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Acknowledgement

This AgroMetShell (AMS) manual has been prepared by the SADC Regional Remote Sensing Unit (RRSU), Harare, Zimbabwe. This is a joint collaboration between the Agrometeorology Group, Environment and Natural Resources Service (SDRN), Food and Agriculture organization of the United Nations and the SADC Regional Early Warning System. The manual is a step-by-step handbook for use in data preparation, running the water requirement satisfaction index (WRSI) water balance model, image creation and yield estimation once the models have been developed for crop monitoring and early warning for food security.

The first version has been under preparation since January 2004 and finalized in August 2004. It is expected that further expansion to this document will continue to include more information and exercises for practical operational agrometeorology.

The following are acknowledged for their effort in shaping the manual: Dr. Rene Gommès, Dr. Michele Bernardi, Dr. Kennedy Masamvu and all the RRSU staff.

This manual was prepared and compiled by Dr. Elijah Mukhala, SADC Regional Agrometeorologist and Mr. Peter Hoefsloot, FAO Consultant.

RRSU

August 2004

How to comment

Please feel free to comment on any of the implemented and non-implemented functions. Not much time is spent on colours, button-pictures etc. Please give suggestions. You might find bugs, although a lot of time has been spent to make the package as bug-free as possible. Please report them. Send your comments to one (or all) of the following persons:

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Comments concerning the AgroMetShell manual should be forwarded to Elijah Mukhala (email: emukhala@fanr-sadc.co.zw or emukhala@yahoo.com or to the above three email addresses).

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Section 1

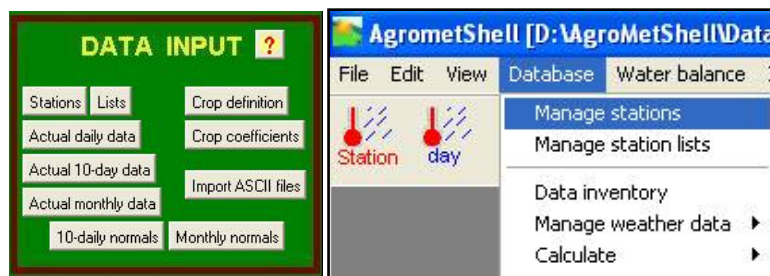
Introduction

Food security is one of the major challenges that developing countries experience especially Africa as a whole. The major causes of food insecurity are mainly poverty, drought, floods, civil strife and disease especially HIV/AIDS. The two areas that underpin food security deal with either challenges of food access by communities in both rural and urban areas as well as poor production as a result of deficit rainfall. Most experts in Africa dealing with food security have embraced the Household Food Economy approach which provides an understanding of the livelihoods of communities and how communities respond to shocks such as floods and drought. The Food Economy Zones provide information on which communities derive their livelihoods from agricultural production and which ones do not. There are several methods that can be and have been used to estimate yield and production depending on specific hazards. This tool can be used to provide targeted analysis based on vulnerability assessment baseline data to determine how the livelihoods of a particular zone will be impacted. In Africa, climate plays a major role in reducing crop yields and ultimately production. One of the tools that can be used to provide early information as to what yields and production statistics are expected is what is being introduced in this manual. This manual has been prepared in such a way that even those who are not in the field of Agrometeorology would be able to understand the stages of data preparation and run the water balance and make use of the outputs. The manual contains several examples from different countries as it is intended to be used by many practitioners outside of Africa. Further training on AgroMetShell can be requested through the SDRN FAO or the SADC Regional Remote Sensing Unit.

AgroMetShell Overview

The AgroMetShell is a new tool developed by FAO SDRN that provides a toolbox for agrometeorological crop monitoring and forecasting. It is a user friendly tool with a “visual menu” that offers easy access to some of the most often used functions. It also offers another choice of using a “pull down” menu. All the buttons in the visual menu have their equivalent in the main pull-down menus. For instance, the top left button on the visual menu in the DATA INPUT box can also be accessed by using the pull down menu as follows: **Database** ⇒

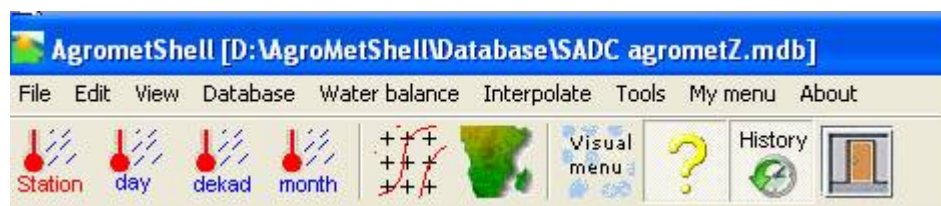
manage stations



The programme includes a database that holds all the weather, climate and crop data needed to analyse the impact of weather on crops. Data can be input into the

database using a variety of options, for instance, they can be:

- typed in from the keyboard,
- read from WINDISP format images or
- imported from ASCII files.

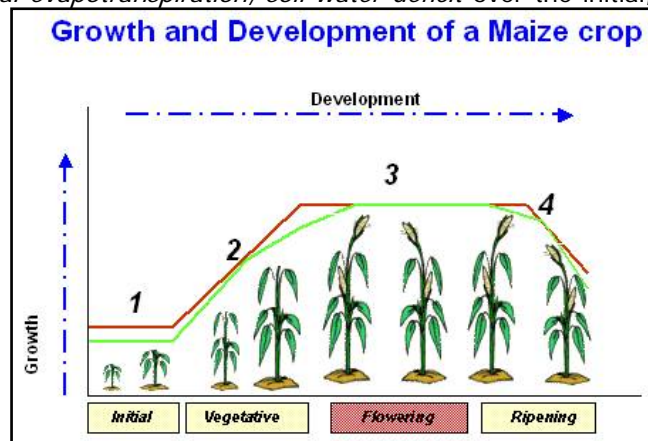


Details of how to input data will be discussed in detail in this manual to allow for first time users to be able to prepare the data and run the water balance model. A number of operations can be performed on the database, such as making backups or "flushing the database". Many options under **Database ⇒ configure** should be used with the utmost care and only by experienced user, and after running the back-up option **Database ⇒ configure ⇒ Back up current database**.

Within the AgroMetShell, the FAO Crop Specific Soil Water Balance can be operated in two modes, (1) "*monitoring mode*" or (2) in "*risk analysis*" mode. The monitoring mode is an analysis of one growing season covering many stations in a specific area, usually a country or a province in a country. This would be performed from the beginning of the growing season until the harvest time. However, early warning information would have to be extracted before the harvest time. The second mode (risk analysis) covers the same type of analysis, but for one station only, and over many years. This provides the food security expert with some information indicating whether a particular crop should actually be grown in that particular area or not, looking at the output of a risk analysis which show how many years or seasons the water requirement was satisfied or have been beyond a certain threshold value.

The FAO Crop Specific Soil Water Balance model produces a number of outputs for the various stages in the growth and development of the crop as shown the **figure**. In developing models for yield estimation, the various outputs are regressed with historical yield data. The water balance variables that are produced include, such as *excess soil water*, *actual evapotranspiration*, *soil water deficit* over the initial, vegetative, flowering and ripening phase. Other outputs include *total water requirement* as well as *water requirement satisfaction index* at the time of monitoring as well as at the end of the growing season. These outputs can be mapped separately for crop monitoring as will be discussed in detail in this manual.

For crop forecasting, the water balance variables are normally averaged over administrative areas and then compared with crop yields through multiple regression to derive yield functions that in turn can be used to estimate yields.



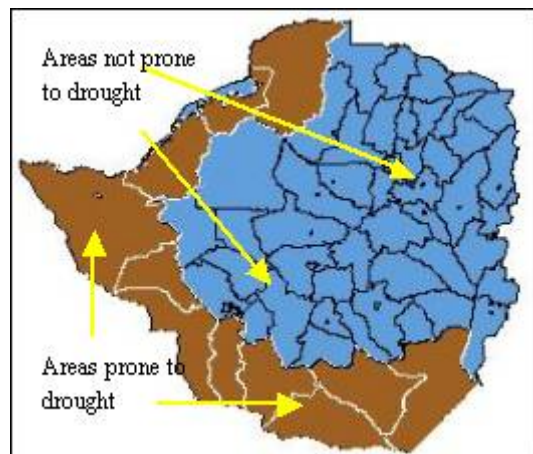
In addition to the FAO Crop Specific Soil Water Balance, the programme proposes many other useful tools, for instance the calculation of rainfall probabilities, spatial interpolation tools and the determination of growing season characteristics based on climatological parameters.

Target group for AMS

Advance knowledge of the potential agricultural production is important for those in decision-making positions and those whose job description is to provide this information. In early warning, advance warning is critical and this requires appropriate information for decision making. In the SADC Region Livelihood-Based Vulnerability Approaches have largely been adopted and incorporated into the Vulnerability Activities Committee activities. These approaches try to understand -

- How people survive in most years (food, income and expenditure) and
- How households cope when 'hazards' occur etc.

Food security experts using the food economy approach in assessing the vulnerability of communities especially when it come to looking at the impacts of shocks such as floods and drought can make use of the AgroMetShell. Once zones prone to drought or floods have been identified (**figure**), the AgroMetShell water balance can be used to estimate yields and production as well as areas experiencing excess moisture for appropriate interventions for disaster management. The AgroMetShell is a simple to use tool targeted at a wider user community which includes: Agronomists, Agrometeorologists, hydrologists, decision makers, Food Security Economists, Food security experts, climatologists, humanitarian aid specialists, disaster management specialists and many other professions with an interest in food security and disaster management.



Use of AMS in Early Warning

AMS is a tool that was developed specifically for early warning purposes. Humanitarian assistance requires that grain deficits are computed long before the harvest takes place. This allows Governments and the international community enough time to mobilize resources for relief purposes. The development of AMS started in the 1980's to try and find a tool that would help with yield estimation for early warning purposes and it was then that the water requirement index (WRSI) was used to relate to yield to moisture condition and a relationship was established (see graph). However, the effect of water deficits on crop yields has been actually established long before. At that time, the tool was referred to as FAOINDEX. It is this tool that has now been developed further

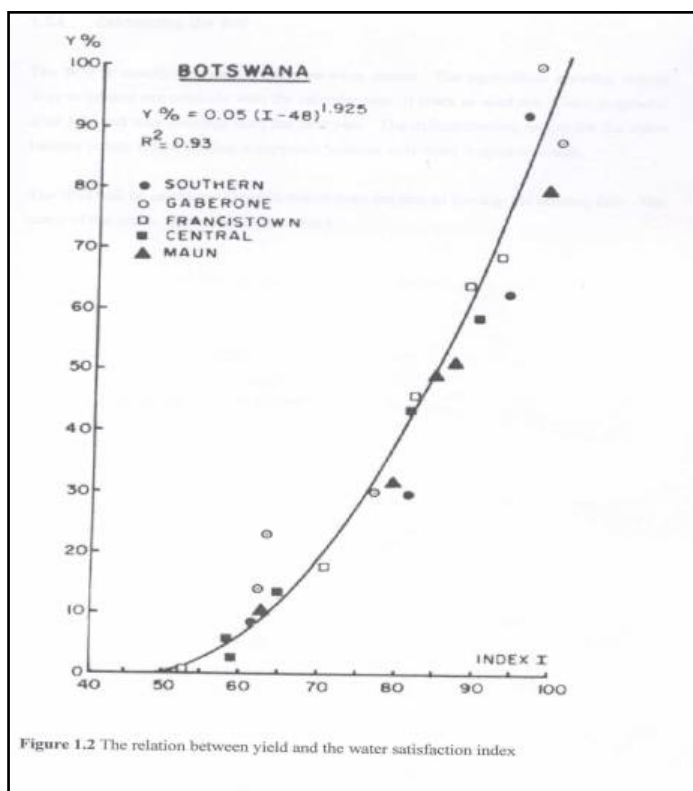


Figure 1.2 The relation between yield and the water satisfaction index

into what is now known as the AgroMetShell. At that time, the major predictor of yield was WRSI but with the new development of AMS, there are several outputs/parameters from the water balance model that can be regressed with historical yield to develop models that may be used for yield estimation and production once the area under cultivation has been established.

For early warning purposes, the tool is used to monitor the growing season from the onset of the planting. The various outputs indicate which areas in a region, country or province have received minimal rainfall, water deficits, excess water at the various stages of crop growth as these affect yield ultimately. As input data is on a dekadal basis, such information can also be obtained at the same intervals and when persistent water deficits or indeed excess water are experienced, this may lead to poor crop yields, resulting in poor production and food insecurity.

Compatibility with other software

The developers of the AMS software recognize that the more versatile the software is, the more food security experts or practitioners will use it. Therefore, AMS was developed with this view for maximum utility with commonly used software. AMS is a freeware that was paid for by the United Nations Food and Agriculture organization for the sole purposes of early warning for food security to save human life. AMS is compatible with the following software:

WinDisp

AMS is compatible with WinDisp. WinDisp is another software developed by FAO for analysis and viewing remote sensing data for seasonal monitoring for early warning for food security. WinDisp is a public domain, easy to use software package for the display and analysis of satellite images, maps and associated databases, with an emphasis on early warning for food security. WinDisp was originally developed for the FAO Global Information and Early Warning System. It allows users to:

- Display and analyse satellite images
- Compare two images and analyse trends in a time-series of images
- Extract and graph trends from a number of satellite images such as during the growing season for comparison with other years
- Compute new images from a series of images
- Display tabular data in map format
- Build custom products combining images, maps and specialised legends
- Write and execute batch files to automate routine and tedious tasks
- Build a customized project interface for providing users with detailed menus of available data for a country or a specific area

Images produced by AMS can be viewed using WinDisp as well as further analysis for better presentation food security bulletins.

Excel

AMS is also compatible with Excel. Excel is one of the most commonly used spreadsheets. Excel is used to prepared input data for importation into AMS. In many cases, data may actually be archived in an excel format such that importing such data is easy. The process of importing data from Excel is very easy as will be explained in the manual.

Instat

There have been discussions to make the two software compatible as Instat is very strong in climate data analysis, an important component in crop monitoring and food security. Instat+ is a general statistical package. It is simple enough to be useful in teaching statistical ideas, yet has the power to assist research in any discipline that requires the analysis of data. Instat has been used widely in the UK and elsewhere by a range of companies, research institutes, schools, colleges, universities and private individuals.

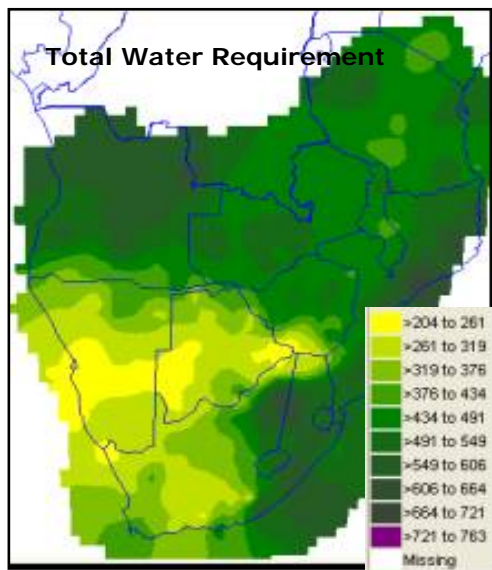
At The University of Reading it has been used extensively on training courses run by the SSC and the School of Applied Statistics. It has also been used in many countries on statistics courses and on courses related to health, agriculture and climatology. "Instat+" (i.e. the Windows version of Instat) has been developed mainly because of its continued use for the analysis of climatic data. Funding from the UK Met Office for a new climatic version,

supplemented by support from the SSC and the efforts of other friendly collaborators, led to the Windows version, which was first used on training courses in 1999.

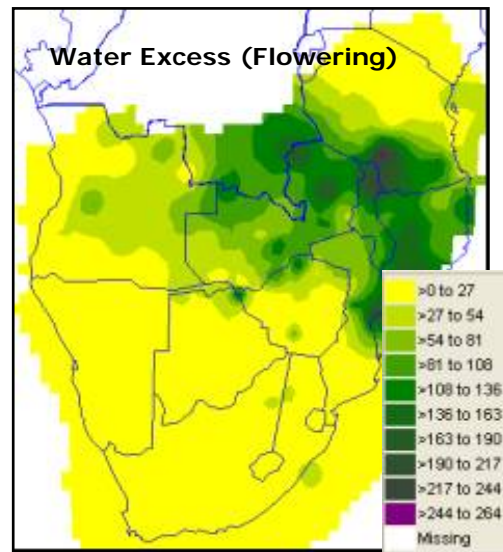
AMS Products

Overview of products

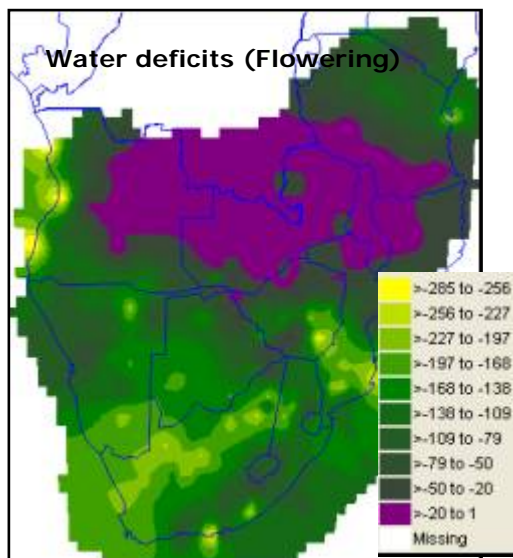
AMS will provide images of total water requirement during the growing season. This provides information of water demands of the crop in different areas of the country.



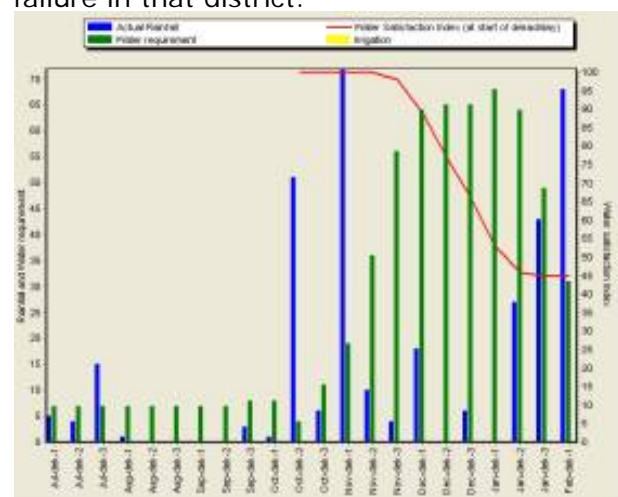
AMS will provide the images of the excess water during the flowering stages of the crop. This information will provide information as to what caused crop failure as crops are sensitive to excess water at this stage.



AMS will provide the images of the water deficits during the flowering stages of the crop. This information will provide information as to what caused crop failure as crops are sensitive to water deficits at this stage.



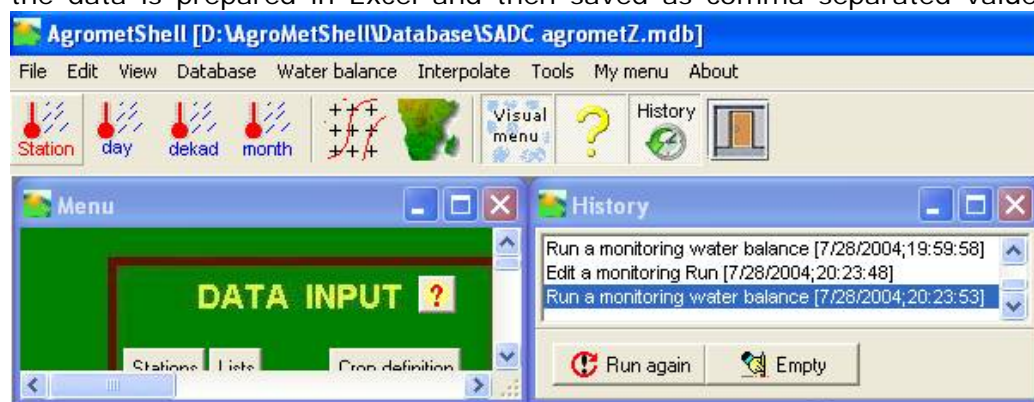
AMS will provide a graph that shows the performance of the rainy season in terms of satisfying the water requirement of the crop. Each time the crop experiences a water deficit, the index drops and when the index drops to below 50%, there is total crop failure in that district.



Section 2

Getting started

To use the AgroMetShell effectively, it is important that all the necessary data requirements are in place. Data can be input into the database using a variety of options, for instance, they can be typed in from the keyboard, read from WINDISP format images or imported from ASCII files. AgroMetShell is a new development from the old FAOINDEX that was used in agricultural season monitoring. Therefore, there is a lot of data that was prepared for the old software. To make use of this data set, this manual will illustrate importing of data into the AgroMetShell database to run the water balance model. If data has to be imported, it is advisable that the data is prepared in Excel and then saved as comma separated values (CSV). It is important to familiarise oneself with the main menu of the AgroMetShell which is shown in figure.



Data requirement

AMS input Files

To run any model or computer programme, data availability forms an important component of the whole process. The data requirement of AMS are quite reasonable when you compare it to other heavy duty models for crop simulation. There are basically 10 input files that one needs, to be able to run a water balance model in AgroMetShell as shown below. However, it may not be necessary to have all the input files listed depending on the circumstances. These circumstances may be that you are unable to calculate evapotranspiration on a dekadal basis and hence preparing an evaporation file may be difficult and one has no option but to use the normal evapotranspiration file. However, should the data be available, AMS has extra tools among which the tool to calculate evapotranspiration is one of them. There are also instances where the monitoring is done for rain-fed crops and therefore it may not be necessary to have a file on irrigation.

This basically reduces the number of files to run the water balance to 5 input files. Every time the user requests a water balance calculation to be carried out, the programme prepares a set of files that will be read by the Crop Specific Soil Water Balance programme to compute the water balance variables (such as soil moisture, actual evapotranspiration over the vegetative phase or the water stress at flowering, etc).

The files required are in comma-separated quoted string format and can be directly imported into a spreadsheet. All the files will have common data in the first four columns which will contain:

- "NAME", the station Name
- "LON", the longitude in decimal degrees
- "LAT", the latitude in decimal degrees
- "ALT", elevation above sea level

To run a crop specific water balance calculation, one needs the following files:

Input 1: Country Name_2003_Crop_Dekad_Input.dat

The file contains a summary of the parameters used to run the water balance, including the following:

- "WHC", soil water holding capacity
- "Efrain", effective rain (a percentage by which actual rain is multiplied to assess actual water supply. Usually Efrain<100% on slopes and Efrain>100% in low lying areas
- "Crop-ID#", the internal identification number of the crop
- "Cycle", the cycle length in dekads
- "Pldek", the planting dekad, a value between 1 and 36
- "Irrig", the type of irrigation (1=yes, 0=no and 2=automatic)
- "BundH", the height of the bund, for irrigated crops
- "k1","k2","k3","k4".... Up to the value corresponding to the last dekad of the cycle, crop coefficients KCP

	A	B	C	D	E	F	G	H	I
1	Malawi, Maize, 1987								
2	NAME	LON	LAT	ALT	WHC	Efrain	Crop-ID	Cycle	Pldek
3	MW-BALAKA	34.97	-14.98	625	50	95	1	10	33
4	MW-BOLERO	33.78	-11.02	1100	40	95	1	12	34
5	MW-BVUMBWE	35.07	-15.92	1146	70	100	1	12	33
6	MW-BWENGU	33.92	-11.07	1052	40	95	1	12	33
7	MW-CHICHIRI	35.05	-15.78	1132	70	100	1	12	33
8	MW-CHIKANGAWA	33.8	-11.85	1728	50	90	1	12	31
9	MW-CHIKAWA	34.78	-16.03	107	60	95	1	10	33
10	MW-CHIKWEO	35.67	-14.75	717	40	95	1	10	33
11	MW-CHILEKA	34.97	-15.67	767	70	100	1	10	33
12	MW-CHINGALE	35.25	-15.37	610	70	100	1	10	33
13	MW-CHINTHECHE	34.17	-11.83	495	50	95	1	10	34
14	MW-CHIRADZULU	35.18	-15.7	884	60	95	1	12	33
15	MW-CHITEDZE	33.63	-13.97	1149	70	100	1	12	33
16	MW-CHITIPA	33.27	-9.7	1285	40	90	1	12	33
17	MW-DEDZA	34.25	-14.32	1632	70	95	1	12	33
18	MW-DOWA	33.93	-13.65	1403	40	95	1	12	33
19	MW-DWANGWA	34.08	-12.48	488	40	95	1	10	35
20	MW-DZALANYAMA	33.6	-14.22	1219	70	95	1	12	34

Input 2 and 3: Country Name_2003_Rain_Dekad_Input.dat Country Name_2004_Rain_Dekad_Input.dat

The two files have actual rainfall for two consecutive years, as it often occurs that the crop is planted in one year and harvested in the following one. This kind of situation is what happens in southern Africa where rainfall commences in September/October of one year and terminates in April/May of the following year. However, in situations where an agricultural season falls within a calendar year, AMS will still work.

Input 4 and 5: Country Name_2003_Irrigation_Dekad_Input.dat Country Name_2004_Irrigation_Dekad_Input.dat

The files contain actual values only if they have actually been provided. In monitoring rain-fed crops, this may not be necessary.

Input 6 and 7: **Country Name_2003_PET_Dekad_Input.dat**
 Country Name_2004_PET_Dekad_Input.dat

The two files have actual potential evapotranspiration for two consecutive years, as it often occurs that the crop is planted in one year and harvested in the following one. Evapotranspiration plays an important role in the water balance as it represents the atmospheric demand.

Input 8 to 10: **Country Name _Normal_Rain_Dekad_Input.dat**
 Country Name _Normal_PET_Dekad_Input.dat
 Country Name _Normal_Irrigation_Dekad_Input.dat

The files contain normal rainfall, PET and Irrigation. The data from these files is utilized if the actual data is missing in the input files.

AMS Output Files

The programme generates 18 output files. It is not necessary that the user knows the details of the structure of those files, but with experience you may feel the need to carry out some non-standard analyses, in which case the information below will be of help. The names of output files are assigned automatically to the files based on the year, file list, type of data (input or output, daily or by dekad, actual or normal data) so that the file contents should be easy to determine. In addition, the first line of each file has a description of the data. Missing values in the files are usually coded as -999. All input and output files with DAT extensions follow the same "FAO format".

Two types of output files are produced. Those with extension TXT (text) provide some descriptive material about the crop monitoring exercise, while those with DAT extensions are in comma-separated quoted string data files used by other options of the programme, for instance many of the options under the *Tools* menu.

Output 1 and 2: TXT (text) output files, **Country Name _2004_Details_Dekad_Output.txt** and **Output_Comments.txt**

Output_Comments.txt simply lists information about the files as they are processed. An example follows:

AO-SUNGINGE	: No calculations done: Missing Planting Dekad
BW-BAINESDRIFT	: No calculations done: Missing Water Holding Capacity
BW-BOBONONG	: Water balance calculated successfully
MW-MAKHANGA	: No calculations done: Missing Planting Dekad
MW-MAKOKA	: Water balance calculated successfully

The second file (**Country Name_2004_Details_Dekad_Output.txt**) contains the full details about the water balance. An example is given below. The abbreviations have the following meaning: **NOR** is normal rainfall, **ACT** is actual rainfall, **WRK** stands for "working" rainfall, i.e. $WRK = ACT * EfRain / 100$ if Act is available, otherwise $WRK = NOR * EfRain / 100$, **Irr** is the irrigation amount if any, **PET** is the potential evapotranspiration while **WR** (the water requirement) is the product of $KCR * PET$. **AvW** is the crop available water, **S/D** stands for water Surplus or Deficit and, finally **INDEX** is the Water satisfaction index, the percentage of the crop water requirements that has actually been met. The end of the table lists actual evapotranspiration, water surplus and deficit by phenological phases:

Station number:	29/ Crop 1
Country Name:	BW-MARTINSDRIFT (Elevation:820 m)
Crop type:	Maize

Cycle length: 12 dekads (C)
 Total water requirements: 561 mm (TWR)
 Normal water requirements: 561 mm (TWRNor)
 Planting dekad: 34 (P)
 Maximum soil water storage: 100 mm (H or WHC)
 Effective/Total rain: 100 % (E or EfR%)
 Irrigation applied: No
 Pre-season Kcr : 0.19

The actual rangeland index uses only actual data (NO estimates)

DATE	NOR	ACT	WRK	IRR	PET	KCR	WR	AvW	SW	S/D	INDEX
Aug-dek-3	0	0	0	0	41	0.19	8	-8	0		
Sep-dek-1	2	0	0	0	45	0.19	9	-9	0		
Sep-dek-2	3	0	0	0	49	0.19	9	-9	0		
Sep-dek-3	5	0	0	0	52	0.19	10	-10	0		
Oct-dek-1	3	0	0	0	56	0.19	11	-11	0		
Oct-dek-2	11	4	4	0	59	0.19	11	-7	0		
Oct-dek-3	18	0	0	0	59	0.19	11	-11	0		
Nov-dek-1	21	0	0	0	60	0.19	11	-11	0		
Nov-dek-2	21	13	13	0	60	0.19	11	2	2		
Nov-dek-3	23	0	0	0	62	0.19	12	-12	0		
Dec-dek-1	17	40	40	0	63	0.07	4	36	36	0	100
Dec-dek-2	17	0	0	0	63	0.22	14	-14	22	0	100
Dec-dek-3	20	27	27	0	64	0.37	24	3	25	0	100
Jan-dek-1	26	29	29	0	63	0.71	45	-16	9	0	100
Jan-dek-2	27	7	7	0	62	1.10	68	-61	0	-52	91
Jan-dek-3	28	43	43	0	59	1.25	74	-31	0	-31	85
Feb-dek-1	18	9	9	0	56	1.25	70	-61	0	-61	74
Feb-dek-2	16	17	17	0	52	1.25	65	-48	0	-48	66
Feb-dek-3	13	10	10	0	51	1.25	64	-54	0	-54	56
Mar-dek-1	15	5	5	0	51	1.19	61	-56	0	-56	46
Mar-dek-2	14	19	19	0	50	0.90	45	-26	0	-26	41
Mar-dek-3	14	32	32	0	46	0.60	28	4	4	0	41

Phase	ETAt	Surplus	Deficit
Initial	18	0	0
Vegetative	85	0	-52
Flowering	84	0	-250
Ripening	47	0	-26

Surplus: 0mm (WEXt) Deficit: 328mm (WDEft)
ETAt: 234mm % data avail: 100% (%AVAIL)
Norm.index: 40% (INDXn)

Output 3 to 6: DAT output files,

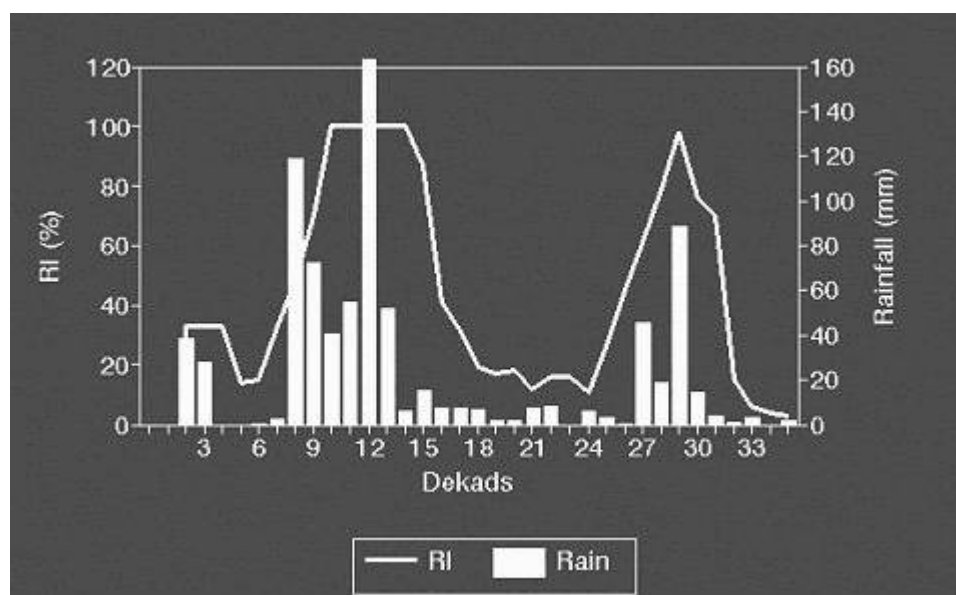
Country Name _1991_WaterSatisfactionIndex_Dekad_Output.dat,
Country Name _1991_WaterStorage_Dekad_Output.dat,
Country Name _1991_WaterSurplusDeficit_Dekad_Output.dat and
Country Name _1991_ActualPET_Dekad_Output.dat

The files are "monitoring-oriented" as they contain sequences of several dekad values for display and inter-station comparisons. They respectively contain water satisfaction index values, soil moisture, water surplus or deficit and actual evapotranspiration, dekad by dekad, for all the stations in the list. Note that dekads are crop dekads (from 1 to cycle length). Values beyond cycle length are coded with the default value

for missing data. D1, D2...D36 are the dekad numbers in crop dekads (i.e. planting dekad is 1 and the last values corresponds to C, the cycle length).

Output 7: **Country Name _1991_RangelandIndex_Dekad_Output.dat**

The "**rangeland-index**" (RI) is the classic FAO water satisfaction index computed for periods of 5 dekads, with normal evapotranspiration kept at potential level ($KCR=1$) and an assumed WHC of 50 mm. Similar to moving averages, the value assigned to a dekad corresponds to the five-dekad period centred about that dekad. Thus 3 for dekads 1 to 5, 4 for dekads 2 to 6... The rangeland index, when plotted over time, assumes a smoothed aspect, as shown in the figure below that compares "rangeland index" (RI) with rainfall (mm) in Msabaha (Kenya) in 1984. RI is associated with crop phenology. Based on local experience, there is usually a rather good association between planting and the RI. For instance, in Tanzania, it was found that the planting of millet usually occurs when the rising RI curve crosses the 0.4 (40%) threshold.



The RI is computed using actual rain (not "working rain" as described above, *i.e.* future values are coded as missing and not taken as their normal).

The dekads when the RI curve passes the 30 to 70% thresholds is given in the second text output file (**Country Name _1991_Details_Dekad_Output.txt** above).

Output 8: **Country Name _1991_Summary_Dekad_Output.dat**

The "**summary**" output file is certainly the most useful, as it lists the parameters which are likely to be used for further processing and analysis, in particular for developing yield models for yield estimation and crop forecasting. In addition to station ID, longitude (X) and latitude (Y), **%AVAIL** (percent of actual data used in the calculations) and Z (elevation) the variables listed in the "summary" are the following:

- H and WHCi, the soil Water Holding Capacity, and its initial value, respectively;
- Efr%, the ratio between effective and actual total and rain, in percent (Efrain, see above);
- P, the planting dekad (1-36);
- C, the length of the crop cycle (dekads);
- TWR, total water requirements in mm;

Indx, IndxNor and IndxLatest, FAO soil water satisfaction index, in % of requirements, respectively **actual**, **normal** and **"last"** values. **"Actual"** corresponds to the value expected at the end of the cycle, **"normal"** is the end-of-cycle index computed with normal rain and PET, all other parameters being those from the crop file; the **"last"** value is that of the last dekad for which actual data are available (^{1[1]});

WEXi, WEXv, WEXf, WEXr, WEXt, water excess over the phenological phases described as initial, vegetative, flowering, harvest and the whole cycle (sum of previous values)

WDEFi, WDEFv, WDEFf, WDEFr, WDEFt, water deficit over the phenological phases and the value totalled over the growing cycle

ETAi, ETAv, ETAf, ETAr, ETAt, actual evapotranspiration over the phenological phases and the value totalled over the growing cycle

ETA: actual crop evapotranspiration (i.e. actual crop water consumption), a factor directly related with crop yield;

%Av, ("available") the percentage of actual rainfall data used for the calculations (the rest being assumed to be "normal")

Cr1a to Cr4a and Cr1n to Cr4n (for **"Crossing"** and **"Normal Crossing"**) indicate the dates (dekads) when the rangeland index (see above) crosses the $0.4 \cdot \text{PET}$ line. The dekads given in the file can be used to map the beginning of the actual (current) season (Cr1 to Cr4) and the normal beginning (NCr1 to NCr4). In areas with only one rainfall peak, there is only one "normal" start, but there are two in bimodal rainfall areas. In marginal areas, where rainfall is very close to 40% of PET, there may be more than one "start" even in areas with unimodal rainfall. The actual starts may be more than the "normal starts", particularly in the not so rare event of "false starts" when rain decreases again after a first start: in the field, farmers must frequently replant when this happens.

^{1[1]} If there are no actual data available (in which case "actual" and "normal" are identical), then the "last" index is coded as missing.

Section 3

AMS Weather Data Preparation

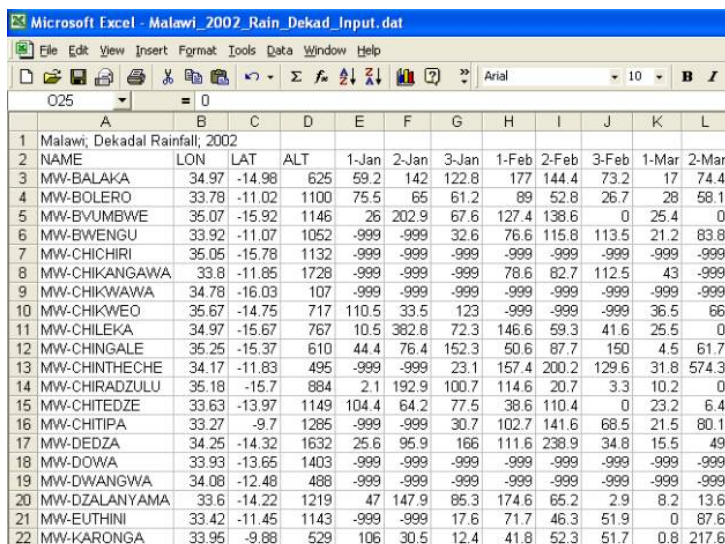
Importing datasets from spreadsheets and ASCII files

To run a water balance model in AMS, appropriate data preparation is an important component of the entire process. This can be done by typing in the information from the source document into the AMS database. However, this is subject to error and takes a long time to complete. Therefore, the best way to input data is to import it.

AMS can import all ASCII data as long as the data are organized in columns and rows. Data can only be imported into AMS if the file to import contains a column that can be matched with a corresponding AMS station list. Linkage can be provided through the station code or through the station name. Its always easier to import data from an excel file that has been served as "comma separated values" (*.csv). As indicated earlier on, to run the water balance, one needs at least five files, it is advisable to prepare a template in excel with the station names and their longitude, latitude and altitude. The template is then used to prepare all the required files to run the water balance.

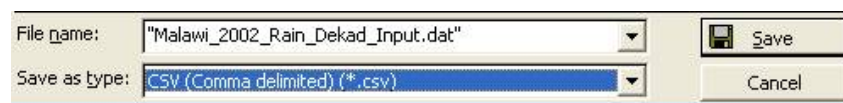
Preparing rainfall data for importing

In excel, prepare rainfall data for importing in columns with station name, longitude, latitude and altitude. The following columns should contain dekadal rainfall data from January to December arranged in dekads from 1-36 as shown in **figure**. The agricultural season in southern Africa overlaps two calendar years and therefore, rainfall data for two calendar years should be prepared as shown in the figure. Please make sure that the file names indicate appropriately the data contents e.g. **2002_Rain_Dekad_input.dat** will contain dekadal data for the year 2002 while **2003_Rain_Dekad_input.dat** will contain dekadal data for the year 2003.



1	Malawi: Dekadal Rainfall, 2002												
2	NAME	LON	LAT	ALT	1-Jan	2-Jan	3-Jan	1-Feb	2-Feb	3-Feb	1-Mar	2-Mar	
3	MW-BALAKA	34.97	-14.98	625	59.2	142	122.8	177	144.4	73.2	17	74.4	
4	MW-BOLERO	33.78	-11.02	1100	75.5	65	61.2	89	52.8	26.7	28	58.1	
5	MW-BVUMBWE	35.07	-15.92	1146	26	202.9	67.6	127.4	138.6	0	25.4	0	
6	MW-BWENGU	33.92	-11.07	1052	-999	-999	32.6	76.6	115.8	113.5	21.2	83.8	
7	MW-CHICHIRI	35.05	-15.78	1132	-999	-999	-999	-999	-999	-999	-999	-999	
8	MW-CHIKANGAWA	33.8	-11.85	1728	-999	-999	-999	78.6	82.7	112.5	43	-999	
9	MW-CHIKAWA	34.78	-16.03	107	-999	-999	-999	-999	-999	-999	-999	-999	
10	MW-CHIKWEO	35.67	-14.75	717	110.5	33.5	123	-999	-999	-999	36.5	66	
11	MW-CHILEKA	34.97	-15.67	767	10.5	382.8	72.3	146.6	59.3	41.6	25.5	0	
12	MW-CHINGALE	35.25	-15.37	610	44.4	76.4	152.3	50.6	87.7	150	4.5	61.7	
13	MW-CHINTHECHE	34.17	-11.83	495	-999	-999	23.1	157.4	200.2	129.6	31.8	574.3	
14	MW-CHIRADZULU	35.18	-15.7	884	2.1	192.9	100.7	114.6	20.7	3.3	10.2	0	
15	MW-CHITEDZE	33.63	-13.97	1149	104.4	64.2	77.5	38.6	110.4	0	23.2	6.4	
16	MW-CHITIPA	33.27	-9.7	1285	-999	-999	30.7	102.7	141.6	68.5	21.5	80.1	
17	MW-DEDZA	34.25	-14.32	1632	25.6	95.9	166	111.6	238.9	34.8	15.5	49	
18	MW-DOWA	33.93	-13.65	1403	-999	-999	-999	-999	-999	-999	-999	-999	
19	MW-DWANGWA	34.08	-12.48	488	-999	-999	-999	-999	-999	-999	-999	-999	
20	MW-DZALANYAMA	33.6	-14.22	1219	47	147.9	85.3	174.6	65.2	2.9	8.2	13.6	
21	MW-EUTHINI	33.42	-11.45	1143	-999	-999	17.6	71.7	46.3	51.9	0	87.6	
22	MW-KARONGA	33.95	-9.88	529	106	30.5	12.4	41.8	52.3	51.7	0.8	217.6	

Once preparation of data is complete in excel, save the data as "comma separated values" as follows:



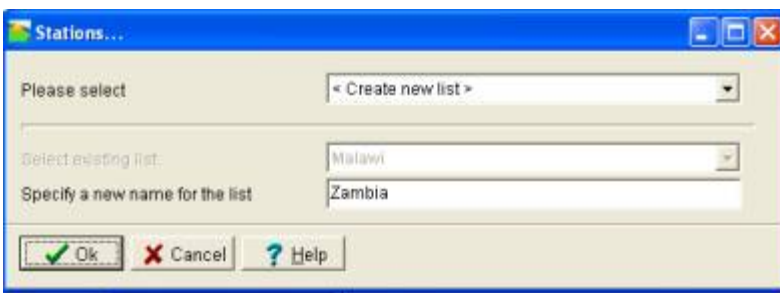
Once the data has been prepared, it is now ready for importing into the AMS database.

Section 4

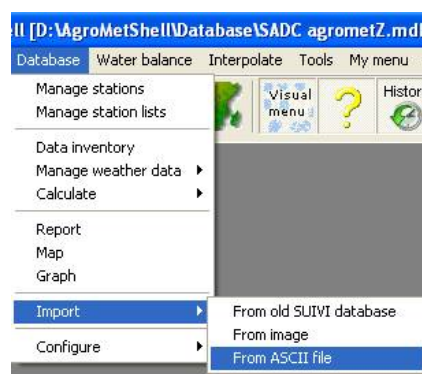
Importing rainfall data into AMS Database

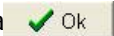
Before importing data into the AMS, it is important that you create a list to which all the data you import will go to. This is done by activating **Database ⇒ Manage station lists**

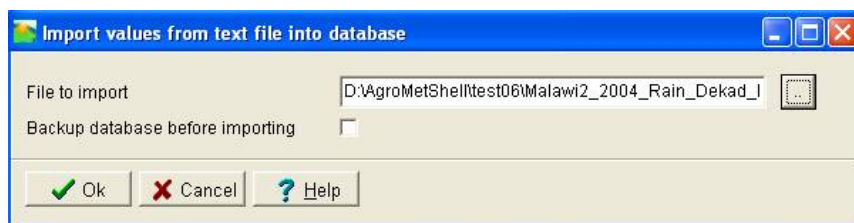
Then the following screen appears which requires that you specify a new name for the list. After this you are ready to import data.

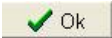
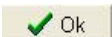


To import data into the AMS database, you can use the “visual or pull down menu. When using the pull down menu, activate **Database ⇒ Import ⇒ From ASCII file** as shown in figure.



The following screen appears as shown in figure with a statement “import values from text file into database”. Specify the name of the file that you intend to import in the blank space a  Then click



Once you click  the following screen as in figure comes up. With this screen, you help AMS by indicating the format by which the data is separated. The data is **separated** by comma. This may be either by space, semicolon or tab. The **data-lines begin at line 3** and the **text qualifier** is “ and **missing value code -999 or -99**. These have to be indicated for the data to be imported correctly. Then click 

Step 1: Specifying the file

```

Malawi2: Dekadal Rainfall: 2004
"NAME","LON","LAT","ALT","Jan1","Jan2","Jan3","Feb1","Feb2","Mar1","Mar2","Mar3","Apr1"
"CHILEKA",34.97,-15.68,767,11.2,119.2,169.4,9.6,21.0,15.9,89.0,3.0,14.8,38.9,19.0,1.0,-999,-99
"CHITIEDZI",33.63,-13.98,1149,11.5,116.4,95.0,121.6,74.1,62.6,31.9,79.1,0.0,51.1,24.0,0.0,-999,-
"CHITIPA",33.68,-10.34,1440,33.6,84.2,61.3,74.0,15.5,54.9,145.9,48.5,0.0,100.0,8.0,12.0,-999,-
"DEZDA",34.25,-14.32,1632,19.3,92.5,65.4,12.6,32.2,66.0,81.1,40.0,2.4,127.0,21.0,7.0,-999,-999

```

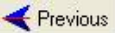
Separator: <Comma> Datelines begin at line: 1 Text qualifier: "" Number of lines: 11
Missing Value: 999


NAME	LON	LAT	ALT	Jan1	Jan2	Jan3	Feb1	Feb2
CHILEKA	34.97	-15.68	767	11.2	119.2	169.4	9.6	21.0
CHITIEDZI	33.63	-13.98	1149	11.5	116.4	95.0	121.6	74.1
CHITIPA	33.68	-10.34	1440	33.6	84.2	61.3	74.0	15.5
DEZDA	34.25	-14.32	1632	19.3	92.5	65.4	12.6	32.2
KARONGA	33.82	-9.99	819	43.0	88.5	54.2	62.6	57.0
KASUNGU	33.47	-12.91	1121	15.0	36.3	68.4	22.0	198.9
LILONGWE	33.68	-13.97	1159	20.6	93.5	79.0	29.4	18.9
MAJHANGA	35.00	-15.00	1000	20.0	85.0	111.0	1.0	37.0
MANGOCHI	34.93	-14.46	721	32.0	43.7	126.0	32.8	47.6

Next Cancel

The following screen appears which requires that you give direction to AMS in terms of the contents of the columns. Indicate to which list the data should be added (**Note: The list should be created before importing the data**). Indicate the column that uniquely identifies the stations and what column 1 represents by using the pull down arrow.

On other parameters, skip station ID as the data is being identified by station name. Indicate the columns that contain longitude, latitude and altitude.

If you are not sure of the columns contents, click on  you could see the data and be reminded on which column contains longitude or latitude data.

When this is complete, then click .

Step 2: identifying stations

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
CHILEKA	34.97	-15.68	767	11.2	119.2
CHITIEDZI	33.63	-13.98	1149	11.5	116.4
CHITIPA	33.68	-10.34	1440	33.6	84.2
DEZDA	34.25	-14.32	1632	19.3	92.5
KARONGA	33.82	-9.99	819	43.0	88.5
KASUNGU	33.47	-12.91	1121	15.0	36.3


List to add new stations to: Malawi

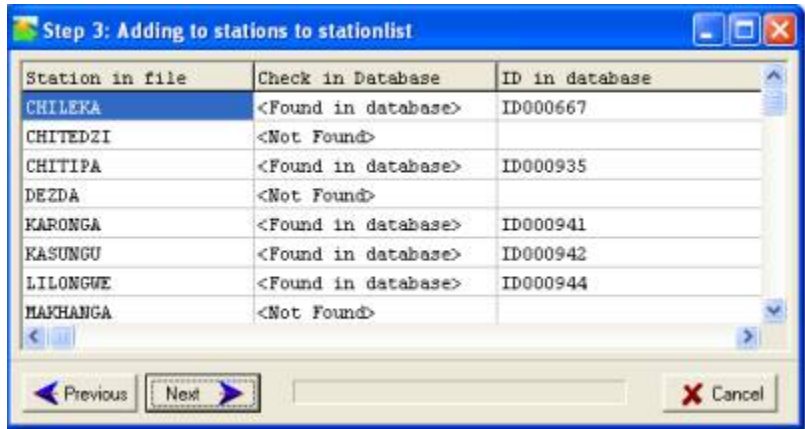
☒ File contains data for more than one station
The column that uniquely identifies the station is: Column 1
Column 1 represents: Station Name

☐ File contains data for one station only

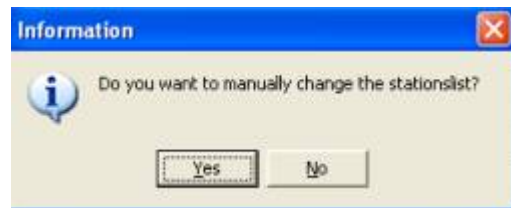
Other parameters (optional):
Station ID:
Longitude: Column 2
Latitude: Column 3
Altitude: Column 4

Previous Next Cancel

AMS then checks the file line by line for valid station names. Some stations have been found in the database except a few and you just have to proceed and click .



The following screen enables you to change the station-list. However, this is only necessary in cases where new stations were added and in this case its not necessary and so click No




Then, you obtain the following which may be referred to as the data definition screen in which you specify exactly what the columns in the file represent. It is much easier for columns with single parameter like rainfall, evapotranspiration etc. However, when importing a crop parameter file with multiple parameters such as water holding capacity, planting dekad, cycle length etc, care should be taken to make sure appropriate columns are identified correctly.

	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Data line 1	CHILEKA	34.97	-15.68	767	11.2	119.2
Data line 2	CHITEDI	33.63	-13.98	1149	11.5	116.4
Data line 3	CHITPA	33.68	-10.34	1440	33.6	84.2
Data line 4	DEZDA	34.25	-14.32	1632	19.3	92.5
Data line 5	KARONGA	33.82	-9.99	819	43.0	88.5
Type of data ..		<Longitude>	<Latitude>	<Altitude>		
Parameter ..						
Day..						
Dekad..						
Month..						
Year..						
Water Balance Run						

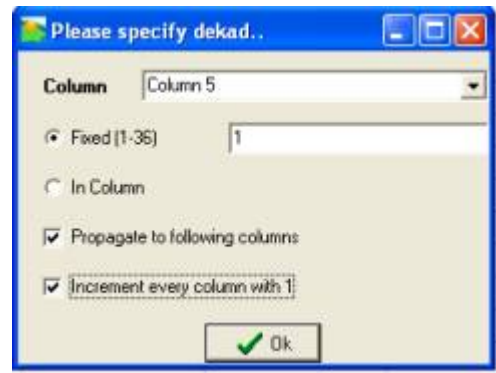
The longitude, latitude and altitude will be showing already and now you need to specify the type of data to import. You may place the cursor in the column (figure) or may use the column form to indicate the column (figure).

Click on type of data to define the type of data. The type of data being imported is "*Dekadal Actual Weather*" and the following columns contain the same type of data (therefore the "*Copy to columns to the right*" checkbox is checked). Click



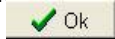
Press the "*Parameter*" button and select "*Rainfall*" to specify the exact parameter being imported as shown in figure click to proceed  next level.

The data are dekadal, so you ignore the "*Day*" button. You press the Dekad button. The first column represents the first dekad of January. This is dekad number 1 in the year. Every next column represents the next dekad in the year. Click to proceed to the next level.

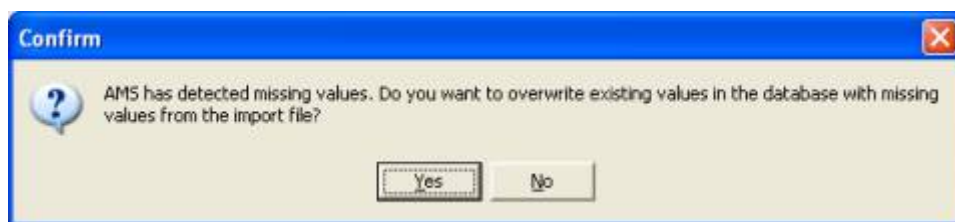


You ignore the "*Month*" button because the data you are importing is on a dekadal basis and not monthly.

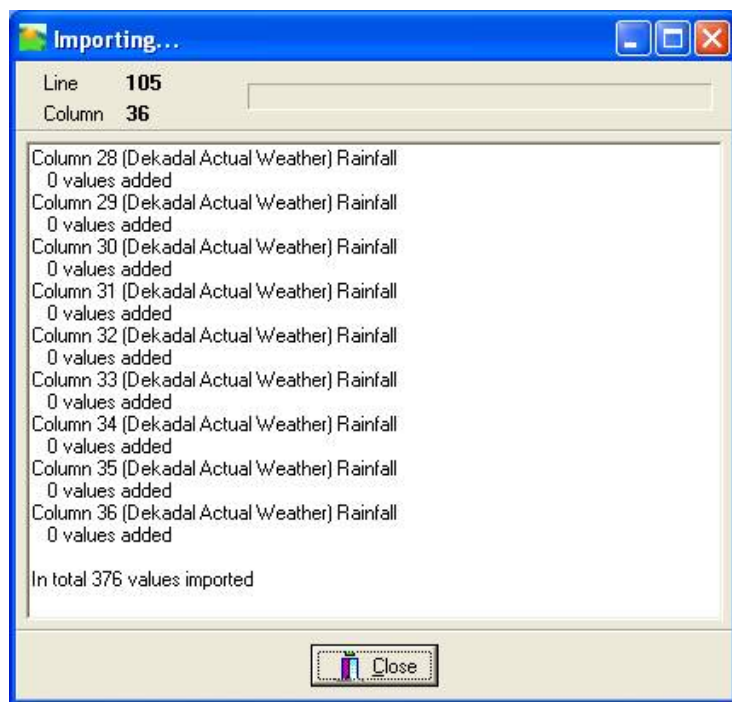
You specify the year depending on which year you are importing but in this example we are importing "2004" for column 1 to 36. The year will have to be propagated to all the following columns by checking the propagate box. Click to proceed to the next level.



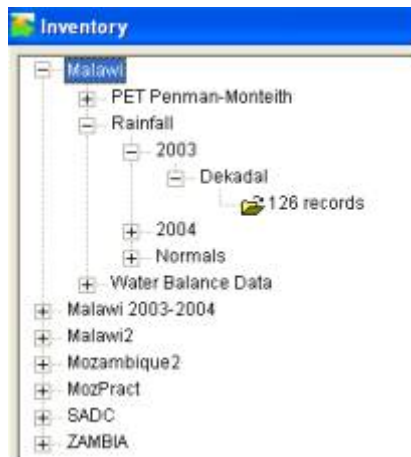
You ignore the Water Balance button. Press and the  importing process begins and the data are imported! In case of missing data you get the following message:



Answer "*No*" to prevent existing values from being overwritten by missing values. Press next and the data are being imported:



It is important to check if all the weather data are imported and in the database by checking the "*Database ⇒ Data Inventory*" function.



Importing the crop parameter file

The crop parameter file is the file that contains data for running the water balance calculation. It contains the water holding capacity, effective rainfall, the planting dekad, the cycle length, pre-season crop coefficient and irrigation data if needed.

The process of importing data starts in the same way as demonstrated for the rainfall data above. Once you obtain the screen to start specifying the data, then it gets slightly different as you have to specify each column as follows:

	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Data line 1	MMV-BALAKA	34.97	-14.98	625	50	95
Data line 2	MMV-BOLERO	33.78	-11.02	1100	40	95
Data line 3	MMV-BVUMBWE	35.07	-15.92	1146	70	100
Data line 4	MMV-BWENGU	33.92	-11.07	1052	40	95
Data line 5	MMV-CHICHIRI	35.05	-15.78	1132	70	100
Type of data ..		<Longitude>	<Latitude>	<Altitude>		
Parameter ..						
Day..						
Dekad..						
Month..						
Year..						
Water Balance Run						

As in the previous exercise, you start specifying the type of data that you are importing. In this case, all the data being imported will be used in the water balance and so it is important that the data type is copied to the columns to the right.

Column: Column 5

Type of data: Water Balance Data

☒ Copy to columns to the right

Ok Cancel

The next stage is to indicate the "parameter" and clicking on parameter will bring up a screen that you need to indicate the type of parameter. This will have to be done for all the parameters as shown below:

Column: Column 5

Parameter: Water Holding Capacity (mm)

☐ Copy to columns to the right

Ok Cancel

Column: Column 6

Parameter: Percentage Effective Rainfall (0-100)

☐ Copy to columns to the right

Ok Cancel

The screenshot shows a dialog box titled "ColumnForm" with a blue title bar and standard Windows window controls. It contains two dropdown menus: "Column" set to "Column 8" and "Parameter" set to "Cycle Length (dekads)". Below these is a checkbox labeled "Copy to columns to the right" which is currently unchecked. At the bottom are two buttons: "Ok" with a green checkmark icon and "Cancel" with a red X icon.

The screenshot shows a dialog box titled "ColumnForm" with a blue title bar and standard Windows window controls. It contains two dropdown menus: "Column" set to "Column 9" and "Parameter" set to "Planting Dekad". Below these is a checkbox labeled "Copy to columns to the right" which is currently unchecked. At the bottom are two buttons: "Ok" with a green checkmark icon and "Cancel" with a red X icon.

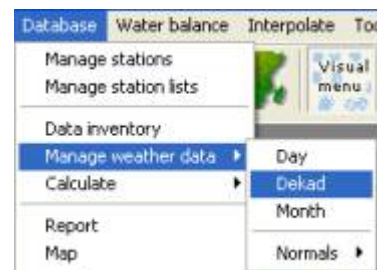
Section 5

Manual data entry into AMS

AMS can store daily, dekadal and monthly values. All values are stored independently in the database. As expected, monthly data can be calculated from dekadal and dekadal data can be calculated from daily values. Also, dekadal estimates can be created from monthly values. Entering of dekadal weather data manually is recommended when updating weather data on a dekadal basis once the dekad has come to an end. Once the data has been entered, a water balance model can be run.

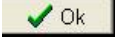
Entering dekadal rainfall data

Start the "**Database ⇒ Manage weather Data Dekad**" function as shown in **figure**. Specify the list for which you want to enter then data, the parameter and the year:



Select the station list which will contain the data and this case it is **Malawi** and then select the parameter, **Rainfall** and the year **2004**.

A screenshot of the 'Dekadal data' dialog box. It has three input fields: 'List' with 'Malawi' selected, 'Parameter' with 'Rainfall' selected, and 'Year' with '2004' entered. At the bottom are three buttons: 'Ok' (with a green checkmark icon), 'Cancel' (with a red X icon), and 'Help' (with a question mark icon).

Click  the following screen is presented. In this screen you can enter new data. Simply move to the right cell in the input screen and start typing. AMS uses the dot as decimal separator. In this window two types of data can be entered. The top window provides access to **actual** data, the bottom window provides access to **normal** data.

Dekadal data

List: **Malawi** Year: **2004**
Parameter: **Rainfall (RAIN; 005)**
in 1 mm

ID	Station Name	Jan1	Jan2	Jan3	Feb1	Feb2	Feb3	Mar1	Mar2	Mar3	Apr1	Apr2	Apr3	May1	May2	M
ID000048	BALAKA	199.8	68.3	225.9												
ID000157	BOLERO	53.7	75.5	69.9	21.7	58.7	66.0	99.2	11.9	0.0	52.3	10.1				
ID000167	BVUMBWE	98.4	54.8	74.4	16.5	81.6	45.5	80.9	11.8	1.1	75.7					
ID000208	CHICHIRI	16.5	82.0	148.2	14.6	122.4	47.7	131.3	14.1	26.1	72.9	12.2				
ID000527	CHIKANGAWA	20.4	68.3	136.1	55.1	143.1	9.0	141.2	79.3	53.6						
ID000602	CHIKWAWA	0.0	57.4	155.1	14.0	42.3	52.2	48.1	5.8	38.1						
ID000615	CHIKWED	50.7	54.7	32.9	2.4	96.6	114.9	54.1	32.3	2.5						
ID000657	CHILEKA	11.2	119.2	169.4	9.6	21.0	15.9	89.0	3.0	14.8	38.9	17.6				
ID000669	CHINGALE	11.5	66.5	259.5	8.0	41.0	27.5	104.0	19.5	7.0						
ID000670	CHINTHECHE	161.6	122.0	115.2	88.0	171.5	74.6	42.0	36.9	87.0						
ID000759	CHIRADZULU	8.4	109.3	100.0	4.4	16.1	62.0	97.3	1.8	20.2						
ID000930	CHITEDZE	11.5	116.4	95.0	121.6	74.1	62.6	16.0	73.1	0.0	51.1					
ID000936	DEDZA	19.3	92.5	65.4	12.6	32.2	34.9	81.1	48.0	2.4	62.6	68.3				
ID000937	DOWA	6.4	81.1	111.4	21.1	51.0	120.4	80.9	15.6	5.4	33.3	19.8				
ID000938	DWANGWA	127.9	245.0	42.8	5.6	110.7	65.9	30.5	98.7	51.0	277.4	59.6				
ID000939	DZALANYAMA	113.2	65.3	118.8												









Normals

ID	Station Name	Jan1	Jan2	Jan3	Feb1	Feb2	Feb3	Mar1	Mar2	Mar3	Apr1	Apr2	Apr3	May1	May2	M
ID000048	BALAKA	62.0	40.0	85.0	80.0	37.0	47.0	63.0	32.0	40.0	19.0	16.0	1.0	0.0	5.0	
ID000157	BOLERO	69.0	52.0	43.0	63.0	74.0	32.0	61.0	39.0	25.0	18.0	13.0	5.0	3.0	1.0	
ID000167	BVUMBWE	82.0	78.0	83.0	84.0	81.0	44.0	67.0	66.0	52.0	36.0	34.0	19.0	8.0	7.0	

Ok Cancel

BALAKA Total: - Mini: - Maxi: -

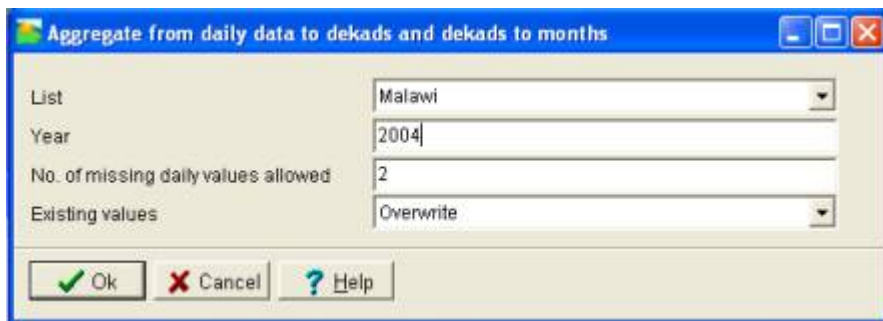
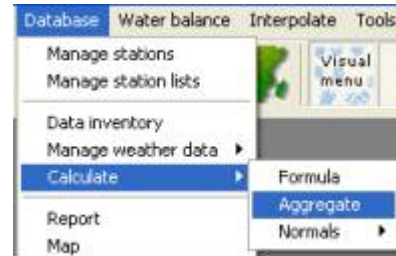
The two button-bars give full navigational functionality:

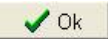
Button	Meaning
	Move to first line
	Move to previous line
	Move to next line
	Move to last line
	Add a record for a station
	Delete a record
	Save the changes when editing a record
	Cancel the changes when editing a record

Section 6

Calculating monthly rainfall data from dekadal rainfall

Situations may arise that require that monthly values be calculated from either the daily or dekadal data already in the AMS database. For this purpose, monthly values may be calculated as follows using the "**Database** ⇒ **Calculate** ⇒ **Aggregate**" function:



Press  check whether the data have been calculated with the "**Database-Inventory**" function.



Section 7

The water balance

In early warning for food security you need an understanding of the condition of crops. Crops are dependent on water, and water is scarce in many developing countries. Especially in semi-arid countries water is the most important factor determining crop yield.

FAO has developed a simple method based on a water balance calculation scheme that will help you determine whether the agricultural season has performed well and that crops have had enough water to achieve a potential yield. The outcome of a water balance calculation is an index that roughly represents the percentage of needed water the plant has received during its cycle. In semi-arid areas this index is closely related to yield, presuming no other limiting factor is in place (such as crop diseases). In the new revised water balance model, other predictors besides the index can now be used to estimate yields of crops.

Besides the index many other useful parameters are calculated from the water balance. Very informative are:

- ❖ Actual evapotranspiration. In a number of cases yield is more closely related to actual evapotranspiration than to the WSI index.
- ❖ Water storage in the soil
- ❖ Water excess and
- ❖ Water deficit at various phenological stages

This manual will not provide details concerning the background of the water balance calculation. You can find a manual on the FAO Website. The water balance model is usually run on a dekadal (10-day) basis, although running it on a daily basis is possible. This will also be the time-step mostly used in this manual.

Calculating the water balance with AMS is a station based activity. Afterwards, the outcome of the calculations can easily be converted into images and aggregated by province/district to compare to yield data.

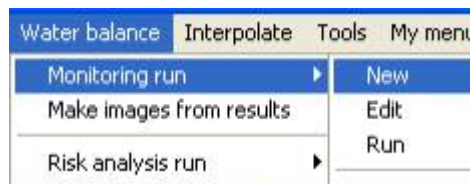
Data availability check

For the calculation of the water balance you need the following information:

1. **Dekadal Actual Rainfall**
2. **Dekadal Normal Rainfall**
3. **Dekadal actual PET.** PET can be calculated from temperature, windspeed, humidity and other parameters that are only available from full-blown weather stations. Often actual PET data are not available. In that case normal PET data can be used with little damage to the accuracy of the water balance method.
4. **Dekadal normal PET.**
5. **Crops.** Which crops are grown? Each crop has its own crop coefficients.
6. **Planting dekads.** In which dekad planting occurred?
7. **Cycle length** of the crops grown.
8. **Water Holding Capacity** of the soil.
9. **Percentage Effective Rainfall.** This parameter is non-essential and is usually kept at 100%
10. **Pre-season crop coefficient.** This is the "*crop*" coefficient related to bare soil.
11. **Irrigation amounts.** This setting is very important for areas where there is a lot of irrigated crops such as in Afghanistan where as much as half of the crops are irrigated.

Preparing a water balance

After checking the availability of data you can prepare a water balance. Activate the "**Water Balance – Monitoring Run – New**" function.



The following window is shown:



You specify a new name for the run. You choose for example "*Zambia-01-02*" for the 2001-2002 growing season. You will use the rainfall monitoring network in Zambia as a basis for the weather data. The selected crop is Maize. This crop is cultivated in almost all districts of the country as it is the main staple food crop in Zambia and many other African countries. In the following screen you can enter all the data needed for the water balance. The rainfall and PET are entered elsewhere (see previous sections).

When setting a monitoring run for the first time, the screen may come empty. You may type in the various data requirements i.e. planting dekad, cycle length, water holding capacity, effective rainfall and



pre-season crop coefficient. If the data sets to go into a column are similar, for example pre-season crop coefficient, there is a simpler way of inputting the data. Put the cursor in the column and press the following button:

You will assign the value of 0.15 to the planting dekad. This means that you will the value to all the stations in the station list.

Press Ok. The pre-season crop coefficient column is filled with the value 0.15.



Assign a value to all stations

Column: KCP (Pre-season KCR)

Value: 0.15

Ok Cancel

Monitoring Run:

List: ZAMBIA Year: 2001 Crop: Maize (Crop coefficients : Default)

Station Name	Planting Dekad	Cycle Length (dekads)	Water Holding Capacity (mm)	Percentage Effective Rainfall (0-100)	Pre-seas
KABWE002	34	14	50	100	0.15
KAFIRO01	28	14	50	100	0.15
KAFUE001	34	12	50	100	0.15
KALABO01	33	11	50	100	0.15
KAOMA001	33	12	50	100	0.15
KASAMA01	33	14	50	100	0.15
KASEMP01	33	14	50	100	0.15
KAWAMB01	29	14	50	100	0.15
LIVING01	34	10	57	100	0.15
LUNDAZ01	34	12	50	100	0.15
LUSAKA01	34	12	50	100	0.15
LUSAKA02	33	12	50	100	0.15
MAGOYE01	34	11	50	100	0.15
MANSA001	31	14	50	100	0.15
MBALA001		14	50	100	0.15
MFLUME001	33	10	54	100	0.15
MISAMF01	33	14	50	100	0.15
MONGU002	34	12	50	100	0.15
MPIKA001	33	13	57	100	0.15
MSEKER01	34	12	50	100	0.15
MTMAKU01	31	12	50	100	0.15
MUMBWA01	28	12	50	100	0.15
MVINILO1	29	14	50	100	0.15
NDOLA001	33	14	50	100	0.15
PETAUK01	33	12	50	100	0.15

Close Save Save and Run

Do the same for the following columns. You assign the following values to the next columns where necessary :

- ❖ Cycle length : 12 dekads
- ❖ Water Holding Capacity of the soil : 50 mm

- ❖ Percentage effective rainfall : 100 %
- ❖ Pre-season Kcr : 0.15
- ❖ Irrigation application : 0 (this means NO irrigation)
- ❖ Irrigation bund height : 0

Refining the water Balance

You have just completed a very simple Water Balance calculation. You have assigned the same values to the water balance parameters for all stations. In this paragraph you will discuss the possibilities to make the water balance calculation more realistic.

Filling Data gaps

First of all you have to try to fill gaps in the data. In the previous chapter you have seen that you do not have enough ground data for Zambia. In the following order you should try to do the following:

- ❖ Try again to get the data from the station and enter them in AMS. Measured values are always best.
- ❖ If you lack rainfall or PET data, extract the data from the 10-day data provided by ISPRA. Rainfall is in column J. PET is in column K.

Col	Parameter Description	Param	Unit
J	Precipitation (Rainfall cumulated for the 10 days period)	rain10	mm
K	Potential Evapo-Transpiration (cumulated for the 10 days period)	pet10	Mm

Please note that these data should always be second choice! Therefore never overwrite ground data. Furthermore, mark the data with "E" for "estimate". Should ground data come in at a later stage, replace the satellite data with ground data in AMS.

- ❖ If you cannot achieve any of the above solutions, you can use the function "*Tools – Interpolate for missing data*" to interpolate for missing data.
- ❖ Another method is by creating an image using one of the interpolation techniques (see "*Interpolation*" menu) and extracting values from this image into the database (function "*Database – Import – From image*"). This has previously been described.

Calculate planting dates

Measured values are always the best data around. So if you have planting dates for Afghanistan you should enter them. However a good approximation of planting dates can be figured out with rainfall records. Planting usually occurs as a result of rainfall exceeding a certain amount. You can let AMS calculate the planting dates for us, based on this simple algorithm. Activate the "**Water Balance – Monitoring Run – Calculate planting dekads – Based on Rainfall Threshold**" function. You will assume that planting occurs when 20 millimeters of rainfall have been exceeded.

Calculate Planting Dekads based on a rainfall threshold

Monitoring Run: Afghanistan Wheat 2003

Rainfall threshold first dekad: 20

Rainfall threshold following two dekads: 0

Below specify the range (dekads) in which to search for planting dekads.

Start month: January

Start dekad: 1

End month: July

End dekad: 1

View results? ☒

Ok Cancel Help

Press OK. Notice that the planting dekads can be changed from 1 into other dekads. Whenever the 20 mm rainfall threshold between January 1 and July 31 is not exceeded, the planting date is made "missing value"

Monitoring Run: Afghanistan Wheat 2003

List: Rainfall monitoring network Year: 2003 Crop: Wheat (Crop coefficients : Default)

Station Name	Planting Dekad	Cycle Length (dekads)	Water Holding Capacity (mm)	Percentage Effective Rainfall (0-100)	Pre-seas
Albak		15	60	100	0.15
Asmar		15	60	100	0.15
Baghlan	5	15	60	100	0.15
Bamyan		15	60	100	0.15
Bust	6	15	60	100	0.15
Cheghcharan		15	60	100	0.15
Darulaman		15	60	100	0.15
Faizabad	4	15	60	100	0.15
Farah	2	15	60	100	0.15
Gardez	5	15	60	100	0.15
Ghazi Abad		15	60	100	0.15
Ghazni	5	15	60	100	0.15
Hirat	2	15	60	100	0.15
Jabulsaraj	3	15	60	100	0.15
Jalalabad	5	15	60	100	0.15
Kabul	4	15	60	100	0.15
Kandahar	5	15	60	100	0.15
Kariz Mir	4	15	60	100	0.15
Keshem		15	60	100	0.15
Khost		15	60	100	0.15
Kunduz	5	15	60	100	0.15
Laghman		15	60	100	0.15
Logar	3	15	60	100	0.15
Maimana	4	15	60	100	0.15
Mazarisharif	6	15	60	100	0.15

Close Save Save and Run

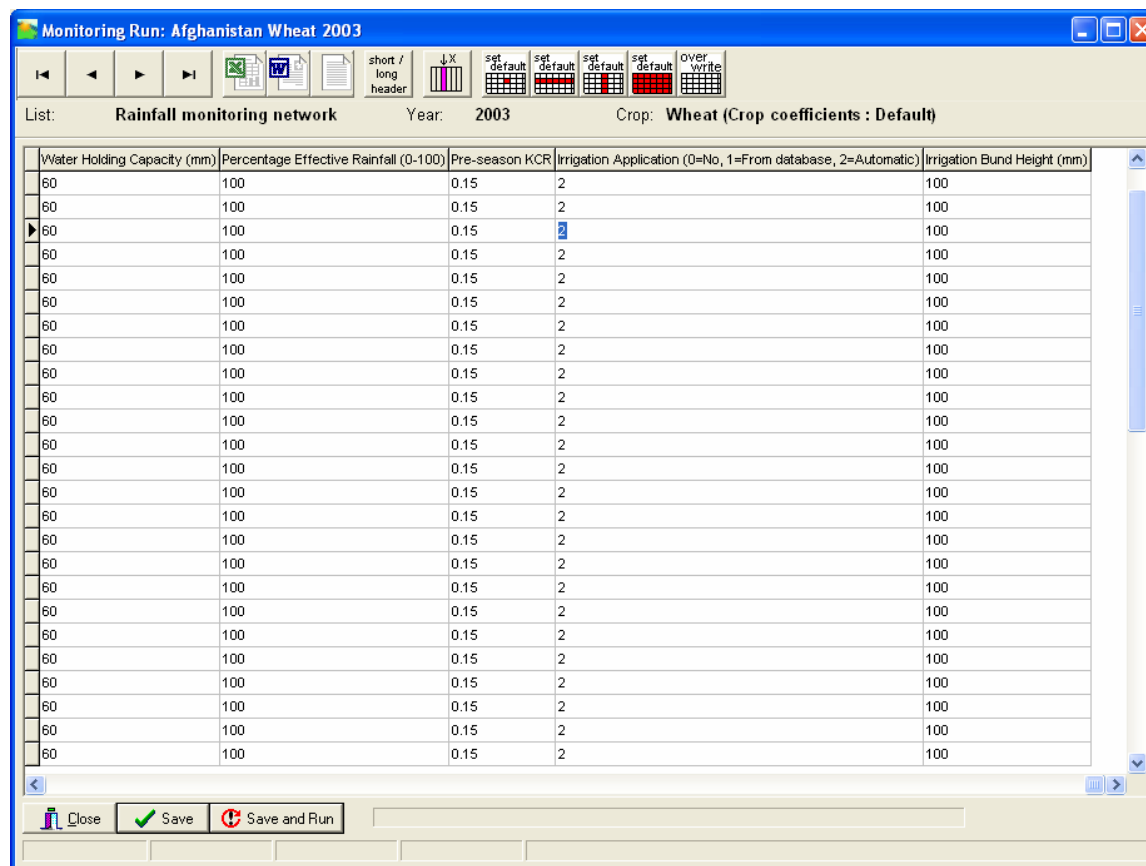
"Save and Run" the Water balance to see the results.

Adding Irrigation

In Afghanistan, irrigation is applied to roughly 50 % of the cropped area. In many places a crop would never reach maturity without irrigation. AMS gives the user the possibility to add irrigation to a crop at a certain station. AMS provides two methods of irrigation:

Automatic irrigation

This type of irrigation will ensure that the crop will never experience water stress. Therefore the final index will always be 100. This type of calculation is useful as it calculates the actual evapotranspiration without water stress. This parameter is closely related to crop yield. Furthermore it also tells you how much water the crop uses to mature. On this knowledge irrigation amounts can be based. Automatic irrigation can be switched on by entering a "2" in the "*Irrigation Application*" field of the Water Balance.

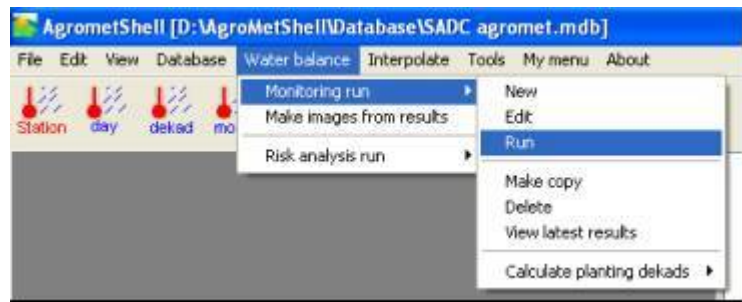


"Save and Run" the water balance to see the result. Yellow bars in the graph indicate the application of automatic irrigation.

Running the Water balance

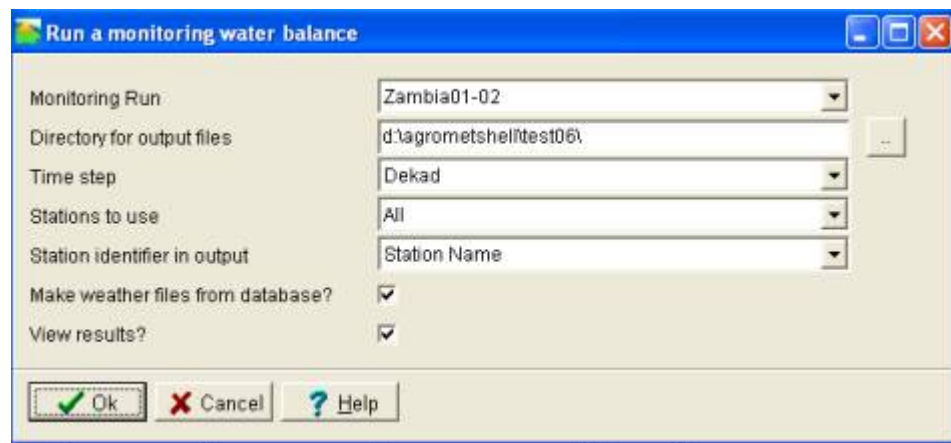
Running the water balance model

Select the water balance run as shown in figure.



Use the pull down menu to select the appropriate run file in the **Monitoring Run**

Fill the resulting screen as follows:

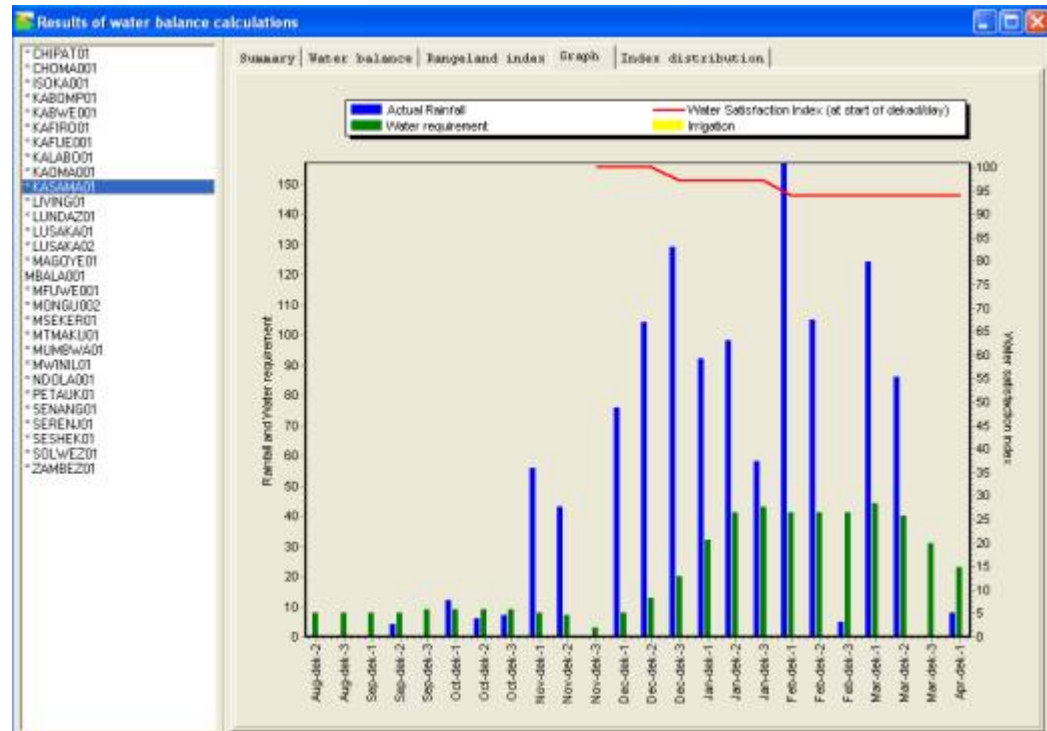


You can either select all the stations in the database or select stations for your country in **Stations to use**. Then click



Results of water balance calculations											
* CHIPAT01	Summary	Water balance		Rangeland index		Graph	Index distribution				
* CHOMA001	DATE	NOR	ACT	WR	IRR	PET	KCP	WR	AvW	SW	S/D INDEX
* ISOKA001	Aug-dek-2	0	-999	0	0	36 0.15	5	-5	0		
* KABOMP01	Aug-dek-3	0	-999	0	0	39 0.15	6	-6	0		
* KABWE001	Sep-dek-1	0	-999	0	0	43 0.15	6	-6	0		
* KAFIRO01	Sep-dek-2	0	-999	0	0	46 0.15	7	-7	0		
* KAFUE001	Sep-dek-3	0	-999	0	0	49 0.15	7	-7	0		
* KALAB001	Oct-dek-1	3	-999	3	0	55 0.15	8	-5	0		
* KADMA001	Oct-dek-2	6	-999	6	0	57 0.15	9	-3	0		
* KASAMA01	Oct-dek-3	9	-999	9	0	57 0.15	9	0	0		
* LIVING01	Nov-dek-1	19	-999	19	0	52 0.15	8	11	12		
* LUNDAZ01	Nov-dek-2	29	-999	29	0	51 0.15	8	21	33		
* LUSAKA01	Nov-dek-3	40	-999	40	0	50 0.07	4	36	50	19	100
* LUSAKA02	Dec-dek-1	50	-999	50	0	49 0.22	11	39	50	39	100
* MAGOYE01	Dec-dek-2	65	-999	65	0	48 0.37	18	47	50	47	100
* MBALA001	Dec-dek-3	79	-999	79	0	48 0.71	34	45	50	45	100
* MFUWE001	Jan-dek-1	66	18	18	0	48 1.10	53	-35	15	0	100
* MONGU002	Jan-dek-2	67	108	108	0	47 1.25	59	49	50	14	100
* MSEKER01	Jan-dek-3	68	34	34	0	46 1.25	58	-24	26	0	100
* MTNAKU01	Feb-dek-1	61	4	4	0	43 1.25	54	-50	0	-24	95
* MUMBWA01	Feb-dek-2	58	39	39	0	42 1.25	53	-14	0	-14	92
* MWINIL01	Feb-dek-3	55	0	0	0	42 1.19	50	-50	0	-50	81
* NDOLA001	Mar-dek-1	37	8	8	0	46 0.90	41	-33	0	-33	74
* PETAUK01	Mar-dek-2	30	20	20	0	45 0.60	27	-7	0	-7	72
* SENANG01											
* SERENJ01											
* SESHEK01											
* SOLWEZ01											
* ZAMBEZ01											
	Phase	ETat	Surplus	Deficit							
	Initial	15	58	0							
	Vegetative	105	92	0							
	Flowering	186	14	-88							
	Ripening	28	0	-40							
	Surplus:	164mm (WEXt)		Deficit:	128mm (WDEFt)						
	ETat:	334mm				* data avail:75% (*AVAIL)					
	Norm. index:	100% (INDXn)									

Inspect the water balance graph for Chipata:



Manual irrigation

In this case the irrigation is applied manually for each station. In AMS irrigation is considered a meteorological parameter that can be entered using the weather parameter input screens.

Enter dekadal irrigation amounts in the following way:

Go to the option : *"Database – Manage Weather Data - Dekad"*. Specify for example the following settings:

The Dekadal data dialog box is shown with the following settings: List: Rainfall monitoring network, Parameter: Irrigation, Year: 2003. The dialog includes Ok, Cancel, and Help buttons.

Press Ok. Enter the irrigation amounts in the same way as you would enter rainfall.

Dekadal data

List: Rainfall monitoring network
 Parameter: Irrigation (IRRI; 900)
 in 1 mm

Year: 2003

ID	Station Name	Jan1	Jan2	Jan3	Feb1	Feb2	Feb3	Mar1	Mar2	Mar3	Apr1	Apr2	Apr3	May1	May2	May3
AF001	Baghlan	10.0	10.0	10.0	10.0	10.0	10.0									

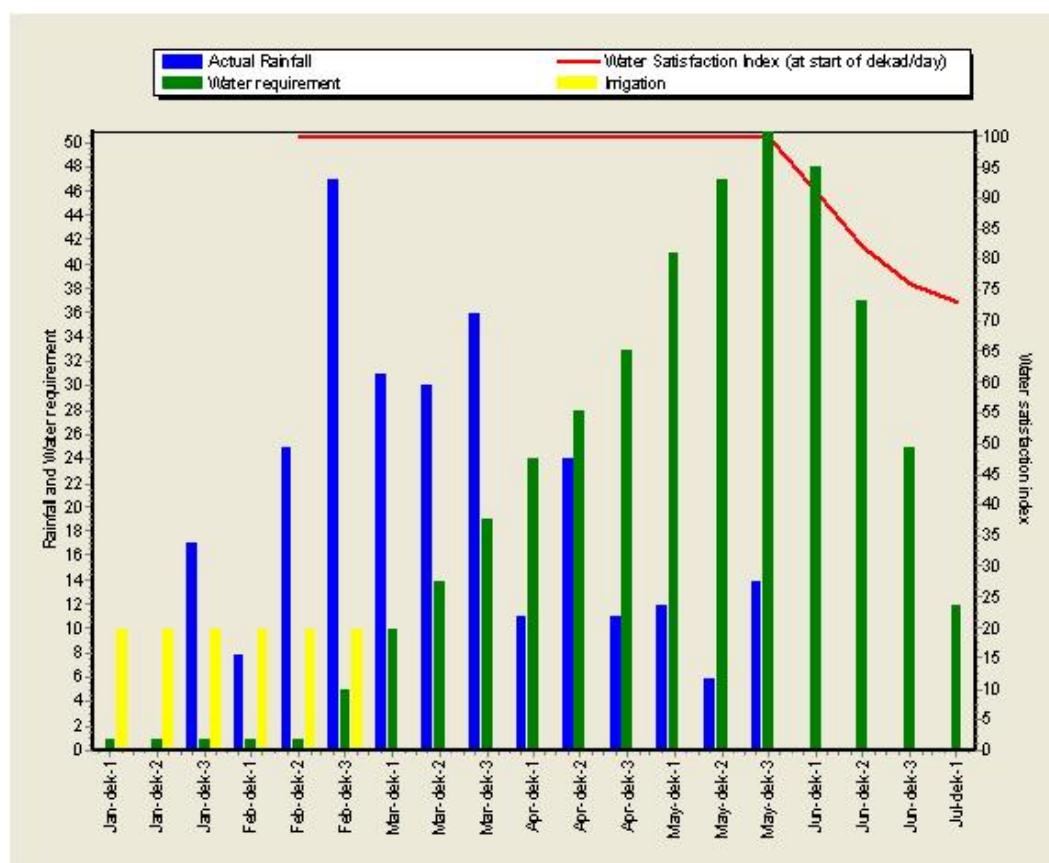
Normals

ID	Station Name	Jan1	Jan2	Jan3	Feb1	Feb2	Feb3	Mar1	Mar2	Mar3	Apr1	Apr2	Apr3	May1	May2	May3

Ok Cancel

Baghlan Total: - Mini: - Maxi: -

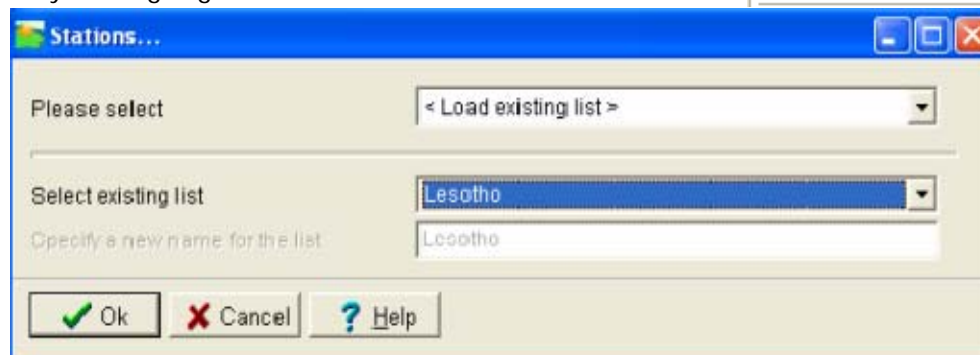
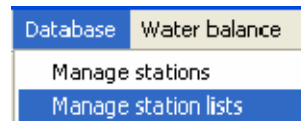
Press OK, Activate the "Water Balance – Monitoring Run - Edit" option and change the "Irrigation Application" field of the Water Balance sheet to 1. By pressing "Save and Run" you calculate the water balance with these amounts of irrigation. The viewer will show the following results:



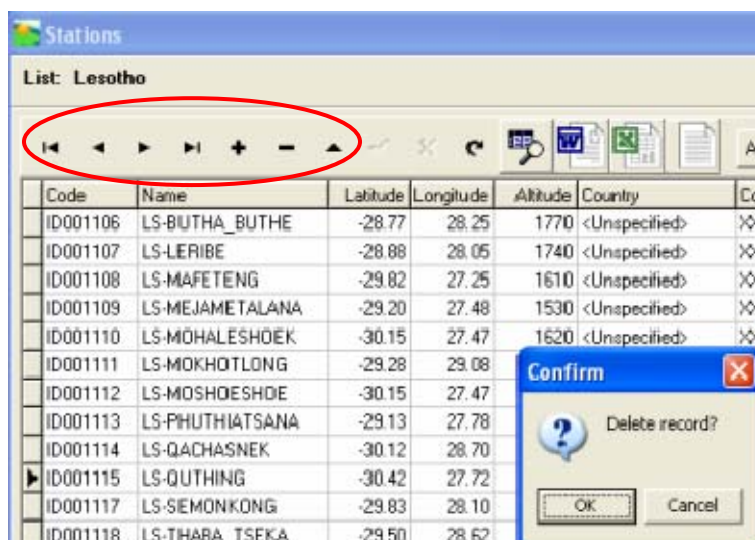
Removing and adding stations from the stations list

Stations can be removed or added to the stations manager in the AMS software. To remove or add a station, you invoke **Database ⇒ Manage station lists** as shown.

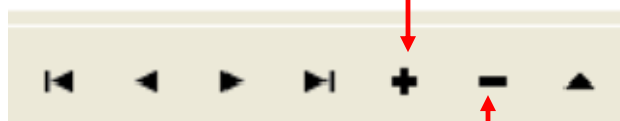
The following screen appears which allows you to load an existing stations list from you which you are going to remove or add stations.



Once you click OK on the screen for loading the station list, you obtain the following screen from which you can remove or add a record using the menu above (in read) as shown in the diagram.



Add record



Remove record

Section 8

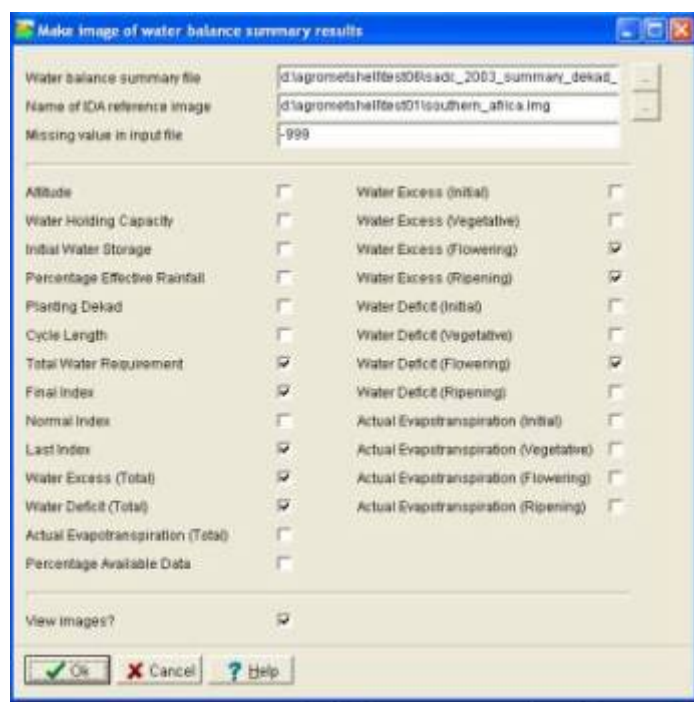
Making images from the water balance calculation

Select water balance and then make images from results

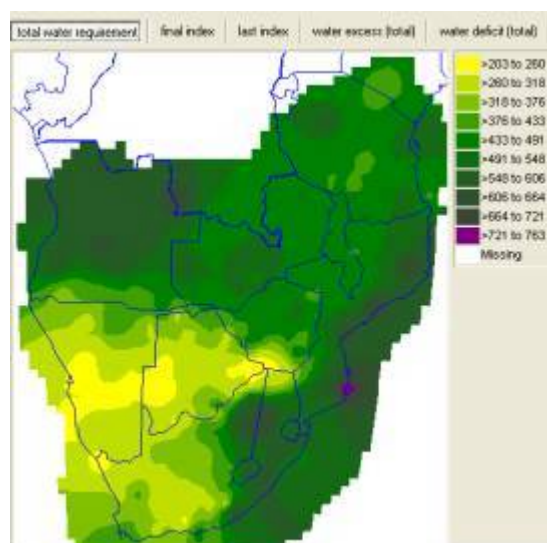


Make sure the appropriate summary file is selected in the **water balance summary file**. Select the images that you want to make by **checking the boxes**.

The images will show you which areas had **excess water** at different stages of the crop in cases where there was a lot of rainfall, areas where there was **water deficits** at different stages of the crop due to low rainfall.



The figure shows an image of the total water requirement. Click on the various images to view the other images selected.



Making a risk analysis for a station

Risk analysis will provide you with information on how many times the water requirement has been higher than a certain level in the time period under study. Select **water balance then risk analysis run** and then **new**.

(Rainfall data in the database is from 1981-2004).

From NEW, provide a name of a station of your choice (e.g. Maputo 1981-2003) then select a station from the pull down menu as shown in the figure. Indicate the time period for the analysis from **1981** to **2003**. Click



Look at the index distribution frequency graph with wrsi on the x-axis and number of years on the y-axis.

How many years had a wrsi of 50 and below?

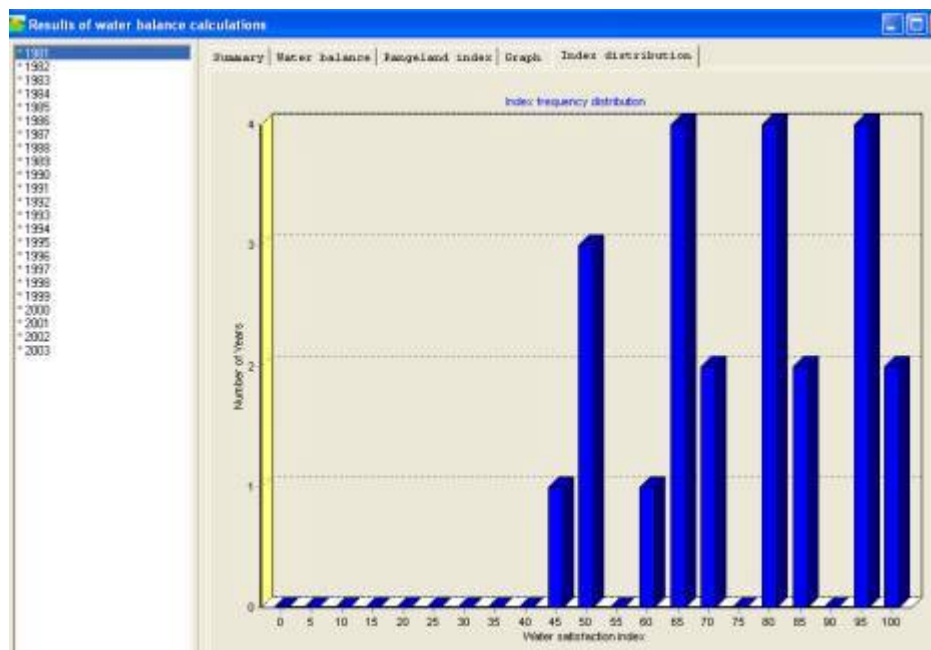
How many years had a wrsi of 65 and below?

How many years had a wrsi of 75 and below?

How many years had a wrsi of 85 and below?

What does this analysis tell you about this station? This analysis was done for a maize crop, would recommend that communities continue to grow the crop?





Section 9

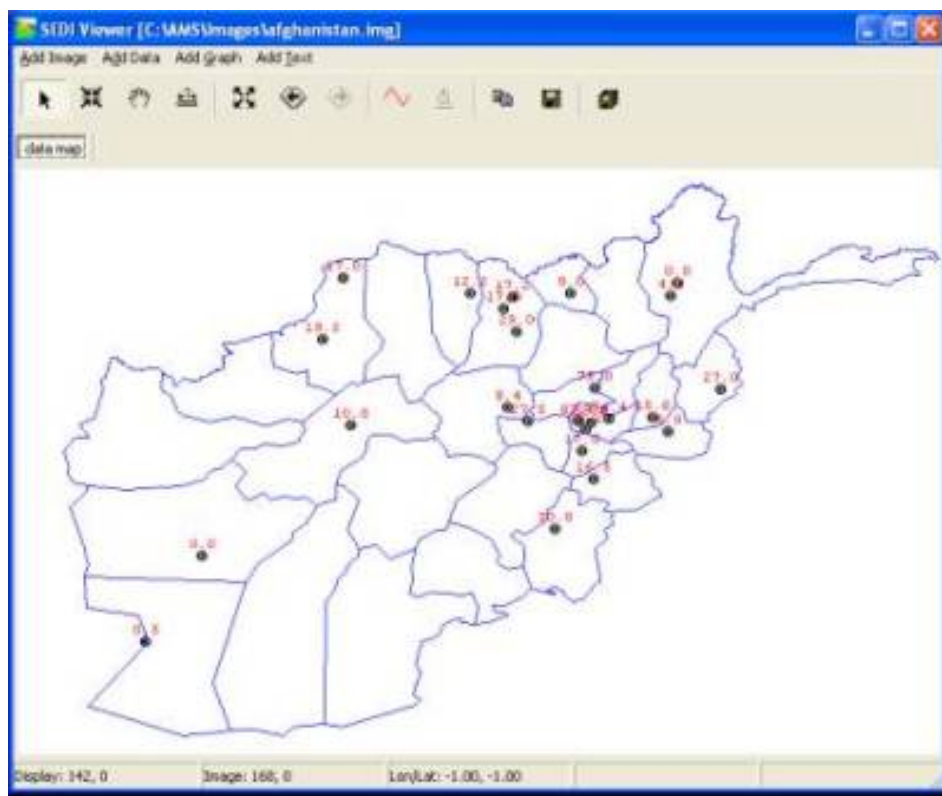
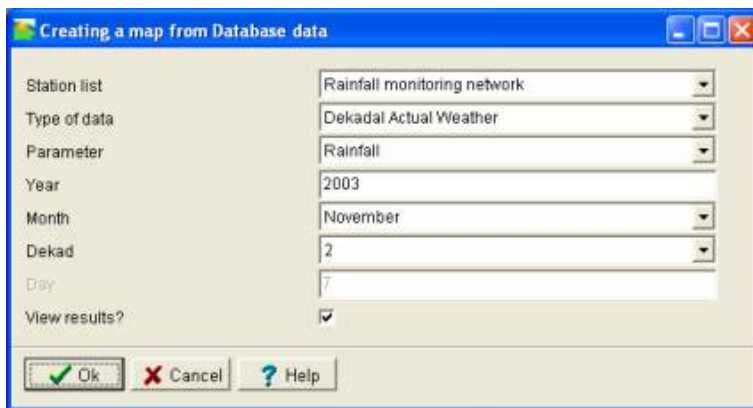
Displaying data in simple way

It is always good to display your data for visual assessment. You can display data in several ways. These display functions are added for quick reference and easy analysis of the data.











Mapping data in AMS

To explore the mapping possibilities of AMS. Activate the pull down menu and start the “**Database-Map**” function. In the screen, “creating a map from Database data, fill in all the required information as shown in the figure.

Click  and a map will be displayed:



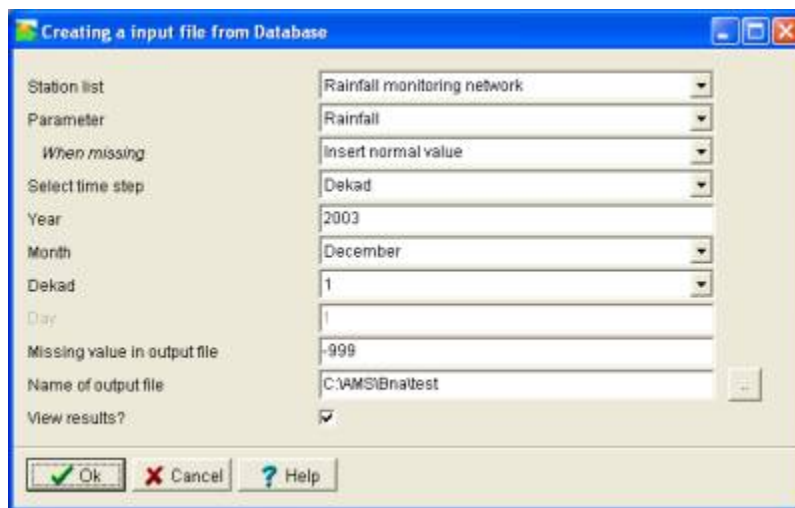
The toolbar provides the following functionality:

Button	Meaning
	Cursor
	Zoom in
	Pan
	Measure distance between two points
	Zoom out
	Previous view
	Load another boundary file
	Copy to clipboard (e.g. to copy image to Word)
	Save image as a bitmap
	Save the set of displayed files

Mapping data in WinDisp

You will map the same data in Windisp. Windisp enables you to improve the lay-out. When inserting a map into a bulletin, Windisp is the preferred application to prepare your images for presentations.

First export the data to BNA format using AMS. Use the "**Interpolate – Make input file – Database**" function. As an example take the following settings:



Be sure to tick the "*View results?*" option. Press Ok. In this example, the directory "*c:\ams\bna*" will contain two output files. The file with the extension "*bna*" is the one you need.

Perform the following steps:

- ❖ Open Windisp
- ❖ Use the function "**File-Open-Map**" to display a background map (e.g. afgad1.bna).
- ❖ Use the function "**Draw-Labels**" with the "*bna*"-file you just created.

You should now see a map of Afghanistan with superimposed the rainfall data.

- ❖ Annotation can be added. E.g. Rainfall dekad 1 December 2003 using the "*Draw text*" function.
- ❖ You can copy your work to the clipboard with the Edit-Copy function. In Windisp Draw a window that covers the part of the screen you want to copy.
- ❖ Paste the map into any Word document with CTRL-V.

[illegible]

Section 10

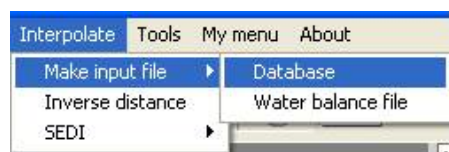
Interpolation of data using AMS

Visual assessment of bigger picture will always relay more information than looking at one locality in this case a station. In Agrometeorology or in food security, you are not only interested in what happens at the station level, you want an estimate of what happens in between so that you can get a complete and bigger picture. In order to do this, you have to convert our data from the world of tables to the world of images.

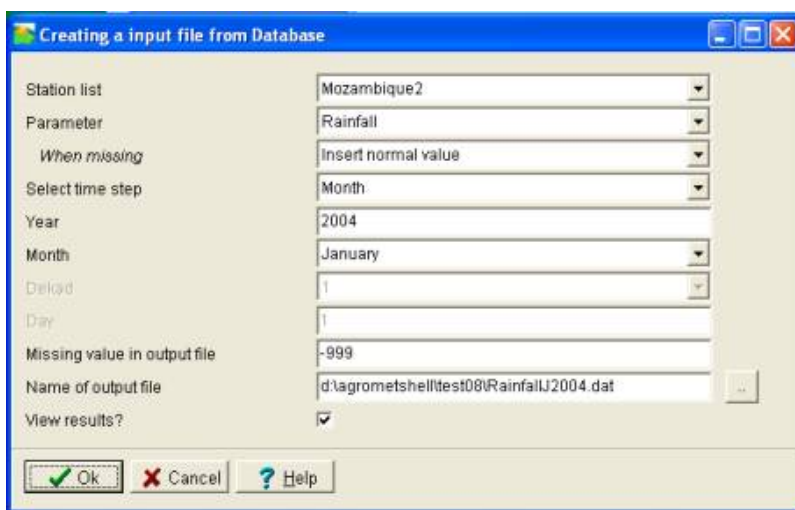
Using the inverse distance interpolation method

To perform an interpolation, first export the data to CSV format using AMS. Use the pull down menu as shown in the example

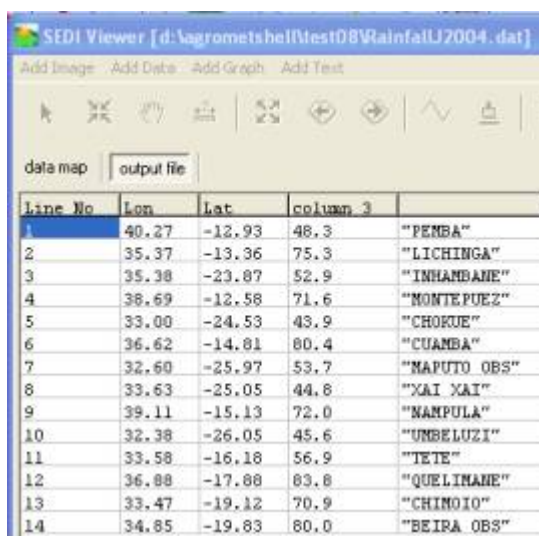
"Interpolate – Make input file – Database" function.



Provide the necessary inputs in terms station-list, parameter, year and month, missing value in output file and output file. Then click

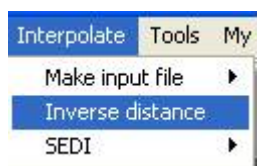


The output file created will shown as in the figure with station names, longitude, latitude and rainfall. The data is now ready for interpolation using AMS. Interpolation may be necessary when you some times intend to make images after running a water balance and images do not appear. The reason that there are not sufficient stations to create an image and so may have to create the data as done and increase the interpolation distance.

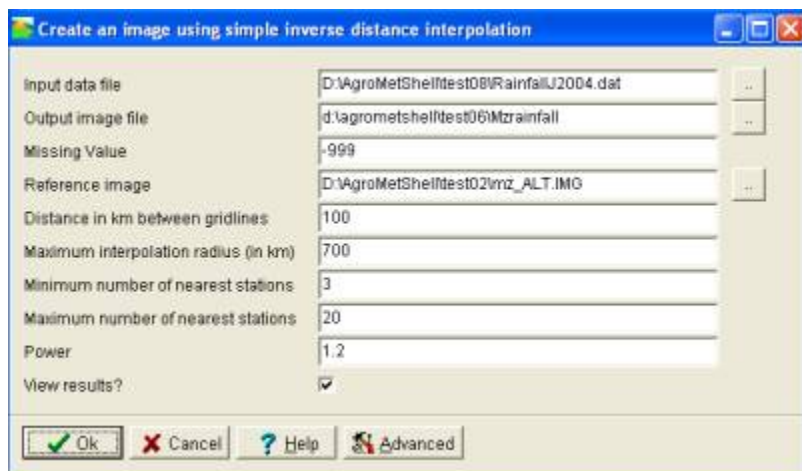


line No	Lon	Lat	column 3	
1	40.27	-12.93	48.3	"PENBA"
2	35.37	-13.36	75.3	"LICHINGA"
3	35.38	-23.87	52.9	"INHAMBANE"
4	38.69	-12.58	71.6	"MONTIEPUEZ"
5	33.00	-24.53	43.9	"CHOKUE"
6	36.62	-14.81	80.4	"CUAMBA"
7	32.60	-25.97	53.7	"NAPUTO OBS"
8	33.63	-25.05	44.8	"XAI XAI"
9	39.11	-15.13	72.0	"NAMPULA"
10	32.38	-26.05	45.6	"UNBELUZI"
11	33.58	-16.18	56.9	"TETE"
12	36.88	-17.88	83.8	"QUELINANE"
13	33.47	-19.12	70.9	"CHINGIO"
14	34.85	-19.83	80.0	"BEIRA OBS"

After creating the input file as shown above, the interpolation process can now begin using the created input file as shown.



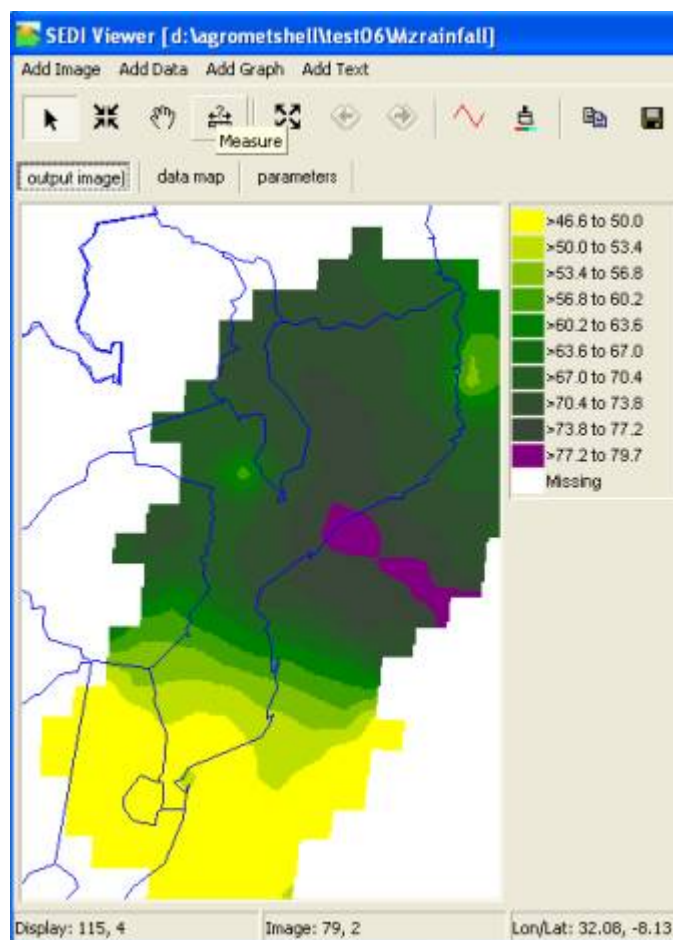
Then click 



The following image will be the result:

Such images may be useful for inclusion in the Agrometeorological Bulletins and therefore you might use the copy to

clipboard functionality () at this stage to paste the map to Microsoft Word.



Try to re-do the previous exercise with different settings under *Distance in Km between gridlines*, *Maximum interpolation radius (in Km)*, *Minimum number of nearest stations* and *Maximum number of nearest stations*. Notice the difference in the resulting images. Exercising with the settings is the best way to understand them.

Try to re-do the previous exercise with different settings under *Distance in Km between gridlines*, *Maximum interpolation radius (in Km)*, *Minimum number of nearest stations* and *Maximum number of nearest stations*. Notice the difference in the resulting images. Exercising with the settings is the best way to understand them.

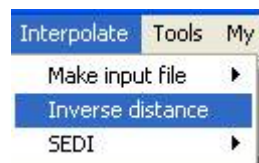
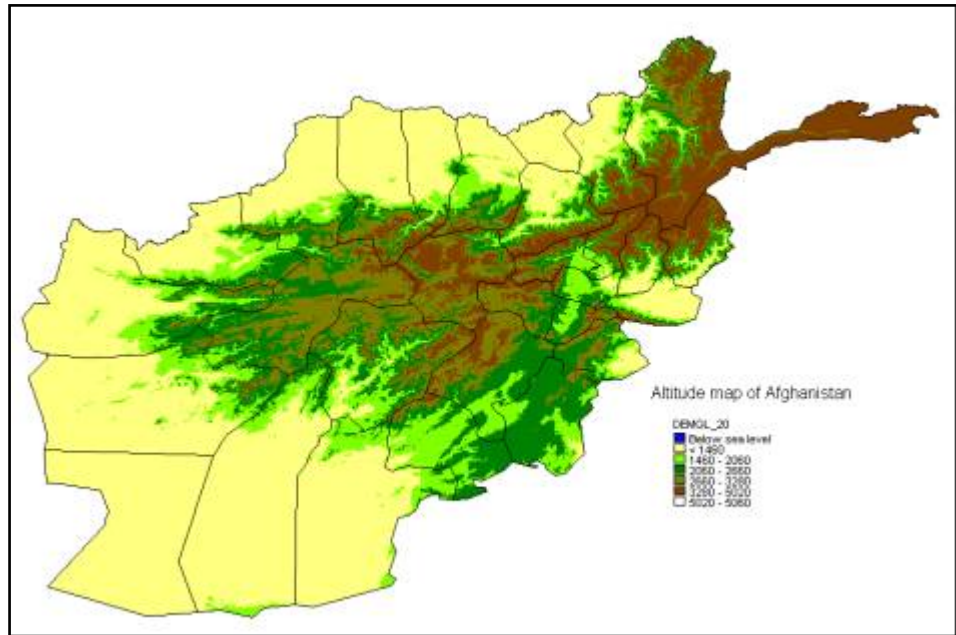
Making an image using altitude as background image


In general, rainfall amounts are higher with higher altitudes. You can use this knowledge to produce better rainfall maps. If for example you have an image of altitude for Afghanistan with a file name of this image is being DemGL_20.afg. The image can be displayed in Windisp using the **File – Open – Image** function.

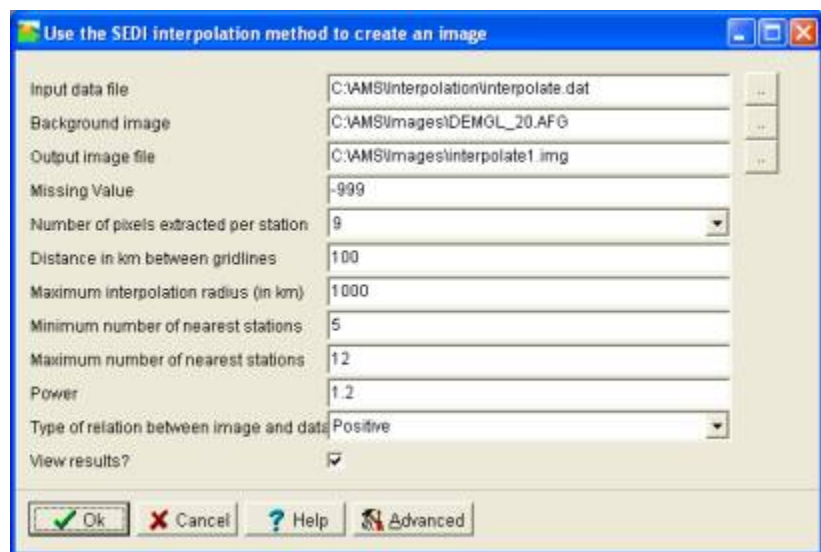
The altitude map can now be used to interpolate rainfall for a particular dekad using the "**SEDI – inverse distance**" method. First, export the data from the database to an ASCII file in exactly the same way as you did in the previous paragraph. The file contains rainfall for the first dekad of December 2003.

Then Start the "**Interpolate – SEDI – Inverse distance**"

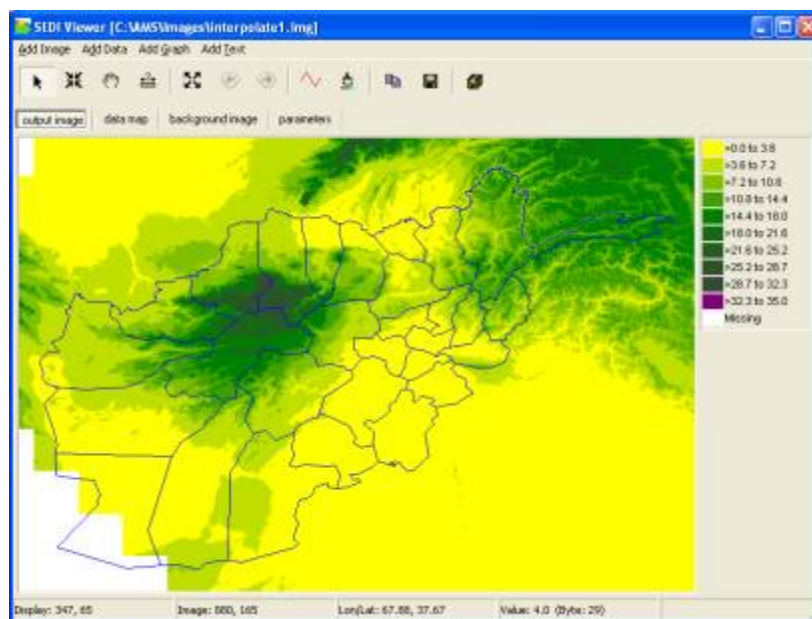
function. Fill the screen according to your needs (it is probably best to accept most defaults and refine later).



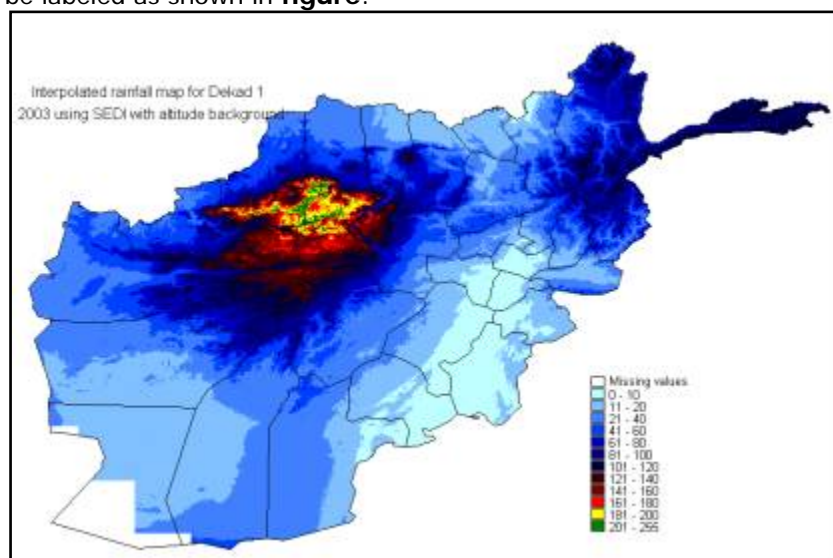
Press  **Ok** MS now displays interpolated rainfall for the first dekad of December 2003:



The details of all settings will not be explained here. The created image is compatible with Windisp.



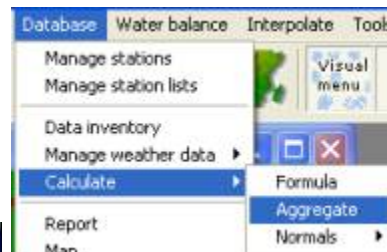
After that you can now view the map in Windisp using a new colour table and create a nice map for input into a bulletin. The map can then be labeled as shown in **figure**:



Making an interpolated image with data for a whole season

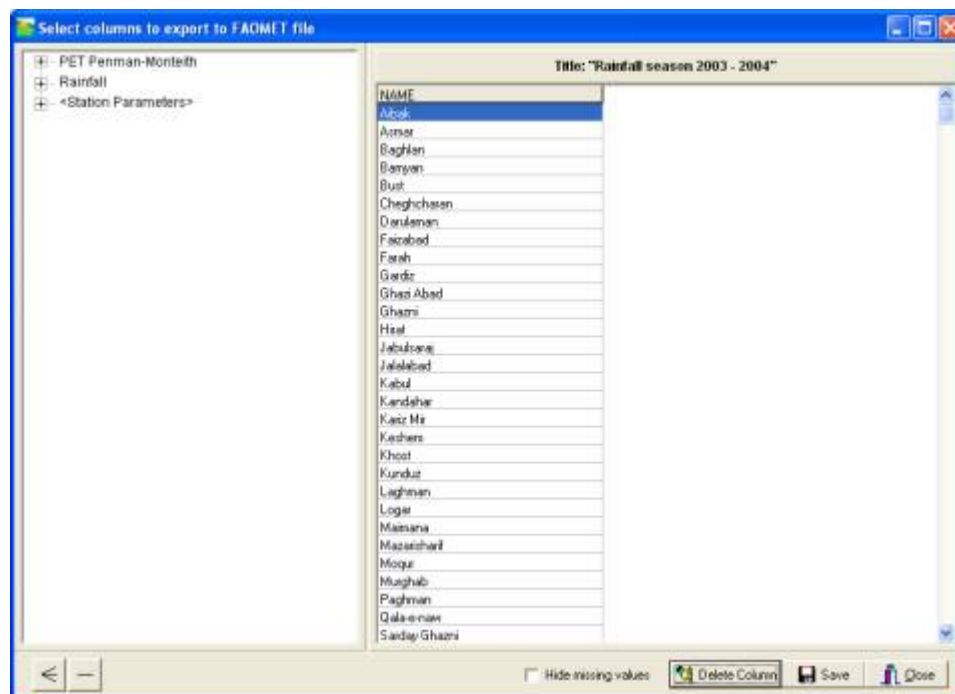
The AMS option you used previously to make the input data file for the SEDI image ("**Interpolate – Make input file – Database**") will not provide accumulated rainfall for a whole season. To have less work in Excel you first aggregate the dekadal values to monthly using the AMS function "**Database – Calculate – Aggregate**".

First you do this for 2003 and then again for 2004.

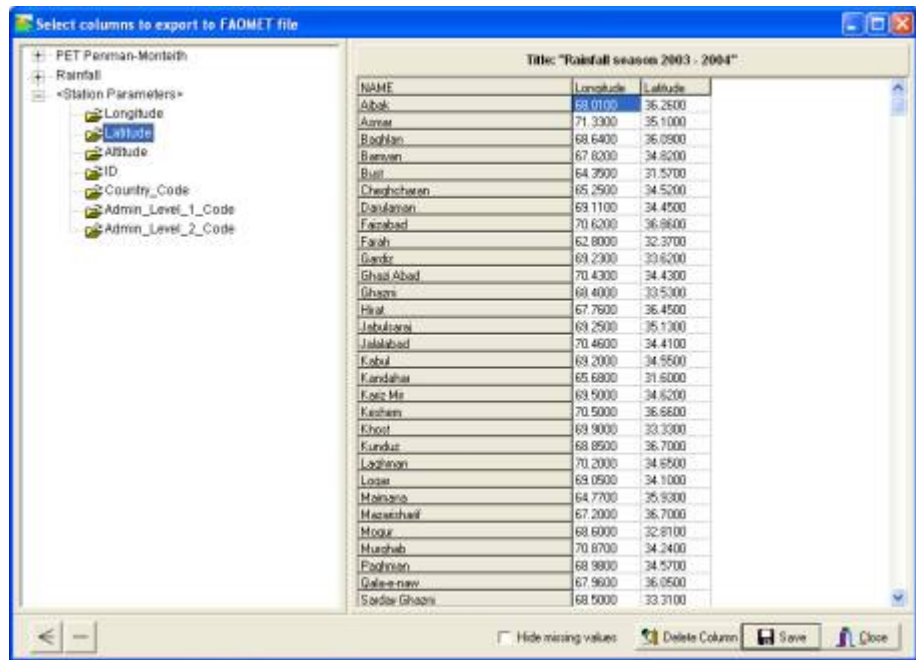


To make such a SEDI input file you need Excel.

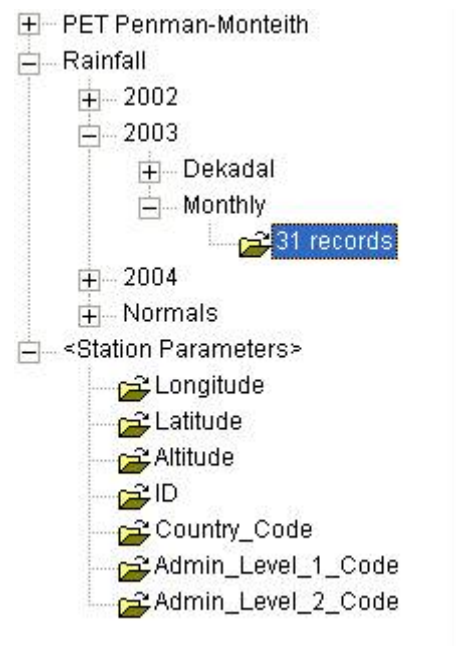
First you export the data from AMS to ASCII using the "**Tools-Make input file from database**" function. This ASCII file will be imported into Excel. You will export columns for all monthly rainfall values from September 2003 up to January 2004. You see the following screen:



First you have to add the longitude and the latitude. Double click on "**Station parameters**" and add longitude and latitude:



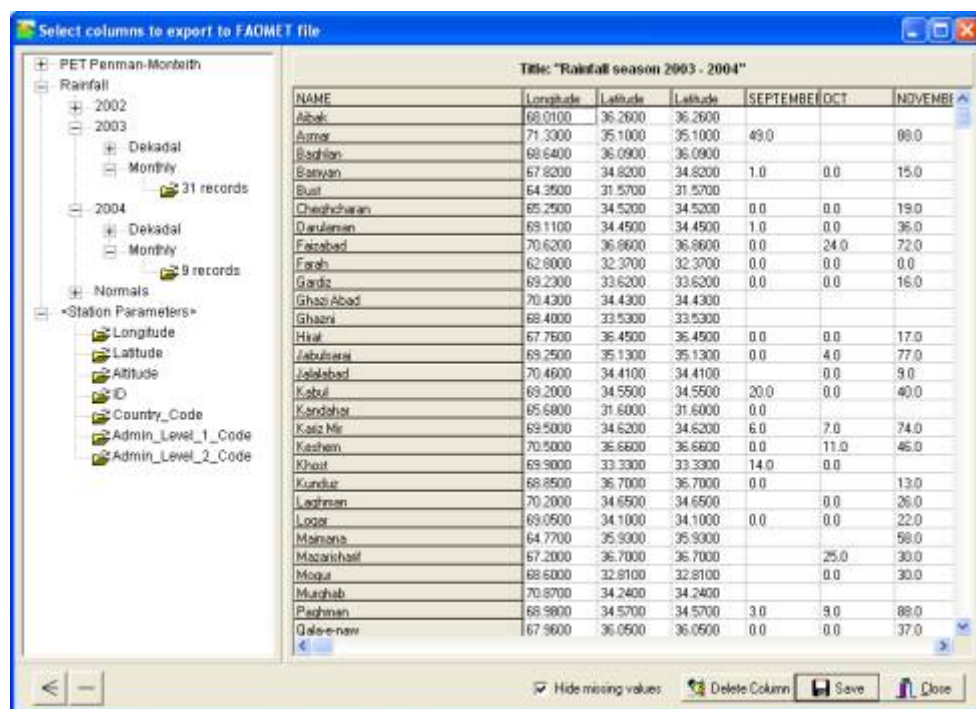
Now add rainfall data for all the months in the season. First double-click the right part of the tree on the left side:



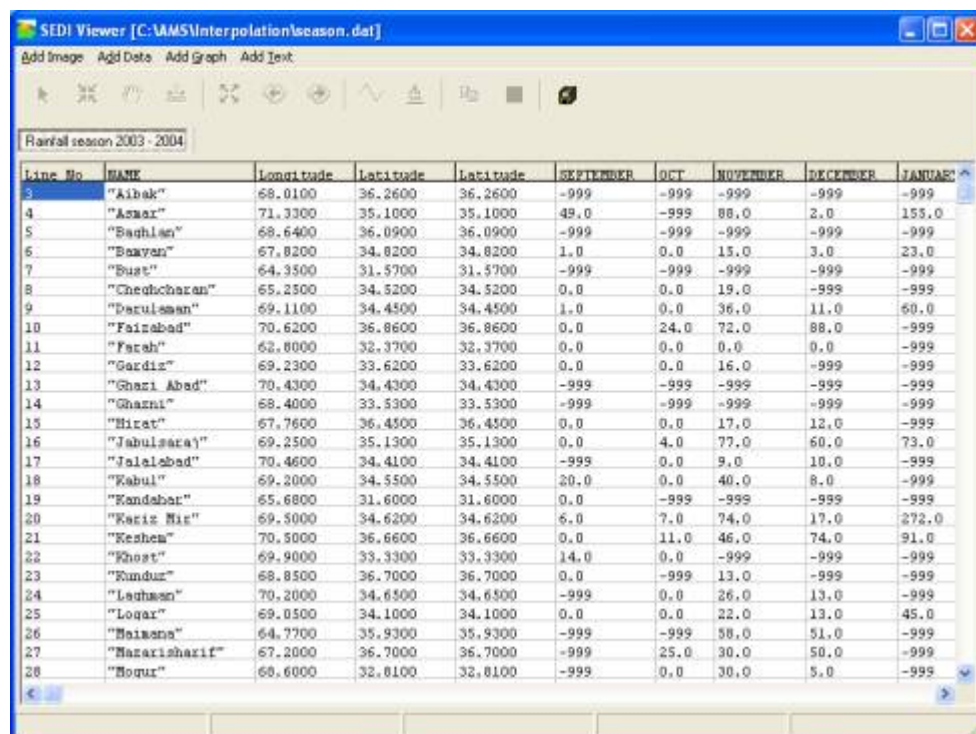
Then specify which month column to add and which appropriate title to use as a heading:



In the same way you add all 5 monthly columns for 2003 and 2004 until you have the following screen:



Press "Save" and the output file is shown in the AMS viewer:



Exit AMS and open Excel with the file you just produced. In Excel use "File-Open". The following screen is presented:

Press "**Next**".
Specify "**Comma**"

Text Import Wizard - Step 1 of 3

The Text Wizard has determined that your data is Delimited.
If this is correct, choose Next, or choose the data type that best describes your data.

Original data type
Choose the file type that best describes your data:

☒ Delimited - Characters such as commas or tabs separate each field.
☐ Fixed width - Fields are aligned in columns with spaces between each field.

Start import at row: File origin:

Preview of file C:\AMS\Interpolation\season.dat.

1	"Rainfall season 2003 - 2004"
2	"NAME", "Longitude", "Latitude", "Latitude", "SEPTEMBER", "OCT", "NOV"
3	"Aibak", 68.0100, 36.2600, 36.2600, -999, -999, -999, -999, -999, -999, -
4	"Asmar", 71.3300, 35.1000, 35.1000, 49.0, -999, 88.0, 2.0, 155.0, -999, -
5	"Baghlan", 68.6400, 36.0900, 36.0900, -999, -999, -999, -999, -999, -999

Cancel < Back Next > Finish

Press "**Finish**"...

Text Import Wizard - Step 2 of 3

This screen lets you set the delimiters your data contains. You can see how your text is affected in the preview below.

Delimiters
☒ Tab ☐ Semicolon ☒ Comma
☐ Space ☐ Other:

☐ Treat consecutive delimiters as one

Text qualifier:

Data preview

Rainfall season 2003 - 2004				
NAME	Longitude	Latitude	Latitude	SEPTEMBER
Aibak	68.0100	36.2600	36.2600	-999
Asmar	71.3300	35.1000	35.1000	49.0
Baghlan	68.6400	36.0900	36.0900	-999

Cancel < Back Next > Finish

The following screen is presented in Excel as shown in figure.

NAME	Longitude	Latitude	SEPTEME	OCT	NOVEMBE	DECEMBE	JANUARY
Asmar	71.33	35.1	49	-999	88	2	155
Bamyan	67.82	34.82	1	0	15	3	23
Darulaman	69.11	34.45	1	0	36	11	60
Jabulsaraj	69.25	35.13	0	4	77	60	73
Kariz Mir	69.5	34.62	6	7	74	17	272
Keshem	70.5	36.66	0	11	46	74	91
Logar	69.05	34.1	0	0	22	13	45
Paghman	68.98	34.57	3	9	88	16	128
Sarobi	68.15	34.57	0	4	28	13	35

First remove all stations with missing values (you cannot calculate totals for those). Create a new column at the end of the data range and calculate the totals. The following file should remain.

Finally you remove some columns, because you no longer need them. Beware: Column I contains formulas, not values. Column I would fail if you would remove column D-G. Therefore, first

	A	B	C	D	E	F	G	H	I
1	Rainfall season 2003 - 2004								
2	NAME	Longitude	Latitude	SEPTEME	OCT	NOVEMBE	DECEMBE	JANUARY	Total
3	Asmar	71.33	35.1	49	0	88	2	155	294
4	Bamyan	67.82	34.82	1	0	15	3	23	42
5	Darulaman	69.11	34.45	1	0	36	11	60	108
6	Jabulsaraj	69.25	35.13	0	4	77	60	73	214
7	Kariz Mir	69.5	34.62	6	7	74	17	272	376
8	Keshem	70.5	36.66	0	11	46	74	91	222
9	Logar	69.05	34.1	0	0	22	13	45	80
10	Paghman	68.98	34.57	3	9	88	16	128	244
11	Sarobi	68.15	34.57	0	4	28	13	35	80

make values in column I. Do this by selecting column I and press Ctrl-C. Then go to the menu-item "**Edit-Paste Special**" and set the settings as follows:

Now remove the name column and the monthly data columns as well as the title until you have the following structure:

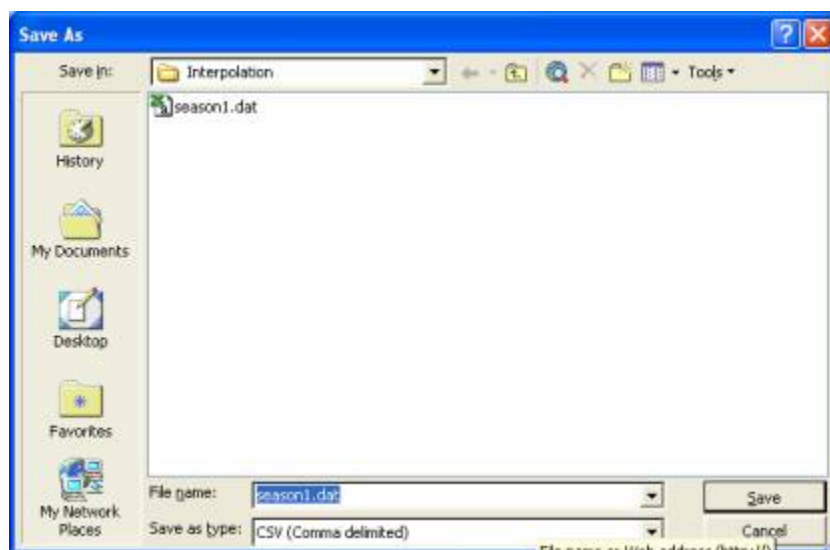
	A	B	C
1	71.33	35.1	294
2	67.82	34.82	42
3	69.11	34.45	108
4	69.25	35.13	214
5	69.5	34.62	376
6	70.5	36.66	222
7	69.05	34.1	80
8	68.98	34.57	244
9	68.15	34.57	80

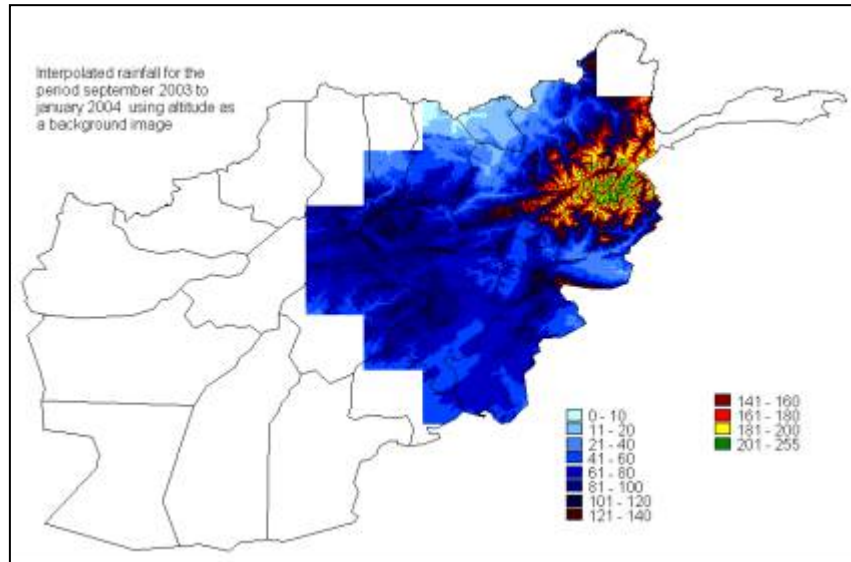


Column A now represents the longitude, B the latitude and C the seasonal total. Save this worksheet to a comma delimited CSV file using "**File-Save as**" with the following settings:

The input file for the interpolation is now ready. Please proceed in the same way as the previous paragraph.

Due to the lack of data, estimates are not produced for a large part of the country. The final map produced looks like this:





From Water Balance results to yields

For Afghanistan the following steps should be taken to run the water balance as part of a crop forecasting activity:

As a separate preparing activity you calculate the water balances for every year in history for which you have sufficient data, calculate the index and establish a relationship between the index and the yield data obtained from the crop assessment missions and the National Statistical Office.

Then for the running season you do the following:

1. For every station in the network, establish the crops to be monitored. In Afghanistan the crops are wheat, rice and perhaps maize and barley.
2. For every station in the network establish early, average and late planting dates and corresponding cycle lengths.
3. Make separate monitoring runs for 2 crops and 3 planting dates, so in this case 6 runs.
4. Throughout the season re-calculate the water balance whenever new data are received. The water balance always calculates the predicted final index.

How to analyze data that have a different geographical format

Basically data come to crop forecasting officers in three different ways:

1. As **point data** (usually by stations). E.G. Rainfall data and other parameters (temperatures etc..) reach Kabul is this way from the field stations. The data from ISPRA are in tabular form as well...
2. By **province** or **district** (technically called polygon data). Yield data are an example of this type of data.
3. By **image** (technically called raster or grid data). As an example: you have images for NDVI, you have an altitude image, you have created images with AMS (e.g. SEDI)

Now, you can only analyze and integrate datasets if the data are in same geographical format. So, if you want to analyze your data, select one of the three basic formats described above. The following paragraphs are an overview of these three data formats and how to get the data from other formats into the right geographic format.

Analyzing information on station level

Station data are easy to work with. You enter the in AMS and you can use AMS, Windisp and Excel to analyze the data. You can present the station data on a map using Windisp, AMS or ArcView. The disadvantage of working with station data is the lack of overview. There is no approximation of the parameters for areas in between the stations. However, you could work with station data as long as the analysis takes place and convert the station data into images for presentation of the results and an estimation of "what happens" in between the stations.

If you have **data by province or district** you can convert them into point data as follows:

1. Assign values to districts and provinces. Make an image of the province/districts data with the AMS function "*Tools – Assign Image Values Within Boundaries*"
2. Extract values for your stations into the database with the AMS function "*Database – Import - From image*". If the parameter does not exist in the database, you will have to define a new parameter in AMS using the "*Database – Configure – Parameter Definitions*" function.
3. If you want to do an analysis in Excel, export the data using the AMS function "*Tools – Make input file from database*" or the "*Database – Report*" function.

If you have data **by image** you essentially do the same:

1. Take the image and extract values for your stations into the database with the AMS function using the function "*Database – Import - From image*". Again, if the parameter does not exist in the database, you will have to define a new parameter in AMS.
2. If you want to do an analysis in Excel, export the data using the AMS function "*Tools – Make input file from database*" or the "*Database – Report*" function.

Analyzing information on province/district level (area averaging)

For the analysis of this type of data you use AMS, Windisp and Excel. ArcView is another possibility. ArcView essentially uses this type of information (polygonal). So, if you plan to work with ArcView this is probably the preferred geographical format to bring your data in.

If you have **station data** and you have to aggregate them to provinces and districts, you do the following:

1. Make an image of the point data using any of the functions in the AMS "*Interpolate*" menu. You might want to use "*Interpolate – Inverse distance*" or (if you have a background field related to the parameter) you can use the SEDI functions.
2. Extract average values for the districts by using the Windisp function Process – Stats – Average. This will create an ASCII file with averaged values for your parameter by district/province.
3. Now you can use your data in Excel next to other data on province district level. If you are an expert in ArcView you might join the ASCII table to an ArcView shape file.

If you have **images** you essentially do this:

1. Extract average values for the districts by using the Windisp function Process – Stats – Average. This will create an ASCII file with averaged values for your parameter by district/province.

Analyzing information on image level

Analyzing information on this level has the advantage that all your (intermediate) products are highly graphical and show a country-wide picture. A disadvantage is that the information uses more hard disk space. However, the affordable huge hard disks of today make this disadvantage less important.

If you have **station data** you can make images in just 1 step:

1. Make an image of the point data using any of the functions in the AMS "*Interpolate*" menu. You might want to use "*Interpolate – Inverse distance*" or (if you have a background field related to the parameter) you can use the SEDI functions.

If you have **data by province or district** you can convert them into images with just one step:

1. Assign values to districts and provinces. Make an image of the province/districts data with the AMS function "*Tools – Assign Image Values Within Boundaries*"

Working with images is not restricted to display only. Images can be subjected to adding, subtracting and every possible other mathematical operation using the "*Tools – Image calculations with formula*" function:



