

JOINT COOPERATION PROGRAMME

*Bangladesh Netherlands*

Knowledge development for a prosperous delta



# LINKING WATER TO FOOD: SWAP-WOFOST TRAINING





**Document information**

Document Title Training report  
 Author(s) Judit Snethlage, Ab Veldhuizen, Martin Mulder, Joop Kroes, Farhana Ahmed, Abdur Rashid, Abdur Farhard  
 Reference

**Dissemination level**

- Technical Report
- Technical Note
- Planning and Progress Report
- Others

**Dissemination level**

- Public
- Other Programme Partners
- Restricted to a specific group
- Confidential

**Document Version and Review Management**

Version No.	Status	Date	Author(s)	Review	Approval
I	Draft		JS		I

**Key Project Information**

This document is an output of the Joint Cooperation Programme (JCP) Bangladesh – the Netherlands

Grant agreement No. DHA/OS/2018/4000001952  
 Grant organization Embassy of the Kingdom of the Netherlands (EKN)  
 Project manager William Oliemans  
 Project start date December 2018  
 Project duration 4 years  
 Coordinating organization Stichting Deltares  
 Partner organization Center for Environmental and Geographic Information Services (CEGIS), Institute of Water Modeling (IWM), Wageningen University and Research (WUR).

## EXECUTIVE SUMMARY

There is a growing global concern of the world food program that food security (and nutritional value of foods) will decrease as an effect of climate change and changing socio-economic circumstances (WFP, 2016). Bangladesh also fits within the trend of growing GDP and is affected by climate change. Although the country has made huge steps the last decades in increasing the food security and the food self-sufficiency of the country (Bishwajit et al.,2013), it is a country with a fast-growing population with a fast-increasing need for more and protein rich food. Some qualitative methods show a trend towards water and food shortage (Zhou et al.,2019). However, a quantitative approach for identifying how big the gap is, is not done yet in an integral way. Therefore, the focus will be on finding out, quantifying how much food is needed, and how much water is needed for this growing population. The SWAP-WOFOST training helps getting insights by upscaling the water needs of crop production. This training is overall aimed at supporting getting insights on quantifying the water need, availability and food crop production. Topics that were covered in the training were using SWAP-WFOSOST to calculate soil moisture flow, irrigation and drainage, crop growth and salinity. Overall, the participants perceived the course as positive and gave more insights in modelling for food and water demands. Follow up will be focussed on local application of SWAP-WOFOST in Bangladesh. The wish from the participants from the first training was to focus on rice modelling for a follow up training. This wish was expressed because of the importance for rice as food crop.



# TABLE OF CONTENTS

EXECUTIVE SUMMARY .....	III
ACRONYMS AND ABBREVIATIONS .....	III
LIST OF TABLES.....	IV
LIST OF FIGURES .....	IV
1 CONTEXT .....	5
2 SWAP-WOFOST .....	5
3 TRAINING.....	6
3.1 Objectives.....	6
3.2 Target audience and background knowledge .....	7
3.3 Approach, materials and planning.....	7
4 REFLECTIONS TRAINING .....	8
4.1 Organizational reflections .....	8
4.2 Content lessons reflections.....	11
4.3 Participants reflections.....	11
4.4 Trainers reflections.....	12
5 FOLLOW UP COURSE.....	14
5.1 Sub-section .....	<b>Error! Bookmark not defined.</b>
6 SECTION FOUR.....	<b>ERROR! BOOKMARK NOT DEFINED.</b>
7 SECTION FIVE .....	<b>ERROR! BOOKMARK NOT DEFINED.</b>
7.1 Sub-section .....	<b>Error! Bookmark not defined.</b>
7.1.1 Sub-section .....	<b>Error! Bookmark not defined.</b>
7.1.2 Sub-section .....	<b>Error! Bookmark not defined.</b>
7.2 Sub-section .....	<b>Error! Bookmark not defined.</b>
7.2.1 Sub-section .....	<b>Error! Bookmark not defined.</b>
7.2.2 Sub-section .....	<b>Error! Bookmark not defined.</b>
7.3 Sub-Section.....	<b>Error! Bookmark not defined.</b>
7.3.1 Sub-section .....	<b>Error! Bookmark not defined.</b>
7.3.2 Sub-section .....	<b>Error! Bookmark not defined.</b>
8 SECTION SIX .....	<b>ERROR! BOOKMARK NOT DEFINED.</b>
ANNEX A.....	<b>ERROR! BOOKMARK NOT DEFINED.</b>
ANNEX B.....	<b>ERROR! BOOKMARK NOT DEFINED.</b>

## ACRONYMS AND ABBREVIATIONS

BCC	- Behavioural Change Communications
CSO	- Civil Society Organisation
CoP	- Community of Practice
ICT	- Information and Communications Technologies
NGO	- Non-Governmental Organisation
RO	- RedOrange Media and Communications
PDSA	- Plan, Do, Study, Act



## LIST OF TABLES

Table 3-1 Table Caption..... **Error! Bookmark not defined.**

Table 3-2 : Table Caption ..... **Error! Bookmark not defined.**

## LIST OF FIGURES

Figure 1 Data ..... **Error! Bookmark not defined.**

Figure 2 Figure 2..... **Error! Bookmark not defined.**

## I CONTEXT

There is a growing global concern of the world food program that food security (and nutritional value of foods) will decrease as an effect of climate change and changing socio-economic circumstances (WFP, 2016). One of the changes in socio-economic circumstances is the increase in GDP, this is linked to a higher intake of protein. The higher intake of protein requires more input of (scarce resources). Bangladesh also fits within the trend of growing GDP and is affected by climate change. Although the country has made huge steps the last decades in increasing the food security and the food self-sufficiency of the country (Bishwajit et al.,2013), it is a country with a fast-growing population with a fast-increasing need for more and protein rich food. This increase in need is mainly because of dietary changes (more welfare is linked to increased demand for protein) and a growing population (Mathijs, 2015). This results in a high pressure on agriculture to produce more food. As agriculture consumes around the 90% of the water use in Bangladesh (FAO Aquastat, 2012) the water demand is also increasing. Moreover, the increase of welfare is also linked to a high-water consumption pattern (Alcamo et al.,2007). Congregating these water and food developments in a water security assessment for agriculture, one can see that it is low in comparison to other countries in Asia (AWDO, 2016). One thing that explains a low water security score for Bangladesh is the changing climate; water resources are becoming more unpredictable under the current climate change scenarios (ADB,2016). This means that the amount of available water may not change, but the distribution of the water could change. For the future, this means a more unpredictable water situation for the country. Combining the unpredictable water situation with the growing population shows a potential problem for the food supply for this population. However, it is unclear how big the gap between the food demand and supply will be in the future. Some qualitative methods show a trend towards water and food shortage (Zhou et al.,2019). However, a quantitative approach for identifying how big the gap is, is not done yet in an integral way.

Therefore, the focus will be on finding out, quantifying how much food is needed, and how much water is needed for this growing population.

Where LPJml helps getting insight by downscaling, SWAP-WOFOST helps getting insights by upscaling. This training is overall aimed at supporting getting insights on quantifying the water need, availability and food production.

## 2 SWAP-WOFOST

The model SWAP (Kroes et al., 2017; Van Dam et al., 2008) simulates transport of water, solutes and heat in the vadose zone in interaction with vegetation development. The model employs the Richards equation including root water extraction to simulate soil moisture movement in variably saturated soils. Concepts are added to account for microporous flow and water repellency. Figure 1 is a brief summary what SWAP does. However, the SWAP model has been integrated with the WOFOST model. This leads to the following developments:

1. Descriptive module: Simple crop growth module
  - Indirect relation with biophysical and chemical processes
  - Based on statistical results
  - No extrapolation possible
  - Relatively simple, few data needed
  - Assume relative yield = relative transpiration
2. Explanatory models: WOFOST module

- Based on biophysical and chemical processes
- Quantitative description of plant development and yield production
- Extrapolation possible to new conditions
- Relatively complex, many data needed

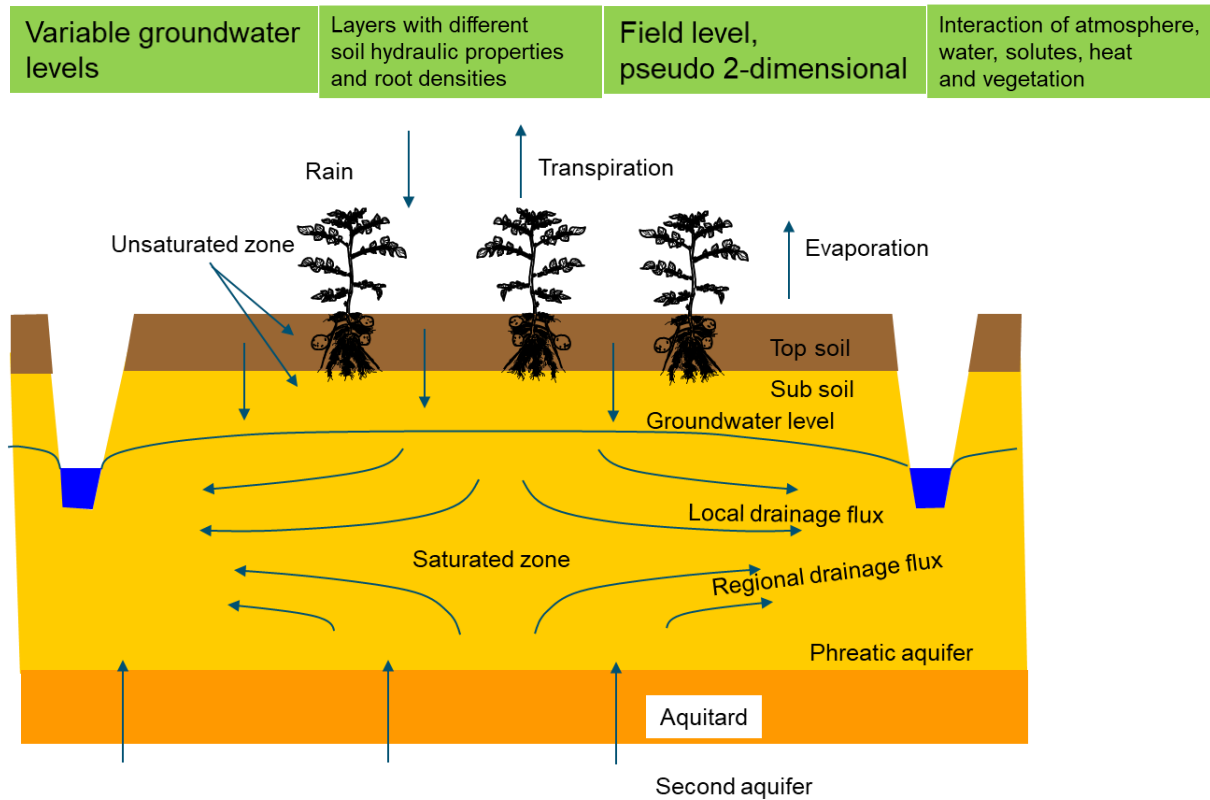


Figure 1 Summary SWAP model processes

Effects of climate, land use and surface water or groundwater management

Scaling up from field to regional scale for broader policy studies is possible with geographical information systems.

### 3 TRAINING

This section explains the content and structure of the training.

#### 3.1 Objectives

As mentioned in the introduction the overall aim is to get insights on quantifying the water need, availability and food production. The specific objectives are the following:

Capacity

- Have the basic capacity to work with SWAP-WOFOST
- Have the capacity to apply the SWAP-WOFOST on local circumstances in Bangladesh

#### Content

- Calculate in project context what the water demand is and the water availability in relation to the crops of Bangladesh.
- Calculate what the food production is for Bangladesh.

## 3.2 Target audience and background knowledge

The audience target in this training is professionals with an interest in modelling to link water to food.

To follow this training, some background knowledge is required from the participants. This includes: basic knowledge about agriculture and water in Bangladesh, interest in the subject and interest in modelling. The targeted amount of people for this course is 12 people.

## 3.3 Approach, materials and planning

### **Necessities**

- PC/laptop with internet
- Internet connection
- Skype account and access

### **Course materials**

The participants will be provided in the beginning of the course with an username and link to the course. In this way they will have access to the materials. In addition, there will be a course document with references and exercises handed out at the beginning.

### **Part I training**

The focus of this part of the training is on general application of SWAP-WOFOST and practicing of the tools used in SWAP and WOFOST.

The course is based on a 4-day approach of 4 hours per day online. Every day will start at BD time: 13:30-17:00.

The specific approach is described below. The medium that is used is Skype. This is chosen because skype is an easy communication tool and well known in Bangladesh and the Netherlands.

### **Monday 15 June**

- 13:30 – 13:45 Welcome –Dr. Akram and Judit Sneathlage
- 13:45 – 14:00 Introduce yourself - All
- 14:00 – 14:15 Introduction to the course – Ab Veldhuizen
- 14:15 – 15:00 Soil moisture flow – Joop Kroes
- 15:00 – 17:00 Assignment soil moisture flow – Martin Mulder and Joop Kroes

**Tuesday 16 June**

- 13:30 – 13:45 Wrap-up soil moisture flow assignment – Martin Mulder
- 13:45 – 14:15 Irrigation and Drainage – Ab Veldhuizen
- 14:15 – 17:00 Assignment Irrigation and Drainage – Martin Mulder and Veldhuizen

**Wednesday 17 June**

- 13:30 – 13:45 Wrap-up irrigation and drainage assignment – Martin Mulder
- 13:45 – 14:30 Crop growth – Joop Kroes
- 14:30 – 17:00 Assignment crop growth – Joop Kroes and Martin Mulder

**Thursday 18 June**

- 13:30 – 13:45 Wrap-up crop growth assignment – Martin Mulder
- 13:45 – 14:30 Introduction salinity – Joop Kroes
- 14:30 – 16:30 Assignment salinity – Joop Kroes and Martin Mulder
- 16:30 – 16:45 Wrap-up salinity assignment – Martin Mulder
- 16:45 – 17:30 Course evaluation and expectations part 2 – Judit Snethlage and Ab Veldhuizen

## 4 REFLECTIONS TRAINING

### 4.1 Organizational reflections

The organizational reflections are collected during the training by the moderators and the trainers. These are sorted per day and in tables by summarizing the comment in themes. Moreover, there is elaboration on how to improve for a future course. These reflections are different from the ones presented in 4.4. In section 4.4 there is a reflection in retro-spect. While here the reflections are made during the course. This shows the learning curve within the course.

**Day I**

Theme comment	Comment	Improvement needed?
Introduction	Mention all the names present in the meeting and ask to introduce them	<b>No</b>
File exchange	Difficulties unzipping files	Send only whole files via wetransfer

File storage	Many people stored the zip file in the download directory	Highlight that it is not working, should save it in another map.
--------------	---	--

## Day 2

Absent: Nahizzaduman, Dahli Dr Akram, Tanvir Ahmed

Theme comment	Comment	Improvement needed?
Presenters exchange information	Sharing screen always different in different online media	Practice with all the presenters how to share the screen in the desired medium
Question moderators		Ask to write questions in the chat and discuss with the moderators and experts which type of questions will be discussed separately and which on the screen.
Replication of information	Participants want to repeat information	Important to record the presentations.
Working with programming	Different levels of modelling skills.	For the modelling it is important to show the possible text editors and some basics as ! means text and not included in the modelling line

### Day 3

Absent: Dhali, Akram, Tanvir Ahmed, Zulfiquir

Theme comment	Comment	Improvement needed?
Guidance trainers	Some exercises are interesting, others less. To see the focus of the participants it is important to anticipate	Ask beforehand which exercises are interesting . Ask 1 person to share the screen and show
Guidance trainers	Important to learn from each day and prepare for next day	End every day with a short reflection skype of the day for the organizers
Duration course	People were quieter during this part. Might be tired? Might be confused?	Good to introduce here an energizer/sharing a story
In-depth info exercises	3.1.1. until 3.1.3 are difficult exercises	Focus on Exercises

### Day 4

Theme comment	Comment	Improvement needed?
Time constraint	Last day a little time constraint for salinity issue	Should plan flexible
Closure	First participants tell them what they learned and the organizers end	

Closure of the day done by:  
Participants reflection

Tapos (BAU)  
 Sheikh Nahiduzzaman (IWM)  
 Farhana Ahmed (CEGIS)  
 Dr Akram (DAE)  
 Judit on behalf of organizing team

## 4.2 Content lessons reflections

The online training course offers a chance to know about SWAP and WOFOST models to us. As the participants were from different institutions, covered a wide range of stakeholders and majority of them were new in modeling arena so theoretical explanations were very much helpful for them. Major subjects cover fulfills almost all the queries of the participants. Trainers proper and sound support made things easy to them.

This training session mostly covered basic things about the stated models. However, trainers tried to give us some insides. The major courses covered during this training was basic on SWAP, soil water flow, irrigation and drainage, basic of WOFOST, plant growth etc. From the participants point of view, the course materials were sufficient and enough. Trainers were also willing to make things easy for the participants during exercise session. But some questions and requirements were highlighted by the participants at the last day of the training. The first one was to simulate rice growth in SWAP-WOFOST model and second one was about the use of local data.

The most helpful and exciting part of the training was the exercise sessions. During this time, participants can easily solve their problems with the help of the trainers. As most of them are new in modeling some problems were arose. Trainers tried to mitigate those. But one common problem was language barrier which made things difficult for some participants.

Apart from this, another common problem was time schedule of the training. The schedule of the training was Monday to Thursday to accommodate weekends of both ends. But this short schedule gives trainers a limited chance to allow more time to help participants. This creates some problems. Sometimes trainers go fast to finish the daily course, sometimes they gave homework or sometimes time of exercise session was shortened. As most of the participants are new in modeling and this course is arranged in online platform so one subject per day was sometimes create burden for the participants because every course contains a theoretical section as well as a practical or exercise section.

For the next training, time budget of the training should be maintained accordingly. So that more time could be allocated for exercise and theoretical session. Moreover, the organizers could also think a solution to overcome language problem.

## 4.3 Participants reflections

The participants were asked to hand in a ½ page of reflection, answering the questions:

1. What you have learned?
2. How you will apply the knowledge?
3. What would you like to learn in the future?



These answers can be summarized have learned and want to learn. The lessons learned are the following:

- Hands on parameterization, initial condition and boundary condition update, simulation, overall software driving
- Fixing initial condition from previous simulation
- Soil water flow dynamics
- Sensitivity of different irrigation and drainage condition and changes in soil hydraulic properties and irrigation scheduling in Grass and Grapes
- Water productivity analysis and understanding water footprint
- Crop growth simulation under different soil moisture and groundwater level condition in wheat and maize
- Parameterization of Bangladeshi crops
- Impact analysis of soil salinity, ground water salinity and groundwater recharge.
- How to assess the relationship between climatic factor and crop yield specially wheat and maize. Relationship among irrigation and drainage and crop production.
  
- Crop growth simulation
  
- Water productivity
  
- Saline ground water and crop yield

Want to learn:

- Oryza modelling which is a crop model for rice.
- to prepare the data and make the input files for the models.
- learning software R would also be helpful for my research.
- How we can simulate water requirements, yield and productivity of rice, especially under Bangladesh condition utilizing SWAP model.
- It would be also interesting to know more detail about how we can adjust different management practices in SWAP model. Also, an example of utilizing SWAP model outputs in GIS would be effective.
- The simulation of rice can be done using this model
- To use this model in wheat simulation
- To learn about the effects of climate change, land use changes, coastal salinity on crop simulation.
- It is a great challenge to our Government to ensure food security of our over population. Please give me the scope to attend such type of training if you will organize in future.
- We can also use this model for crop simulation considering the salinity intrusion by sea level rise.
- Rice production along with impact of salinity and climate change should incorporated in the next course.

## 4.4 Trainers reflections

Total start of the training there were 12 participants. At the end of the training there were 3 participants that did not join the training anymore. The reasons varied from being sick as other duties for work. From this it can be concluded that the majority was fully involved during 3.5-hour sessions for 4 days. Moreover, they actively participated in sessions with questions and showing their progress by sharing their screen. The comments are structured in: preparation comments, content comments, guidance comments and future planning comments

### 4.4.1 Preparation comments

- To prepare a 1-day course, 2 a 3 days are needed for the preparation. In this case it should have been 8 days preparation. However this was not executed due to time constraints and therefore the stress levels what somewhat increased.
- Amount of time given in the assignments. Preparing before beginning with reading. Homework before beginning. Gives more space to in-depth questions.
- Take time for installation of new programs such as R (1.5h was sufficient here)
- Begin every day with short test skype
- Certificate can be gained by handing in a summary answering the question I. What have you learned and how will you use it.

The amount of participants (15 invited) were doable for the online training.

- To follow the course it is useful to have skills in: Excel, software Microsoft office.
- Timing of the online course, every day a half a day of lectures is good. However more time for the homework would be appreciated. This is also a valuable lesson for real life trainings. It is sufficient to only give half day of lectures and half of day for the participants themselves.
- You will need data for the preparation regional rice modelling SWAP-WOFOST. 4-5 days course.

#### 4.4.2 Content comments

- The trainers felt that the training would have made more impact if the training was more connected to local circumstances. This could have been reached by including the participants for data input such as weather measurements from the field.
- As many participants highlighted, the rice is an important crop for them. The trainers mention that SWAP-parameterization rice is available.
- Unpacking zip-files is a challenge. It would be better if the files directly would be shared instead zip files.
- We-transfer as sharing medium works well with Bangladesh laptops.
- Difficulties in storing the csv as an excel file with seperated columns
- Online tool for using SWAP-WOFOST. GUI. Different options, too much options. Has to define all options. Restrict GUI with questions. Making only a part of the GUI available.

#### 4.4.3 Guidance comments

- Giving an online modelling training is very challenging. The trainers feel that the Interaction is missing and feels more like sending and receiving.
- If a problem occurs, it is the fastest way to solve it with the participant 1 on 1. However, if after the solving of the problem, more people seem to have problems it would be advisable to it communal.
- The feeling was that the language was a barrier with explaining as we could not interact with them while explaining on the screen sharing the solution.
- Skype was not the best online medium. This because there is no option for taking over the control of a participant's computer. In this way solutions can be found faster. Therefore, Microsoft teams would be better, this medium contains the option to take over control.

- The language was felt as an extra barrier as it was online, and the faces could often not be seen, making it increasingly difficult to deal properly with the challenges.
- Check while sharing screen, how fast the voice talks. There is sometimes a delay which makes it hard to follow the process on the laptop while this is vital for a modelling course.
- Bengali language support is viewed as helpful. After some Bangla instruction, the participants were more able to understand it
- When people appear absent, email actively for the reason of absence

#### **4.4.4 Future preparation comments**

- For the skills for the follow up trainings Programming in skills in R. depends on wishes. Parcel excel is possible Regional: QGIS/ARCGIS experiences.
- Follow up more of a workshop kind of structure, in-depth modelling
- Many questions regarding link SWAP-WOFOST and rice modelling
- Suggestion is done for regional groundwater management and crop management that the introduction to MODFLOW-SWAP-WOFOST is discussed
- Follow up topic How to set up a model for a region. Next topic, how to couple it to data. We need data from them to set it up.

## **5 FOLLOW UP COURSE**

Part 2 will be focussed on local application of SWAP-WOFOST in Bangladesh. That is why the focus of the training will be on applying regional applications of SWAP-WOFOST. The wish from the participants from the first training was to focus on rice modelling for a follow up training. This wish was expressed because of the importance for rice as food crop. Moreover, the wish from the experts is to focus on a winter crop that might be suffering from salinity increase. This because salinity is in the future an important reducing factor for food production. This is because the climate is changing, and sea level is rising. With the increase of the sea level, there is more salt water in-land , increasing the levels of salt in-land.

