

Guantao Irrigation Calculator



Development Manual



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Authors

Dr. Beatrice Marti
hydrosolutions ltd.
Winkelriedstrasse 5
CH-8006 Zurich, Switzerland
Telephone: +41 44 632 73 28
hs@hydrosolutions.ch and www.hydrosolutions.ch



Title Picture: Winter wheat, Guantao county, spring 2019

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Acronyms and abbreviations

CWD	Crop water demand
DB	Database
ET	Evapotranspiration
EVI	Enhanced vegetation index
GW	Groundwater
GIWP	MWR General Institute of Water Resources and Hydropower Planning and Design
IWD	Irrigation water demand
PET	Potential evapotranspiration
UI	User interface

Acknowledgement

Various authors have contributed to the development of the Irrigation Calculator over the years, namely Dr. Sebastian Stoll, Jakob Steiner, and Jules Henze. Thanks to comments and inputs from the entire project team, namely Dr. Haijing Wang, Dr. Tobias Siegfried, Dr. Silvan Ragetti, 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 a web application 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”. The Guantao Irrigation Calculator calculates crop water demand using a soil water balance model following the FAO Irrigation and Drainage Paper No 56 and applies correction factors for irrigation method, water source and conveyance efficiency according to the Hebei irrigation norm (Hebei Quality and Technical Supervision Bureau, 2009). 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 250 m. For a detailed description of the EVI product, the reader is referred to (Didan et al., 2015). For more details on the method the reader is referred to the user manual of the Guantao Irrigation Calculator (Marti, 2020).

2. How to use this manual

The development manual complements the source code of the Guantao Irrigation Calculator which is hosted on GitHub (<https://github.com/hydrosolutions/irrigationCalc-Guantao>). This user manual focuses on the more detailed description of common tasks required for maintenance, development or deployment. For this purpose, the manual proceeds from simpler maintenance tasks which are required annually to more complex development or deployment tasks which may only be required every 5 to 10 years.

1. Components

The Guantao Irrigation Calculator web application has 2 main components which are computationally independent of each other: The calculation of the irrigation water demand and the crop monitoring. The calculation of the irrigation water demand is written entirely in R and is independent of 3rd party products. The crop monitoring part relies on publicly available data of EVI which are downloaded using the MODIS data-server. Figure 1 shows an overview of the components of the Guantao Irrigation Calculator. Input files and data bases are indicated with boxes with rounded corners. Boxes with darkly shaded backgrounds indicate data sets which can be edited by the user during a user session. Except for the Irrigation Planning Table which can be stored in the Irrigation Planning database (DB), all data edits disappear after closing a user session.

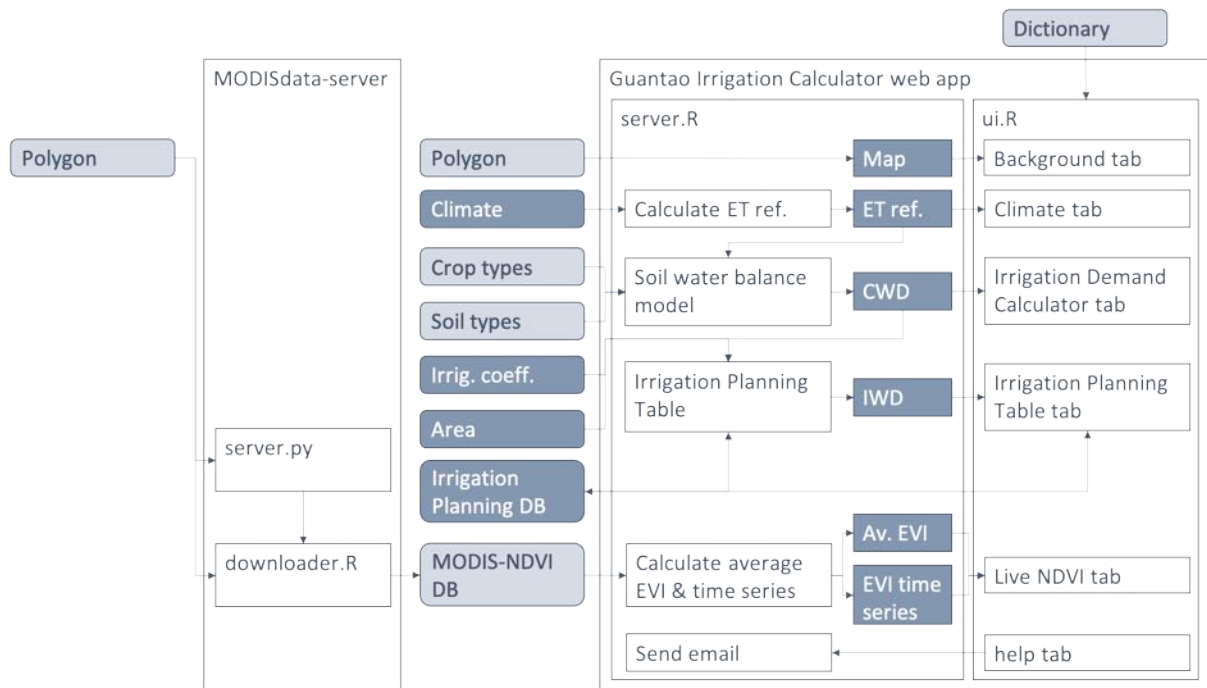


Figure 1: Overview of the components of the Guantao Irrigation Calculator. The user of the Guantao Irrigation Calculator interacts with the UI part (on the right of the image). The boxes with the rounded corners indicate input files and data bases (DB). The boxes with the darker shades indicate data which can be modified by the user during a user session.

The user interacts with the Guantao Irrigation Calculator via the user interface through 6 interactive tabs. All tabs except for the Irrigation Planning Table (which relies on edits in the Irrigation Demand Calculator tab) work independently from each other.

The Guantao Irrigation Calculator is written in the R language (R Core Team, 2020) using the R package RShiny (McPherson, 2020). The remote sensing data is downloaded using the MODISdata-server written in R and python and stored in an SQLite (Hipp, 2020) database.

2. Pre-requisites

The software and skill pre-requisites to perform maintenance tasks, change components of the Guantao Irrigation Calculator and to deploy it on a server are described in detail here below. A summary of the requirements for each task will be given in each Chapter with references to the detailed descriptions here below.

The user should be familiar with (or at least not be reluctant to learn) the common computational terms and tools (for example, the user should have a rough understanding of what a server is).

2.1 Operating system

The Guantao Irrigation Calculator has been developed and deployed in a UNIX environment (Mac OS X & Ubuntu). It is not tested in MS Windows environments.

Mac OS X & Ubuntu users

Requirements for the operating system are met.

Other Unix users

The Guantao Irrigation Calculator is only tested for Mac OS X and Ubuntu. It should in principle run on other Unix operating systems as well but be prepared to encounter footfalls. In the following, the manual only covers instructions valid for Ubuntu users.

MS Windows users

Minor maintenance tasks described in Chapter 3, may be performed directly on the UNIX server that runs the application by connecting to the server, for example through.

For further development of the Irrigation Calculator code it is recommended to work in a UNIX environment. MS Windows users can install Ubuntu on a sub-system on their computer, various step-by-step descriptions of how to do this are available on-line.

2.2 Software tools used for maintenance & development

The following Chapter gives an overview of the software tools which have been used to develop the Guantao Irrigation Calculator. The user should be familiar with these tools.

The Linux command line

All tasks require use of the Linux command line in the terminal. The terminal can be accessed through terminal emulators from any operating system.

Git & GitHub

Git is a version control program used for the development of the Guantao Irrigation Calculator. It is recommended to download the released version 2.5 of the app via GitHub

(<https://github.com/hydrosolutions/irrigationCalc-Guantao/releases/tag/v2.5>) and to further use GitHub for managing developments of the app and to update the app on the server. Tutorials and documentation for GitHub are publicly available online.

R

R is an open source language for data analysis and statistical computation. It comes with many optional packages which implement tasks for modelling and even app building (i.e. RShiny).

RStudio

RStudio is a free programming environment for R. The use of RStudio is not required, other user interfaces are available.

RShiny

RShiny is a package which allows the implementation of web-based tools in R.

Python

Python 3.7 is used to trigger the download of the MODIS tiles.

SQLite

SQLite is a widely used open source database language. Detailed documentation and tutorials are available online.

2.3 Hardware & software tools used to deploy the web app

Acquire server and storage space (1 & 25 GB respectively) on a Unix server of your choice

Connect to the server from your workstation:

Mac OS X users: Connect to the server via ssh

MS Windows users: Use PuTTY to access the server

Unix terminal commands are required, a large number of tutorials and step-by-step guides are available on-line

If the app should be publicly available from the internet, the user will need to acquire a public host name for the app.

3. Maintenance tasks

The maintenance tasks are ordered in increasing frequency required.

3.1 Testing proper working of app

The correct working of the full functionality of the app should be tested after each update of the server or at least once a year. If the app becomes dysfunctional after a software update, the code needs to be debugged.

3.2 Updating climate input data

Every 2-5 years, the average climate data of Guantao station should be updated. In principle, this task can be done on the server directly, but it is strongly recommended to download the Irrigation Calculator code from GitHub, edit the code locally and to then push the changes to the server.

Download already available monthly meteo data from the project data base (if a login is available). If no login for the project data base is available, the average monthly meteo data from the input file of the Guantao Irrigation Calculator can be used.

Make sure that new meteo data is valid, compare new meteo data with old meteo data and check for inconsistencies.

Then update the climate input file with new data and push the changes to the server.

3.3 Adapting of texts in English or Chinese

If changes in the input files or in the code are done, it may be necessary do revise the English and Chinese texts of the App. This is done in the files dictionary.csv and dictionary_UI.csv.

3.4 Updating crop types & parameters

The literature suggests that planting dates, duration of phenological growth stages may be influenced by changing climate (e.g. (Wang et al., 2017), (Tao et al., 2014), (Chen et al., 2010)). Further, new literature on crop parameters will become available and new cultivars or altogether new crop types may become important over time. It is thus suggested to verify the crop types and parameters every 5 years and to adapt them if needed.

In order to adapt the crop types and parameters, edit the croptype.csv file and push the changes to the server.

3.5 Updating irrigation norm

Should a new irrigation norm be enforced, the irrigation calculator should be adapted accordingly. The irrigation water demand for crops, soils and precipitation reliability is to be adapted in the file irrigationnorm.csv. The correction factors for water source, irrigation method and size of the farm are to be adapted in the files watersource.csv, irrigationefficiency.csv and conveyanceefficiency.csv respectively.

Should a revised irrigation norm incorporate different soil types, they can be adapted in the file soiltypes.csv.

4. Development

For further development of the Guantao Irrigation Calculator it is recommended to use a version control software (e.g. Git).

It is recommended to run RStudio on a server (descriptions of how to do this are available on-line) which makes debugging of the code easier.

5. Online deployment

Step-by step descriptions of how to deploy R shiny apps on a number of popular cloud servers are available on-line. To deploy the app on an in-house server, steps are similar. The following steps are necessary:

- Access to unix server (Ubuntu is recommended) with storage & server space
- Install R base and R shiny on the server
- Transfer the Apps files to the server
- Host the server, acquire public hostname if the app should be accessible from the internet

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