



## Appendix 1: Examples of input data files

### 1) Irrigation water use

#### 1.1) Precipitation: daily values of one year per municipality

data type: daily values of precipitation for 1999

data source: WAVES working group at PIK

| municipality | year | day of year | rain [mm/day] |
|--------------|------|-------------|---------------|
| 1999         |      |             |               |
| 1            | 1999 | 1           | 3.711         |
| 1            | 1999 | 2           | 3.711         |
| 1            | 1999 | 3           | 3.711         |
| ...          | ...  | ...         | ...           |
| 1            | 1999 | 363         | 1.727         |
| 1            | 1999 | 364         | 1.727         |
| 1            | 1999 | 365         | 1.727         |
| 2            | 1999 | 1           | 2.991         |
| 2            | 1999 | 2           | 2.991         |
| 2            | 1999 | 3           | 2.991         |
| ...          | ...  | ...         | ...           |
| 332          | 1999 | 363         | 2.650         |
| 332          | 1999 | 364         | 2.650         |
| 332          | 1999 | 365         | 2.650         |

#### 1.2) Potential evapotranspiration: daily values of one year per municipality

data type: daily values of potential evapotranspiration for 1999

data source: WAVES working group at PIK

| municipality | year | day of year | petp [mm/day] |
|--------------|------|-------------|---------------|
| 1999         |      |             |               |
| 1            | 1999 | 1           | 5.039         |
| 1            | 1999 | 2           | 5.039         |
| 1            | 1999 | 3           | 5.039         |
| ...          | ...  | ...         | ...           |
| 1            | 1999 | 363         | 4.645         |
| 1            | 1999 | 364         | 4.645         |
| 1            | 1999 | 365         | 4.645         |
| 2            | 1999 | 1           | 5.142         |
| 2            | 1999 | 2           | 5.142         |
| 2            | 1999 | 3           | 5.142         |
| ...          | ...  | ...         | ...           |
| 332          | 1999 | 363         | 5.477         |
| 332          | 1999 | 364         | 5.477         |
| 332          | 1999 | 365         | 5.477         |



### 1.3) Planting dates, growing periods and crop coefficients of irrigated crops according to the FAO method

data type: planting dates, growing periods and crop coefficients of irrigated crops:  
1 banana, 2 beans, 3 cotton, 4 fruit trees, 5 grass, 6 maize, 7 rice, 8 sugar cane, 9 vegetables  
data source: FAO (1992): CROPWAT. FAO Irrigation and Drainage Paper, Vol. 46, Rome.

| crop | plantating dates [day of year] | length period 1 [days] | length period 2 [days] | length period 3 [days] | length period 4 [days] | kc 1 | kc 2 | kc 3 | kc 4 | kc 5 | kc 6 |
|------|--------------------------------|------------------------|------------------------|------------------------|------------------------|------|------|------|------|------|------|
| 1    | 1                              | 90                     | 90                     | 90                     | 90                     | 0    | 0.40 | 0    | 1.15 | 0.40 | 0    |
| 2    | 20                             | 20                     | 30                     | 30                     | 10                     | 0    | 0.35 | 0    | 1.15 | 0.70 | 0    |
| 3    | 51                             | 30                     | 50                     | 55                     | 45                     | 0    | 0.40 | 0    | 1.15 | 0.65 | 0    |
| 4    | 1                              | 60                     | 90                     | 90                     | 120                    | 0    | 0.75 | 0    | 0.65 | 0.75 | 0    |
| 5    | 1                              | 90                     | 90                     | 90                     | 90                     | 0    | 1.00 | 0    | 1.00 | 1.00 | 0    |
| 6    | 20                             | 25                     | 35                     | 40                     | 30                     | 0    | 0.45 | 0    | 1.10 | 0.55 | 0    |
| 7    | 20                             | 30                     | 20                     | 20                     | 30                     | 0    | 1.20 | 0    | 1.00 | 1.05 | 0    |
| 8    | 1                              | 90                     | 90                     | 90                     | 90                     | 0    | 0.95 | 0    | 0.95 | 0.95 | 0    |
| 9    | 152                            | 30                     | 40                     | 45                     | 30                     | 0    | 0.70 | 0    | 1.10 | 0.60 | 0    |

kc 1 and kc 6 are dummy values necessary for internal calculation. kc 2 to kc 4 are the values taken from FAO (1992). NoWUM calculates kc 3 by linearly interpolating between kc 2 and kc 4 over the length of growing period 2.

### 1.4) Irrigated areas per crop per year per municipality

data type: Total irrigated area and irrigated area per crop per municipality  
data source: IBGE(1998): Censo Agropecuario 1995/96. DNOCS internal reports 1995-1997. self-calculation

| Muni | total irrigated area [ha] | banana [ha] | beans [ha] | cotton [ha] | fruit trees [ha] | grass [ha] | maize [ha] | rice [ha] | sugar cane [ha] | vegetables [ha] |
|------|---------------------------|-------------|------------|-------------|------------------|------------|------------|-----------|-----------------|-----------------|
| 1    | 107                       | 1.6         | 41.1       | 0.0         | 4.6              | 17.1       | 31.2       | 8.2       | 2.6             | 0.6             |
| 2    | 638                       | 46.7        | 50.8       | 0.0         | 42.1             | 102.1      | 31.3       | 68.9      | 282.9           | 13.3            |
| 3    | 22                        | 0.3         | 2.5        | 0.0         | 14.7             | 3.5        | 0.8        | 0.0       | 0.0             | 0.2             |
| ...  |                           |             |            |             |                  |            |            |           |                 |                 |
| 330  | 181                       | 1.4         | 63.9       | 0.0         | 4.5              | 6.3        | 51.9       | 39.5      | 2.9             | 10.5            |
| 331  | 0                         | 0.0         | 0.0        | 0.0         | 0.0              | 0.0        | 0.0        | 0.0       | 0.0             | 0.0             |
| 332  | 8                         | 0.1         | 0.3        | 0.0         | 0.0              | 0.3        | 1.6        | 5.4       | 0.0             | 0.2             |

## 2) Livestock water use

### 2.1) Numbers of livestock species per year per municipality

data type: Amount of animals per species (here poultry include chicken and quails) per municipality  
data source: IBGE (1998): Censo Agropecuário No. 8 Piauí und No. 9 Ceará (data of 1996)

| Muni | cows  | pigs | horses | donkeys | mulesI | mulesII | rabbits | sheep | goats | chickens | poultry | quails |
|------|-------|------|--------|---------|--------|---------|---------|-------|-------|----------|---------|--------|
| 1    | 5132  | 461  | 175    | 111     | 305    | 0       | 0       | 213   | 190   | 0        | 14750   | 0      |
| 2    | 2065  | 93   | 101    | 23      | 125    | 0       | 0       | 309   | 54    | 0        | 1055    | 0      |
| 3    | 11016 | 7676 | 853    | 720     | 373    | 0       | 8       | 6059  | 1820  | 0        | 83730   | 0      |
| ...  |       |      |        |         |        |         |         |       |       |          |         |        |
| 331  | 2968  | 3994 | 601    | 866     | 105    | 0       | 0       | 4532  | 10607 | 0        | 15647   | 0      |
| 332  | 3604  | 7273 | 181    | 884     | 111    | 0       | 0       | 1967  | 6198  | 0        | 23188   | 0      |



### 3) Domestic water use

#### 3.1) Total population per month per municipality

data type: Total population per month 1997; calculated with population growth rates given by CAGECE and AGESPISA from IBGE data, target day 01-08-96

data source: IBGE [1997]: Contagem da População 1996;  
Internal reports of AGESPISA, and CAGECE [1998]

| Muni | Jan97 | Feb97 | Mar97 | Apr97 | May97 | Jun97 | Jul97 | Aug97 | Sep97 | Oct97 | Nov97 | Dec97 |
|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1    | 7542  | 7553  | 7564  | 7574  | 7585  | 7596  | 7607  | 7618  | 7628  | 7639  | 7650  | 7661  |
| 2    | 11001 | 11009 | 11017 | 11024 | 11032 | 11040 | 11048 | 11056 | 11064 | 11071 | 11079 | 11087 |
| 3    | 45921 | 46037 | 46154 | 46272 | 46389 | 46507 | 46625 | 46743 | 46862 | 46981 | 47101 | 47220 |
| ...  |       |       |       |       |       |       |       |       |       |       |       |       |
| 331  | 4422  | 4422  | 4422  | 4422  | 4422  | 4422  | 4422  | 4422  | 4422  | 4422  | 4422  | 4422  |
| 332  | 7969  | 7987  | 8004  | 8022  | 8040  | 8058  | 8076  | 8094  | 8112  | 8130  | 8148  | 8166  |

#### 3.2) Supplied population per month per municipality

data type: Total number of connections to water supply system [-]

data source: AGESPISA (1997) - Boletim Estatístico Mensal 01/97-12/97 CAGECE FNS

| Muni | Jan97 | Feb97 | Mar97 | Apr97 | Mai97 | Jun97 | Jul97 | Aug97 | Sep97 | Oct97 | Nov97 | Dec97 |
|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1    | 1478  | 1465  | 1490  | 1495  | 1499  | 1482  | 1499  | 1516  | 1499  | 1499  | 1499  | 1503  |
| 2    | 3107  | 3138  | 3134  | 3134  | 3138  | 3134  | 3235  | 3505  | 3532  | 3532  | 3523  | 3567  |
| 3    | 3060  | 3135  | 3351  | 3417  | 3487  | 3516  | 3567  | 3586  | 3563  | 3577  | 3530  | 3628  |
| ...  |       |       |       |       |       |       |       |       |       |       |       |       |
| 331  | -9999 | -9999 | -9999 | -9999 | -9999 | -9999 | -9999 | -9999 | -9999 | -9999 | -9999 | -9999 |
| 332  | 2486  | 2497  | 2509  | 2509  | 2517  | 2521  | 2536  | 2543  | 2548  | 2554  | 2560  | 2565  |

-9999: missing value

#### 3.3) Billed water volume in public water supply system per month per municipality

data type: Monthly billed water volume [m<sup>3</sup>] pwer municipality

data source: AGESPISA (1997) - Boletim Estatístico Mensal 01/97-12/97,  
CAGECE (1997): Internal reports, FNS (1997): Internal reports

| Muni | Jan97 | Feb97 | Mar97 | Apr97 | May97 | Jun97 | Jul97 | Aug97 | Sep97 | Oct 97 | Nov97 | Dec97 |
|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|-------|-------|
| 1    | 5603  | 5509  | 5555  | 5603  | 5642  | 5570  | 5562  | 5677  | 5702  | 5718   | 5718  | 5718  |
| 2    | 13601 | 14559 | 13546 | 13284 | 13152 | 12410 | 13512 | 15982 | 17026 | 16438  | 18007 | 18538 |
| 3    | 13490 | 13671 | 13371 | 14149 | 14438 | 13161 | 15453 | 15905 | 15327 | 15464  | 16765 | 15199 |
| ...  |       |       |       |       |       |       |       |       |       |        |       |       |
| 331  | -9999 | -9999 | -9999 | -9999 | -9999 | -9999 | -9999 | -9999 | -9999 | -9999  | -9999 | -9999 |
| 332  | 6221  | 5583  | 5471  | 4743  | 5414  | 5876  | 5836  | 6318  | 5873  | 6086   | 6604  | 5520  |

-9999: missing value

#### 3.4) Water use efficiency of public water supply system per municipality

data type: efficiency of domestic sector

data source: USGS 1998

| Muni | efficiency [-] |
|------|----------------|
| 1    | 0.2            |
| 2    | 0.2            |
| 3    | 0.2            |
| ...  |                |
| 332  | 0.2            |



## Appendix 2: Examples of output data files

### 1) Total withdrawal water use of all sectors per month per municipality

NoWUM output file \*\*\* Total Withdrawal Use [m3/month] per municipality \*\*\*

| Muni | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec    |
|------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 1    | 27381  | 25515  | 25569  | 25592  | 28610  | 28399  | 29265  | 31019  | 31930  | 32507  | 30818  | 29775  |
| 2    | 78935  | 29177  | 29179  | 29190  | 29212  | 46137  | 103525 | 155460 | 160112 | 165630 | 158378 | 140341 |
| 3    | 109863 | 108277 | 105641 | 109334 | 109685 | 106521 | 110821 | 113003 | 114134 | 115327 | 115292 | 115282 |

### 2) Total consumptive water use of all sectors per month per municipality

NoWUM Output file \*\*\* Total Consumptive Use [m3/month] per municipality \*\*\*

| Muni | Jan   | Feb   | Mar   | Apr   | Mai   | Jun   | Jul   | Aug   | Sep   | Oct   | Nov   | Dec   |
|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1    | 12029 | 11097 | 11108 | 11112 | 12615 | 12512 | 12932 | 13797 | 14255 | 14539 | 13689 | 13161 |
| 2    | 33150 | 8245  | 8245  | 8247  | 8252  | 17654 | 45328 | 71090 | 73392 | 76148 | 71468 | 62400 |
| 3    | 38249 | 37347 | 36820 | 37559 | 37629 | 37027 | 38031 | 39055 | 39584 | 40116 | 40080 | 39948 |

### 3) Withdrawal water use of irrigation per month per municipality

NoWUM output file \*\*\* Irrigation Withdrawal water use [m3/month] and municipality \*\*\*

| Muni | Jan   | Feb | Mar | Apr | Mai  | Jun   | Jul   | Aug    | Sep    | Oct    | Nov    | Dec    |
|------|-------|-----|-----|-----|------|-------|-------|--------|--------|--------|--------|--------|
| 1    | 1863  | 0   | 0   | 0   | 2996 | 2794  | 3618  | 5330   | 6251   | 6812   | 5106   | 4041   |
| 2    | 49847 | 0   | 0   | 0   | 0    | 20057 | 74047 | 125295 | 129868 | 135375 | 124611 | 106408 |
| 3    | 1947  | 0   | 0   | 0   | 0    | 102   | 582   | 2540   | 3550   | 4529   | 4431   | 3998   |

### 4) Consumptive water use of irrigation per month per municipality

NoWUM output file \*\*\* Irrigation Consumptive water use [m3/month] and municipality \*\*\*

| Muni | Jan   | Feb | Mar | Apr | Mai  | Jun   | Jul   | Aug   | Sep   | Oct   | Nov   | Dec   |
|------|-------|-----|-----|-----|------|-------|-------|-------|-------|-------|-------|-------|
| 1    | 932   | 0   | 0   | 0   | 1498 | 1397  | 1809  | 2665  | 3126  | 3406  | 2553  | 2020  |
| 2    | 24924 | 0   | 0   | 0   | 0    | 10028 | 37023 | 62647 | 64934 | 67687 | 62305 | 53204 |
| 3    | 974   | 0   | 0   | 0   | 0    | 51    | 291   | 1270  | 1775  | 2265  | 2216  | 1999  |

### 5) Withdrawal water use of livestock per month per municipality

NoWUM output file \*\*\* Withdrawal water use [m3/month\*spec], [m3/month], [m3/year] per municipality \*\*\*

| Muni | cows   | pigs  | horses | donke | muleI | muleII | rabbits | sheeps | goats | chicke | poultr | quails | wd_ total | wd_ month |
|------|--------|-------|--------|-------|-------|--------|---------|--------|-------|--------|--------|--------|-----------|-----------|
| 1    | 127376 | 1851  | 3481   | 2208  | 6067  | 0      | 0       | 661    | 590   | 0      | 1622   | 0      | 143857    | 11988     |
| 2    | 51253  | 373   | 2009   | 458   | 2487  | 0      | 0       | 959    | 168   | 0      | 116    | 0      | 57822     | 4819      |
| 3    | 273417 | 30819 | 16969  | 14323 | 7420  | 0      | 1       | 18801  | 5647  | 0      |        |        |           |           |

### 6) Consumptive water use of livestock per month per municipality

NoWUM output file \*\*\* Consumptive water use [m3/month\*spec], [m3/month], [m3/year] per municipality \*\*\*

| Muni | cows   | pigs  | horses | donke | mulesI | mulesI I | rabbits | sheeps | goats | chicke | poultr | quails | con_ total | con_ month |
|------|--------|-------|--------|-------|--------|----------|---------|--------|-------|--------|--------|--------|------------|------------|
| 1    | 89163  | 1296  | 2437   | 1546  | 4247   | 0        | 0       | 463    | 413   | 0      | 1136   | 0      | 100700     | 8392       |
| 2    | 35877  | 261   | 1406   | 320   | 1741   | 0        | 0       | 671    | 117   | 0      | 81     | 0      | 40476      | 3373       |
| 3    | 191392 | 21573 | 11878  | 10026 | 5194   | 0        | 1       | 13161  | 3953  | 0      |        |        |            |            |



### 7) Withdrawal water use of domestic sector per month per municipality

NoWUM output file \*\*\* Withdrawal water use of domestic sector [m3/month] and municipality \*\*\*

| Muni | Jan   | Feb   | Mar   | Apr   | Mai   | Jun   | Jul   | Aug   | Sep   | Oct   | Nov   | Dec   |
|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1    | 13530 | 13527 | 13581 | 13604 | 13626 | 13617 | 13659 | 13701 | 13690 | 13707 | 13724 | 13746 |
| 2    | 24269 | 24358 | 24360 | 24371 | 24393 | 21261 | 24660 | 25346 | 25426 | 25436 | 28949 | 29115 |
| 3    | 76532 | 76893 | 74258 | 77950 | 78301 | 75034 | 78855 | 79080 | 79200 | 79414 | 79476 | 79900 |

### 8) Consumptive water use of domestic sector per month per municipality

NoWUM output file \*\*\* Consumptive water use of domestic sector [m3/month] and municipality \*\*\*

| Muni | Jan   | Feb   | Mar   | Apr   | Mai   | Jun   | Jul   | Aug   | Sep   | Oct   | Nov   | Dec   |
|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1    | 2706  | 2705  | 2716  | 2721  | 2725  | 2723  | 2732  | 2740  | 2738  | 2741  | 2745  | 2749  |
| 2    | 4854  | 4872  | 4872  | 4874  | 4879  | 4252  | 4932  | 5069  | 5085  | 5087  | 5790  | 5823  |
| 3    | 15306 | 15379 | 14852 | 15590 | 15660 | 15007 | 15771 | 15816 | 15840 | 15883 | 15895 | 15980 |