: If Create new user is active, the user has to specify a valid email address on which to receive the login information for the specified user.

Upon clicking the OK button, the app will send a copy of the specified login information for the Irrigation Planning Table as well as a verification code to this email address from address ic_help@hydrosolutions.ch. Please check your spam folder if the email does not appear in your inbox after a few minutes. The create new user window will add a field where the verification code from the email can be entered (Figure 30).

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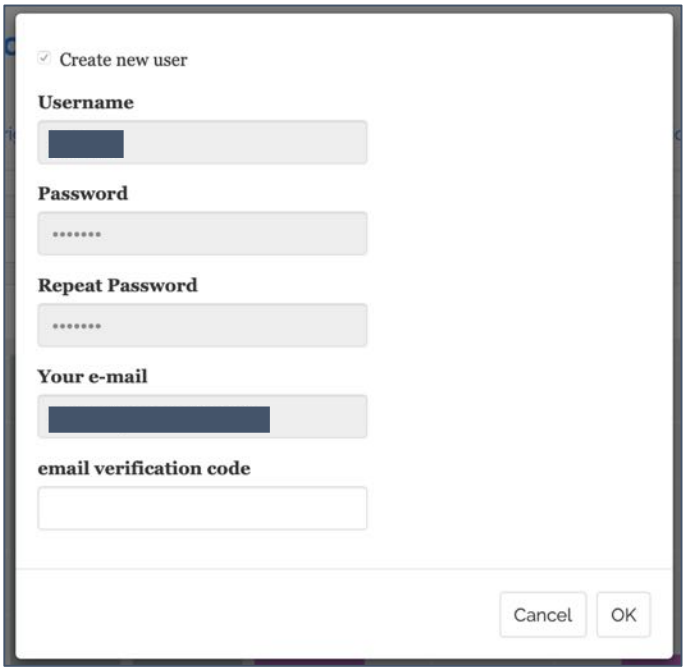

Figure 30: The create new user window waiting for verification. The verification code is sent via email

By clicking OK, the Irrigation Planning Table is written to the data base.

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