

Appendix K *Data sources for irrigated crops (harvested area and crop calendars)*

This Appendix (only contained in electronic form) documents the data sources for harvested area and the cropping periods of the crop calendars for irrigated crops of the 402 spatial units (or entities). The units are listed in alphabetical order, grouped by continents. For consistency, the naming in this appendix follows the current United Nations (UN) standard names of Appendix F that are also used in Appendices B, D, and I (United Nations Statistics Division (2010), *Standard Country and Area Codes. Composition of macro geographical (continental) regions, geographical sub-regions, and selected economic and other groupings*, New York, NY, United States of America, <http://unstats.un.org/unsd/methods/m49/m49regin.htm>).

It is a revised version of Annex C in Frankfurt Hydrology Paper 06 (*Global dataset of monthly growing areas of 26 irrigated crops. Version 1.0*, Frankfurt Hydrology Paper (06), Frankfurt am Main, http://www.geo.uni-frankfurt.de/fb/fb11/ipg/ag/dl/f_publicationen/2008/FHP_06_Portmann_et_al_2008.pdf). The revision concerned especially:

1. New naming according to UN current standard,
2. Extended crop-specific mentioning of data sources for each unit (called entity in FHP 06),
3. Listing of units without irrigation,
4. Correction of errors,
5. Homogenization of styles of tables with main text,
6. Introduction of table of contents and list of tables.

For technical reasons, the bibliographic references were retained in their original format and content.

Contents

Contents	2
List of tables	7
AFRICA	8
Algeria	8
Angola	8
Benin	9
Botswana	9
Burkina Faso	10
Burundi	10
Cameroon	11
Cape Verde	11
Central African Republic	12
Chad	12
Comoros	12
Congo	13
Democratic Republic of the Congo	13
Côte d’Ivoire	13
Djibouti	14
Egypt	14
Equatorial Guinea	15
Eritrea	15
Ethiopia	15
Gabon	16
Gambia	16
Ghana	17
Guinea	17
Guinea-Bissau	17
Kenya	18
Lesotho	18
Liberia	19
Libyan Arab Jamahiriya	19
Madagascar	20
Malawi	20
Mali	20
Mauritania	21
Mauritius	22
Mayotte	22
Morocco	22
Mozambique	23
Namibia	23
Niger	24
Nigeria	24
Réunion	25
Rwanda	25
Saint Helena	26
Sao Tome and Principe	26

Senegal.....	26
Seychelles.....	27
Sierra Leone.....	27
Somalia.....	27
South Africa.....	28
Sudan.....	29
Swaziland.....	29
Togo.....	30
Tunisia.....	30
Uganda.....	31
United Republic of Tanzania.....	31
Western Sahara.....	31
Zambia.....	32
Zimbabwe.....	32
AMERICA.....	33
Anguilla.....	33
Antigua and Barbuda.....	33
Argentina.....	33
Aruba.....	36
Bahamas.....	36
Barbados.....	36
Belize.....	36
Bermudas.....	36
Bolivia (Plurinational State of).....	37
Brazil.....	37
British Virgin Islands.....	40
Cayman Islands.....	40
Canada.....	41
Chile.....	41
Colombia.....	42
Costa Rica.....	42
Cuba.....	43
Dominica.....	43
Dominican Republic.....	43
Ecuador.....	44
El Salvador.....	44
Falkland Islands (Malvinas).....	44
French Guiana.....	45
Grenada.....	45
Guadeloupe.....	46
Guatemala.....	46
Guyana.....	47
Haiti.....	47
Honduras.....	48
Jamaica.....	48
Martinique.....	48
Montserrat.....	49
Mexico.....	49
Netherlands Antilles.....	50
Nicaragua.....	50

Panama.....	50
Paraguay.....	51
Peru.....	51
Puerto Rico.....	51
Saint Kitts and Nevis.....	52
Saint Lucia.....	52
Saint Pierre and Miquelon.....	52
Saint Vincent and the Grenadines.....	52
Suriname.....	53
Trinidad and Tobago.....	53
Turks and Caicos Islands.....	53
United States of America.....	53
United States Virgin Islands.....	54
Uruguay.....	57
Venezuela (Bolivarian Republic of).....	57
ASIA.....	58
Afghanistan.....	58
Armenia.....	58
Azerbaijan.....	59
Bahrain.....	59
Bangladesh.....	60
Bhutan.....	60
British Indian Ocean Territory.....	60
Brunei Darussalam.....	60
Cambodia.....	61
China.....	61
Christmas Island.....	64
Cocos (Keeling) Islands.....	65
Democratic People’s Republic of Korea.....	65
Georgia.....	65
India.....	65
Indonesia.....	69
Iran (Islamic Republic of).....	69
Iraq.....	70
Israel.....	70
Japan.....	71
Jordan.....	72
Kazakhstan.....	72
Kuwait.....	73
Kyrgyzstan.....	73
Lao People’s Democratic Republic.....	74
Lebanon.....	74
Macao.....	75
Malaysia.....	75
Maldives.....	75
Mongolia.....	75
Myanmar.....	76
Nepal.....	76
Occupied Palestinian Territory.....	77
Oman.....	77

Pakistan.....	78
Papua New Guinea.....	78
Philippines.....	79
Qatar.....	79
Republic of Korea.....	79
Saudi-Arabia.....	80
Singapore.....	80
Sri Lanka.....	80
Syrian Arab Republic.....	80
Taiwan, Province of China.....	81
Tajikistan.....	81
Thailand.....	82
Timor-Leste.....	82
Turkmenistan.....	83
United Arab Emirates.....	83
Uzbekistan.....	84
Viet Nam.....	85
Yemen.....	85
EUROPE.....	86
Albania.....	86
Andorra.....	86
Austria.....	87
Belarus.....	87
Belgium.....	88
Bosnia and Herzegovina.....	88
Bulgaria.....	89
Croatia.....	90
Cyprus.....	90
Czech Republic.....	92
Denmark.....	92
Estonia.....	93
Finland.....	94
France.....	94
Germany.....	95
Greece.....	96
Hungary.....	96
Iceland.....	97
Ireland.....	97
Italy.....	98
Latvia.....	99
Liechtenstein.....	99
Lithuania.....	99
Luxembourg.....	100
Malta.....	100
Monaco.....	101
Montenegro.....	101
Netherlands.....	101
Norway.....	102
Poland.....	103
Portugal.....	103

Republic of Moldova	104
Romania	105
Russian Federation	106
San Marino	106
Serbia (including Kosovo)	107
Slovakia	108
Slovenia	109
Spain	109
Svalbard and Jan Mayen Islands	110
Sweden	110
Switzerland	111
The former Yugoslav Republic of Macedonia	112
Turkey	112
Ukraine	113
United Kingdom of Great Britain and Northern Ireland	114
OCEANIA	115
American Samoa	115
Australia	115
Cook Islands	116
Fiji	117
French Polynesia	117
Guam	117
Kiribati	117
Marshall Islands	117
Micronesia (Federated States of)	118
Nauru	118
New Caledonia	118
New Zealand	118
Niue	118
Norfolk Island	119
Northern Mariana Islands	119
Palau	119
Pitcairn	119
Samoa	119
Solomon Islands	119
Tokelau	120
Tonga	120
Tuvalu	120
Vanuatu	120
Wallis and Futuna Islands	120
UNITS WITHOUT ATTRIBUTION TO A SPECIFIC CONTINENT	121
Small Islands	121
Antarctica, Rest of Islands	121
References	122

List of tables

Table K-1.	Spatial units of Argentina (provinces), and their area equipped for irrigation.....	34
Table K-2.	Climate zone grouping of Argentina.....	35
Table K-3.	Scheme for irrigated cultivation seasons of Argentina.	35
Table K-4.	Spatial units of Brazil (states), and their area equipped for irrigation.	39
Table K-5.	Climate zone grouping of Brazil.	40
Table K-6.	Scheme for irrigated cultivation seasons in Brazil.....	40
Table K-7.	Spatial units of the United States of America (states), and their area equipped for irrigation.	55
Table K-8.	Zone grouping of the United States of America.....	56
Table K-9.	Individual adjustments of crop calendars for irrigated crops in different zones for the United States of America.....	56
Table K-10.	Spatial units of China (provinces), and their area equipped for irrigation.....	62
Table K-11.	Actually irrigated areas in China by provinces and FAO regions (years 1997 and 2000) and comparison to areas given in the FAO crop calendar.	63
Table K-12.	Scaled irrigated harvested areas of crops in China by FAO regions (year 2000).	64
Table K-13.	Spatial units of India (states), and their area equipped for irrigation.....	66
Table K-14.	Zone grouping of India.....	67
Table K-15.	Spatial units of Indonesia (zones), and their area equipped for irrigation.	69
Table K-16.	Spatial units of Australia (states), and their area equipped for irrigation.....	115

AFRICA

Algeria

Irrigated area:

The area equipped for irrigation was taken from the latest AQUASTAT report on Africa of the United Nations report on Africa (FAO, 2005e) and sums to 569,418 ha. The actually irrigated area, as the new AQUASTAT report cited only figures for 1986, was taken from the FAO crop calendar for irrigated crops (FAO, 2005b) and scaled to apply to the equipped area of 2001, using the ratio of new to old equipped area cited in the older AQUASTAT report (FAO, 1995a). With roughly 140,000 ha harvested area, vegetables are the most important crop, followed by dates (110,000 ha) for which the total mean harvested area 1998-2002 from the FAOSTAT database (FAO, 2005d) was assumed to be irrigated, largely double the value than cited for 1986 in the AQUASTAT report. Dates and grapes are both cited in (Achtnich, 1980). Permanent cultures are dates, grapes (also FAOSTAT area assumed to be 100% irrigated), citrus, and fruit trees.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used as a basis. For some crops (wheat, rice, barley, sorghum and sugar beets) cultivation periods without harvested area that were cited in the crop calendar available in the FAO Global Information and Early Warning System (GIEWS) (FAO, 2005c) were used to define the cropping seasons. They fit into the calendar of Morocco. Winter cropping season is from October to April (wheat), for fodder from October to March. Summer cropping season is from May to September (potatoes, vegetables, rapeseed, and tobacco). All crops have a cropping intensity of 1.

Angola

Irrigated area:

The area equipped for irrigation was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e) and sums to 80,000 ha. The actually irrigated area was taken from the FAO crop calendar for irrigated crops (FAO, 2005b), the AQUASTAT report and the current survey of 2004. In 1996, roughly 35,000 ha were actually irrigated, mainly rice (ca. 7,000 ha twice), vegetables (ca. 13,000 ha), sugar cane (ca. 8,000 ha) and fruits (equally distributed to cited crops bananas and citrus).

Cropping seasons:

The cropping season as given by the FAO crop calendar for irrigated crops (FAO, 2005b) and those for Zambia were used as a basis. For some crops (wheat, maize, millet, sorghum, and potatoes) cropping seasons are cited in the FAO GIEWS crop calendar (FAO, 2005c), which made adaptations necessary: Rice from September to January and from February to June fits with its first season almost into the mentioned FAO GIEWS crop calendar. All crops have a cropping intensity of 1, besides rice that has a cropping intensity of 2.

Benin

Irrigated area:

The area equipped for irrigation was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e), and sums to 12,258 ha fully or partially controlled or wetland equipped area in 2000. The actually irrigated area was taken from the AQUASTAT report: It is only 2,823 ha! The distribution of this area to crops was made using also information of the FAO crop calendar for irrigated crops (FAO, 2005b), mentioning additionally sugar cane, and of the older FAO AQUASTAT report (FAO, 1995a). Rice as cited major crop is assumed to be grown also in not-equipped area. In equipped areas, only 636 ha rice are harvested, 563 ha in known area and a rest area to the total area. A further 1,000 ha sugar cane, 1,107 ha irrigated vegetables, 70 ha pineapples and 10 ha potatoes are irrigated.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used as a basis. For some crops (maize, rice, millet, sorghum, and cassava) cropping seasons in the FAO GIEWS crop calendar (FAO, 2005c) were used to define the cropping seasons that were in accordance to the seasons of the former source. The calendar is identical to that of neighbouring Togo: Rice is grown in two seasons from January to May (not from November to March like in Nigeria) and from June to October, resulting in a cropping intensity of 2. But potatoes are assumed to be grown from December to April, like sweet potatoes in neighbouring Nigeria and like vegetables. All crops have a cropping intensity of 1, besides rice that has a cropping intensity of 2.

Botswana

Irrigated area:

The area equipped for irrigation was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). There are 1,439 ha of fully and partially controlled areas including equipped lowlands. The actually irrigated area for 2002, 620 ha, was taken from the AQUASTAT report and mentions vegetables and citrus. Unfortunately this list does not at all correspond to that of the FAO crop calendar for irrigated crops (FAO, 2005b), which mentions cotton and maize. Because the latter was considered to be less confident, only vegetables and citrus were considered.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used as a basis. Vegetables and citrus have a cropping intensity of 1.

Burkina Faso

Irrigated area:

The area equipped for irrigation, 25,000 ha, was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). The actually irrigated area was taken basically from the new AQUASTAT report and the FAO crop calendar for irrigated crops (FAO, 2005b), from the latter the area for fruit trees. Rice (9,470 ha harvested), vegetables, sugar cane and fruits are the most important crops on equipped irrigated area with at least 2,000 ha harvested. Only of secondary importance with harvested areas below 500 ha are maize, cereal “niébé” (assumed wheat), potatoes, tobacco and other annual cultures. As permanent crops sugar cane and fruits are cultivated.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used as a basis. For some crops (maize, rice, millet, sorghum) cropping seasons in the FAO GIEWS crop calendar (FAO, 2005c) were used to define the cropping seasons that were in accordance to the seasons of the former source. Rice is grown in two seasons from June to October and from November to March. Main irrigation is in winter during the dry season, from November to March, also for cereal “niébé”. Maize is assumed to be grown in the wet summer season from June to October and to be additionally irrigated. A cropping intensity of 1 is assumed, and a value of 2 for rice.

Burundi

Irrigated area:

The area equipped for irrigation was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). There are 21,430 ha of fully and partially controlled areas including equipped lowlands. The actually irrigated areas around the year 2000 (21,000 ha harvested area) were taken from the AQUASTAT report, assisted by figures from the FAO crop calendar for irrigated crops (FAO, 2005b). Maize and sorghum are cited with large irrigated harvested areas of 43,000 ha and 18,000 ha, respectively, in the latter source. As an inclusion of their areas into the own crop calendar would have exceeded the equipped area, the following assumptions took place: (i) These areas were only cultivated in unequipped irrigation areas and thus, by definition, not included as irrigated crops in this study, or (ii) They ceased to be irrigated crops due to the decrease of market incentive following falling wages and a rising subsistence farming level as cited in the latest AQUASTAT report on Africa (FAO, 2005e). From the rest of the crops, rice is the most important crop with a harvested area of 17,380 ha, followed by sugar cane, vegetables and coffee.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were taken as a basis. For some crops (maize, sorghum, and beans) cropping seasons identical for Burundi and Rwanda are cited in the FAO GIEWS crop calendar (FAO, 2005c). These seasons fit to the seasons of rice that is grown in two cropping seasons from September to January and from February to June. Vegetables are irrigated in three cropping seasons from January to April, May to August, and September to December. All crops have a cropping intensity of 1, besides rice with a value of 2 and vegetables with a value of 3.

Cameroon

Irrigated area:

The area equipped for irrigation was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). There are 25,654 ha fully or partially controlled or wetland equipped area. The actually irrigated area was taken basically from the same source. As areas of the informal sector were also included and no explicit separation of irrigated and rainfed harvested areas was made in Table 4 of (FAO, 2005e), some adaptations to the original values were necessary. Rice (ca. 20,000 ha harvested area) was assumed to be 100% irrigated, with an asymmetric distribution to the seasons, the largest area (1st cropping season) during the rainy season from June to October. Irrigated area of maize is fit in order not to surpass the area equipped for irrigation during these months, leading to about 50% irrigated harvested area. Vegetables (ca. 11,000 ha during first cropping season) are the second largest crop. The cited aggregated irrigated area of both melons and pineapples was assumed to be occupied by 50% of each crop.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) of Cameroon and the Democratic Republic of the Congo were used as a basis. For some crops (maize, rice, millet, sorghum, and cassava) cropping seasons in the FAO GIEWS crop calendar (FAO, 2005c) were used to define the cropping seasons that were in accordance to the seasons of the former source. Rice is grown in two seasons from June to October (wet season) and from November to April (dry season), like specified in the AQUASTAT report (FAO, 2005e), while the original FAO calendar specifies only one season from May to September. Vegetables are irrigated during only one season from December to April, using the larger area of the 2nd cropping season as given in Table 4 of (FAO, 2005e). This procedure leads to a reasonable cropping intensity of nearly 100% during the dry season. Maize is grown from June to October, merging the two seasons given in the GIEWS calendar. A cropping intensity of 1 is assumed, besides for rice with a value of 1.25.

Cape Verde

Irrigated area:

The area equipped for irrigation is 3,109.03 ha (1997) as irrigation potential (2,780 ha fully or partially controlled equipped area) according to was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e), citing (Ministère de l'agriculture de l'élevage et de la sylviculture, 1997). The actually irrigated area was taken from the FAO AQUASTAT report. Most of it is sugar cane, followed by potatoes, vegetables and bananas. As other crops for 1985, the older AQUASTAT report on Africa (FAO, 1995a) lists also flowers, which were considered to still exist.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) for Gambia and Senegal were used as a basis together with climate characteristics cited in the AQUASTAT report (FAO, 2005e). For some crops (maize and pulses) cropping seasons in the FAO GIEWS crop calendar (FAO, 2005c) were used to define the cropping seasons that were in accordance to the seasons of the former source. It resulted in a slightly changed seasonal pattern: irrigated seasons are either July to November (supplementary irrigation for potatoes and vegetables) or from December to April (fully irrigated flowers). All crops have a cropping intensity of 1.

Central African Republic

Irrigated area:

The area equipped for irrigation was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). There are 135 ha fully or partially controlled or wetland equipped area. The actually irrigated area was taken basically from the older AQUASTAT report on Africa (FAO, 1995a), citing 68.5 ha effectively irrigated area, mentioning like (FAO, 2005e) rice and vegetables. Therefore, 40 ha were attributed to rice and the rest of 28.5 ha to vegetables.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) of Cameroon were used as a basis. For some crops (maize, rice, millet, sorghum, and cassava) cropping seasons in the FAO GIEWS crop calendar (FAO, 2005c) were used to define the cropping seasons that were in accordance to the seasons of the former source. Rice is grown from May to September, and vegetables from December to April. All crops have a cropping intensity of 1.

Chad

Irrigated area:

The area equipped for irrigation, 30,273 ha, was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). The actually irrigated area was taken basically from the new AQUASTAT report. According to this source date palm trees, mentioned in FAOSTAT database for 1990-1995 (FAO, 2005d), are not irrigated. Most important is rice (harvested area of 10,000 ha, of which 1,000 ha stems from a double-cropped area of single 500 ha system), followed by maize, sugar cane, millet, wheat, and vegetables (2,000 ha). As permanent crop only sugar cane is cultivated.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used as a basis. For some crops (maize, rice, millet, and sorghum) cropping seasons in the FAO GIEWS crop calendar (FAO, 2005c) were used to define the cropping seasons that were in accordance to the seasons of the former source. Wheat is grown as irrigated crop from January to May, starting 2 months later than in neighbouring Niger and Libya. Rice is grown in only one season from June to October, under supplementary irrigation, neglecting the relatively small double-cropped area of 500 ha cited in the AQUASTAT report (FAO, 2005e). Main irrigation for vegetables and assumedly sweet potatoes is in winter during the dry season, from December to April. All crops have a cropping intensity of 1.

Comoros

Irrigated area:

The area equipped for irrigation, 130 ha, was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). The actually irrigated area consists of 85 ha of bananas as cited there.

Cropping seasons:

Bananas are the only irrigated permanent crop.

Congo

Irrigated area:

The area equipped for irrigation of the Congo (formerly Republic of Congo) was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). There are 2,000 ha fully or partially controlled or wetland equipped area. The actually irrigated area (100% of the equipped area) for 1993 was taken basically from the same source. A small area is vegetables (217 ha), but most is sugar cane (1,783 ha, the rest to the equipped area) that is the only crop in the FAO crop calendar for irrigated crops (FAO, 2005b).

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) of Congo (and the Democratic Republic of the Congo) were used as a basis. For some crops (maize and cassava) cropping seasons mentioned in the FAO GIEWS crop calendar (FAO, 2005c) were used to define the cropping seasons that were in accordance to the seasons of the former source. Vegetables are assumed to be grown from December to April, like in Cameroon. All crops have a cropping intensity of 1.

Democratic Republic of the Congo

Irrigated area:

The area equipped for irrigation was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). There are 10,500 ha fully or partially controlled or wetland equipped. The actually irrigated area for 2000 was estimated to be 6,800 ha by this source. The harvested areas according to the FAO crop calendar for irrigated crops (FAO, 2005b) that mentions the main crops sugar cane and rice were scaled to this figure, resulting in roughly 6,000 ha sugar cane and 2,000 ha rice.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) of the Democratic Republic of the Congo (and the Republic of Congo) were used as a basis. No FAO GIEWS calendar was available for this country, so the one of the Republic Congo was used. Rice is grown in two seasons from January to April and from May to September with a cropping intensity of 2. All crops have a cropping intensity of 1, besides rice with a value of 2.

Côte d'Ivoire

Irrigated area:

The area equipped for irrigation was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). There are 72,750 ha fully or partially controlled or wetland equipped area. The actually irrigated area was taken from the AQUASTAT report, assisted by the FAO crop calendar for irrigated crops (FAO, 2005b). The older AQUASTAT report on Africa (FAO, 1995a) lists basically the same crops and areas: most is sugar cane (ca. 18,000 ha) and seed beds (ca. 12,000 ha), followed by fruit trees and vegetables.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used as a basis. For some crops (maize, rice, millet, sorghum, and cassava) cropping seasons in the

FAO GIEWS crop calendar (FAO, 2005c) were used to define the cropping seasons that were in accordance to the seasons of the former source. This calendar is similar to that of Liberia and Guinea, with the following differences: Vegetables are grown from December to April. Rice is grown in two seasons from January to May (2 months later) and from June to October, resulting in a cropping intensity of 2. All crops have a cropping intensity of 1, besides rice with a value of 2.

Djibouti

Irrigated area:

The area equipped for irrigation was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). According to this source, the fully equipped area of 1,012 ha (1999) is the total usable agricultural land, of which only 388 ha were actually irrigated in 1999. The actually irrigated areas of 1989 were linearly scaled to this area. Cereals were assumed to be maize as this cereal is cited in the FAOSTAT database with a harvested area of a similar order of magnitude (6 ha). Vegetables have the largest area (338 ha). As permanent crop (50 ha) date palm trees were assumed.

Cropping seasons:

The cropping seasons are based on information in the AQUASTAT report that mentions an irrigation season starting not before mid-November and ending mid-May. This is in agreement with the winter season of the FAO crop calendar for irrigated crops (FAO, 2005b) of Eritrea from December to April. This season was applied to maize and vegetables. All crops have a cropping intensity of 1.

Egypt

Irrigated area:

The area equipped for irrigation, 3,422,178 ha, was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). Though desert climate is prominent, in the northern coastal region there is up to 200 mm of annual rainfall. Therefore, the currently actually irrigated areas, being the same, was taken from the AQUASTAT report rather than the mean harvested area from FAOSTAT database (FAO, 2005d), as the former source seemed more reliable given the higher value, especially in the case of barley. Fodder (berseem clover, *Trifolium alexandrinum*, attributed to the crop class of “other annual” crops) (ca. 1.2 Mha harvested area), wheat (1.0 Mha), maize (830,000 ha), rice (650,000 ha, mostly in Nile delta), vegetables (470,000 ha), and cotton (300,000 ha) are the most important crops. Sweet potatoes and other roots and tubers were attributed to the crop class “potatoes”, in order to restrict the number of seasons in the crop class of “other annual” crops to the limit of 5. As permanent crops, fruit trees, citrus, and sugar cane (only present in the Nile valley) exist.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used as a basis. They showed a greater variety in cropping seasons as given in the AQUASTAT report (FAO, 2005e): The cited three cropping seasons “winter” (November to May), “summer” (April/May to October” and “Nili” (July/August to October)”: Winter crops were wheat (November to May) and barley, sorghum and assumedly flowers (November to March). The berseem clover winter cropping season from November to April given in (FAO, 2005b) was enlarged until May and separated into two joint seasons of unequal length and thus halved the growing area of this crop.

The seasons last from November to February and from March to May and account for either multiple cropping as fodder with cuts every 1-2 months within a cropping season of 3 or 6/7 months or as pasture grazed by tethered cattle as cited in the AQUASTAT report (FAO, 2005e). Vegetables are grown in two cropping seasons from March to May and from June to September. Sweet potatoes and other roots and tubers were assumed to be grown during the same seasons as potatoes (February to June), likewise also sunflower was assumed to be grown during the same seasons as groundnuts (May to September). Sesame is assumed to be grown like “other annual crops” from June to October. Cotton is grown from July to January. All crops have a cropping intensity of 1, besides vegetables and berseem clover with a value of 2.

Equatorial Guinea

No irrigation is reported for Equatorial Guinea.

Eritrea

Irrigated area:

The area equipped for irrigation, 21,590 ha, was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). According to this source, only the fully equipped area of 4,100 ha (1993) is usable, whereas the 16,490 ha spate irrigation area only contributes negligibly to the food production. Thus, the areas cited there for cotton (ca. 1,800 ha) and other crops (4,100 ha) should be the actually irrigated areas for 1993. The latter are distributed among 3/4 vegetables and 1/4 fruits, assumed to be fruit trees. Vegetables have the largest area. The areas cited in the FAO crop calendar for irrigated crops (FAO, 2005b) are assumed to be outdated.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) of Eritrea were used. Vegetables are grown from December to April, cotton from May to November. All crops have a cropping intensity of 1.

Ethiopia

Irrigated area:

The area equipped for irrigation was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). There are 289,530 ha fully and partially controlled irrigation area. The actually irrigated areas for 2002 were taken from the detailed figures of the AQUASTAT report (FAO, 2005e) and the FAO crop calendar for irrigated crops (FAO, 2005b), the latter citing additional crops like sorghum, soybeans and tobacco. The areas of the latter were used together with the harvested areas of the FAOSTAT database (FAO, 2005d) to disaggregate harvested area of “other cereals” to sorghum, rice, and barley, “roots and tubers” to potatoes and other roots, and “other permanent crops” besides citrus and bananas to 50% coffee and 50% fruit trees. Most important crops are vegetables and maize.

Cropping seasons:

The cropping seasons are as given by the FAO crop calendar for irrigated crops (FAO, 2005b) of Ethiopia. Cereals are grown in the “Meher” season from June to October. Roots and tubers, pulses and vegetables are grown from November to March. Cotton is grown from April to October. All crops have a cropping intensity of 1.

Gabon**Irrigated area:**

The area equipped for irrigation was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). There are 4,450 ha fully or partially controlled or wetland equipped area. The actually irrigated area was taken from the FAO crop calendar for irrigated crops (FAO, 2005b), that mentions besides rice (4,450 ha) about the same area of vegetables (2,000 ha, crop mentioned without harvested area in the first FAO source) and groundnuts (2,000 ha, crop not mentioned in the first FAO source) that are cultivated during the same seasons as rice.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used as a basis. For some crops (maize and cassava) cropping seasons in the FAO GIEWS crop calendar (FAO, 2005c) were used to define the cropping seasons that were in accordance to the seasons of the former source. Rice is grown in two seasons, from December to April (like vegetables) and from June to September (like groundnuts). The cropping period of vegetables is the same as in Cameroon. A cropping intensity of 1 is assumed, for rice a value of 2.

Gambia**Irrigated area:**

The area equipped for irrigation was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). There are 2,149 ha fully or partially controlled equipped area reported for the year 1991. The actually irrigated area was taken the FAO crop calendar for irrigated crops (FAO, 2005b) attributing all equipped area to rice cultivation. The new AQUASTAT report did not specify crops and harvested area for these equipped areas, but mentions rice cultivation in mangrove and freshwater swamps. The older AQUASTAT report (FAO, 1995a) lists 11,277 ha of rice, but this includes areas in mangrove swamps cultivated from August to January as cited in the new report (FAO, 2005e) that are not considered here as irrigated in the narrow sense.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used as a basis. For some crops (maize, rice, millet, sorghum, and groundnuts) cropping seasons in the FAO GIEWS crop calendar (FAO, 2005c) were used to define the cropping seasons that were in accordance to the seasons of the former source. This calendar is mostly identical to that of Senegal, besides that maize is grown shorter. Rice is grown in two seasons from June to October and from November to March, resulting in a cropping intensity of 2. Besides rice, all crops have a cropping intensity of 1.

Ghana

Irrigated area:

The area equipped for irrigation was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). There are 30,900 ha fully or partially controlled or wetland equipped area reported for the year 2000. The actually irrigated area was taken from the AQUASTAT report: ca. 5,300 ha irrigated rice and assumedly 11,900 ha irrigated vegetables as minimum area in sub-urban Kumasi area. The older AQUASTAT report on Africa (FAO, 1995a) lists rice, vegetables, and maize without a specific area.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used as a basis. For some crops (maize, rice, millet, sorghum, and cassava) cropping seasons in the FAO GIEWS crop calendar (FAO, 2005c) were used to define the cropping seasons that were in accordance to the seasons of the former source. Vegetables are assumed to be grown from December to April. Rice is grown in two seasons from January to May (not from November to March) and from June to October, resulting in a cropping intensity of 2. Besides rice, all crops have a cropping intensity of 1.

Guinea

Irrigated area:

The area equipped for irrigation was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). There are 94,914 ha fully or partially controlled or wetland equipped area reported for the year 2001. The actually irrigated area was taken from the AQUASTAT report, assisted by the FAO crop calendar for irrigated crops (FAO, 2005b). The older AQUASTAT report on Africa (FAO, 1995a) lists rice and vegetables, without a specific area.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used as a basis. For some crops (maize, rice, millet, sorghum, and cassava) cropping seasons in the FAO GIEWS crop calendar (FAO, 2005c) were used to define the cropping seasons that were in accordance to the seasons of the former source. This calendar is similar to that of Gambia, but potatoes, vegetables and other annual cultures are assumed to be grown from June to October rather than from November to March. Rice is grown in two seasons from June to October and from November to March, resulting in a cropping intensity of 2. Besides rice, all crops have a cropping intensity of 1.

Guinea-Bissau

Irrigated area:

The area equipped for irrigation was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). There are 22,558 ha fully or partially controlled or wetland equipped area in 1996. The actually irrigated area was taken from the AQUASTAT report, as no FAO crop calendar for irrigated crops (FAO, 2005b) existed. The older AQUASTAT report on Africa (FAO, 1995a) lists rice with a much larger area that was assumed to be grown also in non-equipped lowlands and is therefore not considered here. The biggest area is of permanent tree cultures, including citrus (1,550

ha of the FAOSTAT database (FAO, 2005d) assumed 100% irrigated) and bananas, mangoes, pineapples (altogether 5,821 ha). Rice (661 ha) and vegetables (530 ha, mentioned to be grown in mangroves) are only marginally irrigated under equipped area.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) of Guinea were used as a basis, as none for Guinea-Bissau was available. For some crops (maize, rice, millet, and sorghum) cropping seasons in the FAO GIEWS crop calendar (FAO, 2005c) were used to define the cropping seasons that were in accordance to the seasons of the former source. Vegetables are assumed to be grown from June to October rather than from November to March. Rice is grown in two seasons from June to October and from November to March, resulting in a cropping intensity of 2. Besides rice, all crops have a cropping intensity of 1.

Kenya

Irrigated area:

The area equipped for irrigation was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). There are 103,203 ha fully and partially controlled areas including equipped lowlands. The actually irrigated areas for 2003 were taken from the AQUASTAT report, assisted by figures from the FAO crop calendar for irrigated crops (FAO, 2005b) and the older AQUASTAT report on Africa (FAO, 1995a) mentioning also values for maize, bananas, citrus, cotton besides the most important crops rice (ca. 14,000 ha), coffee (ca. 13,000 ha) and pineapples.

Cropping seasons:

The cropping seasons are as given by the FAO crop calendar for irrigated crops (FAO, 2005b) of Kenya. Rice is grown in only one season like maize from April to August during the “long rains” season. Vegetables are assumed to be irrigated in the “short rains” season of the year from October to February, like cotton from September to February. All crops have a cropping intensity of 1.

Lesotho

Irrigated area:

The area equipped for irrigation was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). There are 2,638 ha fully and partially controlled areas including equipped lowlands. The actually irrigated area for 2002 (203 ha) was taken from the AQUASTAT report that mentions only vegetables.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) of South Africa were used as a basis. Vegetables as the only crop are assumed to be irrigated in the summer season of the year from December to April, like that specified in South Africa for all irrigated crops besides wheat and supported by the FAO GIEWS crop calendar (FAO, 2005c), with a cropping intensity of 1.

Liberia

Irrigated area:

The area equipped for irrigation was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). There are 2,100 ha fully or partially controlled or wetland equipped area reported for the year 1987. The actually irrigated area was taken from the FAO crop calendar for irrigated crops (FAO, 2005b), as the AQUASTAT report does not mention current values besides rice as a major crop in equipped wetland. But it was not clear whether this status would be the same later on, as the calendar mentions only vegetables instead of rice. The older AQUASTAT report on Africa (FAO, 1995a) lists rice without a specific tabulated area.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used as a basis. Vegetables as the only crop are grown from December to April, during the dry season, with a cropping intensity of 1.

Libyan Arab Jamahiriya

Irrigated area:

The area equipped for irrigation (470,000 ha) was taken from the Global Map of Irrigation Areas version 4 (Siebert *et al.*, 2007), which is more than the 400,000 ha given in the latest FAO AQUASTAT report on Africa (FAO, 2005e). The actually irrigated area was taken basically from the new AQUASTAT report, mentioning a probably underestimated actually (monthly) irrigated area of 316,000 ha. Dates (cited in (Achnich, 1980)) and also grapes were additionally assumed to be present as irrigated crops. For these, the total mean harvested area 1998-2002 from the FAOSTAT database (FAO, 2005d) was assumed to be irrigated. The sum of the harvested areas was scaled down with a factor of roughly 70% to fit to the monthly maximum of 316,000 ha. Fodder is berseem clover (*Trifolium alexandrinum*), and treated as annual crop. Olive trees have the largest area, followed by fodder, wheat, vegetables and barley, only to a much lesser extent potatoes, pulses, groundnuts and tobacco as annual crops. As permanent crops besides dates and grapes, citrus and fruit trees are cultivated.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used as a basis. For some crops (wheat, barley, millet, and potatoes) cropping seasons in the FAO GIEWS crop calendar (FAO, 2005c) were used to define the cropping seasons that were in accordance to the seasons of the former source. The calendar is similar to that of Tunisia: however, wheat is grown shorter in winter from November to April and barley from December to April. Fodder is grown from November to April. All other annual crops are grown in the earlier “summer” season from February to June. All crops have a cropping intensity of 1.

Madagascar

Irrigated area:

The area equipped for irrigation, 1,086,291 ha, was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). The actually irrigated area was taken from the AQUASTAT report, assisted by the list in the FAO crop calendar for irrigated crops (FAO, 2005b) and the FAOSTAT database (FAO, 2005d). In contrast to South Africa with a similar crop calendar, Madagascar has only a small selection of irrigated crops, with solely dominating rice (ca. 1.06 million ha) and some additional sugar cane, cotton (17,000 ha each) and vegetables (9,000 ha). The area of vegetables was taken from the FAO crop calendar for irrigated crops (FAO, 2005b) and scaled with the ratio of the new to the old equipped area cited in the older AQUASTAT report on Africa (FAO, 1995a).

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used as a basis. For some crops (wheat, maize, rice, sorghum, and potatoes) cropping seasons in the FAO GIEWS crop calendar (FAO, 2005c) are cited, which confirmed the former seasons, also for sorghum. Most crops are grown in summer: Rice is grown in two seasons with a cropping intensity of 2, from November to March and from April to August. Vegetables are grown from June to October according to the FAO calendar of irrigated crops (FAO, 2005b), while cotton is assumed to be grown from January to August. A permanent crop is sugar cane. All crops have a cropping intensity of 1, besides rice with a value of 2.

Malawi

Irrigated area:

The area equipped for irrigation was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). There are 56,390 ha fully and partially controlled areas including equipped lowlands. The actually irrigated areas for 2000 were taken from the AQUASTAT report. It mentions mainly sugar cane, tea, coffee, rice and vegetables. The sum area of rice and vegetables was distributed to rice and vegetables according to the relative shares given in the older AQUASTAT report on Africa (FAO, 1995a).

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) of Malawi were used as a basis. Rice is grown in two seasons, from November to March and from April to August. Vegetables are assumed to be irrigated in the dry season of the year from May to September, with a cropping intensity of 1, and 2 for rice.

Mali

Irrigated area:

The area equipped for irrigation, 235,791 ha, was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). The actually irrigated area was taken basically from the new AQUASTAT report and the FAO crop calendar for irrigated crops (FAO, 2005b). Millet, present according to the latter source as irrigated crop, was assumed to have the same harvested area as sorghum, as indicated there. Groundnuts were assumed to be present with the area listed in the irrigation

calendar scaled with the ratio of new 2002 to old 1991 equipped area (roughly 235,000 ha / 191,000 ha). By far the most important crop is rice (145,000 ha harvested), followed by millet, sorghum and sugar cane. As permanent crops sugar cane and tea are cultivated.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used as a basis. For some crops (maize, rainfed/irrigated rice, millet, sorghum) cropping seasons in the FAO GIEWS crop calendar (FAO, 2005c) were used to define the cropping seasons that were in accordance to the seasons of the former source. Wheat is assumed to be grown as in Niger and Libya in winter from November to May. Rice is grown in two seasons from June to October and from November to March. Main irrigation is in winter during the dry season, from November to March. Maize is assumed to be grown in the wet summer season and to be additionally irrigated, whereas groundnuts are cultivated in winter from November to March, in contrast to Niger. Only possibly cotton is outside these seasons (November to May). A cropping intensity of 1 is assumed, and a value of 2 for rice.

Mauritania

Irrigated area:

The area equipped for irrigation was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). There are 45,012 ha fully or partially controlled equipped area. The actually irrigated area was taken basically from the new AQUASTAT report and as indication on crops from the FAO crop calendar for irrigated crops (FAO, 2005b). Permanent crop areas (4,751 ha) were located in oases, assuming that date palm trees cover this area and that other cultures (244 ha) were under palm trees. The latter was assumed to be the minimum vegetable area during parts of the year. Unfortunately, this area is obviously not consistent with the cited annual production in oases: cereals (4,000 tons) and vegetables (4,000 – 5,000 tons). A yield of 16-32 ton/ha would be present while for maize and sorghum about 0.6 t/ha yield were specified for irrigated fields! Nevertheless, most of the irrigated area is covered with rice (ca. 17,000 ha harvested), date palm trees being the second most important crop.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used as a basis. For some crops (maize, rainfed “off-season”/irrigated rice, millet, sorghum, crops in low-lying area, “walo” flood recession crops) cropping seasons in the FAO GIEWS crop calendar (FAO, 2005c) were used to define the cropping seasons that were in accordance to the seasons of the former source. Rice is grown in two seasons from June to October and from November to March. Irrigation is also present in winter during the dry season, from November to March. Maize and sorghum are grown in the wet summer season and to be additionally irrigated, whereas vegetables are cultivated in winter from November to March. Only possibly cotton is outside these seasons (November to May). A cropping intensity of 1 is assumed, and a value of 2 for rice.

Mauritius

Irrigated area:

The area equipped for irrigation, 21,222 ha, was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). The actually irrigated area for 2002 was taken from the AQUASTAT report. Dominating crop is sugar cane (19,490 ha), followed by vegetables (758 ha), and five other crops of minor importance (altogether 671 ha).

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) of Madagascar were used as a basis. For some crops (wheat, maize, rice, sorghum, and potatoes) cropping seasons in the FAO GIEWS crop calendar (FAO, 2005c) are cited. Vegetables are grown from June to October according to the FAO calendar of irrigated crops (FAO, 2005b). The rest of the crops are grown like in Madagascar in winter from December to April, assumedly also tobacco and flowers. All crops have a cropping intensity of 1.

Mayotte

No irrigation is reported for the island of Mayotte.

Morocco

Irrigated area:

The area equipped for irrigation, 1,484,160 ha, was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). The actually irrigated area was taken from the AQUASTAT report and the FAO crop calendar for irrigated crops (FAO, 2005b). With roughly 370,000 ha harvested area, wheat is the most important crop, followed by fodder (assumed to be annual crops), other cereals assumed to be mostly maize, and vegetables. Oil crops were assumed to be sunflower, areas for legumes classified as pulses. Areas of groundnuts and tobacco were directly taken from the FAO crop calendar for irrigated crops (FAO, 2005b) assuming that they have rather a smaller extent than indicated by this figures. Permanent areas besides citrus and bananas were attributed to dates and grapes. The respective harvested areas for the time period 1998-2002 according to the FAOSTAT database (FAO, 2005d) were assumed to be 100% irrigated, the rest to fruit tree/berry orchards and olives (ca. 240,000 ha).

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used as a basis. For some crops (wheat, maize, barley, and potatoes) cropping seasons in the FAO GIEWS crop calendar (FAO, 2005c) are used to define the cropping seasons. Winter cropping season is from October to April (wheat; maize), also assumed to be valid for sorghum (and in principle for millet and rye). Summer cropping season is from May to September, besides for sugar beets (March to September) and cotton (July to January). Sunflowers are assumed to be irrigated in the summer season, also potatoes (also grown in winter as rainfed crop), vegetables and tobacco. Also rice has only a cropping intensity of 1.

Mozambique

Irrigated area:

The area equipped for irrigation, 118,120 ha, was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). The actually irrigated area was taken from the AQUASTAT report, assisted by the list in the FAO crop calendar for irrigated crops (FAO, 2005b). The figures of 2001 represent the year-long degradation in infrastructure and the disruption of systems due to flood-induced sedimentation of furrow systems in 2000 and 2001. Therefore, the irrigated area of rice has drastically sunken to a quarter or about 4,000 ha since the values for the year 1993 cited in the older AQUASTAT report on Africa (FAO, 1995a). Only for sugar cane and vegetables, the area remained more or less constant. As permanent crops, small areas of citrus besides annual tobacco are irrigated. The rest of the irrigated area was attributed to maize that had nearly the same areas as in the last surveys.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used as a basis. For some crops (wheat, maize, and sorghum) cropping seasons in the FAO GIEWS crop calendar (FAO, 2005c) are cited, which confirmed the former season for wheat, but was in contrast to for maize. It was decided to use the GIEWS season, as it was assumed that maize was not longer grown after rice as was obviously assumed before the strong decline of rice areas began. Most crops are grown in summer: Rice is grown in only one season, from November to March, Maize from December to April (like sorghum), and tobacco as well as vegetables are grown from June to October. Permanent crops are sugar cane and citrus. All crops have a cropping intensity of 1.

Namibia

Irrigated area:

The area equipped for irrigation was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). There are 7,572 ha fully and partially controlled areas including equipped lowlands. The actually irrigated area was taken from the AQUASTAT report, assisted by the list in the FAO crop calendar for irrigated crops (FAO, 2005b) which contributed fruit trees. The areas of 1991 were scaled with the ratio of new (2002) to old (1992) equipped area, under the assumption that relative areas of crops remained constant. Maize is the most important crop, followed by wheat, then by fruit trees, and fodder (of which 50% were attributed to be alfalfa/lucerne and 50% to be pasture, which are mentioned in the AQUASTAT report and classified as permanent “fodder grasses”).

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used as a basis. For some crops (wheat, maize, and sorghum) cropping seasons in the FAO GIEWS crop calendar (FAO, 2005c) are cited, which lead to an adjustment of cropping seasons as compared to those of South Africa: Wheat is grown from June to November (rather than May to November), assumedly together with other annual crops. Maize is grown from December to May (rather than December to April). Cotton is grown from October to April. Fodder crops alfalfa and pasture (classified as fodder grasses / managed grassland) are assumed to be grown permanently rather than from June to November. All crops have a cropping intensity of 1.

Niger

Irrigated area:

The area equipped for irrigation, 73,663 ha, was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). The actually irrigated area was taken basically from the new AQUASTAT report and the FAO crop calendar for irrigated crops (FAO, 2005b). Dates were additionally assumed to be present as 100% irrigated cultures. For them, the total mean harvested area for the time period 1998-2002 from the FAOSTAT database (FAO, 2005d) was taken. Total area of cereals (21,500 ha for 1997) was distributed to wheat (3,000 ha as cited in the FAO crop calendar for irrigated crops (FAO, 2005b)), maize (500 ha minimum area assumed) and the rest to rice (18,000 ha). The figure for rice fits well into the harvested area of FAOSTAT (ca. 22,000 ha irrigated and rainfed rice). The area of roots and tubers (6,800 ha for 1997) was distributed to sweet potatoes (assumed 100% irrigated), potatoes (200 ha assumed minimum area) and the rest to cassava/manioc (ca. 60% irrigated). Industrial cultures were cotton and assumedly sugar cane, for which 100% irrigation ratio was assumed, taking mean harvested areas for 1998-2002 (FAO, 2005d). Groundnuts were assumed to be present with the area listed in the irrigation calendar, which was scaled with the ratio of new 2002 to old 1989 equipped area (roughly 74,000 ha / 66,000 ha) and thus had the most important harvested area of 35,500 ha, followed by vegetables (22,500 ha) and rice (18,000 ha). As permanent crops sugar cane and dates are cultivated.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used as a basis. For some crops (maize, rainfed rice, millet, sorghum, groundnut, and cowpea) cropping seasons in the FAO GIEWS crop calendar (FAO, 2005c) were used to define the cropping seasons that were in accordance to the seasons of the former source. Wheat is assumed to be grown as in Libya in winter from November to May. Rice is grown in two seasons from June to October and from November to March. Main irrigation is in winter during the dry season, from November to March, also for cassava. Maize is assumed to be grown in the wet summer season, like groundnuts and to be additionally irrigated. Only possibly cotton is outside these seasons (November to May). A cropping intensity of 1 is assumed, and a value of 2 for rice.

Nigeria

Irrigated area:

The area equipped for irrigation, 293,117 ha, was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). The actually irrigated area was taken basically from the new AQUASTAT report and the FAOSTAT database (FAO, 2005d). The biggest share also cited in the FAO crop calendar for irrigated crops (FAO, 2005b) is for vegetables (tomatoes and onions, ca. 48,000 ha harvested area), followed by wheat, maize, sugar cane (19,000 ha each). The next crops following by area is pepper (16,000 ha), cotton, potatoes, and rice (7,000 ha). Total area of “other crops” (24,000 ha for 1997) was distributed to the crops cited in the source using their mean FAOSTAT harvested area 1998-2002 and their assumed importance: ca. 50% or 12,500 ha of cowpeas (which is the most important crop of the pulses group), ca. 45% or 10,000 ha of oil palm, and the rest to citrus, cocoa, and natural rubber (500 ha minimum area each assumed)

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) that is similar to that of Niger were used as a basis. For some crops (maize, rainfed/irrigated rice, millet, sorghum, cassava, and yams) cropping seasons in the FAO GIEWS crop calendar (FAO, 2005c)

were used to define the cropping seasons that were in accordance to the seasons of the former source. Wheat is assumed to be grown as in Nigeria in winter from November to May, potatoes from December to April, like vegetables. Rice is grown in two seasons from June to October and from November to March. Maize is grown in the summer season like wheat, but only once during the first, second and parts of the third season given in the GIEWS calendar. Only cotton is outside these seasons (November to May). A cropping intensity of 1 is assumed, and for rice 2.

Réunion

Réunion in Africa, French Guiana, Guadeloupe, and Martinique in America are all served by statistical sources of France and EUROSTAT. In some respect, their statistical data are interdependent.

Irrigated area:

The area equipped for irrigation, 13,000 ha, was cited in a regional profile of AGRESTE (AGRESTE Réunion, 2005). The currently actually irrigated area (7,584 ha was taken from the national agricultural census, Table AG 2 in (IFEN, 2005). The areas cited for French overseas territories by the Statistical Office of the European Communities (EUROSTAT, 2005) as a total and for their crop list was scaled to the total cited in the IFEN source (IFEN, 2005). For maize, potatoes, fodder plants, fruits and berry orchards and citrus total sums were given. As further crops rice (not present on Réunion), vegetables, and sugar cane were assumed to fill the rest of the actually irrigated area. The cited or assumed areas were distributed to the four overseas departments using the harvested area of the FAOSTAT database (FAO, 2005d), the aforementioned national data sources (AGRESTE, national agricultural census) and further information in (Achnich, 1980).

Cropping seasons:

The cropping seasons as given by the crop calendar for Madagascar, that is based on the FAO crop calendar for irrigated crops (FAO, 2005b). Vegetables are cropped from July to October, potatoes and fodder plants from December to April.

Rwanda

Irrigated area:

The area equipped for irrigation was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). There are 8,500 ha fully and partially controlled areas including equipped lowlands. The actually irrigated areas were taken from the AQUASTAT report text (rice 3,500 ha) and assisted by figures from the FAO crop calendar for irrigated crops (FAO, 2005b) (vegetables 2,000 ha).

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used. For some crops (maize, sorghum, and beans) cropping seasons identical for Burundi and Rwanda are cited in the FAO GIEWS crop calendar (FAO, 2005c). Contrary to the single cropping season given in the FAO calendar of irrigated crops (FAO, 2005b), a double cropping season for rice on the equipped irrigation area is assumed to exist together with water storage. For other areas such as non-equipped lowlands, only single cropping of rice, in alternation with other crops is assumed. Both types are cited in the AQUASTAT report (FAO, 2005e). The GIEWS calendar

seasons fit to the same seasons as in Burundi: Rice is grown in two cropping seasons from September to January and from February to June. Vegetables are irrigated in three cropping seasons from January to April, May to August, and September to December.

Saint Helena

No irrigation is reported for Saint Helena.

Sao Tome and Principe

Irrigated area:

The area equipped for irrigation was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). There are 9,700 ha fully or partially controlled or wetland equipped area. The actually irrigated area was taken from the same source that lists data for 1991: 9,500 ha of cacao and 200 ha of vegetables. The FAOSTAT data on harvested area indicate that with an increase until 2002 in cultivated area of vegetables, potentially a larger area than in 1991 is irrigated. However, with no current information on equipped area as a boundary condition, this remains speculative.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) of Gabon were used as a basis. For some crops (maize and cassava) cropping seasons in the FAO GIEWS crop calendar (FAO, 2005c) were used to define the cropping seasons that were in accordance to the seasons of the former source. Vegetables are thus assumed to be grown from December to April. As permanent crop, cacao is cultivated. All crops have a cropping intensity of 1.

Senegal

Irrigated area:

The area equipped for irrigation was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). There are 119,680 ha fully or partially controlled equipped area. The actually irrigated area was taken basically from the new AQUASTAT report and from the FAO crop calendar for irrigated crops (FAO, 2005b). Some crops were assumed to be present beyond those crops cited in the AQUASTAT report (FAO, 2005e): Permanent crop areas for maize (same as in the older AQUASTAT report on Africa (FAO, 1995a) and fruits were taken from the latter source, for citrus the mean harvested area for the time period 1998-2002 from the FAOSTAT database (FAO, 2005d) was used. Nevertheless, most of the irrigated area is covered with rice (ca. 56,000 ha harvested), vegetables (8,500 ha) and sugar cane (7,500 ha) being the next important crops. The values cited for 1997 were not scaled to current equipped area, as this would have surpassed the FAOSTAT harvested area.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used as a basis. For some crops (maize, rice, millet, sorghum, and groundnuts) cropping seasons in the FAO GIEWS crop calendar (FAO, 2005c) were used to define the cropping seasons that were in accordance to the seasons of the former source. The calendar is mostly identical to that of

Mauritania located to the north. Rice is grown in two seasons from June to October and from November to March. Irrigation is also present in winter during the dry season, from November to March. Maize and sorghum are grown in the wet summer season and to be additionally irrigated, whereas vegetables are cultivated in winter from November to March. Only possibly cotton is outside these seasons (November to May). A cropping intensity of 1 is assumed, and for rice 2.

Seychelles

Irrigated area:

The area equipped for irrigation, 260 ha, was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). The actually irrigated area consists of 224 ha (208 ha vegetables, 13 ha flowers, 3 ha pulses) as cited there.

Cropping seasons:

Vegetables are assumed to be grown like in Madagascar from June to October, as the dry season of the year starts in May and ends in October according to the AQUASTAT report (FAO, 2005e). Flowers are assumed to be permanent crops, like also permanent nurseries for rainfed annual and permanent crops listed in the AQUASTAT report (FAO, 2005e).

Sierra Leone

Irrigated area:

The area equipped for irrigation was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). There are 29,360 ha fully or partially controlled equipped and lowland area in 1992. The actually irrigated area was taken from the AQUASTAT report, giving sugar cane area, assisted by the FAO crop calendar for irrigated crops (FAO, 2005b) that gave final areas for rice, sugar cane and vegetables. The older AQUASTAT report on Africa (FAO, 1995a) lists rice and vegetables, without a specific harvested area.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used as a basis. For some crops (maize, rice, millet, sorghum, and cassava) cropping seasons in the FAO GIEWS crop calendar (FAO, 2005c) were used to define the cropping seasons that were in accordance to the seasons of the former source. This calendar is similar to that of neighbouring Guinea, but vegetables are assumed to be grown from December to March. Rice is grown in two seasons from June to October and from November to March, resulting in a cropping intensity of 2.

Somalia

Irrigated area:

The area equipped for irrigation (200,000 ha) was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). There are 50,000 ha fully and partially controlled areas including equipped lowlands and 150,000 spate/flood irrigation. The actually irrigated areas for 2003 were taken from the FAO crop calendar for irrigated crops (FAO, 2005b), as the new AQUASTAT report on Africa (FAO, 2005e) as well as the older one (FAO, 1995a) cite only partly tabulated areas. Most

important crop is maize (ca. 120,000 – 150,000 ha) and sorghum (ca. 40,000 ha). Many different crops follow. The data base is extremely poor, as no FAOSTAT data is available to check the figures.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) for Somalia were used. Most crops including maize and rice are grown during the “Gu” rainy season from April to August. Only sweet potatoes and vegetables are grown in the “Der” season from October to February. Cotton is grown from April to October.

South Africa

Irrigated area:

The area equipped for irrigation is 1,498,000 ha according to the latest FAO AQUASTAT report on Africa (FAO, 2005e). The actually irrigated area (1,664,300 ha) was taken from the AQUASTAT report, assisted by the list in the FAO crop calendar for irrigated crops (FAO, 2005b) and the harvested area of the FAOSTAT database (FAO, 2005d). South Africa has a multitude of irrigated crops, with dominating fodder and wheat, followed by pulses, vegetables, and maize. Areas of rice, barley, millet and sorghum were attributed according to a sum for cereals other than wheat and maize cited in AQUASTAT report on Africa, taking the mean harvested area of rice for the period 1998-2002 with 100% irrigation ratio as a constraint and distributing the rest according to the relationship of the harvested areas, assuming ca. 10% irrigation, omitting other cereals. Fodder was separated to alfalfa, the mean harvested area assumed to be 100% irrigated, and the rest assumed to be clover or other items grouped as mixed grasses in the FAOSTAT database, both classified as fodder grasses / managed grassland, assuming ca. 10% irrigation. The figure for other permanent crops was likewise distributed to grapes (assumed 100% irrigated) and the rest attributed to fruit and berry orchards of which ca. 10% are other permanent cultures.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used as a basis. For some crops (wheat, maize, rice, millet and sorghum) cropping seasons in the FAO GIEWS crop calendar (FAO, 2005c) are cited, which confirmed the former seasons besides for sorghum, for which the irrigation season was prolonged for one month. Most crops are grown in summer, besides wheat and barley (May to November), assumed to be possibly cropped after or before the summer crops. Those are cropped from December to April, with the exception of sorghum (December to May) and cotton (October to April). For fodder, in contrast to FAOs growing period in winter from May to September, a growing period throughout the year is assumed because of the aforementioned separation to alfalfa and clover, the latter possibly being harvested before cotton is planted. Roots and tubers crops were assumed to be all grown during summer like groundnuts. Permanent crops are fruit and berry orchards, grapes, sugar cane, citrus, bananas, coffee, tea. All crops have a cropping intensity of 1.

Sudan

Irrigated area:

The area equipped for irrigation, 1,863,000 ha was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). The actually irrigated area was taken from mainly the AQUASTAT report which cites cropped areas for fully and partially controlled irrigation area and thus misses about 10% of the equipped area. From the FAO crop calendar for irrigated crops (FAO, 2005b), only the areas of pulses (46,000 ha) and citrus (ca. 12,000 ha, about 100% of the harvested area from the FAOSTAT database (FAO, 2005d)) were considered to be potentially also irrigated. The cited area of 95,000 ha of irrigated is about five times as large as the cited FAOSTAT harvested area and was considered to be not reliable enough. Only about 800,000 ha or roughly 43% of the equipped area is cited to be actually used, due to deterioration of irrigation and drainage infrastructure. This is found in the present compilation with roughly 840,000 ha as maximum monthly irrigated area and 45% of the equipped area. In contrast to the former AQUASTAT report from 1995 (FAO, 1995a), cotton dropped from 324,240 ha to roughly half of the area (166,900 ha), so that sorghum took position no. 1 with roughly 355,000 ha harvested area, both followed by wheat, groundnuts, vegetables, sugar cane, and maize. For pulses, citrus and fruit trees the only figures available were the areas cited in the FAO crop calendar for irrigated crops. Permanent fodder (classified as fodder grasses / managed grassland) was assumed to be alfalfa, although it is not specified as such in the FAOSTAT database of harvested area (FAO, 2005d).

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used as a basis. For some crops (wheat, maize, millet and sorghum) cropping seasons in the FAO GIEWS crop calendar (FAO, 2005c) are cited, leading to a similar cropping season than in Egypt but ending two months earlier for winter wheat (November to March), assumed to be the standard winter cropping season. The irrigated season for maize was confirmed also for sorghum (June to October) in the FAO GIEWS crop calendar (FAO, 2005c) and was taken as the standard cropping season for summer. Roots and tubers crops were assumed to be all grown during winter like groundnuts and potatoes. Cotton is grown from April to October. Also rice has only a cropping intensity of 1.

Swaziland

Irrigated area:

The area equipped for irrigation is 49,843 ha according to sub-national statistics of (Riddell and Manyatsi, 2003). The actually irrigated area (45,482 ha) was taken from the latest AQUASTAT report on Africa (FAO, 2005e), while the list in the FAO crop calendar for irrigated crops (FAO, 2005b) and the FAOSTAT database (FAO, 2005d) suggest potentially more crops. Swaziland has currently only sugar cane as main crop, whereas in 1994 it had also other crops: 7,000 ha pineapples, 400 ha citrus and 4,400 ha other crops as cited in the older AQUASTAT report on Africa (FAO, 1995a). In the FAO crop calendar for irrigated crops (FAO, 2005b) 22,000 ha cotton are cited that are in principle in accordance with roughly the same figure of the harvested area given in FAOSTAT database (FAO, 2005d), but these do not fit to the new figures given in 2003 for the equipped area. So it may be concluded that either cotton is grown under rainfed conditions, or the reported values of irrigated areas should be larger. As a result, besides the 41,516 ha of sugar cane only the 2,513 ha of citrus are bigger areas. All the other crops (vegetables, maize, rice, potatoes, and bananas) have only marginal areas.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used as a basis. For some crops (wheat, maize, rice, and sorghum) cropping seasons in the FAO GIEWS crop calendar (FAO, 2005c) are cited, which confirmed the former seasons and the identical ones of surrounding South Africa. All irrigated crops are grown in summer. All crops have a cropping intensity of 1.

Togo**Irrigated area:**

The area equipped for irrigation was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). There are 7,300 ha fully or partially controlled or wetland equipped area in 1996. The actually irrigated area was taken from the AQUASTAT report, ca. 514 ha irrigated rice, 933 ha sugar cane and 840 ha irrigated vegetables as reported minimum area, and 470 ha fruit trees cited in the FAO crop calendar for irrigated crops (FAO, 2005b) and the older AQUASTAT report on Africa (FAO, 1995a). The latter report lists sugar cane, rice, vegetables, fruits and others.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used as a basis. For some crops (maize, rice, millet, sorghum, and cassava) cropping seasons in the FAO GIEWS crop calendar (FAO, 2005c) were used to define the cropping seasons that were in accordance to the seasons of the former source. Vegetables are assumed to be grown from December to April. Rice is grown in two seasons from January to May (not from November to March) and from June to October, resulting in a cropping intensity of 2.

Tunisia**Irrigated area:**

The area equipped for irrigation, 394,063 ha, was taken from the Global Map of Irrigation Areas version 4 (Siebert *et al.*, 2007), a little bit more than in the latest FAO AQUASTAT report on Africa (FAO, 2005e). The actually irrigated area was taken from the new AQUASTAT report with one exception. For tobacco the area of the FAO crop calendar for irrigated crops (FAO, 2005b) was used and scaled to represent the area in the reference year 2000 with the ratio of new to old equipped area cited in the older AQUASTAT report on Africa (FAO, 1995a). With roughly 92,000 ha harvested area, vegetables are the most important crop, followed by wheat (49,000 ha). The rest of the cereals area was distributed to sorghum (50% of its harvested area) and the very rest to barley, as it is the most important cereal besides wheat and rice is not cultivated. For dates and grapes the total mean harvested area for the time period 1998-2002 from the FAOSTAT database (FAO, 2005d) was assumed to be 100% irrigated, and the rest of permanent crops besides citrus is assumed to be mainly olives (less than 100% irrigation ratio) and probably 100% irrigated fruit and berry orchards. Citrus, dates and olives are cited as permanent crops in (Achtlich, 1980).

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used as a basis. For some crops (wheat, barley, potatoes and sugar beets) cropping seasons in the FAO GIEWS crop calendar (FAO, 2005c) were used to define the cropping seasons. This changed the calendar that is similar to the one of Algeria: Wheat is grown longer in winter from October to

May (not April) unlike barley and sorghum that are grown from October to April. Sugar beets start earlier – they are grown from January (not February) to July, whereas other summer crops like potatoes, water melons, vegetables, and tobacco are grown from March until July. Fodder is grown from October to March. All crops have a cropping intensity of 1.

Uganda

Irrigated area:

The area equipped for irrigation was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). There are 9,150 ha fully and partially controlled areas including equipped lowlands. The actually irrigated areas for 1998 (2,330 ha) were taken from the AQUASTAT report. Rice is the most important crop with an area that decreased from 3,580 ha (1987) to 1,650 ha (1998).

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) for Uganda and Kenya were used. Rice is grown in only one season from April to August, during the same time as the “long rains” season of Kenya. Vegetables are assumed to be irrigated in the “short rains” season of the Kenya from October to February.

United Republic of Tanzania

Irrigated area:

The area equipped for irrigation was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). There are 184,330 ha fully and partially controlled areas including equipped lowlands. The actually irrigated areas for 2002 were taken from the AQUASTAT report: mainly rice, maize and a sum for vegetables/beans, bananas and cotton. The latter three shares were distributed arbitrarily from harvested area (mean 1998-2002) from the FAOSTAT database (FAO, 2005d). Additional private irrigation schemes are mentioned to produce cash crops such as tea, coffee, cashew, and sugar cane, but no respective areas are mentioned in the AQUASTAT report.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) of Tanzania were used as a basis. Rice is grown in only one season, from November to March, maize from April to August. Vegetables are assumed to be irrigated in the dry season of the year from June to October, with a cropping intensity of 1. Cotton is assumed to be grown as in Kenya

Western Sahara

No irrigation is reported for Western Sahara.

Zambia

Irrigated area:

The area equipped for irrigation is 155,912 ha according to the national development plan (Ministry of Agriculture and Cooperatives, 2002). The actually irrigated area (55,387 ha) was taken from the AQUASTAT report (FAO, 2005e). The figures of 2002 show that sugar cane (ca. 18,000 ha) and wheat (ca. 12,000 ha) are the most important crops, followed by rice and vegetables. The area of cotton has strongly declined, probably due to the drought intensive years, as cited in the AQUASTAT report. As permanent crops sugar cane, coffee, bananas, citrus, and small areas of tea are cultivated.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) for Zambia and those for Zimbabwe and South Africa were used as a basis. For some crops (wheat, maize, millet and sorghum) cropping seasons in the FAO GIEWS crop calendar (FAO, 2005c) are cited, which confirmed the former season for wheat. Most crops are grown in summer: Rice is grown like maize in only one season, from December to April, one month later than in Zimbabwe. In winter wheat, vegetables, and assumedly other annual crops are irrigated. Cotton is grown also in winter from May to November. All crops have a cropping intensity of 1.

Zimbabwe

Irrigated area:

The area equipped for irrigation, 173,513 ha, was taken from the latest FAO AQUASTAT report on Africa (FAO, 2005e). The actually irrigated area was taken from the AQUASTAT report, assisted by the list in the FAO crop calendar for irrigated crops (FAO, 2005b) and the harvested areas from the FAOSTAT database (FAO, 2005d). The figure for the year 1999 in the latest AQUASTAT report (49,100 ha) show that wheat is 100% irrigated. As the value surpasses the mean harvested area from FAOSTAT for the period 1998-2002 (47,466 ha), the latter value was used, because it is smaller, and more representative for the period and thus does not generate inconsistencies when using FAOSTAT information on production and trade. To disaggregate “other cereals”, rice and barley were taken, likewise assumed 100% irrigated, and the rest area was distributed to sorghum. Likewise, the area attributed to vegetables, pulses and potatoes was distributed to potatoes (100% irrigated harvested area), pulses (10% irrigated), and vegetables (rest of area). Also other annual crop area was distributed to sunflower (10% irrigated), flowers (40 ha assumed minimum, assumed to be a permanent cultivation) and groundnuts (rest). The flowers were. For other permanent crops, tree nuts were assumed to be 10% irrigated and the rest was distributed to citrus.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used as a basis. For some crops (wheat, maize, and sorghum) cropping seasons in the FAO GIEWS crop calendar (FAO, 2005c) are cited, which confirmed the former season for wheat, but like in neighbouring Mozambique was in contrast to that for maize. It was decided to use the GIEWS season. Most crops are grown in summer: Rice is grown in only one season, from November to March, Maize from December to April (like sorghum). Wheat, barley, vegetables and fodder are grown from June to October. Permanent crops are sugar cane, coffee, tea, tree, and citrus. All crops have a cropping intensity of 1.

AMERICA

Anguilla

No irrigation is reported for the island of Anguilla.

Antigua and Barbuda

Irrigated area:

Area equipped for irrigation, 130 ha, was available for 1996 (FAO, 2000). According to the AQUASTAT report (FAO, 2000) 120 ha of annual crops (vegetables) and 10 ha of permanent crops were cultivated. Based on the list of crops for the Lesser Antilles in (Achtlich, 1980) that mentions sugar cane, bananas, also fruits and vegetables, the permanent crops were assumed to be mainly fruit trees potentially including bananas/plantains, assuming that sugar cane would have been explicitly mentioned in the AQUASTAT report.

Cropping seasons:

The cropping seasons of neighbouring Saint Kitts and Nevis (as based on Trinidad and Tobago) were used. In principle, two cultivation periods of annual irrigated crops exist, during summer from June to November and during the dry winter season from December to April (vegetables).

Argentina

Irrigated area:

The area equipped for irrigation, 1.44 Mha, is the one given in the Global Map of Irrigation Areas version 4 (Siebert *et al.*, 2007). The actually irrigated area was taken from the national agricultural census of the year 2002 (INDEC, 2002). The original data of the 23 mainland provinces and the Federal District (from Jujuy in the North to Tierra del Fuego / Fireland in the South, without territories of Antarctica and the Falkland Islands / Islas Malvinas that are both claimed by Argentina) (Table K-1) was given in an inconsistent set of classes, i.e. they were not the same for all provinces. Therefore, when bigger areas were given in aggregated classes they were re-distributed to a final set of classes according to ancillary information on possible crops cited by the agricultural census on one hand, and on the other hand of crops cited in the national atlas of Argentina (Marin, 1986). Especially the tabulated data of the latter on the ordinal number of each province within the national production per crop group was useful for a prioritisation of distribution of harvested area within unspecified areas of the groups “cereals”, “oil crops”, “horticulture” and “vegetables”, industrial crops such as cotton, sugar cane, mate tea and tobacco, “forage crops” such as sorghum and alfalfa, and “others” in a meaningful way. This included sometimes the introduction of new classes that were not listed in the agricultural census. On the other hand, for citrus, fruit trees including olives and sometimes grapes, the originally larger level of detail with sub-classes and neighbouring classes was simplified with a separation of only 4 aggregated classes “citrus”, “grapes” (including also areas from a separate class), “fruit trees” and “olive trees”.

The final irrigated areas of 2002 are sometimes very different from those given for 1997 in the latest FAO AQUASTAT report (FAO, 2000), especially the much smaller areas cited by the national census for vegetables (ca. 120,000 ha instead of roughly 260,000 ha of horticulture and vegetables), potatoes (ca. 40,000 ha), cotton (ca. 40,000 ha), sugar cane (ca. 80,000 ha). For fruits trees (ca. 175,000 ha), olives (ca. 30,000 ha), grapes (ca. 190,000 ha), citrus (ca. 25,000 ha) and also for maize (ca. 105,000 ha) and rice (ca. 115,000 ha) the values are comparable within some limits. Crops newly identified as irrigated in 2002 include: wheat (ca. 70,000 ha), soybeans (ca. 85,000 ha), tobacco (ca. 35,000 ha), sorghum (ca. 55,000 ha) and alfalfa (ca. 105,000 ha). The harvested area from the FAOSTAT database (FAO, 2005d) as an upper limit was not reached, same as for the area equipped for irrigation of the 24 units (Table K-1).

To define the cropping seasons, the 23 mainland provinces were grouped to 6 regional agro-climatological zones (Table K-2). This was done with own regional expertise and using the climate classification of (Troll and Paffen, 1964) that excellently depicts natural vegetation distribution in South America. This enabled to distinguish the influence of temperate, subtropical and tropical climate, e.g. in terms of number of humid months and mean temperature.

Table K-1. Spatial units of Argentina (provinces), and their area equipped for irrigation in hectares.

No.	Unit name (province)	Area equipped for irrigation
1	Argentina_Buenos Aires	176,500
2	Argentina_Catamarca	64,304
3	Argentina_Chaco	7,550
4	Argentina_Chubut	34,449
5	Argentina_Cordoba	93,835
6	Argentina_Corrientes	68,000
7	Argentina_Entre Rios	109,000
8	Argentina_Formosa	11,513
9	Argentina_Jujuy	120,000
10	Argentina_La Pampa	6,815
11	Argentina_La Rioja	41,817
12	Argentina_Mendoza	359,523
13	Argentina_Misiones	170
14	Argentina_Neuquen	17,700
15	Argentina_Rio Negro	135,171
16	Argentina_Salta	150,000
17	Argentina_San Juan	79,516
18	Argentina_San Luis	18,575
19	Argentina_Santa Cruz	5,467
20	Argentina_Santa Fe	37,421
21	Argentina_Santiago del Estero	142,823
22	Argentina_Tierra del Fuego	0.40
23	Argentina_Tucuman	87,634
24	Argentina_Distrito Federal	0.00

Table K-2. Climate zone grouping of Argentina.

No.	Zone / region name	Province No.	Province name	Climate class (Troll and Paffen)	No. of humid months (Lauer)	Remarks
1	Southern Patagonia and Fireland	4, 19, 22	Chubut, Santa Cruz, Tierra del Fuego	III-10, III-12/12a, III-1	Dry summer, cold winter, III-1: oceanic	Steppe, mainly livestock, selected crops
2	Northern Patagonia	14, 15	Neuquén, Río Negro	III-10, III-12/12a	Dry summer	Steppe, diversified annual crops and fruit trees, also livestock
3	Semidesertic Andes, Precordillera, Pediments	2, 12, 17, 18	Catamarca, Mendoza, San Juan, San Luis	IV-5, partly IV-2	< 2	Warm temperate Semi-deserts and Steppe
4	Dry Pampa	5, 10, 11, 21, 23	Córdoba, La Pampa, La Rioja, Santiago del Estero, Tucumán	IV-3, partly IV-4	< 5	Warm temperate climate
5	Wet Pampa	1, 6, 7, 13, 20	Buenos Aires, Corrientes, Entre Ríos, Misiones, Santa Fe, Distrito Federal	IV-6, IV-4, V-1	> 6	Warm temperate climate
6	Tropical Dry North	3, 8, 9, 16	Chaco, Formosa, Jujuy, Salta	V-4, V-3, V-1, V-2, V-5	< 2 – 12, V-4: 2 – 4.5, V-3: 4.5 – 7, V-5: tropical semideserts	Tropical climate

Cropping seasons:

As a starting point, the cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used together with the cultivation periods of the FAO GIEWS crop calendar (FAO, 2005c) and of the United States Department of Agriculture (USDA, 1994). Irrigated crops are summer crops that are mainly irrigated from November to April, besides cotton that is grown from October to April. Permanent irrigated cultures are sugar cane, citrus and fruit trees including olives, grapes, tea/mate tea, and alfalfa for forage (Table K-3).

Table K-3. Scheme for irrigated cultivation seasons of Argentina.

No.	Zone / region name	Summer crops		Cotton		Remark
		Begin	End	Begin	End	
1	Southern Patagonia and Fireland	11	2			Short summers
2	Northern Patagonia	11	3	10	4	
3	Semidesertic Andes, Precordillera, Pediments	11	3	10	4	
4	Dry Pampa	11	4	10	4	
5	Wet Pampa	11	4	10	4	
6	Tropical Dry North	11	4	10	4	

Aruba

No irrigation is reported for the island of Aruba.

Bahamas

No irrigation is reported for the Bahamas islands.

Barbados

Irrigated area:

The area equipped for irrigation, 1,000 ha, is the one given for 1989 in (FAO, 2000). The actually irrigated area was interpreted from the AQUASTAT report (FAO, 2000) as being the equipped area which was distributed to the cited crops vegetables (90%) and fruit trees (including bananas/plantains, 10%), assuming roughly the same proportions as in Antigua and Barbuda. This is consistent with the list of crops for the Lesser Antilles in (Achtlich, 1980) mentioning sugar cane, bananas, also fruits and vegetables, assuming that sugar cane would have been explicitly mentioned in the AQUASTAT report.

Cropping seasons:

The cropping seasons of neighbouring Trinidad and Tobago were used. In principle, two cultivation periods of annual irrigated crops exist, during summer from June to November and during the dry winter season from December to April (vegetables).

Belize

Irrigated area:

The area equipped for irrigation, 3,000 ha, is the one given in (FAO, 2000) for 1997. The actually irrigated area was estimated using the crop list in the aforementioned AQUASTAT report (rice, maize, sugar cane, bananas, and citrus) and distributing the total equipped area to the crop classes with the relative shares of neighbouring Honduras for which a FAO crop calendar for irrigated crops (FAO, 2005b) exists. Thus, maize, rice, sugar cane are followed by bananas and citrus.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) for Honduras were used. Two cropping seasons of annual irrigated crops exist like in also neighbouring Guatemala: For maize and other crops from April to August (maize, rice) and from September to January (maize).

Bermudas

No irrigation is reported for the island of Bermuda.

Bolivia (Plurinational State of)

Irrigated area:

The area equipped for irrigation, 128,240 ha, is the one given in the Global Map of Irrigation Areas version 4 (Siebert *et al.*, 2007), the AQUASTAT report (FAO, 2000) citing a slightly smaller value (128,239 ha). The irrigated harvested area was taken from the FAO crop calendar for irrigated crops (FAO, 2005b), as in the AQUASTAT report no harvested crop areas were specified, and only four crop classes are listed (rice, cereals for animal production, sugar cane, and other annual crops). Potatoes (40,000 ha), vegetables (30,000 ha), maize (26,000 ha) and rice (10,000 ha) are the most dominant crops. As permanent crops sugar cane, citrus and fruit trees are cultivated, with smaller areas of 5,000 ha and less.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used. Only one cropping season during summer from December to April is present for rice, maize, barley, potatoes, other roots crops and vegetables. The seasons of the FAO GIEWS crop calendar (FAO, 2005c) were in agreement with that of these summer crops, when a broad envelope was defined around the cropping season lasting from December to February/March that was covered by most of the crops with the exception of sweet potatoes that are also sometimes cultivated until May.

Brazil

Irrigated area:

Different estimations of area equipped for irrigation for Brazil as a whole and for its states exist. According to the original sources, estimations per state for the following seasons are given in:

- 2001: (Christofidis, 2002), also cited in the national water resources plan
(Secretaria de Recursos Hídricos and (ANA), 2003),
lists the increasing values of the Brazilian total from 1950 - 2001
- 2003/2004: (Christofidis, 2006)

It seems that these sources overestimate the equipped area at least for 2003/2004, as the total increases steadily since 1996, which might be questioned. Nevertheless, the values cited by FAO in the FAO crop calendar for irrigated crops (FAO, 2005b) and the AQUASTAT report (FAO, 2000) which cites the same values as (Secretaria de Recursos Hídricos and (ANA), 2003) give for 1998 the same value for the area equipped for irrigation, 2,870,404 ha, which is near the 2.656 Mha of the former version 3 of the Global Map of Irrigation Areas. It was decided to take as a reference for the version 4 the regionally detailed values of 2001 (3,149,217 ha) of (Christofidis, 2002), as they are the newest estimation within the reference period 1998-2002 (Siebert *et al.*, 2007).

Sub-national data of actually irrigated areas on state and municipal level for 1996 are available from the agricultural census 1995/1996. It is the most recently available census data as stated by (Cardille and Foley, 2003). (Helfand and Brunstein, 2000) mentions that this relatively well-funded agricultural census for the first time gathered information of planting and harvesting of crops from the same agricultural year. Field trips were done in August 1996, after the harvesting of many annual crops. Due to many precarious establishments (IBGE, 1997), this should lead to a substantial underestimation of the number of counted establishments. In addition, according to (Helfand and Brunstein, 2000), 1996 was a year with small agricultural economic activity. This should lead to an underestimation of agricultural area and production. But this latter finding is not confirmed by the agricultural statistics of the FAOSTAT database (FAO, 2005d). Furthermore, the

census mentions a much higher irrigated area for 1996 (ca. 3.126 Mha) than the previously mentioned sources for 1998. For the present study, the census was considered to deliver the best available inventory with regionally detailed figures on crop areas. It was used also as a representative estimate for the reference year 2000.

The actually irrigated areas were compiled at the level of states with the constraints that the equipped area of 2001 was not overcome. When the total monthly actually irrigated area of the census (for a given year) was larger than the prescribed equipped area, then the crop areas were scaled down to the equipped area (Table K-4).

The crop list of the agricultural census contains 57 items and is much more detailed than the one of the FAO crop calendar for irrigated crops (FAO, 2005b) and that of the AQUASTAT report which mentions for 1996 only areas of rice (ca. 910,000 ha) and vegetables (318,420 ha), and lists sugar cane and “other crops”. In the census, however, even trees for timber and charcoal production are included. These last two classes were excluded from the compilation for our purposes as being non-agricultural usages, extra-ordinary from the global point of view. Sometimes, the documented irrigated area of a specific item is smaller than 0.1 ha. It is assumed that these values are negligible areas generated from artefacts by the technical procedure to compile the census, as the area data were generally provided in ha with a 3 decimals precision.

For the group “other cereals” that initially had no sub-division, crops were selected from the harvested area from the FAOSTAT database (FAO, 2005d). As relevant irrigated crops within this marginal group barley, sorghum, oats and buckwheat were identified. From these crops, sorghum as the only crop was assumed to be irrigated in the sub-national climate zones Centre-West, North and Northeast. In this special case, no area of the aggregate class / crop item was mentioned. Harvested area was distributed for the Southeast assuming 80% sorghum, 10% oats, and 10% buckwheat, and for the South 80% oats, 10% barley, and 10% buckwheat, respectively. As permanent crops sugar cane, citrus, different fruit trees, grapes, flowers, and fodder grasses / managed grassland are cultivated. Besides rice (ca. 1 Mha, from the national compilation), sugar cane (525,000 ha), fodder grasses (530,000 ha), pulses (105,000 ha), vegetables (210,000 ha) are most important.

To define the cropping seasons, Brazil with its 27 states or federal units (Table K-4) was divided into 6 agro-ecological zones as given in the AQUASTAT report and the agricultural census (Table K-5).

Table K-4. Spatial units of Brazil (states), and their area equipped for irrigation in hectares.

No.	Unit name (state)	Area equipped for irrigation
1	Brazil_Acre	680
2	Brazil_Alagoas	156,992
3	Brazil_Amapa	1,910
4	Brazil_Amazonas	1,820
5	Brazil_Bahia	279,887
6	Brazil_Ceara	108,426
7	Brazil_Distrito Federal	11,326
8	Brazil_Espirito Santo	91,250
9	Brazil_Goias	150,943
10	Brazil_Maranhao	44,200
11	Brazil_Mato Grosso	59,139
12	Brazil_Mato Grosso do Sul	81,480
13	Brazil_Minas Gerais	319,349
14	Brazil_Para	6,980
15	Brazil_Paraiba	63,501
16	Brazil_Parana	51,750
17	Brazil_Pernambuco	118,146
18	Brazil_Piaui	24,193
19	Brazil_Rio de Janeiro	74,686
20	Brazil_Rio Grande do Norte	45,636
21	Brazil_Rio Grande do Sul	1,007,750
22	Brazil_Rondonia	4,600
23	Brazil_Roraima	8,960
24	Brazil_Santa Catarina	137,300
25	Brazil_Sao Paulo	468,400
26	Brazil_Sergipe	45,332
27	Brazil_Tocantins	66,085

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were compared to the seasons of the FAO GIEWS crop calendar (FAO, 2005c) and of United States Department of Agriculture (USDA, 1994), in order to be valid for the aforementioned 6 agro-ecological zones (FAO, 2000). Most irrigated crops are summer crops, prevalently grown in the South, Southeast, the Centre, and the West between November and April, and in the Northeast from January to June, a season also valid for vegetables that are assumed to be irrigated in winter in the North. Winter crops are irrigated from May to October in the first group of zones, and in the North and Northeast from April to October. Cotton is irrigated from October to April in the first group of zones, and from April to October in the North and the Northeast (Table K-6).

Table K-5. Climate zone grouping of Brazil.

No.	Zone / region	State name	State number
1	South	Paraná	16
		Santa Catarina	24
		Rio Grande do Sul	21
2	Southeast	Minas Gerais	13
		Espírito Santo	8
		Rio de Janeiro	19
		São Paulo	25
3	Centre-West	Mato Grosso do Sul	12
		Mato Grosso	11
		Goiás	9
		Distrito Federal	7
4	North	Rondônia	22
		Acre	1
		Amazonas	4
		Roraima	23
		Pará	14
		Amapá	3
		Tocantins	27
5	Northeast	Maranhão	10
		Piauí	18
		Ceará	6
		Rio Grande do Norte	20
		Paraíba	15
		Pernambuco	17
		Alagoas	2
		Sergipe	26
Bahia	5		

Table K-6. Scheme for irrigated cultivation seasons in Brazil.

No.	Zone / region name	Winter crops		Summer crops		Cotton		Remark
		Begin	End	Begin	End	Begin	End	
1, 2, 3	South, Southeast, Centre-West	5	10	11	4	10	4	
4, 5	North, Northeast	4	10	1	6	4	10	Cotton in winter, Shorter winter season

British Virgin Islands

No irrigation is reported for the island of British Virgin Islands.

Cayman Islands

No irrigation is reported for the Cayman Islands.

Canada

Irrigated area:

The area equipped for irrigation, 785,046 ha, was taken from the Global Map of Irrigation Areas version 4 (Siebert *et al.*, 2007). The spatial distribution was made using areas from the national agricultural census of 2001 (Statistics Canada, 2001). Distribution to crop groups forage, cereals, oil seeds and special cultures for the most important provinces Alberta, British Columbia, Manitoba and Saskatchewan (ca. 90% of equipped area) were found in (Chinn, 1999). Its relative values were assumed to be representative for Canada and the areas transferred to actually irrigated areas by assuming that in these provinces 100% of the area with “use of irrigation” was actually irrigated. Thus, this province-specific area was multiplied with the percentage of each crop group mentioned for each of the 4 provinces. Subsequently, the resulting sum of all provinces per crop group was broken down to individual crops by relative percentages of harvested irrigated area drawn from the United States of America Agricultural Census 2002 statistics sum for the neighbouring north-western zone (states of Idaho, Montana, North Dakota, Oregon, Washington, and Wyoming). There were finally 17 crops: barley, maize for grain, oats, wheat (winter, durum, other spring), maize for silage or greenchop, sorghum for silage or greenchop, alfalfa, fescue, ryegrass, rest grasses, forage (land used for all hay), land in berries harvested for sale, land used for vegetables, land in orchards, and sunflower. This included the assumption that oil seeds were exclusively represented by sunflower. Because no information on irrigated citrus or grapes was available and assuming that no citrus was grown and that grapes were probably not irrigated, land in orchards was not disaggregated to these two crops. No scaling to the whole area of Canada was made, so that the national ratio of actually used to equipped areas remained at the 90% share of the four provinces on Canada's total. Forage is the most important crop (287,000 ha), followed by barley, wheat, orchards, sunflower, vegetables and maize (26,000 ha).

Cropping seasons:

The cropping seasons were assumed to be the same as for neighbouring United States of America. Winter wheat, barley, and rye are assumed to be winter crops grown from October to June (winter wheat) and from November to May (barley and rye). Summer cropping season is from April to September, with the exception of sugar beets (March to September) and cotton (March to October). The only difference to the United States of America is, that for Canada, only one cropping season for vegetables is assumed from April to September. A cropping intensity of 1 is present for all crops.

Chile

Irrigated area:

The area equipped for irrigation 1,900,000 ha is the one given in (FAO, 2000). The actually irrigated area were taken from the AQUASTAT report (FAO, 2000), supported by information in the FAO crop calendar for irrigated crops (FAO, 2005b), and are representative for 1996. The area of the latter for irrigated wheat (268,000 ha) was assumed to be too high for winter wheat, given that less than half the value (ca. 110,000 ha) was cited in the AQUASTAT report. This lower value corresponds to around 30% of the wheat harvested area from the FAOSTAT database (FAO, 2005d). Fodder (ca. 167,000 ha) was assumed to consist of annual crops, grown permanently on the same set of fields, although it was mentioned to be permanent in the AQUASTAT report. Fruits (ca. 220,000 ha), fodder, wheat, and vegetables (ca. 110,000 ha) are the most important crops.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used. Like in Argentina, summer crops are irrigated from November to March, besides cotton that is grown from April to October. Permanent irrigated cultures are fruits, grapes and citrus. The seasons of the FAO GIEWS general crop calendar were in good agreement with the cropping seasons of the irrigated crops (rice and cotton) or the summer season (millet and sorghum).

Colombia**Irrigated area:**

The area equipped for irrigation 900,000 ha, is the one given in (FAO, 2000). The actually irrigated area were taken from the FAO crop calendar for irrigated crops (FAO, 2005b), as the AQUASTAT report (FAO, 2000) cites only public sector irrigation and no private sector actually irrigated areas. Rice and sugar cane are by far the most important irrigated crops above 100,000 ha, followed by vegetables. As permanent crops besides sugar cane, plantains (bananas), fruit orchards and citrus are cultivated. Fodder is assumed to consist of annual crops.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used. Only one cropping season of annual irrigated crops exist, from March to June, besides fro cotton (August to February) and fodder (September to January). The seasons of the FAO GIEWS crop calendar (wheat, maize, rice, barley, sorghum and soybeans) (FAO, 2005c) were in good agreement with the irrigated crop calendar.

Costa Rica**Irrigated area:**

The area equipped for irrigation, 103,083 ha, is the one given in (FAO, 2000) for 1997. The actually irrigated area was taken from the AQUASTAT report (FAO, 2000), the FAO crop calendar for irrigated crops (FAO, 2005b), and assisted by the harvested area from the FAOSTAT database (FAO, 2005d). For rice, bananas and also sugar cane the areas in the FAO calendar and the AQUASTAT report are more or less the same than those of FAOSTAT, but for periods between 1990 and 1997, indicating that these crops were 100% irrigated at this time. The AQUASTAT harvested areas were used for these crops and also for citrus that was cited, too. For plantains, pulses, and vegetables the areas of the FAO calendar were taken, as it was assumed that these crops were still irrigated during 1998-2002, but by less than 100%. The harvested areas were scaled to fit to the equipped area of 1997, using the ratio of explicitly stated equipped area (FAO, 2000) to uncertain equipped area of the FAO calendar (ca. 120,000 ha) (FAO, 2005b).

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used. Two cropping seasons of annual irrigated crops exist, from April to August and from September to January. The seasons of the FAO GIEWS crop calendar (maize, rice, sorghum) (FAO, 2005c) were in good agreement with the irrigated crop calendar, only sorghum (and likewise millet) was assumed to be cropped later from October to April.

Cuba

Irrigated area:

The area equipped for irrigation, 870, 319 ha, is the one given in (FAO, 2000). The actually irrigated area were taken from the AQUASTAT report (FAO, 2000), supported by information in the FAO crop calendar for irrigated crops (FAO, 2005b). The area of the crop group “roots, tubers, vegetables, grains” (ca. 166,000 ha) was arbitrarily distributed to the crops that were assumed to build the major part of this group, i.e. potatoes (100,000 ha) and the rest to vegetables. The crop group of “citrus and fruit orchards” was assumed to be mainly citrus. As a result, sugar cane, rice and potatoes are major crops above 100,000 ha, besides vegetables and tobacco. Permanent crops are sugar cane and citrus.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used. Only one cropping season of annual irrigated crops exists. Rice, potatoes and tobacco are irrigated from June to September. The seasons of the FAO GIEWS crop calendar (FAO, 2005c) were in good agreement with the main cropping season of rice, but not for potatoes.

Dominica

No irrigation is reported for the island of Dominica.

Dominican Republic

Irrigated area:

The area equipped for irrigation 269,710 ha, is the one given in (FAO, 2000) which is only the area of public systems. The actually irrigated area was taken from the FAO crop calendar for irrigated crops (FAO, 2005b), as the AQUASTAT report (FAO, 2000) does not cite crop areas, but mainly sugar cane, rice and bananas. Similar to Cuba, sugar cane and rice are dominant crops above 100,000 ha harvested area, while vegetables and fruit trees (assumed to be the cited bananas) only have marginal areas.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used. A main cropping season from March to July is present, about 3 months earlier than in Cuba (June to September). Rice is irrigated on the same areas another time from August to December, with a cropping intensity of 2. The seasons of the FAO GIEWS crop calendar (FAO, 2005c) were in good agreement with the main and secondary cropping season of rice. For maize and sorghum they list three identical cropping seasons, of which the first corresponds roughly to the main cropping season of rice.

Ecuador

Irrigated area:

The area equipped for irrigation, 863,370 ha, is the one given in (FAO, 2000). The actually irrigated area was taken from the FAO crop calendar for irrigated crops (FAO, 2005b). The AQUASTAT report (FAO, 2000) cited only public sector crop-specific harvested irrigated area, also “pastos” which was not further considered as its definition was unclear (pasture or fodder). A linear scaling of the crop-specific areas via the ratio of total used area of private and public irrigation sector did not yield the same relative shares of the FAO crop calendar. The latter was considered to be the better source, including the private sector and mentioning also crop-specific harvested area of wheat, barley, potatoes, and pulses. Rice and maize are by far the most important irrigated crops above 100,000 ha, followed by permanent crops fruits and sugar cane.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used. Only one cropping season of annual irrigated crops exist, from May to September. The seasons of the FAO GIEWS crop calendar (FAO, 2005c) (wheat, maize, rice and barley) were in bad agreement with the irrigated crop calendar, perhaps of the difficulties of associating rainfed and irrigated cultivation seasons in a inner-tropical climate.

El Salvador

Irrigated area:

The area equipped for irrigation, 44,993 ha, is the one given in (FAO, 2000) for 1997. The actually irrigated area was taken from the AQUASTAT report (FAO, 2000), that gave consistent values to the FAO crop calendar for irrigated crops (FAO, 2005b). The latter also mentions rice an harvested area (8,000 ha) that is supported by nearly the same mean for 1998-2002 (8,111 ha) in the FAOSTAT database (FAO, 2005d). Fodder (ca. 27,000 ha harvested area), sugar cane (ca. 9,000 ha), and rice are the most important crops, followed by maize (ca 2,700 ha), coffee and citrus.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used. Like in neighbouring Honduras, two cropping seasons of annual irrigated crops exist, which start earlier (with the exception of rice) than in neighbouring Guatemala: For rice and other crops from April to August (rice, maize) and from September to January (rice, fodder). The seasons of the FAO GIEWS crop calendar (maize, rice, beans) (FAO, 2005c) were in good agreement with the irrigated crop calendar for the main cropping season of maize and the main (but not the secondary) cropping season of rice, respectively.

Falkland Islands (Malvinas)

No irrigation is reported for the Falkland Islands (Malvinas).

French Guiana

Irrigated area:

The area equipped for irrigation given in the Global Map of Irrigation Areas version 4 (Siebert *et al.*, 2007) is 2,000 ha. The currently actually irrigated areas for this French overseas department was drawn from data of the French Environmental Agency (IFEN, 2005), summing to 6,007 ha which was taken as the current equipped area. Information of the EUROSTAT regional database on irrigated areas (EUROSTAT, 2005) was used to distribute additionally areas of specific crops with weighted shares using information on existing equipped areas in French Guiana, Guadeloupe, Martinique, and Réunion. The list of crops not cited by EUROSTAT and their shares were estimated based on information in (Achnich, 1980) and (FAO, 2000), mentioning rice and small amounts of vegetables in the case of French Guiana, up to the total actually irrigated area of 6,007 ha. Thus, French Guiana has mostly irrigated rice and sugar cane, with some marginal vegetable, fruit and berry orchards (including bananas / plantains), citrus and potatoes areas.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) for Guyana were used as far as possible. The cropping seasons of the FAO GIEWS crop calendar (FAO, 2005c) (maize, rice, soybeans) corresponds for rice to the irrigated seasons. In contrast to Guyana, only one single cropping season for rice is necessary to fill the irrigated harvested area of rice with the equipped area. Potatoes are cropped in winter from December to April, vegetables from May to September.

Grenada

Irrigated area:

The area equipped for irrigation, 218.5 ha, is the one given for 1996 in (FAO, 2000). The actually irrigated area was interpreted from the AQUASTAT report (FAO, 2000) as being the equipped area which was distributed to the cited crops vegetables (90% assumed relative share of irrigated area), fruit trees (5%), cut flowers (2%, assumed to be annual crops), maize (2%) and root crops assumed to be cassava (1%). Vegetables are by far the important irrigated crop (197 ha of 219 ha).

Cropping seasons:

The cropping seasons of neighbouring Trinidad and Tobago were used. Two cropping seasons of annual irrigated crops exist, during summer from June to November (maize, cassava) and during winter from December to April (Vegetables, cut flowers).

Guadeloupe

Irrigated area:

The area equipped for irrigation given in the Global Map of Irrigation Areas version 4 (Siebert *et al.*, 2007) is 2,000 ha. The currently actually irrigated areas for this French overseas department was drawn from data of the French Environmental Agency (IFEN, 2005), summing to 8,146 ha which was taken as the current equipped area. Information of EUROSTAT regional database on irrigated areas (EUROSTAT, 2005) was used to distribute additionally areas of specific crops with weighted shares using information on existing equipped areas in French Guiana, Guadeloupe, Martinique, and Réunion. The list of crops not cited by EUROSTAT and their shares were estimated based on information in (Achnich, 1980) and (FAO, 2000), mentioning besides fruits also sugar cane and vegetables, up to an actually equipped irrigated area of 5,697 ha. Thus, Guadeloupe has mostly irrigated sugar cane and fruit and berry orchards (including bananas / plantains), with some marginal vegetable, potatoes, and citrus areas.

Cropping seasons:

The cropping seasons as given by the crop calendar for Saint Kitts and Nevis were used, that itself is derived from the FAO crop calendar for irrigated crops (FAO, 2005b) for Trinidad and Tobago. In contrast to French Guiana and Guyana, Potatoes are cropped in winter from February to April, vegetables from December to April.

Guatemala

Irrigated area:

The area equipped for irrigation, 129,803 ha, is the one given in the AQUASTAT report (FAO, 2000). The irrigated harvested area (129,803 ha) was taken from the FAO crop calendar for irrigated crops (FAO, 2005b). In the AQUASTAT report only relative percentages for 1997 were given for the crop groups “basic cereals and vegetables”, “sugar cane” and “pastos” (omitted because of unclear classification as fodder or pasture), “bananas” and “fruits”, which did not correspond to the areas of the FAO calendar with the exception of “fruits” that corresponded to citrus in the latter. Sugar cane is by far the most dominant crop with roughly 99,000 ha harvested area, followed by rice (ca. 7,000 ha harvested), and equal shares of ca. 5,000 ha of maize and vegetables each (harvested each 10,000 ha) and bananas. For consistency, the original harvested area was scaled with the corresponding ratio of the equipped area of the FAO (FAO, 2000) (129,803 ha) and the (rounded) equipped area (130,000 ha) of the FAO crop calendar for irrigated crops (FAO, 2005b).

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used. In summer, crops are irrigated from April to August (rice, maize, vegetables) and partly also from September to January (maize, vegetables). Permanent irrigated cultures are sugar cane, bananas / plantains and citrus. The seasons of the FAO GIEWS crop calendar (FAO, 2005c) were in good agreement with the summer irrigated crops rice, maize (main and second season).

Guyana

Irrigated area:

The area equipped for irrigation, 150,134 ha, is the one given in (FAO, 2000). The actually irrigated area was taken from the mean harvested area (1998-2002) from the FAOSTAT database (FAO, 2005d) with the following assumptions from the FAO crop calendar for irrigated crops (FAO, 2005b) and the AQUASTAT report (FAO, 2000), because the relative harvested areas and the absolute areas showed strong coincidence in all of the three sources: Sugar cane (ca. 127,000 ha) and rice (ca. 48,000 ha) are 100% irrigated. For irrigated vegetables (ca. 3,200 ha), the ratio of the area in the FAO calendar and the FAOSTAT harvested area for the period 1990-1995 gave an irrigation ratio of roughly 3/5 that was applied to the FAOSTAT harvested area for the period 1998-2000. Like in neighbouring Venezuela and Colombia, rice and sugar cane are by far the most important irrigated crops. No permanent crops besides sugar cane are irrigated.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used as far as possible. The cropping seasons of the FAO GIEWS crop calendar (FAO, 2005c) (maize, rice, soybeans) correspond only for rice to the irrigated seasons. A second cropping season for rice is arbitrarily introduced from October to February to reconcile the irrigated harvested area of rice with the small equipped area which is for 1991 and is reported to be in bad conditions in (FAO, 2000) and the assumed 100% irrigated sugar cane as a constraint, as the area of it fits to the still bigger area of sugar state farms as cited in (FAO, 2000). For Maize, the cropping season of the FAO GIEWS calendar was used. For the other crops, the same repartitioning as in Venezuela was used, with the summer season starting in April with the rainy season in the interior.

Haiti

Irrigated area:

The area equipped for irrigation, 91,502 ha, is the one of a national survey for 1991 given in (FAO, 2000). The actually irrigated area was taken from the FAO crop calendar for irrigated crops (FAO, 2005b), as the AQUASTAT report (FAO, 2000) does not mention crop areas, and neither sugar cane, vegetables, citrus, cotton, or fruits. In contrast to Cuba and the Dominican Republic, sugar cane (9,000 ha harvested area) has only position 4 after rice (41,000 ha), vegetables (15,000 ha), and maize (12,000 ha). It is followed by citrus, pulses and small areas of fruit trees and cotton (1,000 ha each).

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used. The same two cropping seasons as in the Dominican Republic are present. A main cropping season from March to July is present, about 3 months earlier than in Cuba (June to September). Rice is irrigated on the same areas another time from August to December, with a cropping intensity of 2. The seasons of the FAO GIEWS crop calendar (FAO, 2005c) were in good agreement with the main and secondary cropping season of rice. For maize the second cropping season is more or less parallel to the main cropping season. Thus, its meaning is unclear and is not further considered. Sorghum is grown during the second cropping season, from August to December, rather than the first as in the Dominican Republic. Cotton is irrigated from August to February.

Honduras

Irrigated area:

The area equipped for irrigation, 73,210 ha, is the one given in (FAO, 2000) for 1997. The actually irrigated area was taken from the FAO crop calendar for irrigated crops (FAO, 2005b), as the AQUASTAT report (FAO, 2000) does not mention crop areas, and neither plantains, bananas, pulses, vegetables, citrus, or cotton. Maize (29,000 ha harvested area), pulses, rice, and sugar cane (11,000 ha) are the most important. As permanent crops besides sugar cane, bananas, citrus and plantains are cultivated. Other annual crops are vegetables and cotton.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used. Like in neighbouring Nicaragua, two cropping seasons of annual irrigated crops exist, which start earlier (with the exception of rice) than in neighbouring Guatemala: For maize and other crops from April to August (maize, rice, vegetables) and from September to January (maize, pulses). The seasons of the FAO GIEWS crop calendar (wheat, maize, rice, sorghum, potatoes) (FAO, 2005c) were in good agreement with the irrigated crop calendar for the main and second cropping season of maize and main cropping season of rice, respectively. Cotton is grown from September to March.

Jamaica

Irrigated area:

The area equipped for irrigation, 25,214 ha, is the one for 1997 given in (FAO, 2000). The actually irrigated area was taken from the AQUASTAT report (FAO, 2000), supported by information in the FAO crop calendar for irrigated crops (FAO, 2005b). Pasture as cited under annual crops in the AQUASTAT report is considered to be fodder in the FAO calendar, and is included as annual fodder crops, and classified as the similarly treated “other (annual) crops”. Sugar cane is by far the most important crop, followed by bananas, fodder and vegetables. Other permanent cultures (berry orchards, papaya, and coffee) are only present with minor areas.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used and extended with information by the seasons of the FAO GIEWS crop calendar (FAO, 2005c) for Cuba. Two cropping seasons of annual irrigated crops exist. Vegetables are irrigated from May to September, starting one month earlier than in Cuba. Other annual cultures are grown from December to March, pasture as fodder grasses / managed grassland throughout the year.

Martinique

Irrigated area:

The area equipped for irrigation given in the Global Map of Irrigation Areas version 4 (Siebert *et al.*, 2007) is 3,000 ha. The currently actually irrigated areas for this French overseas department was drawn from data of the French Environmental Agency (IFEN, 2005), summing to 6,730 ha which was taken as the current equipped area. Information of the EUROSTAT regional database on irrigated areas (EUROSTAT, 2005) was used to distribute additionally areas of specific crops with weighted shares using information on existing equipped areas in French Guiana, Guadeloupe, Martinique, and Réunion. The list of crops not cited by EUROSTAT and their shares were

estimated based on information in (Achnich, 1980) and (FAO, 2000), concerning sugar cane and vegetables in the case of Martinique. This led to an actually equipped irrigated area of 6,730 ha. Thus, Martinique has mostly irrigated sugar cane and fruit and berry orchards (including banana / plantains), with some marginal vegetable, potatoes, and citrus areas.

Cropping seasons:

The cropping seasons as given by the crop calendar for Saint Kitts and Nevis were used, that itself is derived from the FAO crop calendar for irrigated crops (FAO, 2005b) for Trinidad and Tobago. In contrast to French Guiana and Guyana, Potatoes are cropped in winter from February to April, vegetables from December to April.

Montserrat

No irrigation is reported for the island of Montserrat.

Mexico

Irrigated area:

The area equipped for irrigation sums to 6,435,800 ha from irrigation units (“unidades de riego”) for 1998 and from irrigation districts (“distritos de riego”) for 2004 as given by (CNA, 2005). The irrigated harvested area was taken from the FAO crop calendar for irrigated crops (FAO, 2005b). The harvested area for fodder crops as given by the FAO crop calendar for irrigated crops (FAO, 2005b) was partitioned according to consistent areas of the AQUASTAT report (FAO, 2000) between crop groups “cereals for fodder” and “alfalfa for fodder”, the latter classified here as permanent fodder grasses / managed grassland. The cereals for fodder were disaggregated to maize, rye and sorghum using roughly the consistent mean harvested areas for 1990-1995 in the FAOSTAT database (FAO, 2005d). For sorghum and sugar cane the two sources mention different areas, and the area of the FAO calendar was taken in order to use a consistent source as much as possible. Other cereals were assumed to be mostly oats, as rye for fodder was already contained elsewhere. The final harvested areas were slightly scaled to 5,958,094 ha with the ratio of the areas equipped for irrigation of the year 2004 of the Global Map of Irrigation Areas version 4 (Siebert *et al.*, 2007), representing sub-national data, to the national total area of the year 1995 from the AQUASTAT report (FAO, 2000). Maize is the most important irrigated crop (ca. 1.4 Mha), followed by wheat (ca. 635,000 ha) and sorghum (ca. 650,000 ha). The original harvested area cited by the FAO crop calendar for irrigated crops (FAO, 2005b) was scaled with the corresponding ratio of national equipped area of FAO and sub-national equipped area of FAO.

Cropping seasons:

Main crops are maize (summer season) and sorghum (summer season) that are irrigated like the other summer crops from June to October. Besides the permanent irrigated cultures of sugar cane, citrus and fruit trees, only wheat (November to May) and rye (for fodder) (November to May) are irrigated in winter. Alfalfa for fodder is assumed to be grown as a permanent crop. Oil crops (ca. 24,000 ha) are repartitioned between linseed and mustard seed roughly according to their shares of harvested area in 1998-2002 in the FAOSTAT database (FAO, 2005d) and cropped with the same cropping season but greater share for mustard in the summer than for linseed in winter. This fits well into the kernel seasons given by the FAO GIEWS crop calendar (FAO, 2005c). For maize, the second cropping season during winter for the north-west of Mexico is not considered (kernel

growing from November to December, sowing starting in September, and harvest ending in March). Likewise for sorghum, the second cropping season in winter was not considered, too (season (2)4-5(6)). The resulting percentage of monthly irrigation intensity is a rounded 44% throughout the year.

Netherlands Antilles

No irrigation is reported for the Netherlands Antilles.

Nicaragua

Irrigated area:

The area equipped for irrigation, 61,365 ha, is the one given in (FAO, 2000) for 1997. The actually irrigated area was taken from the FAO crop calendar for irrigated crops (FAO, 2005b), for which consistent areas are mentioned in the AQUASTAT report (FAO, 2000) with the exception of maize, pulses, and vegetables that were not cited. For consistency, the original harvested area was slightly scaled with the corresponding ratio of the equipped area of the FAO (FAO, 2000) and the (rounded) equipped area (61,000 ha) of the FAO crop calendar for irrigated crops (FAO, 2005b). Sugar cane and rice are by far the most important crops (21,000-22,000 ha harvested area). As permanent crops besides sugar cane, citrus and bananas are cultivated. Other annual crops are maize, pulses, vegetables, and fodder.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used. Like in neighbouring Costa Rica, two cropping seasons of annual irrigated crops exist, which start in different months: Rice from February to June and from July to November, and for maize and other crops they start from June to October and from November to March. The seasons of the FAO GIEWS crop calendar (maize, rice, sorghum, beans) (FAO, 2005c) were in good agreement with the irrigated crop calendar for the main cropping season. The secondary and third cropping season are joined for maize and rice, and the secondary are omitted for sorghum.

Panama

Irrigated area:

The area equipped for irrigation, 34,626 ha, is the one given in (FAO, 2000) for 1997. The actually irrigated area was mainly taken from the AQUASTAT report (FAO, 2000) and for vegetables and fruits from the FAO crop calendar for irrigated crops (FAO, 2005b). Sugar cane (15,000 ha), bananas (6,000 ha) and fruit trees are the most important crops. As permanent crops besides sugar cane, bananas, fruit trees, also plantains are cultivated.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used. In contrast to Costa Rica, only one cropping season of annual irrigated crops exists from May to September starting a month later than in Costa Rica. The seasons of the FAO GIEWS crop calendar (maize, rice) (FAO, 2005c) were in good agreement with the irrigated crop calendar.

Paraguay

Irrigated area:

The area equipped for irrigation, 67,000 ha, is the one given in the AQUASTAT report (FAO, 2000). The irrigated harvested area was taken from the FAO crop calendar for irrigated crops (FAO, 2005b), as in the AQUASTAT report no harvested crop areas were specified for sugar cane and rice. Sugar cane (34,000 ha) and rice (18,000 ha) are the most dominant crops. Vegetables, which are listed only as “other annual crops” in the AQUASTAT report, only have marginal areas (2,000 ha harvested area).

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used. In summer, crops are irrigated from November to March, as in Argentina (rice, vegetables). Permanent irrigated culture is sugar cane. The seasons of the FAO GIEWS crop calendar (FAO, 2005c) were in good agreement with the summer irrigated crops rice and vegetables.

Peru

Irrigated area:

The area equipped for irrigation on province level for 1994 is 1,729,068 ha (Instituto Nacional de Estadística e Informática, 1996), which is given in (FAO, 2000). The actually irrigated area for 1994 is 1,109,000 ha (Ministerio de Agricultura, 2006). This area is a little bit less than the area in the FAO crop calendar for irrigated crops (FAO, 2005b) from which the crop-specific harvested areas were taken, as in the AQUASTAT report (FAO, 2000) only wheat, rice, sugar cane, and the crop groups “cereals for animal production” and “permanent crops” were listed without harvested area. For consistency, the original harvested area was slightly scaled with the corresponding ratio of the equipped area of the FAO (FAO, 2000) and the (rounded) equipped area (1,195,000 ha) of the FAO crop calendar for irrigated crops (FAO, 2005b). Rice, maize, vegetables, wheat and potatoes are major crops above 100,000 ha. Permanent crops are sugar cane, plantains, fruits and citrus.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used. Two seasons exist: Cereals in late summer from February, and other annual crops during winter from June to November. Cotton is grown from November to May. The seasons of the FAO GIEWS general crop calendar were in good agreement with the cropping seasons of the irrigated crops.

Puerto Rico

Irrigated area:

The area equipped for irrigation, 37,079 ha, is the one given in the Global Map of Irrigation Areas version 4 (Siebert *et al.*, 2007). The actually irrigated area (44,439 cuerdas or 17,465 ha) for 2002 was taken from the USDA Agricultural Census 2002 (USDA and NASS, 2004b), the areas in cuerdas converted into hectares according to the conversion factor of 0.3930 hectare per cuerda specified there. The irrigated crop areas were taken from the list specified there in Table 75. The area missing to the total irrigated area (100 ha) was attributed equally to the 3 classes sugar cane,

root crops/tubers, and general primarily livestock farms (classified as fodder grasses / managed grassland), for which data was withheld to avoid disclosing data for individual farms. The major part is dairy and livestock farming (ca. 10,000 ha), then fruits (ca. 3,500 ha), and vegetables (ca. 1,500 ha) and horticultural specialities (ca. 1,600 ha), followed by grains (assumed mostly maize, ca. 400 ha) and coffee (ca. 200 ha).

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) for the Dominican Republic were used. A main cropping season from March to July is present for annual crops, about 3 months earlier than in Cuba (June to September).

Saint Kitts and Nevis**Irrigated area:**

The area equipped for irrigation, 18 ha, is the one given for assumedly 1996 in (FAO, 2000). The actually irrigated area was interpreted from the AQUASTAT report (FAO, 2000) as being the equipped area which was attributed arbitrarily to be 100% vegetables.

Cropping seasons:

The cropping seasons of near-by Trinidad and Tobago were used as a starting point. In principle, two cropping seasons of annual irrigated crops exist, during summer from June to November and during the dry winter season from December to April (vegetables).

Saint Lucia**Irrigated area:**

The area equipped for irrigation, 297 ha, is the one given for assumedly 1996 in (FAO, 2000). The actually irrigated area was interpreted from the AQUASTAT report (FAO, 2000) as being the equipped area which was distributed to the cited crops pastures (65 ha), bananas (70% of rest), vegetables (20% of rest) and fruit trees (10% of rest). Bananas have by far the largest area.

Cropping seasons:

The cropping seasons of neighbouring Trinidad and Tobago were used. In principle, two cropping seasons of annual irrigated crops exist, during summer from June to November and during the dry winter season from December to April (vegetables).

Saint Pierre and Miquelon

No irrigation is reported for the islands of Saint Pierre and Miquelon.

Saint Vincent and the Grenadines

According to the AQUASTAT report (FAO, 2000), there is no irrigation in Saint Vincent and the Grenadines.

Suriname

Irrigated area:

The area equipped for irrigation, 51,180 ha, is the one given for 1998 in (FAO, 2000). The actually irrigated area was taken from the AQUASTAT report (FAO, 2000). Rice (49,000 ha) and bananas seem nearly 100% irrigated and fill the equipped area by 100%. No permanent crops besides bananas are irrigated.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used as far as possible. The cropping seasons of the FAO GIEWS crop calendar (FAO, 2005c) (maize, rice, soybeans) correspond for rice to the single irrigated season from May to September.

Trinidad and Tobago

Irrigated area:

The area equipped for irrigation, 3,600 ha, is the one given in (FAO, 2000). The actually irrigated area was interpreted from the AQUASTAT report (FAO, 2000) as being the equipped area which was distributed arbitrarily to the cited crops sugar cane, rice and vegetables according to their relative relationship of harvested area from the FAOSTAT database (FAO, 2005d). Sugar cane is by far the most important irrigated crop.

Cropping seasons:

The cropping seasons of Venezuela as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were tried to be used, but the FAO GIEWS general crop calendar showed other main cropping seasons. Two cropping seasons of annual irrigated crops exist, during summer from June to November and during winter from December to April.

Turks and Caicos Islands

No irrigation is reported for the Turks and Caicos Islands.

United States of America

Irrigated area:

The area equipped for irrigation, roughly 27.9 Mha, was taken from the Global Map of Irrigation Areas version 4 (Siebert *et al.*, 2007). For the sub-national distribution of the irrigated crop areas they were divided into the 51 states or federal districts. Further territories governed by the United States of America are listed separately, e.g. American Samoa, Guam, etc. (Table K-7). The actually irrigated area was taken from the national agricultural census of 2002 (USDA and NASS, 2004a) and (USDA and NASS, 2004e) that cites 41 classes of irrigated crops. The state-level values were aggregated to the national sums, in order to have consistency when sub-national units are considered in downscaling. The values were then converted from data unit acres into data unit hectares using a conversion factor of 0.40468564224. On a national scale, the most important crops are forage crops (e.g. hay) (ca. 4.16 Mha irrigated harvested area), maize (ca. 4.4 Mha), soybeans

(2.2 Mha), cotton (1.9 Mha), rice (1.29 Mha), and vegetables (954,000 ha). Permanent cultures are “orchards” (including bearing and non-bearing fruit trees, citrus and vineyards/grapes), berry orchards, and pineapple cultures. For not explicitly cited citrus and grapes, assumptions had to be made according to agro-ecological zones (Tables K-8 and K-9): The cultivated area of citrus was assumed to be fully irrigated, including all areas cited for Florida, using information on the states of Arizona, California, Florida, Hawaii, Louisiana, Mississippi, and Texas. The cultivated area of grapes was assumed to be fully irrigated in all states not belonging to the north-eastern, north-western (exception Oregon), and northern Great Plains zone (all besides North and South Dakota). Of course, strong regional differences exist, as the area equipped for irrigation is very different (Table K-7).

Cropping seasons:

To define the cropping seasons, the United States of America with its 51 sub-national units (Table K-7) were assigned to 7 agro-ecological zones (Table K-8). The overall cropping seasons were synthesised using crop calendars of Europe, information of the normal crop calendar of the United States Department of Agriculture (USDA) - Foreign Agricultural Service (FAS) - Production Estimates and Crop Assessment Division (PECAD) (USDA, 2006), a crop calendar for Oklahoma for 2001-2002 (Oklahoma State University, 2006), for vegetables and fruits in California (DHS, 2006), and for rice according to the International Rice Research Institute (IRRI, 2005).

Irrigated crops were assumed to be mostly cultivated during the summer, normally between May and September or October. Two annual crops have longer seasons: cotton (April to November) and sugar beets (April to September). Winter wheat is the only overall exception, assumed to be grown from October to June, besides in Alaska. A cropping intensity of 1 is assumed, besides for vegetables that are assumed to be grown in two seasons, some times of unequal length, with a cropping intensity of 2. For specific zones, this standard scheme was adjusted (Table K-9)

United States Virgin Islands

Irrigated area:

The area equipped for irrigation, 185.54 ha, is the one given in the Global Map of Irrigation Areas version 4 (Siebert *et al.*, 2007), as derived from the 456 acres specified in the USDA Agricultural Census 2002 (USDA and NASS, 2004b). The actually irrigated area (456 cuerdas or 185.54 ha) for 2002 was taken from the same source, the areas in cuerdas converted into hectares according to the conversion factor of 0.3930 hectare per cuerda specified there. The irrigated crop areas were taken from the list specified there in Tables 9, 10, and 11 for fruit orchards and coconuts (ca. 50 ha), vegetables, roots and tubers that are all assumed to be 100% irrigated. The rest (ca. 95 ha) is assumed to be managed grassland (fodder grasses) for diary products.

Cropping seasons:

The cropping seasons of Puerto Rico, based on that of the FAO crop calendar for irrigated crops (FAO, 2005b) for the Dominican Republic were used. A main cropping season from March to July is present for annual crops, about 3 months earlier than in Cuba (June to September).

Table K-7. Spatial units of the United States of America (states), and their area equipped for irrigation in hectares.

No.	Unit name (state)	Area equipped for irrigation
1	United States of America_Alabama	49,943
2	United States of America_Alaska	1,890
3	United States of America_Arizona	479,016
4	United States of America_Arkansas	1,908,202
5	United States of America_California	4,260,584
6	United States of America_Colorado	1,517,947
7	United States of America_Connecticut	8,486
8	United States of America_Delaware	39,983
9	United States of America_Florida	942,116
10	United States of America_Georgia	642,721
11	United States of America_Hawaii	54,875
12	United States of America_Idaho	1,536,160
13	United States of America_Illinois	188,314
14	United States of America_Indiana	135,438
15	United States of America_Iowa	71,816
16	United States of America_Kansas	1,376,642
17	United States of America_Kentucky	30,143
18	United States of America_Louisiana	453,645
19	United States of America_Maine	15,295
20	United States of America_Maryland	36,580
21	United States of America_Massachusetts	24,325
22	United States of America_Michigan	195,655
23	United States of America_Minnesota	245,623
24	United States of America_Mississippi	653,488
25	United States of America_Missouri	568,601
26	United States of America_Montana	908,364
27	United States of America_Nebraska	3,464,899
28	United States of America_Nevada	337,429
29	United States of America_New Hampshire	3,557
30	United States of America_New Jersey	53,456
31	United States of America_New Mexico	431,792
32	United States of America_New York	50,235
33	United States of America_North Carolina	129,221
34	United States of America_North Dakota	108,370
35	United States of America_Ohio	33,266
36	United States of America_Oklahoma	270,267
37	United States of America_Oregon	936,536
38	United States of America_Pennsylvania	19,491
39	United States of America_Rhode Island	2,885
40	United States of America_South Carolina	78,522
41	United States of America_South Dakota	190,326
42	United States of America_Tennessee	33,513
43	United States of America_Texas	2,978,787
44	United States of America_Utah	582,467
45	United States of America_Vermont	2,169
46	United States of America_Virginia	50,784
47	United States of America_Washington	866,946
48	United States of America_West Virginia	2,405
49	United States of America_Wisconsin	172,625
50	United States of America_Wyoming	908,873
51	United States of America_District_of_Columbia	0

Table K-8. Zone grouping of the United States of America.

No.	Zone / region name	US states
1	Northwest	Idaho, Montana, North Dakota, Oregon, Washington, Wyoming
2	California	California
3	Southwest	Arizona, Colorado, Nevada, New Mexico, Utah
4	Great Plains North	Illinois, Indiana, Iowa, Kansas, Minnesota, Missouri, Nebraska, Oklahoma, South Dakota, Wisconsin
5	Great Plains South and South	Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, South Carolina, North Carolina, Tennessee, Texas
6	Northeast	Connecticut, Delaware, Kentucky, Maine, Maryland, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, Virginia, West Virginia, District of Columbia
7	Alaska	Alaska
8	Hawaii	Hawaii

Table K-9. Individual adjustments of crop calendars for irrigated crops in different zones for the United States of America.

No.	Zone name	Remarks on irrigated crops	Citrus irrigated	Grapes irrigated
1	Northwest	Barley and rye are irrigated. Cotton and vegetables start later than United States general.	Not present	Only in Oregon
2	California	Starting and (often) ending earlier (-1 month) than in Northwest. Barley and rye are irrigated only in summer. Cotton longer (10+1). Rice longer (9+1) (IRRI calendar).	Yes	Yes
3	Southwest	Ending later (+1) than Northwest. Barley and rye are irrigated in winter. Cotton longer.	Yes (Arizona present)	Yes
4	Great Plains North	Similar to Northwest. Cotton, sorghum, soybeans ending later. Oats start early (as cited in Oklahoma calendar).	not present	Not in North & South Dakota
5	Great Plains South and South	Starting much earlier (-2) / often ending later (+1) than in Northwest. Oats start very early (because cited in Oklahoma calendar). Also irrigation in winter. Vegetables longer.	Yes (Florida, Louisiana, Mississippi, Texas present)	Yes
6	Northeast	Like Northwest	Not present	No
7	Alaska	Only short summer season (May to August). No winter wheat. Only 1 vegetable cropping season.	Not present	No
8	Hawaii	Similar to Great Plains South & South. Vegetables longer. Starting much earlier (-2) / often ending later (+1) than in Northwest. Oats very early. Also irrigation in winter.	Not present	Yes

Uruguay

Irrigated area:

The area equipped for irrigation is 217,593 ha according to the agricultural census 2000 (Ministerio de Ganadería, 2001) while the AQUASTAT report (FAO, 2000) lists 181,200 ha for 1998. The irrigated harvested area for outdoor crops is 216,979 ha, not counting covered horticulture. The sum of the sub-national values by department is only 197,492 ha. The crop group “other cereals and oilcrops” was distributed arbitrarily to be 10% wheat, 10% soybeans, and 80% sunflower. Likewise, outdoor horticulture was distributed to 30% potatoes and 70% vegetables. Other cultures were assumed to be sugar cane, and pasture to be fodder grasses / managed grassland. Rice is by far the most dominant crop with roughly 175,000 ha harvested area, followed by horticulture, fodder grasses, citrus, and other fruit trees.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used. Summer crops including wheat are irrigated from December to April (rice), only vegetables from January to April. Permanent irrigated cultures are citrus, fruit trees, grapes and sugar cane. The seasons of the FAO GIEWS crop calendar (FAO, 2005c) were in good agreement with the summer irrigated crops (December to April and January to April, respectively), with the exception of wheat that is in GIEWS assumed to be grown as winter wheat.

Venezuela (Bolivarian Republic of)

Irrigated area:

The area equipped for irrigation, 570,219 ha, is the one given in (FAO, 2000). The actually irrigated areas were taken from the FAO crop calendar for irrigated crops (FAO, 2005b), as the AQUASTAT report (FAO, 2000) cited no actually irrigated areas. Like in neighbouring Colombia, rice and sugar cane are by far the most important irrigated crops above around 100,000 ha, followed by maize, fruits, coffee, and vegetables. As permanent crops besides sugar cane, fruits, coffee, bananas/plantains and citrus are cultivated.

Cropping seasons:

The cropping seasons as given by the FAO crop calendar for irrigated crops (FAO, 2005b) were used. Two cropping seasons of annual irrigated crops exist, during summer from March to September (3 months longer than in Colombia) and during winter from December to April, besides for cotton (October to April) and fodder (September to January). The seasons of the FAO GIEWS crop calendar (maize, rice, sorghum and potatoes) (FAO, 2005c) were in good agreement with the irrigated crop calendar.

ASIA

Afghanistan

Irrigated area:

The area equipped for irrigation, 3,199,069 ha, was set to the one aggregated from district information for 1993 (Siebert *et al.*, 2005). The original harvested area cited by FAO crop calendar for irrigated crops (FAO, 2005b) was scaled with the corresponding ratio of equipped area of the FAO calendar and (Siebert *et al.*, 2005). In the Statistical Yearbook 2003 (CSO, 2004), areas of the oilseeds sunflower, linseed and sesame are cited like for seed cotton for the period 1992-2002. They are consistent with the values given by FAO, so that they were taken as the new reference values, assuming that 100% of these crops are irrigated. For wheat the areas of 1991-1996 and 2000-2003, and areas irrigated (1,067,000 ha) and rainfed (1,237,000 ha) for 2003 are given (CSO, 2004). As these areas are not consistent with scaled FAO area (ca. 1.9 Mha), the irrigated share of 2003 from this data was applied to the mean wheat area of 2000-2002 given in the Statistical Yearbook (ca. 860,000 ha). Likewise for paddy rice, the value of the latter source (ca. 130,000 ha, only half of the scaled FAO area) was used.

Cropping seasons:

The crop calendar shows some similarities to that of Pakistan.

In the winter season, irrigated wheat is grown from November to May. Similarly, barley is cultivated from December to April, potatoes from December to May. Fodder is assumed to be fodder grasses / managed grassland and cultivated throughout the year, and not only from November to April. The oilseeds were cultivated throughout the year according to the FAO irrigated crop calendar. This is distributed arbitrarily to sunflower (May to October) and linseed (November to April). Sesame is grown from July to October. All the other annual crops are grown in summer from May to September, besides cotton from April to October. Throughout the year fruit tree cultures are cultivated. The FAOSTAT database (FAO, 2005d) has no information on production in Afghanistan.

Armenia

Irrigated area:

The area equipped for irrigation, 286,027 ha, was set to the value for 1993 from a national report (Republic of Armenia, 1993) and cited in (Siebert *et al.*, 2005). The actually irrigated areas of (FAO, 1997b) were scaled with the ratio of areas equipped for irrigation of (FAO, 1997b) and (Republic of Armenia, 1993).

Cropping seasons:

Main season is the summer season from July to October. In the winter season, wheat and assumedly barley are cultivated according to the seasons given for winter wheat by the FAO GIEWS crop calendar (FAO, 2005c) from November to June (May assumed for barley), and for maize from May to October.

Azerbaijan

Irrigated area:

The area equipped for irrigation, 1,453,318 ha, was set to the value for 1995 from (FAO, 1997b) and cited in (Siebert *et al.*, 2005). (World Bank, 2003a) mentions currently 1,100,000 ha actually irrigated for 2001, also suggesting strong structural changes, such as cutting the cotton area by half from 1995 until 2001, while doubling vegetable area. The fact that in this source no areas of irrigated crops were specified needed a review of the information, of which the final result is presented here. The original harvested area for 1995 cited on page 74 in Table 3 by FAO (FAO, 1997b) was taken as a starting point, even if the sum (ca. 760,000 ha) is much smaller than the cited area for 2001. The figures for harvested area from the FAOSTAT database (FAO, 2005d) for the available time period 1992-1995 were taken as a reference, as indicated by the following fact: The rounded irrigated area of cotton for 1995 corresponds nearly exactly to the harvested area. Therefore, irrigation ratios were adjusted to fit the cited irrigated crop areas of 1995 with the following shares: For rice, cotton, melons and vegetables a ratio of 100% was assumed, for the other crops 65%. To yield the final irrigated areas for 1998-2002, the mean harvested area of FAOSTAT was multiplied with the same assumed irrigation ratios, additionally also grain maize, potatoes and sugar beets were assumed to be 100% irrigated. The total sum is much less than the cited 1.1 Mha, but it was assumed to be a more reliable estimation given the use of irrigation ratios.

Cropping seasons:

The seasons cited in the FAO GIEWS crop calendar (FAO, 2005b) for winter and spring cereals, potatoes and cotton were applied. Wheat, barley and maize are assumed to be irrigated as summer crops from April to August, also potatoes. Cotton is grown from April to October. Only rye is assumed to be irrigated from November to May. All the other annual crops including millet and sorghum are irrigated from July to October.

Bahrain

Irrigated area:

The area equipped for irrigation, 4,060 ha, is the value cited for 2000 and 2001 in national statistics (Government of Bahrain, 2004) and (Arab Organization for Agricultural Development - Agricultural Information, 2003a) as cited in (Siebert *et al.*, 2005). All cropped area is irrigated due to desert climatic reasons (FAO, 1997c). The crop areas are taken from the FAOSTAT database as mean harvested areas for the time period 1998-2002 (FAO, 2005d).

Cropping seasons:

The seasons are assumed to be the same as for neighbouring Saudi-Arabia with similar climate. As permanent crops dates, citrus, grapes and others (e.g. bananas, nut trees) are cultivated. As annual crops besides vegetables, pulses and potatoes are grown during summer from July to November. Theoretically they could be cropped in three seasons of equal length of 4 months starting in January with a cropping intensity of 3. Alfalfa as forage and silage crop is assumed to be grown semi-permanently throughout the year with 3-4 cuts per year.

Bangladesh

Irrigated area:

The area equipped for irrigation, 3,751,045 ha, was set to the one cited for 1995 by (Bangladesh Bureau of Statistics, 2004) and cited in (Siebert *et al.*, 2005). The original harvested area cited by the FAO crop calendar for irrigated crops (FAO, 2005b) was scaled with the corresponding ratio of equipped area of FAO and of (Bangladesh Bureau of Statistics, 2004) as cited in (Siebert *et al.*, 2005), leading to slightly increased values because of an increased number of significant figures.

Cropping seasons:

The crop calendar is based on FAO information and is similar to that of eastern India. Main crop is rice that is irrigated in two cropping seasons throughout the year. The original FAO irrigated crop calendar (FAO, 2005b) that cited a main season in May and June was updated with the information of the FAO GIEWS crop calendar (FAO, 2005c) mentioning three single different cropping seasons for different varieties of rice. So besides the cropping season from December to April, another extended cropping season from May to November is assumed to be present. All the other crops (wheat, potatoes, pulses, vegetables, and rapeseed) are irrigated during winter from December to April, besides the permanently cropped sugar cane.

Bhutan

Irrigated area:

The area equipped for irrigation, 38,733 ha, is for 1994 as given by (Land Use Planning Project, 1995) in the FAO AQUASTAT report (FAO, 1999) and cited in (Siebert *et al.*, 2005). Rice is the most important crop. The original harvested area cited by FAO was scaled with the corresponding ratio of equipped “wetland” area and (Land Use Planning Project, 1995).

Cropping seasons:

Main crop is rice on the terraced valley bottoms being irrigated on roughly 39,000 ha almost only in summer (38,734 ha, assumed June to October) and to a much lesser extent in winter (545 ha, November to May). The other crops are irrigated in winter from November to May on the same areas as rice. The resulting maximum percentage of monthly irrigation intensity is 100% during summer.

British Indian Ocean Territory

No irrigation is reported for the British Indian Ocean Territory.

Brunei Darussalam

Irrigated area:

The area equipped for irrigation, 1,000 ha, is the 1995 value of FAO (FAO, 1999) cited in (Siebert *et al.*, 2005). In the FAO AQUASTAT report (FAO, 1999), only harvested area for rice is mentioned, besides vegetables and fruits. Rice is dominating the crops on ca. 375 ha, but also

vegetables (estimated same area as rice) and fruit trees (estimated as rest of equipped area) are cultivated, neglecting other mentioned crops as marginal.

Cropping seasons:

The crop calendar is assumed to be the same as for eastern Malaysia, with only single cropping of rice. Main crops are rice and vegetables, irrigated only once in summer from May to September. Permanent fruit tree cultures are cultivated.

Cambodia

Irrigated area:

The area equipped for irrigation, 284,172 ha, is for 2001 as compiled by (Siebert *et al.*, 2005) from data of (Mekong River Commission, 2003) and (FAO, 1994). Rice is the most important irrigated crop, while sugar cane has only relatively small areas. For maize cited in the FAO GIEWS crop calendar (FAO, 2005c), no irrigated area was specified. The original harvested area cited by the FAO crop calendar for irrigated crops (FAO, 2005b) was scaled with the corresponding ratio of equipped area FAO and the sum given in (Siebert *et al.*, 2005).

Cropping seasons:

The crop calendar is very similar to that of Thailand. Like in Lao People's Democratic Republic, the cultivation seasons of rice are different: the second season is longer.

Main crop is rice that is irrigated twice on roughly 165,000 ha from May to September (wet season) and from October to April (dry season). The second season was extended by 2 months, as the crop calendar for 2002 of the FAO GIEWS (FAO, 2005c) gives a longer kernel cultivation seasons. The other culture is permanent sugar cane.

China

Irrigated area:

China excluding Taiwan has roughly 53.8 Mha area equipped for irrigation. This is the total actually irrigated area in the year 2000 mentioned in the Statistical Yearbook 2001 of China (National Bureau of Statistics, 2001) as cited in (Siebert *et al.*, 2005) and used in the Global Map of Irrigation Areas version 4 (Siebert *et al.*, 2007). China was divided into 31 provinces or special autonomous territories with individual area equipped for irrigation (Table K-10). Taiwan is treated as a separate unit.

To define the cropping seasons, these 31 units were grouped into 3 zones or regions (Northeast, Southeast and West) given by the FAO crop calendar for irrigated crops (FAO, 2005b). The assignment of the provinces to these regions was done following notes of (Wang *et al.*, 1999). Some assignment uncertainties exist, as the sum of the areas attributed to the regions according to this source is not fully consistent to the values given for the equipped area in the FAO crop calendar for irrigated crops. The Chongqing province within the Chang Jiang (Yangtze) basin became independent from the Sichuan province in March 1997 and therefore has no values for 1997 (Wikipedia-Encyclopedia, 2005b). On the other hand, the provinces of Beijing and Tianjin had joint statistics for the area equipped for irrigation. Therefore, both provinces were treated as a new joint unit (Tables K-10 and K-11).

Table K-10. Spatial units of China (provinces), and their area equipped for irrigation in hectares.

No.	Unit name (province)	Area equipped for irrigation
1	China_Anhui	3,197,200
2	China_Beijing & Tianjin	681,400
3	China_Chongqing	624,600
4	China_Fujian	940,200
5	China_Gansu	981,500
6	China_Guangdong	1,478,500
7	China_Guangxi	1,501,600
8	China_Guizhou	653,400
9	China_Hainan	179,800
10	China_Hebei	4,482,300
11	China_Heilongjiang	2,032,000
12	China_Henan	4,725,300
13	China_Hubei	2,072,500
14	China_Hunan	2,677,500
15	China_Nei Monggol	2,371,700
16	China_Jiangsu	3,900,900
17	China_Jiangxi	1,903,400
18	China_Jilin	1,315,100
19	China_Liaoning	1,440,700
20	China_Ningxia	398,800
21	China_Qinghai	211,400
22	China_Shaanxi	1,308,000
23	China_Shandong	4,824,900
24	China_Shanghai	285,900
25	China_Shanxi	1,105,000
26	China_Sichuan	2,469,000
27	China_Tibet_(Xizang)	157,000
28	China_Xinjiang	3,094,300
29	China_Yunnan	1,403,400
30	China_Zhejiang	1,403,200
31	China_Hong_Kong	0

The basic source of irrigated crop areas was the crop calendar for irrigated crops of FAO. The areas specified there for the group “other cereals” were distributed according to the relative mean harvested areas for the years 1998-2002 in the FAOSTAT database (FAO, 2005d) to barley (ca. 46%), rye (ca. 22%), oats (ca. 16%) and buckwheat (ca. 16%). Oil crops were attributed to other annual crops, as oil palm fruit (with a modelling class of its own) is only a minor product as compared to e.g. linseed and hempseed according to the FAOSTAT database (FAO, 2005d).

The original harvested areas cited in the crop calendar were scaled with the corresponding ratio of equipped area from (Siebert *et al.*, 2007) to (FAO, 2005b). Thus, the irrigated harvested area is 85.6 Mha for China as a whole. The difference between the harvested area and the monthly total of actually irrigated area and the area equipped for irrigation arises from the seasonal intercropping. E.g. in north-eastern China winter wheat is intercropped from October to April, just outside the season of the other annual crops that are cultivated from May to September (Table K-12).

Table K-11. Actually irrigated areas in China by provinces and FAO regions (years 1997 and 2000) and comparison to areas given in the FAO crop calendar (data unit 1,000 ha, unless otherwise specified).

Province	Regions of FAO crop calendar	1997	Regions 1997	2000	Regions 2000	Regions mean 1997 & 2000	FAO crop calendar
Beijing	NE	320.7		328.2			
Tianjin	NE	352.3		353.2			
Hebei	NE	4,322.6		4,482.3			
Shanxi	NE	1,058.1		1,105			
Nei Monggol	NE	1,972		2,371.7			
Liaoning	NE	1,277.1		1,440.7			
Jilin	NE	1,078		1,315.1			
Heilongjiang	NE	1,607		2,032			
Shandong	NE	4,736.7		4,824.9			
Henan	NE	4,333.1		4,725.3			
Shaanxi	NE	1,293.3		1,308			
Gansu	NE	954.4		981.5			
Ningxia	NE	379.8	23,685.1	398.8	25,666.7	24,675.9	23,295
Shanghai	SE	281.6		285.9			
Jiangsu	SE	3,836.5		3,900.9			
Zhejiang	SE	1,405		1,403.2			
Anhui	SE	3,049		3,197.2			
Fujian	SE	933.6		940.2			
Jiangxi	SE	1,900.1		1,903.4			
Hubei	SE	2,150.4		2,072.5			
Hunan	SE	2,676.8		2,677.5			
Guangdong	SE	1,516		1,478.5			
Guangxi	SE	1,489.1		1,501.6			
Hainan	SE	226.9		179.8			
Guizhou	SE	631.2		653.4			
Yunnan	SE	1,321	21,417.2	1,403.4	21,597.5	21,507.35	23,295
Chongqing	W			624.6			
Sichuan	W	2,865.1		2,469			
Xizang (Tibet Autonomous Region)	W	156.5		157			
Qinghai	W	204.6		211.4			
Xinjiang	W	2,910.2	6,136.4	3,094.3	6,556.3	6,346.35	6,353
Total China (excl. Taiwan)		51,240	53,820.5				52,943
Total [ha]		51,240,000	53,820,500				52,943,000

Table K-12. Scaled irrigated harvested areas of crops in China by FAO regions (year 2000) (data unit ha, unless otherwise specified).

Harvested area [ha]	CHINA (North-east)	CHINA (South-east)	CHINA (West)	Total harvested area China (excl. Taiwan)
Crop/year	2000	2000	2000	2000
Wheat	15,879,308	3,817,923	2,124,889	21,822,120
Rice	6,960,144	27,454,182	3,666,698	38,081,024
Maize	10,700,794	1,334,140	865,849	12,900,783
Millet	172,984	149,268	48,504	370,756
Sorghum	176,290	152,049	49,536	377,875
Other Cereals	243,500	210,459	69,144	523,103
Potatoes	236,889	203,969	67,080	507,938
Sugar cane	220,362	189,135	61,920	471,417
Vegetables	473,779	407,937	134,160	1,015,876
Citrus	201,632	173,373	56,760	431,765
Fruits	674,309	580,384	190,920	1,445,612
Oil crops	138,828	119,600	39,216	297,644
Soybean	1,414,726	1,218,249	400,416	3,033,391
Groundnut	915,605	788,988	259,032	1,963,625
Sunflower	137,726	118,673	39,216	295,615
Cotton	1,361,839	545,153	209,496	2,116,488
All irrigated crops	39,908,716	37,463,481	8,282,837	85,655,034
Area equipped for irrigation	25,666,700	21,597,500	6,556,300	53,820,500
Cropping intensity [-]	155	173	126	159

Cropping seasons - China North-East and West:

Irrigated wheat is cropped as winter wheat from October to April, whereas the other annual irrigated crops are cultivated from May to September, besides cotton which is grown from May to November. Sugar cane is grown throughout the year. Permanent fruit and citrus tree orchards are assumed to be frost-irrigated and irrigated against water deficiency in summer.

Cropping seasons - China South-East:

The seasons are quite different from north-eastern China. Irrigated wheat is intercropped as summer wheat from January to May, whereas the other annual irrigated crops are cultivated in two distinct seasons. Cereals are grown in winter from November to March. Other annual crops are grown one month earlier than in north-eastern China, from April to August, besides cotton which is grown from April to October. Sugar cane is grown throughout the year. Permanent fruit and citrus tree orchards are assumed to be frost-irrigated and irrigated against water deficiency in summer.

Christmas Island

No irrigation is reported for the Christmas Island.

Cocos (Keeling) Islands

No irrigation is reported for the Cocos (Keeling) Islands.

Democratic People's Republic of Korea

Irrigated area:

The area equipped for irrigation, 1,460,000 ha, is for 2002, unchanged since 1995 as cited in (Siebert *et al.*, 2005) from FAOSTAT data. Rice is the most important irrigated crop besides vegetables. The original harvested area cited by the FAO crop calendar for irrigated crops (FAO, 2005b) was taken, as no changes in equipped area occurred.

Cropping seasons:

The crop calendar is similar to that of the Republic of Korea.

Main crop is rice that is irrigated only once on 420,000 ha from May to September, like the other annual cultures as well, besides potatoes that are cultivated from April until September, according to the FAO GIEWS crop calendar (FAO, 2005c). Permanent irrigated culture is fruit trees.

Georgia

Irrigated area:

The area equipped for irrigation was set to the value for 2001, 300,000 ha, from a World Bank report (World Bank, 2001) and cited in (Siebert *et al.*, 2005). The actually irrigated areas given in the FAO crop calendar for irrigated crops (FAO, 1997b) were scaled with the ratio of areas equipped for irrigation of (FAO, 1997b) and (World Bank, 2001).

Cropping seasons:

Like in neighbouring Armenia, main season is the summer season from July to October. In the winter season, wheat and assumedly barley are cultivated according to the seasons given by the FAO GIEWS crop calendar (FAO, 2005c), from November to June and for barley assumed from November to May, whereas maize is cultivated from May to October.

India

Irrigated area:

India has roughly 57.3 Mha equipped area for irrigation according to the Global Map of Irrigation Areas (Siebert *et al.*, 2007). To distribute irrigated crop areas on a sub-national level, India was divided into 35 states or national territories with different area equipped for irrigation from 1000 ha to 12.5 Mha (Table K-13). To define the cropping seasons, these 35 spatial units were grouped to 4 zones or regions (North, East, South, and West) by the FAO crop calendar for irrigated crops (FAO, 2005b). The distribution of the states to these regions is the mainly the same as that given by the national agronomic statistical institute INDIAAGRISTAT. Some attribution insecurities exist. The new state of Chhatisgarh became independent from the state of Madhya Pradesh in November 2000. The island groups of Andaman / Nicobar and Lakshadweep were both excluded from region

“South”, but counted as separate regions. Andaman and Nicobar Islands have no irrigation. Lakshadweep Islands have a total of 1,000 ha, but with the crop groups below 500 ha each and no detailed information on crops. Therefore, they were treated as if they had no irrigation.

Table K-13. Spatial units of India (states), and their area equipped for irrigation in hectares.

No.	Unit name (state)	Area equipped for irrigation
1	India_Andra Pradesh	4,384,124
2	India_Arunachal Pradesh	39,043
3	India_Assam	458,071
4	India_Bihar	3,439,545
5	India_Chandigarh	2,000
6	India_Chhatisgarh	1,078,400
7	India_D & N Haveli	6,000
8	India_Daman & Diu	1,000
9	India_Deqli	39,070
10	India_Goa	22,372
11	India_Gujarat	3,092,400
12	India_Haryana	2,888,000
13	India_Himachal Pradesh	101,897
14	India_Jammu & Kashmir	310,870
15	India_Jharkhand	185,455
16	India_Karnataka	2,491,871
17	India_Kerala	380,043
18	India_Madhya Pradesh	5,514,979
19	India_Maharastra	3,140,200
20	India_Manipur	65,000
21	India_Meghalaya	45,045
22	India_Mizoram	9,000
23	India_Nagaland	63,000
24	India_Orissa	2,090,000
25	India_Pondicherry	21,390
26	India_Punjab	4,020,700
27	India_Rajasthan	5,611,874
28	India_Sikkim	16,000
29	India_Tamil Nadu	3,018,839
30	India_Tripura	35,000
31	India_Uttaranchal	332,502
32	India_Uttar Pradesh	12,469,624
33	India_West Bengal	1,911,000
34	India_Andaman and Nicobar	1,093
35	India_Lakshadweep	1,000

The basic source of irrigated areas per crop was the time series from 1995/1996 to 2000/2001 from INDIAAGRISTAT, extended by information of the crop calendar for FAO (FAO, 2005b). The area equipped for irrigation was set to the one cited for 2000 by INDIAAGRISTAT. If no corresponding group could be found, the original harvested areas cited by FAO were scaled with the corresponding ratio of equipped area. For the groups of potatoes, vegetables and fruits, the harvested areas cited in the FAO crop calendar were taken to distribute accordingly the new crop area cited for 2000 for the group of vegetables, fruits and root crops to these three groups. Millet was formed of the tabulated items “other cereals & millets”, “ragi / marua” (with ragi = *Eleusine coracana* (L.) Gaertn. subsp. *Coracana*) and “bajira” (i.e. *Pennisetum glaucum*). Sorghum was formed from the item “jowar” (i.e. *Sorghum bicolor* (L.) Moench).

For the Lakshadweep Islands INDIAGRISTAT cites less than 500 ha of food crops (pulses, vegetables) and less than 500 ha of non-food crops, summing to a total of roughly 1,000 ha, which is the minimum statistical unit of the INDIAGRISTAT dataset. As for other units such values were also not counted, the actually irrigated area was set to be zero to obtain consistency with sum values for regions and India as a whole.

In the four sub-national regions different crops dominate (Table K-14):

- In eastern India: rice (ca. 6.6 Mha harvested in 2 cropping seasons) and wheat (2.3 Mha).
- In northern India: wheat (14.7 Mha, assumed 2 cropping seasons), rice (8.9 Mha, assumed 3 cropping seasons), sugar cane (2.1 Mha), rapeseed (1.1 Mha), cotton (1.3 Mha).
- In southern India: rice (7.3 Mha, 2 seasons), sugar cane (1 Mha), and cotton (330,000 ha).
- In western India: wheat (5.7 Mha) outcompetes rice (2.2 Mha, 1 cropping season only), also strong: pulses (1.7 Mha), rapeseed (1.5 Mha) and cotton (1.4 Mha).

Table K-14. Zone grouping of India.

State	Zone / region
Arunachal Pradesh	East
Assam	East
Bihar (including Jharkhand)	East
Orissa	East
West Bengal	East
Manipur	East
Meghalaya	East
Nagaland	East
Sikkim	East
Tripura	East
Mizoram	East
Haryana	North
Himachal Pradesh	North
Jammu & Kashmir	North
Punjab	North
Uttar Pradesh	North
Chandigarh	North
Delhi	North
Andhra Pradesh	South
Karnataka	South
Kerala	South
Tamil Nadu	South
Pondicherry	South
Andaman & Nicobar Islands	South
Lakshadweep Islands	South
Chhatisgarh	West
Gujarat	West
Madhya Pradesh	West
Maharashtra	West
Rajasthan	West
Goa	West
Daman & Diu	West
Dadra & Nagar Haveli	West

Cropping seasons:

India East:

In the eastern region, the harvested area according to the FAO crop calendar and INDIAAGRISTAT were in accordance.

For sunflowers that are not included in the FAO crop calendar, a cropping season like for soybean from June to October was assumed.

India North:

In the northern region, in the Ganges basin at the foot of the Himalayan mountain range, the cropping intensity is very high. In order to meet the constraints of the high harvested area and the fixed area equipped for irrigation, for the dominating crops wheat and rice additional cropping seasons to those of the original FAO crop calendar for irrigated crops (FAO, 2005b) were introduced. This enabled the consistency with the equipped area which would have been extremely exceeded with the standard calendar.

First, instead of two cropping seasons for rice as cited by FAO, a third cropping season was assumed to exist according to the cropping seasons cited in the rice crop calendar for the International Rice Research Institute (IRRI, 2005). There, for the winter season (“kharif”) an early and a main cropping season are cited, positioned on the mean from April to July and from August to November, respectively. For the summer season (“rabi”), one cropping season is cited, lasting from December to March. So rice is assumed to be cultivated and irrigated throughout the year.

For wheat, instead of only one cropping season in winter from November to March, a second one during the summer from June to October was introduced. Under the assumption that the winter season is the main irrigated season with less precipitation, an asymmetry between the two cropping seasons. For the winter cropping season the original crop area (for one cropping season) was scaled to current conditions (ca. 8.08 Mha) with the ratio of the equipped area cited in the crop calendar by FAO and the current one cited by INDIAAGRISTAT. The remainder to the total harvested area was distributed to the summer season.

Soybeans were not cited by INDIAAGRISTAT for the north, so that zero values instead of higher values cited by FAO were assumed to be correct.

For groundnuts and sunflowers that are not included in the FAO crop calendar, a cropping season from June to October like that for soybeans was assumed.

India South:

In the southern region, the harvested area according to the FAO crop calendar and INDIAAGRISTAT were in accordance.

No rapeseed is cultivated. For sunflowers that are not included in the FAO crop calendar, a cropping season like for soybeans and groundnuts from July to November was assumed.

India West:

The harvested area according to the FAO crop calendar and INDIAAGRISTAT are very different for wheat of which only 6 million hectares instead of 9 million hectares were irrigated. Therefore, the overall cropping intensity is much smaller than with the older data. Wheat is grown in only one cropping season from December to June, two months longer than in the corresponding season of the other regions.

For sunflowers that are not included in the FAO crop calendar, a cropping season like for soybeans and groundnuts from July to November was assumed.

Indonesia

Irrigated area:

The area equipped for irrigation, roughly 4.5 Mha, is the one cited for 1990 by (Elshof, 1990) and found to be consistent with the 1996 values of FAO (FAO, 1999) as cited in (Siebert *et al.*, 2005). The original harvested area cited by the FAO crop calendar for irrigated crops (FAO, 2005b) was scaled with the corresponding ratio of equipped area of (FAO, 1999) and (Elshof, 1990) as cited by (Siebert *et al.*, 2005). According to (Siebert *et al.*, 2005), the island of Java has a bigger equipped irrigated area than the rest of the Indonesian islands and not the same areas as cited in (FAO, 2005b) (Table K-15).

Table K-15. Spatial units of Indonesia (zones), and their area equipped for irrigation in hectares.

No.	Unit name (zone)	Area equipped for irrigation
1	Indonesia_Java	2,907,000
2	Indonesia_Outside Java	1,552,000

Cropping seasons:

Crop calendars are separated into the island of Java and the rest of the countries' islands, but in principle similar to that of neighbouring Thailand. The cropping seasons are in the same, besides that for Java a second cropping season for rice is present.

Main crop is rice that is irrigated from July to November, on the island of Java the bigger area share is irrigated in another cropping season from December to April on a higher area. All the other crops are irrigated also from July to November, besides the permanently cropped sugar cane.

Iran (Islamic Republic of)

Irrigated area:

The area equipped for irrigation 6,913,800 ha, was set to the one cited for 1994 by the Statistical Yearbook 2003 (Statistical Centre of Iran, 2004) and cited in (Siebert *et al.*, 2005). For most crops, the original harvested area cited by the FAO crop calendar for irrigated crops (FAO, 2005b) was scaled with the corresponding ratio of equipped area FAO and (Siebert *et al.*, 2005). Areas for wheat, fodder, and vegetables were taken from the FAO AQUASTAT report (FAO, 1999) The AQUASTAT area for permanent crops (ca. 1.5 Mha) was assumed to consist of fruit trees, citrus and dates. The relationship between the statistical yearbook value for orchards and nurseries for 1994 (756,000 ha) and the FAO value for citrus (153,000 ha) was taken to distribute the remaining permanent crop area, the permanent crop area minus the area for dates (185,000 ha harvested area for 2000 cited in the FAOSTAT database (FAO, 2005d)). The resulting areas for citrus and fruit trees are higher than the values in the statistical yearbook. Nevertheless, they fit into the crop calendar pattern of FAO and the consistent FAO information.

Cropping seasons:

The crop calendar shows similarities to that of Pakistan. In the winter season, irrigated wheat is grown from October to May. Similarly, barley is cultivated from November to March and fodder from November to April. All the other annual crops are grown from May to September, besides cotton from April to October. Throughout the year tree cultures (citrus, fruits, dates) are cultivated. Sugar cane which is cited by (Achnich, 1980) has zero values in the FAOSTAT database and thus not considered.

Iraq**Irrigated area:**

The area equipped for irrigation, 3,525,000 ha, was set to the one cited for 1990 by FAO (FAO, 1997c) and cited in (Siebert *et al.*, 2005). The original harvested areas cited by the FAO crop calendar for irrigated crops (FAO, 2005b) were taken directly, as the reference value for the equipped area is identical. As neither FAOSTAT information nor other sources specified additional crops, the list was considered as exhaustive.

Cropping seasons:

The crop calendar shows similarities to that of Iran, but much more spread in terms of cultivation seasons. The kernel cultivation seasons of the FAO GIEWS crop calendar (FAO, 2005c) correspond to the FAO calendar of the irrigated crops. In the winter season, irrigated wheat is grown from December to June. Similarly, barley is cultivated from December to April and fodder from November to April. All the other annual crops are grown in different seasons: potatoes from February to May, pulses and vegetables from March to July, sunflower and sesame from April to August, besides cotton from April to October. Throughout the year tree cultures (citrus, fruits) are cultivated.

Israel**Irrigated area:**

The area equipped for irrigation as given by (Central Bureau of Statistics, 2003) and cited in (Siebert *et al.*, 2005) is 183,408 ha for 2000. The cultivated areas were drawn from the same source. The areas given in dunams were converted to hectares assumed that values were given in metric dunams, with 1 dunam = 1,000 square meter following (Wikipedia-Encyclopedia, 2006).

Cropping seasons:

The seasons of Jordan of the FAO crop calendar for irrigated crops (FAO, 2005b) are assumed to be valid also in Israel, too. No main season can be determined there, but a summer cropping season between April and August is assumed. Wheat is grown as irrigated crop in winter from September to March, the rest of the annual field crops possibly on the same areas from April to August. Potatoes are grown from March until July. Vegetables are assumed to be grown in three seasons of equal length of 4 months starting in January with a cropping intensity of 3. Permanent crops are citrus, grapes, olives, dates, other fruit trees, and flowers and garden plants.

Japan

Irrigated area:

The area equipped for irrigation, 3,129,000 ha, is for 1994 from (Ministry of Agriculture, 1994) cited in (FAO, 1999) and cited in (Siebert *et al.*, 2005). The original harvested areas (FAO, 1999) are cited from an AQUASTAT survey questionnaire for Japan (FAO, 1997a). The paddy field area for August 2001 given in (Ministry of Agriculture, 2001) is the sum of field and dyke areas for paddy culture for rice and other cultures. It is considerably higher (2.6 Mha) than the originally harvested area for rice cited by FAO (2.2 Mha), even when only the area of paddy fields without dyke area (2.46 Mha) is looked at. The respective total paddy area on province level is 2,745,260 ha (Siebert *et al.*, 2005). The Japan Statistical Yearbook 2006 (Ministry of Internal Affairs and Communications - Statistics Bureau & Statistical Research and Training Institute, 2006) cites even different national sums: 2,641,000 ha for 2000 and 2,575,000 ha for 2004. In this source, as planted rice area 1,665,000 ha for 2000 and 1,770,000 ha for 2003 are cited. The latter figures, together with the original FAO value, correspond to the mean of the harvested rice area in the FAOSTAT database (FAO, 2005d): 2.1 Mha for 1990-1995 and 1.75 Mha for 1998-2002. The necessary conclusion is that currently much less than 100% of the equipped area of paddy fields is cultivated, contradicting (Japanese Society of Irrigation, 1995) that says that paddy fields are almost 100% irrigated, whereas for non-paddy fields the irrigation rate are said to be just above 10%. It was suspected that the area classified as paddy fields (either field or dyke areas) in the Yearbook, at best, corresponds only to the equipped area, even if probably nearly 100% of rice grown on paddy field is irrigated. Additionally, rice could be grown in upland field areas without irrigation. As no actually irrigated areas were cited in the Yearbook, the 1994 area of the irrigated crops cited by FAO (FAO, 1999) was scaled to the corresponding 2000 areas by the ratio of the mean FAOSTAT harvested areas for the seasons 1990-1995 and 1998-2002. For non-rice crops, the irrigated area of 346,668 ha for 1993 was assumed to be also valid for the time period 1998-2002, and in a first step, the scaled cited areas for wheat, barley, pulses, buckwheat were subtracted. The remainder was then attributed to further crops cited by FAO and (Achnich, 1980), for which besides for fodder grasses / grassland (arbitrarily fixed 1,000 ha) a percentage of the mean harvested area (1998-2002) was assumed to be irrigated. These include fruit tree orchards (ca. 40% irrigated), citrus (50% irrigated), tobacco (assumed 100% irrigated), grassland (1,000 ha). In a third step, further crops not yet mentioned were assumed to be irrigated, too: sugar cane (100% irrigated), maize for forage (roughly 10%), potatoes, and sugar beets (roughly 35%). At this stage, all irrigated harvested areas refer still to the originally cited equipped area (year 1993). Subsequently, the harvested areas of all crops were scaled with the corresponding ratio of equipped area FAO and the sum matching prefecture-level of (Ministry of Agriculture, 1994) used for downscaling in (Siebert *et al.*, 2005). This lead to an only marginally increased irrigated harvested area.

Rice is by far the most important irrigated crop besides other crops, although the equipped area is by far not used. This is in agreement with shrinking agricultural production (-10% up to -30%) for nearly all cited crops, as documented in the FAOSTAT database (FAO, 2005d). An exemption is buckwheat, for which the area increased by 50%.

Cropping seasons:

Main crop is rice. According to (Achnich, 1980) it is irrigated twice in the warmer climate zone of Japan, for which 1/3 of the harvested area was arbitrarily estimated. The main cropping season is from May to September, in agreement with the FAO GIEWS crop calendar (FAO, 2005c) and the IRRI rice cropping seasons (IRRI, 2005). The second cropping season is assumed to be from October to April. In winter, wheat and barley are potentially irrigated on paddy rice areas from November to May (assuming a late planting of rice) and from November to April, respectively. All

the other crops are irrigated during summer from May to September, besides permanent fruit tree orchards, citrus, sugar cane and fodder grasses / managed grassland.

Jordan

Irrigated area:

The area equipped for irrigation, 76,912 ha, was set to the value for 2000 from (Department of Statistics (Jordan), 2004) and cited in (Siebert *et al.*, 2005). The actually irrigated areas of the irrigated crop calendar for (FAO, 2005b) and of the consistent (FAO, 1997c) were scaled with the ratio of areas equipped for irrigation of (FAO, 1997c) and (Department of Statistics (Jordan), 2004).

Cropping seasons:

No main season can be determined. Wheat is grown as irrigated crop in winter from September to March, barley possibly on the same areas from April to August. Potatoes are grown from March to July. Vegetables are grown in three seasons of equal length of 4 months starting in January with a cropping intensity of 3. Oil crops other as olives are assumed to be grown during the same seasons as barley.

Kazakhstan

Irrigated area:

The area equipped for irrigation, 1,855,200 ha, was set to the one aggregated from “oblast” level information for 1993 from (UNDP, 2004) and cited in (Siebert *et al.*, 2005). The fact that different sources within the same publication (FAO, 1997b) and data for the same years in another publication (World Bank, 1996a) present inconsistent and quite different values of actually irrigated area crop entailed a very detailed review of the information, of which the final result is presented here. The values of (World Bank, 1996a) were considered less reliable. The original harvested area for 1993 cited on page 112 in Table 3 by FAO (FAO, 1997b) was taken as a starting point, even if the sum (2,313,100 ha) is much bigger than the area equipped for irrigation. The figures for harvested area from the FAOSTAT database (FAO, 2005d) for the available time period 1992-1995 were taken as a reference, as indicated by the following fact: The rounded irrigated area of cotton corresponds nearly exactly to the harvested area. For cereals, an irrigation ratio between 20 and 100% (maize, rice) was assumed. As fodder crops (cited to be mostly alfalfa), only maize (ca. 1/3, 20% irrigation ratio) and grasses plus vegetables/roots for fodder (ca. 2/3, in total only 7% irrigation ratio) were assumed to be irrigated, as this way they perfectly fit the cited irrigated area and for these crops figures by FAOSTAT are given. For the moment grasses for fodder are classified as fodder grasses / managed grassland. Besides that, other crops could not directly be identified as fodder crops. The originally cited harvested areas were taken, as they are smaller than the harvested areas of FAOSTAT, for the following crops: For wheat and barley (both below 2% irrigation ratio). They were fit into the value of 733,200 ha of cereals cited in the tables of (FAO, 1997b), assuming that millet and sorghum were also irrigated (ca. 30% irrigation ratio). Also for potatoes (ca. 30% irrigation ratio) and oil seeds (ca. 47% irrigation ratio) this was done, whereas for sugar beets the mean harvested area was taken, as it was lower than the cited value. The value of 311,700 ha of perennial crops given on page 112 in the Table 3 (FAO, 1997b) was assumed to be too high, as fruit trees and berry orchards together with grapes just have roughly 86,000 ha.

Cropping seasons:

In the winter season, irrigated wheat and barley are grown from October to May and from December to April, in the southern parts of Kazakhstan according to (World Bank, 1996a), whereas most of them is grown as rainfed cereals in the northern parts, assumedly during summer. Maize (including maize for fodder) is grown from May until October and cotton from May until November, according to the FAO GIEWS crop calendar (FAO, 2005c). The rest of fodder was assumed to be annual cultures to be potentially irrigated all over the year (mixed grasses, vegetables/roots as fodder crops from the FAOSTAT database (FAO, 2005d)).

Kuwait**Irrigated area:**

The area equipped for irrigation of 6,968 ha was set to the value for 2000 from (Ministry of Planning, 2002) and cited in (Siebert *et al.*, 2005). All cropped area is irrigated due to desert climatic reasons (FAO, 1997c). The crop areas are taken from the FAOSTAT database as mean harvested areas for the time period 1998-2002 (FAO, 2005d).

Cropping seasons:

The seasons are assumed to be the same as for neighbouring Saudi-Arabia with similar climate. Wheat and barley are grown as irrigated crop in winter from December to June and from December to April, respectively. Maize and potatoes are possibly cropped on the same plots as wheat and barley from July to November. Vegetables are grown in only one season from July to November. Theoretically they could be cropped in three seasons of equal length of 4 months starting in January with a cropping intensity of 3. Other annual forage crops are assumed to be grown only from December to April, other annual crops from July to November. As permanent crops dates, citrus, and grapes are cultivated.

Kyrgyzstan**Irrigated area:**

The area equipped for irrigation, 1,075,040 ha, was set to the one aggregated from “raion” and “oblast” level information for 1994 from (Asian Development Bank, 1995) and cited in (Siebert *et al.*, 2005). The original harvested area for 1994 cited by FAO (FAO, 1997b) was taken as a starting point, as the sum (1,076,900 ha) is slightly lower than the area equipped for irrigation. The figures for harvested area from the FAOSTAT database (FAO, 2005d) for the available time period 1992-1995 were taken as a reference, as indicated by the following fact: The rounded irrigated area of cotton corresponds nearly exactly to the harvested area. For most of the crops, an irrigation ratio of 100% was assumed. As fodder crops, only maize and grasses plus vegetables/roots for fodder (almost 100% irrigation ratio) were assumed to be irrigated, as they perfectly fit the cited irrigated area and for these crops figures by FAOSTAT are given. For the moment grasses for fodder are classified as fodder grasses / managed grassland. Besides that, other crops could not directly be identified as fodder crops. For barley and potatoes, the originally cited harvested areas were taken, as they are smaller than the harvested areas of FAOSTAT (35% and 20% irrigation ratio). Rice is not cited and the FAOSTAT data were used. The FAOSTAT harvested area of other crops was used as it gives assumedly a more realistic estimation for the actually irrigated area, especially when a trend in the time series of the harvested area is present like for wheat and sugar beets, that both increase. Sometimes the FAOSTAT values are higher than the tabulated ones (like for maize). The rest of the value for cereals given in (FAO, 1997b) was assumed to be too high, such as a maximum

extent, whereas for vegetables, it was the contrary. The value for perennial crops given in (FAO, 1997b) was assumed to be quite realistic for permanent crops fruit trees and berry orchards, grapes and citrus that were assumed to be irrigated. Other irrigated harvested areas cited by FAO (FAO, 1999) were considered less reliable, besides the mentioning of tobacco as a crop.

Cropping seasons:

The crop calendar for Afghanistan was used as a starting point for neighbouring mountainous Tajikistan and Kyrgyzstan.

In the winter season, irrigated wheat is grown from October to May according to the FAO GIEWS crop calendar (FAO, 2005c), one month earlier than in Afghanistan. Similarly, barley is cultivated from December to April. Rice, vegetables and tobacco (not cited for Afghanistan) were assumed to be grown during summer from July to October, maize (including maize for fodder) from May until October according to the FAO GIEWS crop calendar (FAO, 2005c), different to Afghanistan, cotton from May until November. All other fruits are grown from July to October, like potatoes and sugar beets (in Afghanistan from December to May) and sunflower (in Afghanistan from May until October). Perennial fodder was assumed to be mainly fruit and nut trees. The rest of fodder was assumed to be annual cultures to be potentially irrigated all over the year (mixed grasses, other fodder crops from the FAOSTAT database (FAO, 2005d)).

Lao People's Democratic Republic

Irrigated area:

The area equipped for irrigation is for 2000 by (Ministry of Agriculture and Forestry - Department of Planning - Statistics Division, 2006), also cited in (Ministry of Agriculture and Forestry - Department of Planning, 2002) and cited in (Siebert *et al.*, 2005). There are 295,535 ha as the sum of wet season irrigated schemes. The harvested area for rice is 150,000 ha and vegetables with 18,000 ha are second most important crops. The original harvested area cited by the FAO crop calendar for irrigated crops (FAO, 2005b) was scaled with the corresponding ratio of equipped area FAO and (Ministry of Agriculture and Forestry - Department of Planning - Statistics Division, 2006).

Cropping seasons:

The crop calendar is very similar to that of Thailand, only the cultivation seasons of rice (second season longer) and of cotton (during winter).

Main crop is rice that is irrigated twice on 75,000 ha from May to September (wet season) and from October to April (dry season). The second season was extended by 2 months, as the crop calendar for 2002 of the FAO GIEWS (FAO, 2005c) gives a longer kernel cultivation seasons.

Besides the permanent culture of sugar cane, as other crop vegetables are also irrigated from October to February, and cotton from August to February.

Lebanon

Irrigated area:

The area equipped for irrigation, 117,113 ha, is the value cited for 1997 from (ESCWA, 1999) as cited in (Siebert *et al.*, 2005). The cropped area was taken from the FAO AQUASTAT report (FAO,

1997c) and when no specific areas were available, also from the crop calendar for irrigated crops (FAO, 2005b). The values were scaled with the ratio of area equipped for irrigation of the 1990ies (FAO, 1997c) and for 1997 (ESCWA, 1999).

Cropping seasons:

The seasons are taken basically from the FAO crop calendar for irrigated crops (FAO, 2005b) and are similar to those of Syrian Arab Republic, but are shorter. Wheat is grown as irrigated crop in winter from November to March. Potatoes and tobacco are cropped during the standard summer season from May to September. Sugar beets start one month earlier in April, while groundnuts are grown from April to August. Fodder is grown from October to March. Vegetables are grown with a cropping intensity of 3 throughout the year, from January to April, May to August, and September to December. As permanent crops fruit trees, citrus, and bananas are cultivated.

Macao

No irrigation was assumed in this city-state. It was joined to neighbouring Guangdong province of China for further geographical analysis.

Malaysia

Irrigated area:

The area equipped for irrigation, 362,600 ha, is the 1994 value of FAO (FAO, 1999) cited in (Siebert *et al.*, 2005). The original harvested area cited by the FAO crop calendar for irrigated crops (FAO, 2005b) was directly used, as (Siebert *et al.*, 2005) used this figure to scale down the national total equipped area to the state level totals. Rice is dominating the crops on ca. 215,000 ha.

Cropping seasons:

Main crop is rice that is irrigated twice from October to February and from May to September. According to (IRRI, 2005), the second cropping season is only present in the western part of Malaysia, the first also in the states of Sabah and Sarawak. All the other crops are irrigated also from May to September, besides the permanently cropped sugar cane and flowers.

Maldives

No irrigation is present on the Maldives according to the FAO AQUASTAT report (FAO, 1999).

Mongolia

Irrigated area:

The area equipped for irrigation is for 1993, with 57,300 ha area equipped for crops. 27,000 ha estimated for pasture are not considered here, but are cited in (FAO, 1995b) and (FAO, 1999), as cited in (Siebert *et al.*, 2005). FAO mentions vegetables, some fruits and early potatoes as main crops. Their areas are estimated according to the constraints given by the harvested areas in the FAOSTAT database (FAO, 2005d).

Cropping seasons:

The crop calendar is similar to that of neighbouring north-eastern China.

Main crop is early potatoes, for which the cultivation season is assumed to start as early as in March and last until September, whereas vegetables are grown during the regular season from May to September. Permanent fruit orchards are assumed to include nut trees, the only tree fruit cited in FAOSTAT, and berries.

Myanmar**Irrigated area:**

The area equipped for irrigation, 1,841,320 ha, was set to the one cited in (Stibig *et al.*, 2003) and cited in (Siebert *et al.*, 2005). The harvested area was taken from FAO crop calendar for irrigated crops (FAO, 2005b) as a starting point. The FAO AQUASTAT report (FAO, 1999) delivered more details. The special information of the Myanmar Ministry of Agriculture (Ministry of Agriculture - Water Resources Utilisation Department) was assessed to be the most confident source, as it agreed with the area of irrigated rice of the FAO crop calendar and the areas cited in the AQUASTAT report. Only for vegetables and fruit trees that were only explicitly cited, the FAO calendar source was used and the rest of the area given by (Ministry of Agriculture - Water Resources Utilisation Department) distributed as annual crops.

Cropping seasons:

Main crop is rice that is irrigated twice on roughly 940,000 ha from July to October (main season) and from November to March (second season). Seasons for spring-autumn rice and autumn-spring rice for the south of the crop calendar for the FAO GIEWS (FAO, 2005c) correspond well to this, like those for wheat and maize. All the other crops pulses, vegetables, also assumedly groundnut, sesame and jute are irrigated from March to July, besides cotton (February to August). Other annual cultures are assumed to grow during the winter season like wheat and maize from November to March. Permanent cultures of sugar cane and fruit trees exist.

Nepal**Irrigated area:**

The area equipped for irrigation is 1,168,348.60 ha for 2001/2002 as given by (Central Bureau of Statistics, 2004) and cited in (Siebert *et al.*, 2005). Wheat is more important than rice as irrigated crop besides vegetables. The original harvested area cited by the FAO crop calendar for irrigated crops (FAO, 2005b) was taken, with oil crops assumed to be linseed and mustard. The area was scaled with the corresponding ratio of equipped area of (Central Bureau of Statistics, 2004) and that from known sources (1,134,334 ha) as cited in the FAO AQUASTAT report on Asia (FAO, 1999), also cited in the FAO crop calendar for irrigated crops (FAO, 2005b).

Cropping seasons:

Main crops are wheat and rice that are irrigated from November to May on roughly 615,000 ha and from June to October on roughly 500,000 ha, respectively. It is assumed that they are cultivated on the same areas. Oil crops (ca. 24,000 ha) are repartitioned between mustard seed (95%) and linseed (ca. 5%) roughly according to their shares of harvested area in 1998-2002 in the FAOSTAT

database (FAO, 2005d) and cropped with the same cropping season but greater share for mustard in the summer. As other cultures, maize and vegetables are grown from May to October. This fits well into the kernel seasons given by the FAO GIEWS crop calendar (FAO, 2005c). Permanent irrigated culture is sugar cane. The resulting percentage of monthly irrigation intensity is 44%.

Occupied Palestinian Territory

Irrigated area:

The area equipped for irrigation is 19,466 ha for the area of Occupied Palestinian Territory, i.e. Gaza Strip and West Bank. The value as cited in (Siebert *et al.*, 2005) comprises 16,222 ha for 2001 as given by Palestinian statistics (Palestinian National Authority - Palestinian Central Bureau of Statistics, 2003) and ca. 3,200 ha of Israeli settlements in Gaza Strip and West Bank as cited by the statistics of Israel (Central Bureau of Statistics, 2003). The cultivated areas were drawn from (Palestinian National Authority - Palestinian Central Bureau of Statistics, 2004). The areas given in dunums were converted to hectares assumed that values were given in metric dunums, with 1 dunum = 1,000 square meter following (Wikipedia-Encyclopedia, 2006). Next, the values were scaled with the ratio of the total 19,466 ha to the 16,222 ha equipped area under Palestinian authority only.

Cropping seasons:

The seasons of Jordan of the FAO crop calendar for irrigated crops (FAO, 2005b) are assumed to be valid also in Palestine, too. No main season can be determined there, but a summer cropping season between April and August is assumed. Wheat is grown as irrigated crop in winter from September to March, barley, pulses, other annual field crops and maize possibly on the same areas from April to August. Potatoes are grown from March until July. Vegetables are assumed to be grown in three seasons of equal length of 4 months starting in January with a cropping intensity of 3. Clover is assumed to be cultivated as fodder during winter from September to February. Permanent crops are citrus, dates, grapes and other fruit trees.

Oman

Irrigated area:

The area equipped for irrigation per region is 72,630 ha for 2001 (Arab Organization for Agricultural Development - Agricultural Information, 2003a), close to the 72,714 ha mentioned for 2000 in (Ministry of National Economy, 2003) and both cited in (Siebert *et al.*, 2005). All cropped area is irrigated due to desert climatic reasons (FAO, 1997c). The crop areas are taken from the FAOSTAT database as mean harvested areas for the time period 1998-2002 (FAO, 2005d).

Cropping seasons:

The seasons are assumed to be the same as for neighbouring Saudi-Arabia with similar climate. Wheat and assumedly barley are grown as irrigated crop in winter from December to June and from December to April, respectively. Sorghum and potatoes are possibly cropped on the same plots as wheat and barley from September to November and from July to November, respectively. Vegetables are grown in only one season from July to November. Theoretically they could be cropped in three seasons of equal length of 4 months starting in January with a cropping intensity of 3. Tobacco is assumed to be grown during the summer season from July to November. Alfalfa as

forage and silage crop is assumed to be grown as a semi-permanent crop from January to December with cuts 3-4 months apart. As permanent crops dates and citrus are cultivated.

Pakistan

Irrigated area:

The area equipped for irrigation, 14,417,464 ha, was set to the one mentioned for 2000 by the agricultural census (Government of Pakistan - Statistics Division - Agricultural Census Organization, 2003) as cited in (Siebert *et al.*, 2005) and used in the Global Map of Irrigation Areas version 4 (Siebert *et al.*, 2007). The census also lists irrigated and non-irrigated harvested areas per crop for wheat, maize for grain, sugar cane, potatoes, oilseed, pulses, fodder and vegetables including potatoes. For rice, only paddy rice (with different varieties including “IRRI”, all assumed to be irrigated) is mentioned. For cotton only total area is mentioned, that was assumed to be 100% irrigated. In addition to 23,439,748 ha harvested area of annual crops cropped in “kharif” (10,394,203 ha, sowing in autumn) and “rabi” (12,665,006 ha, sowing in spring) crop seasons, 380,521 ha of fruit orchards are cited. For crops not cited in the census, like barley, millet, sorghum, rapeseed and citrus, the original harvested area cited by the FAO crop calendar (FAO, 2005b) was scaled with the corresponding ratio of equipped area from the Global Map of Irrigation Areas version 4 (Siebert *et al.*, 2007) and that cited by FAO. The distribution of oil seed area cited in the agricultural census to classes besides rapeseed that is used in the own data set was unclear. Therefore, the scaled area of rapeseed replaced the area of the class oilseeds. The final fruit tree orchard area (199,948 ha) was calculated as the value for fruit orchards, cited in the agricultural census and assumed to be 100% irrigated, minus the scaled area of citrus that was assumed to be contained in the former area. Probably this area contains area of irrigated date palms, which are only specified as total tree numbers but without specific irrigated area or irrigation share. The final vegetables area (335,121 ha) was calculated as the census area including potatoes minus the census area for potatoes.

Cropping seasons:

The agricultural census (Government of Pakistan - Statistics Division - Agricultural Census Organization, 2003) mentions for annual crops the relative distribution of total crop area, irrigated and rainfed, for the “kharif” and “rabi” season. They are given either as relative percentages of crop area (wheat, rice, cotton, maize for grain, and sugar cane) or as absolute areas (potatoes, oil seed, pulses and fodder). This mixture of rainfed and irrigated areas could not be separated to form cropping seasons for irrigated crops. Therefore, the FAO crop calendar (FAO, 2005b) was used. In the “kharif” autumn sowing season, irrigated wheat is grown from November to May. Similarly, rapeseed and fodder are cultivated from November to May. In the “rabi” spring sowing season, all the other annual crops are grown from June to October, besides cotton from June to December. Throughout the year sugar cane and tree cultures (citrus, fruits) are cultivated.

Papua New Guinea

Irrigated area:

There is no irrigation according to the FAO AQUASTAT report on Asia (FAO, 1999).

Philippines

Irrigated area:

The area equipped for irrigation, 1,550,000 ha, was set to the one mentioned for 1993 by (National Irrigation Administration, 1993), cited by the FAO AQUASTAT report on Asia (FAO, 1999) and cited in (Siebert *et al.*, 2005). The original harvested area cited by the FAO crop calendar for irrigated crops (FAO, 2005b) were directly used, as now newer information was available.

Cropping seasons:

The crop calendar is mostly identical to that of Thailand, besides shorter rice cropping seasons. Main crop is rice that is irrigated twice on ca. 900,000 ha from May to September and from October to February. Besides vegetables that are also irrigated from October to February, the other crop cited (sugar cane) is irrigated throughout the year.

Qatar

Irrigated area:

The area equipped for irrigation, 12,520 ha, is the value mentioned for 1993 in the FAO AQUASTAT report (FAO, 1997c) and cited in (Siebert *et al.*, 2005). All cropped area is irrigated due to desert climatic reasons (FAO, 1997c). The crop areas are taken from the FAOSTAT database as mean harvested areas for the time period 1998-2002 (FAO, 2005d).

Cropping seasons:

The seasons are assumed to be the same as for neighbouring Saudi-Arabia with similar climate. Wheat and barley are grown as irrigated crops in winter from December to June and from December to April, respectively. Maize and potatoes are possibly cropped on the same plots as wheat and barley from July to November. Vegetables are grown in only one season from July to November. Theoretically they could be cropped in three seasons of equal length of 4 months starting in January with a cropping intensity of 3. Clover as forage crop is assumed to be grown only from December to April. As permanent crops dates, citrus, and grapes are cultivated.

Republic of Korea

Irrigated area:

The area equipped for irrigation, 880,365 ha, is for 2002 as compiled by (Siebert *et al.*, 2005) from data of (Ministry of Agriculture and Forestry, 2003). Rice is the most important irrigated crop besides vegetables. The original harvested area cited by the FAO crop calendar for irrigated crops (FAO, 2005b) was scaled with the corresponding ratio of equipped area of (FAO, 2005b) and the sum given in (Siebert *et al.*, 2005). This lead to a reduced irrigated area, as (Ministry of Agriculture and Forestry, 2003) cites roughly 290,000 ha partially irrigated paddy rice land that is not included in the equipped area which was scaled down to fit province level totals by (Siebert *et al.*, 2005).

Cropping seasons:

Main crop is rice that is irrigated only once on roughly 600,000 ha from May to September, like the other annual cultures as well. The permanent cultures are citrus and fruit trees.

Saudi-Arabia

Irrigated area:

The area equipped for irrigation is 1,730,767 ha, derived as the maximum values for 2000 and 1992 from sources (Arab Organization for Agricultural Development - Agricultural Information, 2003b) and (Dabbagh and Abderrahman, 1997) as cited in (Siebert *et al.*, 2005). All cropped area is irrigated due to desert climatic reasons (FAO, 1997c). The crop areas are taken from the FAOSTAT database as mean harvested areas for the time period 1998-2002 (FAO, 2005d).

Cropping seasons:

The seasons are taken basically from the FAO crop calendar for irrigated crops (FAO, 2005b) and validated by the FAO GIEWS crop calendar (FAO, 2005c). Wheat and barley are grown as irrigated crop in winter from December to June and from December to April, respectively. Maize and potatoes are possibly cropped on the same plots as wheat and barley from July to November. Vegetables are grown in only one season from July to November. Theoretically they could be cropped in three seasons of equal length of 4 months starting in January with a cropping intensity of 3. Groundnuts, pulses, sesame seed are equally assumed to be equally grown from July to November. Unspecified forage crops are grown only from December to April, whereas alfalfa (classified as fodder grasses / managed grassland) is grown as semi-permanent crop throughout the year. As permanent crops dates, citrus, and grapes are cultivated.

Singapore

No irrigation is reported for Singapore.

Sri Lanka

Irrigated area:

The area equipped for irrigation, 570,000 ha, was set to the one cited for 1995 by (FAO, 1999) and by (Siebert *et al.*, 2005) found to be the best for downscaling. The original harvested area cited by the FAO crop calendar for irrigated crops (FAO, 2005b) was directly used, as no change in equipped area was present.

Cropping seasons:

Main crop is rice that is irrigated twice from November to March and from June to October. All the other crops are irrigated also from June to October, besides the permanently cropped sugar cane.

Syrian Arab Republic

Irrigated area:

The area equipped for irrigation, 1,266,900 ha, is the value cited for 2001 from (Arab Organization for Agricultural Development - Agricultural Information, 2003c) as cited in (Siebert *et al.*, 2005). The cropped area was taken from the FAO crop calendar for irrigated crops (FAO, 2005b), oil crops were assumed to be sesame. The area was scaled with the ratio of area equipped for irrigation of the

1990ies (FAO, 1997c) and for 2001 (Arab Organization for Agricultural Development - Agricultural Information, 2003c).

Cropping seasons:

The seasons are taken basically from the FAO crop calendar for irrigated crops (FAO, 2005b). Wheat is grown as irrigated crop in winter from November to May. All the other annual irrigated crops (maize, barley, potatoes, pulses, vegetables, oil crops (assumed to be sesame), groundnuts, sunflower, tobacco) are grown in the summer season from June to October, besides sugar beets that start already in May and cotton that is grown from May to November. Fodder crops are grown from December to April. As permanent crops fruits and citrus are cultivated.

Taiwan, Province of China

Irrigated area:

The area equipped for irrigation, 525,528 ha, is the value mentioned for 1995 in (Directorate-General of Budget, 1997) as cited in (Siebert *et al.*, 2005). The harvested areas cited in (Directorate-General of Budget, 1997) were taken as a reference. It was assumed that rice, sugar cane and vegetables, the only irrigated crops on the Philippines, were 100% irrigated, but no other crops, as for the other crops no detailed statistical data existed. (Achnich, 1980) mentions also maize, sweet potatoes, fruits, and tobacco as irrigated crops.

Cropping seasons:

The seasons are assumed to be the same as for neighbouring south-eastern China (e.g. province of Fujian). Rice is cropped twice on the same area from May to October and from November to March with a cropping intensity of 2. Vegetables are grown from April to August. As permanent crop sugar cane is grown throughout the year.

Tajikistan

Irrigated area:

The area equipped for irrigation, 719,200 ha, was set to the figure for 1994 from (FAO, 1997b) and confirmed by (USAID, 2002) as cited in (Siebert *et al.*, 2005).. The original harvested area cited by FAO (FAO, 1997b) was taken as a starting point, as the sum is the area equipped for irrigation. In (FAO, 1997c), additional information on crops are given. The figures for harvested area from the FAOSTAT database (FAO, 2005d) for the available time period 1992-1995 were taken as a reference, as indicated by the following fact: The rounded irrigated area of cotton corresponds exactly to the harvested area. For most of the crops, an irrigation ratio of 100% was assumed. As fodder crops, only maize and grasses were assumed to be irrigated, as for these crops figures by FAOSTAT are given and other crops could not directly to be identified as fodder crops. Grasses for fodder are classified as fodder grasses / managed grassland. Rice is not explicitly cited, so FAOSTAT data was used. The FAOSTAT harvested area of cereals for maize, rye and oats was similarly taken, as the irrigated areas cited by (FAO, 1997b) were much higher (factors 3 and 10!). To the contrary, irrigated areas for barley and wheat seemed realistic, with 50% and 30% irrigation ratio. Summing all “other annual” crops, a share of roughly 50% of the figure given in (FAO, 1997b) was flatly attributed to own crop group “others annual”, with approximately 15% irrigation ratio. As permanent crops, all citrus, grapes and fruit trees were assumed to be irrigated.

Cropping seasons:

The crop calendar for Afghanistan was used as a starting point for neighbouring mountainous Tajikistan and Kyrgyzstan.

In the winter season, irrigated wheat is grown from November (Kyrgyzstan: October) to May according to the FAO GIEWS crop calendar (FAO, 2005c), like in Afghanistan. Similarly, barley is cultivated from December to April, rye and oats from November to April. All the other annual crops are summer crops assumed to be grown from July to October (rice, soybeans, sunflower, potatoes (different to Afghanistan), pulses, melons, other annuals). Maize (including maize for fodder) is grown from May until October according to the FAO GIEWS crop calendar (FAO, 2005c), different to Afghanistan, cotton from May until November. The rest of fodder was assumed to be annual cultures to be potentially irrigated all over the year (mixed grasses, other grasses).

Thailand**Irrigated area:**

The area equipped for irrigation, 4,985,708 ha, was set to the one mentioned for 2000 by (Office of Agricultural Economics - Thailand, 2005) and cited in (Siebert *et al.*, 2005). The original harvested area cited by the FAO crop calendar for irrigated crops (FAO, 2005b) was scaled with the corresponding ratio of equipped area FAO and (Office of Agricultural Economics - Thailand, 2005).

Cropping seasons:

Main crop is rice that is irrigated twice on ca. 2.2 Mha from May to October (extended by 1 month the date of (FAO, 2005b) according to major rice season of (Office of Agricultural Economics - Thailand, 2005)) and from October to April (extended by 2 months the date of (FAO, 2005b) per 1 month according to minor rice season of (Office of Agricultural Economics - Thailand, 2005)). Besides vegetables that are also irrigated from October to February, all the other crops (sugar cane, bananas, citrus, and fruit tree orchards) are irrigated throughout the year.

Timor-Leste**Irrigated area:**

The area equipped for irrigation (14,000 ha) was set to the one mentioned for 1990 by (Elshof, 1990) as cited in (Siebert *et al.*, 2005). It was assumed that all irrigation was concentrated in rice, but due to deterioration of irrigation schemes, only 50% of the areas were actually irrigated around the year 2000.

Cropping seasons:

Crop calendars as for Indonesia outside Java were used, rice being cultivated from December to April.

Turkmenistan

Irrigated area:

The area equipped for irrigation, 1,744,100 ha, was set to the figure for 1994 from (FAO, 1997b) and cited in (Siebert *et al.*, 2005). The original harvested area cited by FAO (FAO, 1997b) was taken as a starting point, as the sum is the area equipped for irrigation, i.e. the maximum area. The figures for harvested area from the FAOSTAT database (FAO, 2005d) for the available time period 1992-1995 were taken as a reference, as indicated by the following fact: The rounded irrigated area of cotton corresponds nearly exactly to the harvested area. For most of the crops, an irrigation ratio of 100% was assumed. As fodder crops, only maize and grasses plus vegetables/roots for fodder (ca. 60% irrigation ratio) were assumed to be irrigated, as for these crops figures by FAOSTAT are given and other crops could not directly to be identified as fodder crops. Grasses for fodder are classified as fodder grasses / managed grassland. Rice is cited, but the FAOSTAT data were used, as they give a smaller value that was assumed to be a more realistic estimation for the actually irrigated area. The FAOSTAT harvested area of cereals for maize, rye and wheat was similarly taken, as the irrigated area cited by (FAO, 1997b) for wheat was much higher (factor 2), likewise assumed to be maximum equipped areas for cereals. To the contrary, irrigated area for barley seemed realistic, with 50% irrigation ratio. Like for Tajikistan, potatoes, pulses, melons and vegetables were assumed exist as 100% irrigated crops. The rest of the value for annual crops given in (FAO, 1997b) is about 75,000 ha and was assumed to be filled by cereals barley (40,000 ha) and grain maize (43,000 ha) and rye (ca. 600 ha) and by areas foreseen for wheat or for perennial crops. As permanent crops, all grapes and fruit trees were assumed to be irrigated. Nevertheless with roughly 34,000 ha they reached by far not the equipped area of ca. 233,000 ha.

Cropping seasons:

The crop calendar for Tajikistan was assumed to be valid for neighbouring Turkmenistan, too.

In the winter season, irrigated wheat is grown from November to May according to the FAO GIEWS crop calendar (FAO, 2005c). Similarly, barley is cultivated from December to April, rye from November to April. All the other annual crops are summer crops assumed to be grown from July to October (rice, potatoes, soybeans, pulses, melons, other annuals). Maize (including maize for fodder) is grown from May until October according to the FAO GIEWS crop calendar (FAO, 2005c), cotton from May until November. The rest of fodder was assumed to be annual cultures to be potentially irrigated all over the year (mixed grasses, vegetables and roots for fodder).

United Arab Emirates

Irrigated area:

The area equipped for irrigation, 280,341 ha, is the value mentioned for 2001 in (Ministry of Planning, 2003) and cited in (Siebert *et al.*, 2005). All cropped area is irrigated due to desert climatic reasons (FAO, 1997c). The crop areas are taken from the FAOSTAT database as mean harvested areas for the time period 1998-2002 (FAO, 2005d).

Cropping seasons:

The seasons are assumed to be the same as for neighbouring Saudi-Arabia with similar climate. Wheat is grown as irrigated crop in winter from December to. Potatoes are possibly cropped on the same plots as wheat from September to November. Vegetables are grown in only one season from July to November, as indicated by the 9,683 ha irrigated area for vegetables only for the 2000-2001

cropping season given by the national statistics (Ministry of Planning, 2003) that corresponds to 9,576 ha given in the FAOSTAT database for 2001. Theoretically they could be cropped in three seasons of equal length of 4 months starting in January with a cropping intensity of 3. Tobacco is assumed to be grown during the summer season from July to November. Grasses for forage and silage are assumed to be grown from December to April. Alfalfa as forage and silage crop (classified as fodder grasses / managed grassland) is assumed to be grown as a semi-permanent crop from January to December with cuts 3-4 months apart. As permanent crops dates, citrus, and grapes are cultivated, also others (mangoes, figs, tree-nuts, and bananas).

Uzbekistan

Irrigated area:

The area equipped for irrigation, 4,223,000 ha, was set to the figure for 1996 from (European Commission - Directorate General, 1996) and cited in (Siebert *et al.*, 2005). The original harvested area for 1993 cited by FAO (FAO, 1997b) was taken as a starting point, as the sum (4,308,800 ha) is slightly higher than the area equipped for irrigation. The figures for harvested area from the FAOSTAT database (FAO, 2005d) for the available time period 1992-1995 were taken as a reference, as indicated by the following fact: The rounded irrigated area of cotton corresponds nearly exactly to the harvested area. For most of the crops, an irrigation ratio of 100% was assumed. As fodder crops, only maize and grasses plus vegetables/roots for fodder (ca. 95% irrigation ratio) were assumed to be irrigated, as for these crops figures by FAOSTAT are given and other crops could not directly to be identified as fodder crops. Grasses for fodder are classified as fodder grasses / managed grassland. For wheat and potatoes, the originally cited harvested areas were taken, as they are smaller than the harvested areas of FAOSTAT (50% and 60% irrigation ratio). Rice is cited, but like for maize the FAOSTAT data were used, as they give assumedly a more realistic estimation for the actually irrigated area, even if they are higher. The FAOSTAT harvested area of "other cereals" (ca. 45,000 ha) including rye, barley, millet and sorghum was scaled to the value given in Figure 9 of (FAO, 1997b), by applying irrigation ratios of 50% and 12.5% (barley). Like for Turkmenistan, pulses and sunflowers were assumed to exist besides potatoes, melons and vegetables as 100% irrigated crops. The rest of the value for perennial crops given in (FAO, 1997b) was assumed to be much too high, as permanent crops, all fruit trees and berry orchards, grapes and citrus were assumed to be irrigated, nevertheless with roughly 230,000 ha by far not reaching the equipped area of about 678,000 ha.

Cropping seasons:

The crop calendar for Tajikistan was assumed to be valid for neighbouring Uzbekistan like for Turkmenistan, too. In the winter season, irrigated wheat is grown from November to May according to the FAO GIEWS crop calendar (FAO, 2005c). Similarly, barley is cultivated from December to April, rye from November to April. All the other annual crops are summer crops assumed to be grown from July to October (rice, potatoes, sunflower, soybeans, pulses, melons, other annuals). Maize (including maize for fodder) is grown from May until October according to the FAO GIEWS crop calendar (FAO, 2005c), cotton from May until November. The rest of fodder was assumed to be annual cultures to be potentially irrigated all over the year (mixed grasses, vegetables and roots for fodder). Perennial crops are fruits and berry orchards, grapes and small areas of citrus.

Viet Nam

Irrigated area:

The area equipped for irrigation, 3,000,000 ha, was set to the one cited for 1994 by (FAO, 1999). The harvested area for rice of 5.46 Mha and for vegetables of roughly 380,000 ha is cited in the FAO AQUASTAT report (FAO, 1999). The rice harvested area is calculated from an equipped area of 2.1 Mha multiplied by a cropping factor of 2.6. The area does not correspond to the harvested area cited by the FAO crop calendar for irrigated crops (FAO, 2005b), that probably was calculated on the basis of an cropping intensity of roughly 2. In (World Bank, 1996b), an area of 5.4 Mha harvested irrigated paddy rice is cited, out of 6.4 million totally harvested paddy area. The first number is identical to the FAO AQUASTAT report value. According to the World Bank, in 1996, out of 4 million cultivated irrigated area, 3 Mha were irrigation design area, and 2 Mha each were irrigated and not-irrigated, i.e. area equipped for irrigation was planned to increase by 50% area (see (World Bank, 1996b) page 22, e.g. Figure 4.2). The same source also mentions that even if the reported cropping intensity is 2.6, the actual one is closer to 2.0. For the Mekong delta double and triple cropping in some areas exist (see source on page 76). The paddy rice harvested area as cited in the FAOSTAT database (FAO, 2005d) shows an increase from 1990 until 2002. The mean is roughly 6.45 million for 1990-1995 and 7.54 million for 1998-2002. Therefore, for vegetables an area of roughly 380,000 ha for 1997 in the AQUASTAT report (FAO, 1999) was taken as a new reference, and the other crop areas including rice (4.5 Mha, with a cropping intensity of 2) were taken from the FAO crop calendar for irrigated crops (FAO, 2005b), as no change in equipped area could be found in references.

Cropping seasons:

Main crop is rice that is irrigated twice on 2.25 Mha from May to September and from October to February. The crop calendar for FAO GIEWS (FAO, 2005c) gives somewhat different cultivation seasons, but seasons for spring-autumn rice and autumn-spring rice for the south correspond well. Only seasons of ten moth rice are a little bit longer, but are assumed to be negligible within the scope of global modelling. All the other crops besides the permanent cultures of sugar cane, bananas, and citrus are also irrigated from October to February (maize, sweet potatoes, and vegetables).

Yemen

Irrigated area:

The area equipped for irrigation, 388,000 ha, is the value mentioned for 1996 from (World Bank - Rural Development, 1999) excluding spate irrigation, as cited in (Siebert *et al.*, 2005). The cropped area was taken basically from the FAO crop calendar for irrigated crops (FAO, 2005b). For fodder, from the FAOSTAT database (FAO, 2005d) mean harvested areas for the period 1990-1995 were taken and the irrigated area distributed to sorghum for fodder and alfalfa for forage and silage, assuming that other grasses were cultivated as rainfed cultures only.

Cropping seasons:

The seasons are taken basically from the FAO crop calendar for irrigated crops (FAO, 2005b) and validated by the crop calendar for neighbouring Saudi-Arabia. Wheat is grown as irrigated crop in winter from November to May, barley and millet from December to April. Maize, sorghum, potatoes, pulses, sesame and tobacco are grown from June to October. Maize and sorghum are possibly cropped on the same plots as wheat, barley, and millet. Vegetables are grown in only one season from June to October. Theoretically they could be cropped in three seasons of equal length of 4 months starting in January with a cropping intensity of 3. Cotton is grown from May to November. Unspecified forage crops are grown only from December to April, whereas alfalfa (classified as fodder grasses / managed grassland) is grown as semi-permanent crop throughout the year. As permanent crops fruits, coffee, citrus and bananas are cultivated.

EUROPE

For many European countries the Statistical Office of the European Communities (EUROSTAT) cites area equipped for irrigation and actually irrigated area. The latter is given as total area irrigated once a year and as crop-specific area for the non-exhaustive crop list durum wheat, maize, potatoes, sugar beet, sunflower, soybeans, fodder plants, fruit and berry orchards, citrus, and vines (EUROSTAT, 2005).

Albania

Irrigated area:

Current areas equipped for irrigation (340,000 ha, according to AQUASTAT) and actually irrigated (180,000 ha) of (Brewer, 2001) were taken as the best guess reference. His areas are in line with somewhat older sector reviews of the World Bank (World Bank, 1994) and (World Bank, 1999). He lists as main crops maize, alfalfa, vegetables and watermelon, in line with the list of irrigated crops of 1990 from FAO sector review (FAO, 1992). The latter list was taken, the corresponding harvested areas for the year 2000 from the FAOSTAT database (FAO, 2005d) transformed to absolute irrigated crop areas with estimated percentages, until fitting the current total actually irrigated area of (Brewer, 2001) taken as representative for 2001. Irrigated harvested area was estimated with a cropping intensity of 1, also for vegetables, assuming that some non-irrigated vegetable area remains, so that the harvested area from the FAOSTAT database (FAO, 2005d) is not fully reached. Alfalfa is here classified as permanent crop.

Only national data on irrigated areas are available.

Cropping seasons:

In winter, only winter wheat and oats are irrigated from November to June. Irrigated crops are mainly summer crops, also cotton, grown between April and September. Rice is grown from May to September. Potatoes are grown from March to September according to the crop calendar for the FAO GIEWS (FAO, 2005c). Vegetables are grown from March until November. Fruit orchards are assumed to be frost-irrigated and irrigated against water deficiency in summer, like grapes and olives in summer.

Andorra

Irrigated area:

Current areas equipped for irrigation, 150 ha, and actually irrigated (150 ha) were taken from the CORINE Land Cover 1990 data base (European Environment Agency, 2000) and assumed to be of identical size. Agricultural area was taken from (Wikipedia-Encyclopedia, 2005a), and repartitioned to crops maize, grapes and tobacco in ascending order of assumed importance in the list given by (Infoplease, 2005). Irrigated harvested area was estimated with a cropping intensity of 1, as no values in the FAOSTAT database (FAO, 2005d) are present.

Only national data on irrigated areas are available.

Cropping seasons:

Irrigation calendar is assumed to be the same for Andorra and for France.

Irrigated crops are only summer crops grown between May and September: maize and tobacco. Rice is grown from May to September. Maize, maize for fodder, potatoes and sugar beets are grown from April until October. Vegetables are grown from March until November. Grapes are grown throughout the year and irrigated against water deficiency in summer.

Austria**Irrigated area:**

The EUROSTAT data (EUROSTAT, 2005) on irrigated area (equipped 97,480 ha and actually irrigated 34,230 ha) are for 2003 and consistent with literature values in (Neudorfer, 2003). Crop list was taken from (Baldock *et al.*, 2000) and potatoes as ubiquitous crop for central and eastern Europe added, in accordance with (Neudorfer, 2003) and (Katzmayer and Rennert, 2003). The relative percentages of the classes were estimated following (Neudorfer, 2003) and (Katzmayer and Rennert, 2003), with the highest area values attributed to sugar beets cited by (Huettler, 1996). Irrigated harvested area was estimated with a cropping intensity of 1, only for vegetables the area given in the FAOSTAT database (FAO, 2005d) was rounded and used, with an intensity of roughly 2.

Sub-national data on irrigated areas are available for the EUROSTAT crop list

Cropping seasons:

Irrigation calendar is assumed to be similar to that of Slovakia. Potatoes and sugar beets are grown from May to October. Vegetables are grown from March to October in two cropping seasons of increasing area (March – June, July – October). Fruit tree orchards are assumed to be frost-irrigated and irrigated against water deficiency in summer. Grapes / vines are grown throughout the year and also irrigated against water deficiency in summer.

Belarus**Irrigated area:**

Latest available data on irrigated crops is for 1993 in an FAO AQUASTAT report (FAO, 2005a). The 115,000 ha equipped for irrigation and actually irrigated are distributed according to relative percentages derived from absolute values for 1990 (148,200 ha) given there. The distribution of area of these classes to crops and subgroups of own nomenclature was done according to repartitioning of harvested area for 1993 from the FAOSTAT database (FAO, 2005d): Cereals and pulses to 10% oats, 45% barley, 40% rye, 5% pulses irrigated, wheat having a relatively small area of around 100,000 ha such as pulses. The latter were included as they are cited in the class name and therefore assumed to be definitely present. Vegetables (65,000 ha harvested area) and potatoes (690,000 ha harvested area) irrigated areas were distributed the same way to be covered 80% by potatoes and 20% by vegetables. Fodder crops were taken to be 100% maize, given the harvested area as high as for oats, 1/3 of those of barley and rye. For all of these mentioned crops, the assumed irrigated harvested areas were calculated with a cropping intensity of 1; only for vegetables an intensity of 2 was assumed. Nevertheless, the FAOSTAT harvested areas are by far not reached. Irrigated industrial crops were assumed to be 100% flax, having a relatively high area compared to potatoes (Marks, 1992).

Only national data are available.

Cropping seasons:

Irrigation calendar is assumed to be similar to that of Moldova. As irrigated winter cereals barley, rye and oats are grown from November to June. The greater share of summer crops (maize for forage, potatoes) are generally grown within the season between April and October: Maize from April to September, pulses and potatoes from April to October. Industrial crops (assumed to be flax) are grown from May to October. Vegetables are grown on the same areas in two separate cropping seasons (April – June, July – October) on the same area. Fodder grasses / managed grassland are cultivated throughout the year and irrigated against dryness in summer.

Belgium

Irrigated area:

The EUROSTAT data (EUROSTAT, 2005) on irrigated area equipped for irrigation, 35,170 ha, is for 2003. The actually irrigated area, roughly 6,500 ha, was taken from the agricultural census of 2003 (Direction générale Statistique et Information économique of Belgium, 2004). Major areas are maize (ca. 1,100 ha), potatoes (ca. 700 ha), other annual crops that were assumed to be vegetables (ca. 3,900 ha). Irrigated harvested area was estimated with a cropping intensity of 1, only for vegetables with an intensity of 2, assuming oceanic climate mildness prolonging the vegetation season.

Sub-national data on irrigated areas per crop are available from the agricultural census of 2003, but not from the census of the years 2004 and 2005.

Cropping seasons:

Irrigation calendar is assumed to be similar to that of the Netherlands. Irrigated crops are summer crops. Maize is grown in the standard season from May to October. Potatoes and sugar beets are grown from April to October. Vegetables are grown on the same areas in two separate cropping seasons (March – June, July – October). Fruit and berry orchards are assumed to be frost-irrigated and irrigated against water deficiency in summer.

Bosnia and Herzegovina

Irrigated area:

Current areas equipped for irrigation was set to be the 4,630 ha cited in (Civil Society Promotion Center, 2002), while the value for the areas actually irrigated (3,000 ha) was taken from the uniform figure (World Bank, 2003b) assuming that the cited extent of around 3,000 ha large-scale irrigation in Ljubuski Polje is representative for the total area actually irrigated including small-scale irrigation in Neretva River alluvium, seasonal irrigation in other areas, and the early crop production in Dubrava Plateau. The crops are repartitioned for the year 2000 to the gross land covers cited in (Agency for Statistics of Bosnia and Herzegovina, 2002) using estimated relative percentages based on harvested area and estimated irrigated share for the high-income crops potatoes (40%, also for subsistence), and vegetables (40%), maize (15%), and tobacco (5%) that are cited as crops in (Agency for Statistics of Bosnia and Herzegovina, 2001). Irrigated harvested area was estimated with a cropping intensity of 1, also for vegetables, as indicated in the figures of nearly identical sown areas and harvested areas in (Agency for Statistics of Bosnia and

Herzegovina, 2001). The resulting harvested areas are far less below those given in the FAOSTAT database (FAO, 2005d).

Only national data on irrigated areas were used, as also no data on the district of Brcko, the third sub-national unit besides the Federation of Bosnia and Herzegovina and the Republika Srpska area given in the national statistics.

Cropping seasons:

Irrigation calendar is assumed to be the same for Bosnia and Herzegovina, Croatia, and Serbia and Montenegro. Vegetables are cultivated during a relatively long cropping season from March to October. The cropping season for maize starts in April and ends in September. The cropping season of sugar beets and potatoes starts in April, that for tobacco starts in May and both end in October. Fruit tree orchards are assumed to be frost-irrigated and irrigated against water deficiency in summer. Grapes / vines are grown throughout the year. Meadows are assumed to be fodder grasses / managed grassland grown or cultivated throughout the year and possibly actually irrigated in the summer.

Bulgaria

Irrigated area:

The area equipped for irrigation, 545,160 ha, was taken from (Ministry of Agriculture and Forestry, 2004) Another national source (Chehlarova-Simeonova *et al.*, 2006) specifies 37,001 ha mean actually irrigated area. These values are derived from a time series and from national expertise, therefore were assumed to be more confidential, than the EUROSTAT data with area equipped for irrigation of 124,490 ha and actually irrigated area of 79,370 ha for 2003 (EUROSTAT, 2005). The numbers are much less than literature data for 1990 (Republic of Bulgaria - Council of Ministers, 1999). The EUROSTAT list of crops (durum wheat, maize, potatoes, sugar beet, sunflower, soybeans, fodder plants, fruit and berry orchards, citrus, and vines) was extended by crops cited in (Achnich, 1980) and (Chehlarova-Simeonova, 2001). Fodder plants of EUROSTAT are assumed to be maize (cited in the FAOSTAT database (FAO, 2005d)). FAOSTAT harvested areas for rice and cotton were assumed to be fully irrigated areas. Tobacco and alfalfa (classified as fodder grasses / managed grassland) were assumed to have 1,000 ha irrigated harvested area. Irrigated harvested area was estimated with a cropping intensity of 1, only for vegetables with an intensity of 2, assuming sub-humid winter warm climate.

Sub-national data on irrigated areas are available for the EUROSTAT crop list.

Cropping seasons:

Irrigation calendar is assumed to be the similar to that of Romania. Irrigated crops are summer crops mainly grown from May to October. Durum wheat is grown from April to July, maize from April to September, potatoes and sugar beets from April to October. Rice is grown from June to October. Vegetables are grown in two cropping seasons with the same area (March-June and July-October). Grapes, fruit orchards and alfalfa are assumed to be cultivated throughout the year, with irrigation during dry weather conditions. Seed cotton, like tobacco (classified as others annual) is grown between May and October.

Croatia

Irrigated area:

Current area equipped for irrigation, 5,790, ha for 1996 is specified by (CRCID, 2005). The area actually irrigated (5,000 ha) was taken from the uniform figure of irrigated land of the Agricultural Census 2003 (as of 1 June 2003) (CROSTAT, 2003). The crops are distributed for the year 2003 to the gross land covers cited in the Agricultural Census 2003 (CROSTAT, 2003) using estimated relative percentages from the high-income crops maize, grapes, potatoes, vegetables and fruit orchards that are cited as crops in the harvested areas in the FAOSTAT database (FAO, 2005d). Irrigated harvested area was estimated with a cropping intensity of 1, also for vegetables, as indicated in the figures of nearly identical sown areas and harvested areas in the neighbouring Bosnia and Herzegovina (Agency for Statistics of Bosnia and Herzegovina, 2001). As in the case of the neighbouring country, the resulting harvested areas are far less below those given in the FAOSTAT database (FAO, 2005d).

Detailed sub-national data on irrigated areas are available on municipality area level (CROSTAT, 2003).

Cropping seasons:

Irrigation calendar is assumed to be the same for Bosnia and Herzegovina, Croatia, and Serbia and Montenegro. Vegetables are cultivated during a relatively long cropping season from March to October. The cropping season for maize starts in April and ends in September. The cropping season of sugar beets and potatoes starts in April, that for tobacco starts in May and both end in October. Fruit tree orchards are assumed to be frost-irrigated and irrigated against water deficiency in summer. Grapes / vines are grown throughout the year. Meadows are assumed to be fodder grasses / managed grassland grown or cultivated throughout the year and possibly actually irrigated in the summer.

Cyprus

Irrigated area:

The data on equipped irrigated area (44,930 ha for Greek part (EUROSTAT, 2005) and 55,813 ha for total Cyprus according to (Siebert *et al.*, 2005)) and on the actually irrigated area 35,410 ha (EUROSTAT, 2005) are for 2003. The actually irrigated area corresponds well to FAO AQUASTAT data (FAO, 2005a) and (FAO, 1997c). The EUROSTAT list of crops included durum wheat, maize, potatoes, sugar beet, sunflower, soybeans, fodder plants, fruit and berry orchards, citrus, and vines. Fodder plants were assumed to be fodder grasses / managed grassland. The crop list for the rest of actually irrigated area according to EUROSTAT that is not included in the EUROSTAT list was taken for 1994 from (FAO, 1997c) and the FAOSTAT database of harvested area for 2000 and 2003 (FAO, 2005d). In a first step, the areas from the AQUASTAT report for barley (main cereal besides durum wheat cited by EUROSTAT), pulses, vegetables, and other annual crops including oil crops, and also fruit trees other than citrus were scaled to fit the actually irrigated area total of EUROSTAT. Final areas of these crops were adjusted then to fit within the harvested area of FAOSTAT database with the following sequence of importance: vegetables (high harvested area of 4,400 ha, with a maximum irrigated area of 3,600 ha for the larger cropping season), almond trees (perennial, high harvested area of 3,600 ha, specifically cited), olives (perennial, high harvested area of 3,300 ha), barley (specifically cited), pulses (specifically cited),

others annual (high irrigated area, specifically cited). Irrigated harvested area was estimated with a cropping intensity of 1, only for vegetables fit to FAOSTAT data with an intensity of 1.25.

Only national data on irrigated areas are available for the EUROSTAT crop list.

Cropping seasons:

In winter, only barley is irrigated from November to May. Irrigated crops are mainly summer crops, grown between April and September. Potatoes are grown from February to June, according to the FAO GIEWS crop calendar (FAO, 2005c). Others annual are grown from April until September. Vegetables are grown from February to November on the same area in two cropping seasons, mainly as early vegetables (February – June and July – November). Fruit orchards and specifically cited almond trees are assumed to be frost-irrigated and irrigated against water deficiency in summer, like citrus, grapes, olives, and irrigated fodder. Fodder is assumed to be fodder grasses / managed grassland, as fodder maize according to the harvested area from the FAOSTAT database is negligible (FAO, 2005d).

Czech Republic

Irrigated area:

The area equipped for irrigation, 50,590 ha, of the Global Map of Irrigation Areas version 4 (Siebert *et al.*, 2007) is based on sub-national data of EUROSTAT for 2003 and 2005 (EUROSTAT, 2006). Total actually irrigated area was 16,860 ha for 2003 and 17,320 ha for 2005 according to EUROSTAT, while (Miskovsky, 2001) lists 16,238 ha for 1997. Thus, the actually irrigated area (16,554 ha) representative for the period 1998-2002 was calculated as mean of the values for 1997 and 2003. There was no EUROSTAT data on harvested area of individual crops. A list of irrigated crops is cited for privatised irrigation systems for vegetables and fruits (e.g. strawberries and fruit tree orchards) by (Miskovsky, 2001). According to (Štastná *et al.*, 2006) irrigation is nowadays only being used for crops that cannot be grown without irrigation or for those for which irrigation generates high added value (vegetables, hop-fields, orchards, vineyards and potatoes). This latter list is used together with FAOSTAT data of harvested area for 1998-2002 (FAO, 2005d) and the irrigated crop areas in neighbouring countries Austria and Germany to distribute the total to the crop groups: Vegetables (assumed 50% of irrigated area, ca. 8,300 ha,), fruit and berry orchards (ca. 3,300 ha, 20%), hops, vineyards, potatoes (each ca. 1,700 ha or 10%). Irrigated harvested area was estimated with a cropping intensity of 1.

Sub-national data on total actually irrigated areas are available for regions from EUROSTAT.

Cropping seasons:

Irrigated crops are mainly summer crops. Vegetables and potatoes are grown from April to October. Permanent crops fruit and berry orchards, Grapes / vines, and hops are assumed to be frost-irrigated (fruits) and irrigated against water deficiency in summer.

Denmark

Irrigated area:

The EUROSTAT data (EUROSTAT, 2005) on irrigated area (equipped 476,000 ha and total actually irrigated 201,480 ha) are for 2003. EUROSTAT mentions only areas for potatoes, fodder plants, and fruit and berry orchards. The crop list for the rest of actually irrigated area not included in the EUROSTAT list of crops was taken from (Achnich, 1980), mentioning managed grassland, fodder plants, horticultural fruits and cereals, while (Baldock *et al.*, 2000) mentions semi-intensive

and intensive (maize, horticulture, glasshouses) for 1999 questionnaire returns. The harvested area of FAOSTAT database (FAO, 2005d) for vegetable was taken to be 100% irrigated, as the fruit and berry orchard irrigated area of 960 ha from EUROSTAT seems very low, such as the 0 ha of maize. A very conservative estimate of 1% of the cereal harvested area listed by FAOSTAT was assumed to be irrigated, with fodder grasses (managed grassland) having the biggest share of nearly 100,000 ha, an estimation supported by (Achtlich, 1980) and the large harvested areas of forage clover, rye grass and other forage products of FAOSTAT. Irrigated harvested area was estimated with a cropping intensity of 1, also for vegetables which nearly reach the FAOSTAT harvested area, assuming winter-cold conditions.

National data on irrigated areas are available for the EUROSTAT crop list, but not all classes are filled.

Cropping seasons:

Irrigated crops are winter and summer crops. Winter wheat is grown from November to June, barley from December to April, and rye and rye for fodder from November to May. Potatoes, sugar beets, and vegetables are grown from April to October. All the other summer crops including maize and fodder maize are grown from May to October. Oats and triticale are grown from November to June. Fruit orchards are assumed to be frost irrigated and like fodder grasses / managed grassland are assumed to be cultivated throughout the year and both irrigated under dry conditions.

Estonia

Irrigated area:

Area equipped for irrigation in 2005 was 1,363 ha (Tonismae, 2006). Latest available data on irrigated crop area is in the FAO AQUASTAT country report (FAO, 2005a) mentioning mainly grassland and vegetables. The 3,680 ha actually irrigated in 1995 declined later on, in line with only 600 ha actually irrigated in 1999 (Baldock *et al.*, 2000). These 600 ha were arbitrarily distributed mostly to vegetables (250 ha) and fodder grasses (managed grassland, 200 ha), assuming a change in irrigation use from the latter to potatoes, fodder plants, and fruit and berry orchards (50 ha each). Irrigated harvested area was estimated with a cropping intensity of 1, for vegetables an intensity of roughly 1 assuming only short continental summers, a resulting vegetables area only 10% of the harvested area from the FAOSTAT database (FAO, 2005d) was used. This is in line with the assumption of only partly irrigated outdoor vegetables due to lack of finance for irrigation infrastructure.

Only national data on irrigated areas are available.

Cropping seasons:

The same crop calendars are assumed in Estonia, Finland, Latvia, and Lithuania. Irrigated crops are mainly vegetables, also potatoes and sugar beets from May to October. Fruit orchards are assumed to be frost-irrigated and irrigated against water deficiency in summer.

Finland

Irrigated area:

The EUROSTAT data (EUROSTAT, 2005) on irrigated area (equipped 103,800 ha and actually irrigated) is for 2003. The actually irrigated area (20,000 ha) and the crop list beyond those crops included in the EUROSTAT crop list was taken from (Baldock *et al.*, 2000) that mentions semi-intensive and mainly intensive horticulture (potatoes, beets, vegetables) for 1999 questionnaire returns. The harvested area of FAOSTAT database (FAO, 2005d) was assumed to stem from one cropping season only. For vegetable, the 9,000 ha harvested area for the year 2000 were assumed to be 100% irrigated, roughly 15% irrigated area conservative estimation for both potatoes and sugar beets (5,000 ha each) replacing the probably erroneous zero values of EUROSTAT for the dry summer of 2003. The rest of the area, 1,000 ha, was assumed to be irrigated fodder grasses (managed grassland) that has the same share in the harvested area as barley, each ca. 500,000 ha. The conservatively estimated actually irrigated area of 20,000 ha corresponds to the lower value of the 1-3 percent of arable land irrigated in dry summers cited in (Baldock *et al.*, 2000).

Sub-national data on total irrigated area were available for the EUROSTAT crop list, specifying unrealistic zero values for individual crops.

Cropping seasons:

The same crop calendars are assumed in Estonia, Finland, Latvia, and Lithuania. Irrigated crops are mainly vegetables, also potatoes and sugar beets from May to October. Fodder grasses / managed grassland are grown throughout the year and irrigated against water deficiency in summer.

France

Irrigated area:

The area equipped for irrigation for mainland France is 2,906,081 ha, based on the maximum of 1997, 2000 and 2003 of the EIDER database (SCEES, 2006), whereas EUROSTAT mentions slightly lower 2,842,180 ha. For the actually irrigated area, data from the agricultural census (SCEES, 2006) was taken (1,575,626 ha, consistent with the value of EUROSTAT). Crop list from (Baldock *et al.*, 2000) support the EUROSTAT crop list when detailed percentages per crop of 1999 were corrected for probable rounding errors and applied to the actually irrigated area of 2000. Nevertheless, the crop list from AGRESTE was used, as it differentiates more classes than EUROSTAT and both data sets have mutually consistent values. AGRESTE gives details for vegetables, for fodder crops and meadows. Other annual fodder crops besides the explicitly cited maize were assumed to be sorghum and not rye. The area for the fodder crop maize from AGRESTE is nearly the same as the mean 1998-2004 harvested area for fodder maize cited in the FAOSTAT database (FAO, 2005d). Olive trees, pulses and following (De Réparaz, 1993) the arable crops colza/rapeseed and rice were introduced. Rice harvested area (year 2000) was set to be 100% irrigated cultivation area, and subtracted from the value of “other cereals”. The rest was distributed to barley and sorghum with relative share of ca. 85% and 15%. Area of “protéagineux” (legumes in high protein content) was attributed to pulses. From the rest area of 46,287 ha, the bigger share was attributed to rapeseed (40,000 ha, less than 0.5% of harvested area) and roughly 6,300 ha to olive trees (ca. 40% of harvested area). Vegetables that are explicitly cited in the EIDER database were assumed to have a cultivation intensity of 2 in order to yield roughly 265,000 ha irrigated harvested area, less than the harvested area from FAOSTAT (480,000 ha), assuming that also rainfed

cultivation of vegetables exist. Irrigated harvested area was estimated with a cropping intensity of 1, besides the mentioned value of 2 for vegetables.

Sub-national data on irrigated areas are available for canton level for the crop lists of AGRESTE (SCEES, 2006) and for region level for the crop list of EUROSTAT.

Cropping seasons:

Irrigation calendar is assumed to be the same for Andorra and for France. Irrigated crops are only summer crops grown between May and September, e.g. sunflower, soybean, pulses, and rapeseed. Rice is grown from May to September. Maize, maize for fodder, potatoes and sugar beets are grown from April until October. Vegetables are grown from March until November on the same area in two cropping seasons with increasing area in the second season (March – June and July – November). Fruit orchards are assumed to be frost-irrigated and irrigated against water deficiency in summer, like grapes and olives in summer. Managed grassland classes of AGRESTE temporary and permanent are assumed to be permanently grown fodder grasses throughout the year and to be irrigated at any time during the year when water stress, most often in summer.

Germany

Irrigated area:

The area equipped for irrigation based on sub-national statistics is 496,871 ha of the Global Map of Irrigation Areas version 4 (Siebert *et al.*, 2007), mainly based on data from the 2001 inquiry of the national technical association (Fachverband Feldberegnung - Federal Sprinkler Irrigation Association, 2001). For the actually irrigated area the mean value of the surveys of 1998 and 2002 (Statistisches Bundesamt - Federal Statistical Office, 1998) & (Statistisches Bundesamt - Federal Statistical Office, 2004) was used, differentiating between the groups arable cultures, horticulture and permanent crops. The figure for arable crops irrigated area (187,277 ha) was distributed to known irrigated cultures maize, potatoes and sugar beets. For maize and potatoes the values were proportional to assumed irrigation ratios 5% and 25% of the respective mean harvested areas 1998-2002 given in the FAOSTAT database (FAO, 2005d). The rest was attributed to sugar beets, roughly 20% of the harvested area. The figure for horticulture (40,854 ha) was similarly distributed to 300 ha of medical plants and spices cited by (Pfleger, 2005), the rest attributed to vegetables without detailed specification. From the figures for permanent crops 220 ha of irrigated hops from (Pfleger, 2005) were withdrawn to yield as rest the irrigated areas of fruit and berry orchards. Irrigated harvested area was estimated with a cropping intensity of 1, only for vegetables with an intensity of 2, assuming also non-irrigated vegetable cropping areas.

Sub-national data on irrigated areas are available for the mentioned groups of crops (arable, horticulture, permanent) on Länder level by (Statistisches Bundesamt - Federal Statistical Office, 1998) & (Statistisches Bundesamt - Federal Statistical Office, 2004).

Cropping seasons:

Irrigated crops are mainly summer crops. Maize is grown from May to October, potatoes and sugar beets are grown from April to October. All the other crops are grown from May to October, besides vegetables that have two cropping seasons with the same area (April-June and July-October). Grapes, fruit orchards (frost irrigated) and fodder grasses / managed grassland are assumed to be cultivated throughout the year and irrigated under dry conditions.

Greece

Irrigated area:

The EUROSTAT data (EUROSTAT, 2005) on irrigated area (equipped 1,544,530 ha and actually irrigated ca. 1,16 Mha) for 2000 was used. The crop list beyond those included in the EUROSTAT crop list was taken mainly from (Baldock *et al.*, 2000) mentioning semi-intensive (maize); intensive (cotton, beets, horticulture, vines) and extensive tree crops for 1999, along with traditionally trees and horticulture. Fodder crops were distributed to the harvested area of fodder maize (6,940 ha) and the rest to annual summer fodder plants (66,300 ha). The mean 1998-2002 harvested area maize for fodder, also that for additional crops rice, cotton, olive trees, pulses, and vegetables was taken from the FAOSTAT database (FAO, 2005d). Rice, cotton and vegetables were assumed to be 100% irrigated, and olive tree cultures and pulses to have roughly 20% irrigation of the total harvested area. Finally, wheat other than durum wheat filled the rest of the actually irrigated areas, about 50% of the area for durum wheat, only 5% of irrigated area of maize. Actually irrigated area was estimated with a cropping intensity of 1, and for vegetables with an intensity of 2.

Sub-national data on irrigated areas are available for the EUROSTAT crop list. Some information of regional distribution of crops at prefecture level is given in on pages 41-43 in (Bazzani *et al.*, 2001).

Cropping seasons:

Crop calendars are assumed to be the similar for Italy and Greece. In winter, only winter wheat is irrigated from November to May. Irrigated crops are mainly summer crops, also cotton, grown between April and September. Rice is grown from May to September. Potatoes and sugar beets are grown from April until October. Vegetables are grown from March until November on the same area in two cropping seasons (March – June and July – November). Fruit orchards are assumed to be frost-irrigated and irrigated against water deficiency in summer, like grapes and olives in summer.

Hungary

Irrigated area:

The area equipped for irrigation is 292,147 ha for 2002-2003 as used in the Global Map of Irrigation Areas version 4 (Siebert *et al.*, 2007). For the actually irrigated area, very different values are cited. EUROSTAT data (EUROSTAT, 2005) is 67,100 ha for 2000 and 148,690 ha for 2003, while the National Water Authority gives values within the period 1998-2003 from 33,800 ha in 1999 up to 115,200 ha in 2003, and two different figures for 2004 (87,500 ha and 102,856 ha) (Ligetvári *et al.*, 2006). Therefore, the mean of the EUROSTAT values for 2000 and 2003 and of the National Water Authority 1998-2003 was used (103,764 ha). As the crop list of EUROSTAT is not exhaustive, other sources were used to fill the areas with unspecified crops. Fodder plants were assumed to be maize. The crop list of (Achtlich, 1980) mentions, besides some 28,000 ha in 1972 for paddy rice, cereals, roots & tubers, alfalfa, fodder crops, vegetables, fruit orchards, also especially important maize. The cultivated areas for 2000-2002 of (Bundesministerium für Verbraucherschutz, 2003) were used as control especially for vegetables. For rice, the FAOSTAT database (FAO, 2005d) mean harvested area was assumed to be 100% irrigated. Pulses were assumed to be 1/3 irrigated, rapeseed roughly 10%, tobacco 100%, annual spices roughly 10%, fodder grasses (managed grassland) 100% (9,000 ha). Finally, areas for barley (ca. 5% irrigated),

wheat other than durum wheat (ca. 1% irrigated) were estimated. Harvested irrigated area was estimated with a cropping intensity of 1.

Cropping seasons:

Irrigated crops are mainly summer crops. Winter cropping seasons are present for wheat and barley. The cropping season of winter wheat lasts from November to June, that of barley from December to May. All the other annual crops are grown from May to October, with the following exceptions: potatoes and sugar beets start in April. Rice is grown from May to September. Vegetables have one cropping season from April to October. Grapes, fruit orchards (frost irrigated) and fodder grasses / managed grassland are assumed to be cultivated throughout the year, with possible irrigation during dry seasons.

Iceland

No irrigation due to climatic conditions unsuitable for outdoor horticulture agriculture was assumed. No figures from the FAOSTAT database (FAO, 2005d) are available.

Ireland

Irrigated area:

Actually irrigated and equipped areas for 1999 were both set equal to the total actually irrigated area of 1,100 ha cited in (Baldock *et al.*, 2000), mentioning early potatoes, vegetables, and soft fruit. As there were no data on irrigation available from EUROSTAT (EUROSTAT, 2005), the area were distributed to early potatoes (500 ha), vegetables (500 ha) and strawberries (classified as permanent crop, 100 ha). Irrigated harvested area was estimated with a cropping intensity of 1, also for vegetables.

Only national data on irrigated areas are available.

Cropping seasons:

Irrigated crops are mainly summer crops grown between April and September. Strawberries are classified as perennial, e.g. sunflower, soybeans, pulses, and rapeseed. Rice is grown from May to September. Maize, maize for fodder, potatoes and sugar beets are grown from April until October. Vegetables are grown from March until November on the same area in two cropping seasons with increasing area in the second season (March – June and July – November). Fruit orchards are assumed to be frost-irrigated and irrigated against water deficiency in summer, like grapes and olives in summer. Fodder grasses / managed grassland are grown throughout the year, but only irrigated in summer.

Italy

Irrigated area:

Area equipped for irrigation on a community level is 3,892,202 ha according to the Italian agricultural census of 2000 (ISTAT, 2002). Actually irrigated area is 2,471,379 ha according to the same source. The EUROSTAT data (EUROSTAT, 2005) on irrigated area for 2000 are slightly different, mentioning area equipped for irrigation of 4,084,290 ha from sub-national data and actually irrigated area of 2,453,460 ha. From the ISTAT data, data on durum wheat, soft wheat, maize for grain, sugar beet, sunflower, soybeans, vegetables (tomatoes and others), grapes/vine, fruits, potatoes, citrus fruits, fodder/grazing and other cultures can be derived. The EUROSTAT crop list is non-exhaustive and does not mention vegetables. As (Baldock *et al.*, 2000) mentions olives, vines, fruit trees, field crops, horticulture for southern Italy and cereals, maize, rice for northern Italy, the ISTAT area of “other cultures” was set to comprise maize for fodder (50% of ‘grazing’), rice, olives, and other cultures. The area of EUROSTAT class “fodder plants” is identical with that for ISTAT class “grazing”. Sub-national distributions of ISTAT area shows very high percentages of irrigation of the cultivated areas for north-western region of Italy, especially between roughly 45% and 60% for provinces Piemonte, Valle d’Aosta, and Lombardia, and north-eastern Italy, especially between roughly 25% and 35% for provinces Trentino-Alto Adige and Veneto. These areas are assumed to be mainly fodder grasses / managed grassland. As their sub-total corresponds to roughly 50% of the total class area, 50% of the “grazing/fodder plants” class area, ca. 139,000 ha was assumed to be fodder grasses (managed grassland). The other 50% were assumed to be maize for fodder, corresponding to roughly 20% of the harvested area from the FAOSTAT database (FAO, 2005d). The rest area was distributed to rice harvested area from FAOSTAT ca. 220,000 ha, assumed to be 100% irrigated, next olive trees, of which 25% of the harvested area or roughly 297,000 ha was assumed to be from irrigated areas, and finally about 9,000 other annual crops. Besides for vegetables, irrigated harvested area was calculated with a cropping factor of 1. Vegetables with a cropping intensity of 2 double the area of 199,000 ha to 398,000 ha harvested area, which is still less than the 602,000 ha rounded FAOSTAT harvested area of the year 2000.

Sub-national data on irrigated areas are available from ISTAT and from EUROSTAT.

Cropping seasons:

Crop calendars are assumed to be the similar for Italy and Greece. In winter, only winter wheat is grown from November to May. Besides this exception, irrigated crops are mainly summer crops (cotton is marginal or not existent), grown between April and September. Rice is grown from May to September. Potatoes and sugar beets are grown from April until October. Vegetables are grown from March until November on the same area in two cropping seasons (March – June and July – November). Fruit orchards are assumed to be frost-irrigated and irrigated against water deficiency in summer, like grapes and olives in summer.

Latvia

Irrigated area:

The EUROSTAT database (EUROSTAT, 2005) mentions equipped area of 590, 1,150 and 790 ha for 2000, 2003, and 2005 respectively. The area equipped for irrigation, 1,150 ha, for 2003 was taken as the reference. This is far less than the 20,000 ha irrigated area that is cited in the 1997 version of the FAO AQUASTAT Country Profile (FAO, 2005a) and that is assumed to be the equipped area at that time. 569 ha are cited to have sprinkler irrigation in 2001 (Latvia, 2002). The AQUASTAT country profile lists as major irrigated crops potatoes, vegetables and sugar beets. This was assumed to be still reasonable, as for Lithuania potatoes and vegetables are cited elsewhere. It was assumed that the zero actually irrigated area according to EUROSTAT was rather a lack in data than a real estimate (like for neighbouring Estonia and Lithuania). Hence, the mean of the equipped areas 2000-2005 was set to be actually irrigated (833 ha) for the mentioned crops with 30%, 40% and 30% shares, respectively. Irrigated harvested area was calculated with a cropping intensity of 1 also for vegetables, a vegetables area only 5% of the harvested area cited in the FAOSTAT database (FAO, 2005d) resulted. This is in line with the assumption of only partly irrigated outdoor vegetables due to lack of finance for irrigation infrastructure.

Only national data on irrigated areas are available for the EUROSTAT crop list.

Cropping seasons:

The same crop calendars are assumed in Estonia, Finland, Latvia, and Lithuania. Irrigated crops are mainly vegetables, also potatoes and sugar beets from May to October.

Liechtenstein

No irrigation is assumed due to climatic conditions. The FAOSTAT database (FAO, 2005d) only mentions grapes (120 ha, 1998-2002).

Lithuania

Irrigated area:

The area equipped for irrigation given by ICID for 1998 is 8,112 ha (Lithuanian National Committee of ICID, 2005), and for 2005 4,416 ha (Ministry of Agriculture, 2005). The EUROSTAT data (EUROSTAT, 2005) on irrigated area (equipped 740 ha) are for 2003. This is, similar to Latvia, far less than the 9,427 ha irrigated area and assumed to be equipped area that is cited in the 1997 version of the FAO AQUASTAT Country Profile (FAO, 2005a) which lists for the year 1990 the irrigated pastures and meadows (ca. 77%), as crops fodder (beets), barley, vegetables, wheat and fruit gardens. According to (Kucera and Genovese, 2004), today the main irrigated crops are potatoes and vegetables. It was assumed that the 230 ha cited by EUROSTAT to be actually irrigated was rather a small figure by lack of data than a real estimate. Hence, the fully equipped area was set to be actually irrigated (4,416.3 ha) covered 60% by potatoes and 40% by vegetables. Harvested irrigated area for both crops was estimated with a cropping intensity of 1, for vegetables also, assuming only short continental summers. This results in a vegetables area far below the harvested area from the FAOSTAT database (FAO, 2005d). This is in line with the assumption of only partly irrigated outdoor vegetables due to lack of finance for irrigation infrastructure.

Only national data on irrigated areas are available for the EUROSTAT crop list.

Cropping seasons:

The same crop calendars are assumed in Estonia, Finland, Latvia, and Lithuania. Irrigated crops are mainly vegetables in summer (May – October). Fruit orchards are assumed to be frost-irrigated and irrigated against water deficiency in summer.

Luxembourg

Irrigated area:

As EUROSTAT (EUROSTAT, 2005) mentions no irrigation, other sources of information were taken. (Baldock *et al.*, 2000) lists very little irrigation for small-scale vegetable production. The area of horticulture according to (Ministère de l'agriculture et du développement rural - Service d'économie rurale, 2005) was assumed to be roughly 75% equipped for irrigation. The value from the maximum horticulture area for the years 2000-2003 was taken as the area equipped for irrigation (27 ha). The 75% value for 2000 (16 ha) was assumed to be the currently actually irrigated area and was attributed 100% to vegetables. The harvested area of 24 ha was set in accordance to the FAOSTAT data in the reference year 2000 (23 ha for 2000; 20 ha for 2003) and assuming a practiced cropping intensity of 1.5 for vegetables, with 8 ha in the first season and 16 ha in the second. However, it is expected that potentially parts of the much larger fruit harvested area (2,000 – 3,000 ha) is irrigated at least in case of frost in spring. As definite information on this is missing, these areas were not included in the current evaluation.

Only national data on irrigated areas are available as given in (Baldock *et al.*, 2000).

Cropping seasons:

Irrigated crops are vegetables in summer, grown in two seasons with smaller area from April to June and higher area from July to October.

Malta

Irrigated area:

The EUROSTAT data (EUROSTAT, 2005) on irrigated area (equipped 2,300 ha and actually irrigated 2,130 ha) are for 2003. They are in accordance with the 1997 version of the FAO AQUASTAT Country Profile (FAO, 2005a) which lists completely used agricultural area. Crops cited for supplementary reservoir-based irrigation are spring potatoes and vegetables, both also cited in (Achnich, 1980). Full or partial control-irrigation exists for melons, tomatoes, potatoes, pumpkins, marrow (called squash in the United States) and cauliflower. Therefore, the rest of the actually irrigated area not comprised in the EUROSTAT list of crop (potatoes, fruit and berry orchards, citrus and vines) is fully attributed to vegetables (1,090 ha), and a harvested area of roughly 2,500 ha assumed, in line with a cropping intensity of 2.5 cited in the AQUASTAT Country Profile. Assuming the up to the same area of non-irrigated vegetable cultures this value fits into the framework of roughly 5,000 ha harvested area for vegetables from the FAOSTAT database (FAO, 2005d). Besides vegetables, all crops have a cropping intensity of 1.

Only national data on irrigated areas are available for the EUROSTAT crop list.

Cropping seasons:

Irrigated crops are summer crops. Potatoes are grown from March to November. Vegetables are grown on the same areas in three separate cropping seasons (February – May, June – August, September – November) the first two seasons with 1,090 ha and the last season with a reduced area of only 320 ha, according to the cropping intensity between 2 and 2.5. Fruit orchards are assumed to be frost-irrigated and irrigated against water deficiency in summer. Citrus and grapes are grown throughout the year, with irrigation against water deficiency in summer.

Monaco

No irrigation is assumed in this city-state. It was joined to neighbouring France for further geographical analysis.

Montenegro:**Irrigated area:**

Current area equipped for irrigation, 2,115 ha, for the year 2004 is cited in the national statistics (Republic of Montenegro Statistical Office, 2006). It is taken to be representative at least for the season 2000-2005. Actually irrigated area (2,109 ha) for 2004 for crop groups “arable fields and gardens”, orchards, vineyards, and meadows (classified as fodder grasses / managed grassland) were taken from (Serbia and Montenegro Statistical Office, 2005), in order to be compatible with the data for Kosovo (SOK, 2005) for the same season. The crop area for arable fields and gardens (only 9 ha) were repartitioned using estimated relative percentages for the high-income crops vegetables (ca. 40%), potatoes (ca. 50%) that are cited in (Serbia and Montenegro Statistical Office, 2005). Irrigated harvested area was estimated with a cropping intensity of 1, also for vegetables, as single cropping is the norm according to (World Bank, 2005). The resulting harvested areas for the total of Serbia and Montenegro are far less below those given in the FAOSTAT database (FAO, 2005d).

Cropping seasons:

Irrigation calendar is assumed to be similar in Macedonia, Serbia, Montenegro, and Kosovo. Vegetables are cultivated during a relatively long cropping season from March to October. The cropping season for maize starts in April and ends in September. The cropping season of sugar beets and potatoes starts in April, that for tobacco starts in May and both end in October. Fruit tree orchards are assumed to be frost-irrigated and irrigated against water deficiency in summer. Grapes / vines are grown throughout the year. Meadows are assumed to be fodder grasses / managed grassland grown or cultivated throughout the year and possibly actually irrigated in the summer.

Netherlands**Irrigated area:**

The EUROSTAT data (EUROSTAT, 2005) on irrigated area (equipped 498,330 ha) is somewhat higher than the reference value of 476,315 ha on municipal level as drawn from (Kroon, 2006). The area actually irrigated representative for the season around 2000 (146,333 ha) was calculated as mean of dry and wet years cited in the study of (Hoogeveen *et al.*, 2003) for the Droogtestudie

Nederland. The area is much higher than the 62,190 ha for the dry year 2003 cited by EUROSTAT and is assumed to be more realistic given the national expertise in its compilation. (Hoogeveen *et al.*, 2003) cites shares for the reference year 1997 for grassland (“gras”) (65%, ca. 95,000 ha), maize (7%), potatoes (13%), vegetables (5%), and other crops (10%). The absolute areas were calculated by applying these percentages to the current actually irrigated reference area. For the crop group of “other crops”, the relative shares of sugar beet, fodder, and fruit and berry orchards as given by EUROSTAT were used to distribute the area to these crops, with the final absolute areas being similar. The crop lists for 3 geographical regions cited for 1999 in (Baldock *et al.*, 2000) confirm this picture: grass and arable land, some vegetables in the west and north, arable land, horticulture, grass in the east, centre and south, with additionally intensive glasshouse and horticulture all over the country. (Baldock *et al.*, 2000) also mentions grassland as a very important crop. Irrigated harvested area was calculated with a cropping intensity of 1, for vegetables a cropping intensity of 2 was assumed.

Sub-national data on irrigated areas are available as relative shares for the 5 groups cited in (Hoogeveen *et al.*, 2003) and as areas for the EUROSTAT crop list.

Cropping seasons:

Irrigated crops are summer crops. Maize and fodder plants are grown from May to October. Potatoes and sugar beets are grown from April to October. Vegetables are grown on the same areas in two separate cropping seasons (March – June, July – October). Fruit and berry orchards are assumed to be frost-irrigated and irrigated against water deficiency in summer. Fodder grasses / managed grassland are assumed to be potentially irrigated throughout the year.

Norway

Irrigated area:

The EUROSTAT data (EUROSTAT, 2005) on area equipped for irrigation (134,396 ha) is for 2000. The actually irrigated area (25,000 ha) was taken from (Achnich, 1980) who mentions mainly vegetables and fodder. (Arnoldussen, 2006) mentions berries, vegetables, cereals, potatoes and grassland, in line with the rounded harvested areas for the year 2000 from the FAOSTAT database (FAO, 2005d) for potatoes (15,000 ha), vegetables (5,200 ha), and fruit and berry orchards (together 4,800 ha) fit exactly the area specified by (Achnich, 1980). Assumptions of smaller than harvested areas were made for barley (4,000 ha) and oats (2,000 ha) and potatoes (5,000 ha). The rest of the area was attributed to fodder grasses (managed grassland) (ca. 3,800 ha) Irrigated harvested area was calculated with a cropping intensity of 1, also for vegetables.

Sub-national data on areas equipped for irrigation are available from (EUROSTAT, 2005), and partially from (Arnoldussen, 2006).

Cropping seasons:

Irrigated crops are summer crops. Barley, oats, potatoes and vegetables are grown from May to October. Fruit and berry orchards are assumed to be frost-irrigated and irrigated against water deficiency in summer. Grassland is assumed to be potentially irrigated throughout the year.

Poland

Irrigated area:

Maximum of the areas reported by EUROSTAT as irrigable for the years 2003 and 2005 per province summed up to 134,050 ha area equipped for irrigation. The EUROSTAT data (EUROSTAT, 2005) mention 98,430 ha and (Achnich, 1980) mentions much bigger areas of irrigated managed grassland than of agricultural land. Similarly (POCID, 2005) mentions 418,000 ha grassland and 62,000 ha arable land, respectively. Total actually irrigated area for 2003 according to EUROSTAT is 46,910 ha, while a national ICID contribution lists 83,292 ha (Labeledzki *et al.*, 2006). National statistics mention the same value for 2003 and 99,089 ha for 2000 (GUS, 2004). The figure of 83,892 ha is considered to be the most reliable, and was distributed to a selection of the list of irrigation demand of crops in Poland cited in (Labeledzki *et al.*, 2006) with the following estimated relative shares: winter wheat (5%), maize (5%), rye (5%), potatoes (15%), sugar beet (15%), vegetables (20%), fruit and berry orchards (20%), maize for forage and silage (5%), alfalfa (10%, classified as fodder grasses), grass and permanent grassland (10%, assumed fodder grasses / managed grassland). Irrigated harvested area was calculated with a cropping intensity of 1, also for vegetables.

Sub-national data on irrigated areas (equipped and actually used) for administrative units for 2003 are available from EUROSTAT (EUROSTAT, 2005) and equipped area for provinces for 2000, 2002 and 2003 by (GUS, 2004).

Cropping seasons:

The crop calendar was derived from national information in (Labeledzki *et al.*, 2006), mentioning an average growing period length of 210 days. Winter wheat and rye are grown from November (assumed) to July, the rest of the irrigated crops being mainly summer crops. Potatoes and sugar beets are grown from April to October. Maize and vegetables are grown from May to October. Fruit and berry orchards are assumed to be frost-irrigated and irrigated against water deficiency in summer. Alfalfa and fodder grasses / managed grassland are assumed to be present throughout the year.

Portugal

Irrigated area:

The area equipped for irrigation, 792,008 ha, was taken from the agricultural census of 1999 (Instituto Nacional de Estadística - Portugal, 2001). It also presents detailed information on irrigated areas (and number of units) down to the NUTS3 (municipal) level, for 6 regions by region and by municipality and for 11 crop types, including rice that is – like vegetables – not cited in the EUROSTAT list. The actually irrigated area (600,314 ha) for 1999 for continental Portugal on a national level was taken from (Instituto Nacional de Estadística - Portugal, 2001), as the crop list was more complete, even if private gardens were not included. The area of private gardens was assumed to be negligible. Temporary and permanent meadows were classified as fodder grasses / managed grassland. The harvested area for sugar cane according to the FAOSTAT database (FAO, 2005d) was assumed to be included in the area of “others”, and was separately listed in the final compilation. Harvested areas were calculated with a cropping intensity of 1, for vegetables with an intensity of 2, as the harvested area of vegetables (ca. 84,000 ha for the year 2000) from the FAOSTAT database (FAO, 2005d) suggested such an intensity.

Sub-national data on irrigated areas equipped for irrigation are available from EUROSTAT (EUROSTAT, 2005), although with inconsistent old and new spatial units. The areas actually used for irrigation are listed in the 1999 census (Instituto Nacional de Estadística - Portugal, 2001).

Cropping seasons:

The cultivation of summer crops was assumed to start approximately one month earlier than in neighbouring Spain. Main characteristics are winter cropping season of (winter) wheat from November to June. All the other crops (hybrid / regional / silage maize, rice, sugar beet, sunflower) are grown from April to September. Maize for forage in spring cropping season are grouped to other maize seasons, as it is assumed that no specific prediction of whether a field is used for forage or not could be made. Other forage crops are assumed to be grown during this season as well.

The cropping season of potatoes starts in March and end in October. Double cropped tomatoes and horticulture as vegetables have two cropping seasons on the same area (March-June and July-October). All the other crops like fruit orchards, citrus, grapes, olives, and “others” (assumed to be mainly permanent cultures) were taken to be cultivated throughout the year, besides sugar cane whose cultivation is assumed to start in March and end in December as in Spain.

Republic of Moldova

Irrigated area:

Area equipped for irrigation which is currently used for Moldova is 307,000 ha cited by the World Bank (World Bank, 2003c), while the newer value for 2002 of 280,800 ha is assumed to be more correct (Department of Statistics and Sociology, 2005). Data in the FAO AQUASTAT country profile (FAO, 2005a) and report (FAO, 1997b) on irrigated crops is for 1986 and 1994. The 312,000 ha equipped for irrigation (1994) and the 300,000 ha actually irrigated (1986) correspond excellently to the newer information available at the national statistical institute that lists 302,100 ha irrigated land for the year 2000 (Department of Statistics and Sociology, 2005). For 2003, a decrease to 230,000 ha is reported at the latter source. This latter figure was assumed to be the representative actually irrigated area for the current situation 1998-2002.

The distribution of these areas to the classes in the AQUASTAT report and to crops and subgroups of own nomenclature was done the following way: First, the areas of permanent crops and annual arable crops for 2003 were derived from the total irrigated land area according to the mean relationship for these irrigated land uses for the years 2002-2004, both given in (Department of Statistics and Sociology, 2005). Secondly, the irrigated area with permanent tree crops was distributed to fruit trees and vines according to the listed crops in (World Bank, 1995) using relative percentages of harvested area from the FAOSTAT database (FAO, 2005d) for the year 2000. Third, the annual crops irrigated area was distributed to the crop groups and crops listed in the AQUASTAT report the according to the relative shares of harvested area (2000) within the groups:

- Fodder crops were distributed to three FAOSTAT-equivalent groups: maize for forage (74%), mixed grasses (1%), and vegetables and roots for fodder (25%).
- The cereals were distributed to winter wheat 40%, barley 12%, maize 47%, and buckwheat 1%.
- Vegetables and potatoes were distributed to 52% potatoes and 48% vegetables. The AQUASTAT report information on shares of cultivated area that should be irrigated of potatoes (18%) and vegetables (70%) did not correspond to the given harvested areas especially for vegetables (much higher cropping intensity). For vegetables, a cropping intensity of 2 was assumed.

- As industrial crops sugar beet (90%) and sunflower (10%) was added, although the harvested area of the latter is much larger than that of the former one, roughly 20% and 80%. But it was assumed that sugar beets had a much bigger market value and thus were much more likely irrigated than sunflower.

The assumed irrigated harvested areas were calculated with a cropping intensity of 1, and for vegetables 2. Besides for vegetables, the FAOSTAT harvested areas are by far not reached.

Only national data on irrigated areas and crops is available from the mentioned sources, with some hints of climate sub-regions in the AQUASTAT report.

Cropping seasons:

Irrigated crops are mainly summer crops. In winter, only winter wheat (November – June) and barley (December – April) are grown. In summer, maize, maize for forage, buckwheat, sunflower, and other annual crops, assumed to be pulses, are grown from May to October. Potatoes and sugar beets are grown from April to October. Vegetables are grown on the same areas in two separate cropping seasons (April – June, July – October). Fruit orchards are assumed to be frost-irrigated and irrigated against water deficiency in summer, similarly also grapes.

Romania

Irrigated area:

Area equipped for irrigation is 2,149,902 ha according to the Global Map of Irrigation Areas version 4 (Siebert *et al.*, 2007), different from the value of 2,021,911 ha according to (Nicolaescu *et al.*, 2006), not considering the EUROSTAT value of 1,510,830 ha (EUROSTAT, 2005). Actually irrigated area for the crop year 2001-2002 (400,518 ha) is provided by national statistics (National Institute of Statistics - Romania, 2006). This value corresponds to the value given by EUROSTAT for 2003. The crops and their irrigated area are taken likewise from (National Institute of Statistics - Romania, 2006), with the exception of unmentioned rice. For rice the mean harvested area from the FAOSTAT database (FAO, 2005d) for the period 1998-2002 (1,277 ha) was assumed to be the representative area and to be 100% irrigated. “Pasture and meadows” are classified as fodder grasses / managed grassland. “Other crops (flax / hemp)” are classified as other annual crops. “Fodder crops” were assumed to be maize. Cotton which is cited like rice, vegetables, maize, soybean, sunflower, wheat, and beets in (Nicolaescu *et al.*, 2006) has only 9 ha harvested area and is therefore neglected. Harvested irrigated area was estimated with a cropping intensity of 1, for vegetables with an intensity of 2, not reaching the FAOSTAT harvested area.

Sub-national data on irrigated areas (besides rice) are available from (National Institute of Statistics - Romania, 2006) and with a short crop list from (EUROSTAT, 2005).

Cropping seasons:

Main characteristics are winter cropping season of (winter) wheat from November to June. All the other crops (maize, sunflower, soybean, assumed fodder crop maize, other annual crops like flax and hemp) are grown from May to October, besides potatoes and sugar beets (start in April), rice (start in June), and vegetables whose cultivation starts in March and that have two cropping seasons on the same area (March-June and July-October). Grapes, fruit orchards and pastures and meadows are assumed to be cultivated throughout the year, with possible irrigation during dry seasons. Seed cotton was assumed to be irrigated to a negligible and hardly detectable extent between 1998 and 2002, but present for rainfed agriculture.

Russian Federation

Irrigated area:

Area equipped for irrigation, as derived from “oblast” level data is 4,899,900 ha, out of which 4,002,900 ha are located in the European part of the country and 897,000 ha in the Asian part of the Russian Federation (Siebert *et al.*, 2007). These figures include 138,000 ha for Chechnya. Other sources list 4,868,000 ha in 1997 (GOSCOMSTAT, 1998) and 4,454,100 ha in 2003 (Kireycheva *et al.*, 2006). For 2003, 23% of non-irrigated equipped area is reported by national experts (Kireycheva *et al.*, 2006). This figure is used in order to derive the actually irrigated area of 3,772,923 ha. The disaggregation of areas to crop classes and subgroups was done the following way: The crop areas of (Kireycheva *et al.*, 2006) for 1997 were extended with the areas for industrial crops for 1994 in the AQUASTAT report (FAO, 1997b), and scaled to the 2003 actually irrigated area. For the crop group “cereals and cereal-pulses”, the area was distributed using approximately relative shares of harvested area for wheat (40%, ca. 480,000 ha), barley (25%, ca. 300,000 ha), rye (10%), oats (10%), millet (5%), buckwheat (5%), pulses (5%). Fodder crops were assumed to be 25% maize for forage and 75% fodder grasses / managed grassland (ca. 1.5 Mha, FAOSTAT nomenclature “mixed grasses and legumes”). The area for “industrial crops” was distributed to sunflower (10%), sugar beets (80%), and other annual crops (10%). Areas of rice (ca. 165,000 ha), grain maize, vegetables, and potatoes were directly used. Grain maize and fodder maize are summing up to ca. 615,000 ha. For all of these mentioned crops, the irrigated harvested areas were calculated with a cropping intensity of 1. Nevertheless, the FAOSTAT harvested areas are by far not reached, with the exception of rice.

Only national data on irrigated areas and crops are available from the mentioned sources, with some hints to climate sub-regions.

Cropping seasons:

The crop calendar is based on information for the Former Soviet Union given in the United States Department of Agriculture Agricultural Handbook No. 664 (USDA, 1994) and the assisting calendar for the Ukraine in FAO GIEWS (FAO, 2005c).

Main characteristics are a winter cropping season of winter wheat and rye from September to August. Barley and summer cereals are grown from November to May. All the other crops (oats, millet, buckwheat, rice) are cropped from May to August like vegetables and other annual crops. Maize, sunflower, sugar beets, potatoes are grown from May to October. Mixed grasses and legumes (fodder grasses / managed grassland) are assumed to grown throughout the year, with possible irrigation during dry seasons.

San Marino

No irrigation was reported for San Marino.

Serbia (including Kosovo)

Crop area – Serbia including Kosovo:

Area equipped for irrigation is 163,311 ha, roughly 45% in Kosovo and 55% in Serbia, while Montenegro is treated as a separate unit. Total actually irrigated area is 60,071 ha. It was disaggregated to annual crops vegetables, maize, potatoes, sugar beets and tobacco, and to permanent cultures meadows (fodder grasses / managed grassland), fruit tree orchards and vineyards.

From different sources for Serbia / Montenegro and Kosovo crop shares were compiled separately:

Crop area - Serbia:

Current area equipped for irrigation (86,311 ha) is assumed to be the sum of the partly and fully operational systems area of the total area of 120,000 ha being cited in (World Bank, 2005). It is taken to be representative at least for the season 2000-2005. Actually irrigated area (28,071 ha) for 2004 for arable fields and gardens, orchards, vineyards and meadows (classified as fodder grasses / managed grassland) were taken from (Serbia and Montenegro Statistical Office, 2005), from which the areas of Kosovo (SOK, 2005) and Montenegro (Republic of Montenegro Statistical Office, 2006) were subtracted. The crop area for “arable fields and gardens” were repartitioned using estimated relative percentages for the high-income crops vegetables (35%), potatoes (35%), maize (15%), sugar beets (10%), and tobacco (5%) that are cited in (Serbia and Montenegro Statistical Office, 2005). Irrigated harvested area was estimated with a cropping intensity of 1, also for vegetables, as single cropping is the norm according to (World Bank, 2005). The resulting harvested areas for the total of Serbia and Montenegro are far less below those given in the FAOSTAT database (FAO, 2005d).

Crop area - Kosovo:

Current areas equipped for irrigation (77,000 ha) for Kosovo were taken from statistical sources (Siebert, 2006). The 160,653 ha as calculated from percentages of irrigated cultivated land area given for the municipal level for 2004 (SOK, 2005) were weighted with the cadastral area of the cadastral survey for 2003 (KCA, 2003) in order to yield a national level of 39.8% irrigated land. This level is similar to the percentage of irrigable land to total utilised agricultural land of neighbour countries Macedonia (ca. 20% in 2000) and Greece (ca. 40% in 2003). Surprisingly, the resulting national total irrigated area is much higher than the area of 32,000 ha cited by (SOK, 2005). So the absolute area given by the latter is used as the probably minimum actually irrigated area with respect to the other data yielding the area equipped for irrigation. The area of 32,000 ha given in (SOK, 2005), i.e. approximately 50% of the area equipped for irrigation, is assumed to be actually irrigated. The shares of this area to the crop groups were calculated for vegetables, potatoes, fruit orchards without vines, vine grapes / grapes using the absolute cultivated area of the agricultural survey 2004 (SOK, 2005). As the survey covers roughly a quarter of the country area and does neither represent all private farmers nor the “socially owned enterprises” (e.g. cooperatives) with presumably specialised cropping, the areas of these crops were assumed to be minimum irrigated areas, as possibly in the whole country additional areas exist. For meadows, the number calculated from the national area in the 1980ies multiplied by the national percentage of irrigated cultivated land was used, as the figure for 2004 was extremely large surpassing the arable land area. The rest of the area up to the total was assumed to be irrigated maize. Irrigated harvested area was estimated with a cropping intensity of 1, also for vegetables. No harvested areas can be found in the FAOSTAT database (FAO, 2005d).

Sub-national information of area equipped for irrigation can be derived from percentage of irrigated land cited for municipal level and national percentage of irrigated land for 2003 in (SOK, 2005), and the area of the unit given in the cadastral survey for 2003 (KCA, 2003).

Crop calendar – Serbia including Kosovo:

Irrigation calendar is assumed to be similar in Macedonia, Serbia, Montenegro, and Kosovo. Vegetables are cultivated during a relatively long cropping season from March to October. The cropping season for maize starts in April and ends in September. The cropping season of sugar beets and potatoes starts in April, that for tobacco starts in May and both end in October. Fruit tree orchards are assumed to be frost-irrigated and irrigated against water deficiency in summer. Grapes / vines are grown throughout the year. Meadows are assumed to be fodder grasses / managed grassland grown or cultivated throughout the year and possibly actually irrigated in the summer.

Slovakia

Irrigated area:

The EUROSTAT data (EUROSTAT, 2005) on area equipped for irrigation (225,310 ha for 2000) and of actually irrigated area (104,560 ha for 2003) are the best available sources. (SKNC-ICID, 2005) mentions a higher area equipped for irrigation in 1995, but it is assumed that not all of the area was operational in 2000. For a selected list of crops (durum wheat, maize, potatoes, sugar beet, sunflower, soybeans, fodder plants, fruit and berry orchards, citrus, and vines), crop-specific areas were available (EUROSTAT, 2005). Fodder plants were classified as “other annual crops”. The crop area not included in the EUROSTAT crop list was attributed to the harvested area according to the harvested area cited in the FAOSTAT database (FAO, 2005d). For vegetables the full FAOSTAT area of 28,000 ha (for 2003) was used assuming a cropping intensity of 1. Further crop area was arbitrarily distributed to barley, wheat other than durum wheat, barley and rapeseed assuming that 2% of the harvested area of each crop was irrigated. The rest of the area (4,770 ha) was attributed to fodder grasses (managed grassland). The irrigated harvested area was estimated with a cropping intensity of 1 for all crops.

Sub-national data on irrigated areas are available from (EUROSTAT, 2005).

Cropping seasons:

Wheat is cultivated during two cropping seasons: Summer durum wheat from May to October and winter wheat from November to June. The summer cropping season for most crops lasts from May (wheat, potatoes, sugar beets, sunflowers, and rapeseed) until October. Vegetables are grown during a short cropping season from June to October. The cropping season for maize starts in April, that for soybeans in May, and both in September. Fruit tree orchards are assumed to be frost-irrigated and irrigated against water deficiency in summer. Grapes / vines are grown throughout the year. Fodder plants are assumed to be grown like vegetables from May until October. Fodder grasses / managed grassland are assumed to be grown or cultivated throughout the year and possibly actually irrigated in the summer.

Slovenia

Irrigated area:

The area equipped for irrigation (15,643 ha) was taken from a personal communication of the president of the National Committee of ICID, as the data of (Statistical Office of the Republic of Slovenia, 2006) on area equipped for irrigation (6,339 ha for 2003, 5,303 ha for 2004) and on actually irrigated area (2,535 ha for 2000) and also from EUROSTAT (EUROSTAT, 2005) (2,230 and 1,880 ha, respectively) are obviously underestimating the areas. The actually irrigated area (8,952 ha) was calculated by applying the ratio of actually irrigated to equipped area for 1999-2002 from the statistical yearbook (Statistical Office of the Republic of Slovenia, 2002) to the equipped area. The distribution of this area to individual crops was made using the shares for 2003 of EUROSTAT for maize, potatoes, fodder plants, fruit and berry orchards (ca. 3,800 ha). Fodder plants were assumed to be maize (total of ca. 1,100 ha) according to its dominant share for 2000 cited in (Statistical Office of the Republic of Slovenia, 2006). The rest of about 50% of the irrigated area was distributed to crops cited also in (World Bank, 1997): vegetables (40%, ca. 1,400 ha), pasture (30%, assumed to be fodder grasses / managed grassland, ca. 1,000 ha), grapes (25%), and wheat (5%). The irrigated harvested area was estimated with a cropping intensity of 1, for vegetables with 2.

Some sub-national estimation on proportional crop shares for 6 regions is cited in (World Bank, 1997).

Cropping seasons:

Wheat is cultivated as winter crop from November to June. Vegetables are grown during two cropping seasons on the same areas from March to June (early vegetables) and from July to October, assuming appropriate climate. The cropping season for maize starts in April and ends in September. For other crops (potatoes, sugar beets) it lasts from May to October. Fruit tree orchards are assumed to be frost-irrigated and irrigated against water deficiency in summer. Grapes like pasture (fodder grasses / managed grassland) are permanent cultures.

Spain

Irrigated area:

The area equipped for irrigation of the national agricultural census 1999 on a municipal level is 3,575,488 ha (Instituto Nacional de Estadística, 2002). The EUROSTAT data (EUROSTAT, 2005) on actually irrigated area 3,235,510 ha for 2000 (equipped 3,828,120 ha) were used. This annually 90% of actually used irrigable areas is the highest percentage within a comparable group of big Mediterranean European Union member countries (respective value for Greece 75%, Italy 60%, Portugal 31%). Only half of the area is distributed to specific crops contained in the EUROSTAT list of crops (durum wheat, maize, potatoes, sugar beet, sunflower, soybeans, fodder plants, fruit and berry orchards, citrus, and vines). Therefore, much best possible guess in the estimated disaggregation of the other half of the area is included. The crop lists of (Baldock *et al.*, 2000) for 3 geographical regions cited for 1999 are taken as reference, specifying in continental regions: maize, beet, cereal, in Mediterranean areas: citrus, horticulture, rice, in the south: maize, tobacco, rice, horticulture, olives, fruit. All rounded harvested area from the FAOSTAT database (FAO, 2005d) of rice and tobacco were assumed to be irrigated. Based on the assumption of extremely suitable weather for double cropping of high-value vegetable crops, only 200,000 ha were assumed to be irrigated with a cropping intensity of 2. Sugar cane and cotton harvested areas for 2000 were taken

to be fully irrigated, reducing the olive tree areas that were assumed to be roughly by 1/3 seasonally irrigated, the resulting in roughly 707,000 ha instead of 800,000 ha for total Spain, both consistent with the roughly 271,000 ha that are cited for Andalusia alone (Junta de Andalucía - Consejería de Agricultura y Pesca, 2000). Wheat other than durum wheat was assumed to have the same area as durum wheat, and barley and oats the same relative irrigated percentage as wheat (6%), and rapeseed irrigated about 5% of the harvested area in 2000 (equalling about 15% of the much lower harvested area in 2003). Annual spices of 3,000 ha were assumed to be irrigated, roughly 50% of the harvested area of all spices. Finally the rest of the area, roughly 52,000 ha was assumed to be extensively irrigated fodder grasses / managed grassland (1/5 of harvested area). Irrigated harvested area was calculated with a cropping intensity of 1, for vegetables the rounded FAOSTAT harvested area (388,000 ha) was taken, resulting in an effective cropping intensity of 1.94.

Sub-national data on irrigated areas are available for the EUROSTAT crop list.

Cropping seasons:

Vegetables are grown during two cropping seasons on the same areas from March to June (early vegetables) and from July to October, assuming mainly production on the Mediterranean coast (e.g. Costa del Sol) with appropriate climate. The other crops are assumed to be grown also in other areas of Spain with more continental climate, with a cropping season for maize and cotton starting in April and ending in September, rice from May to September, generally for other crops from May or June (oats, pulses, annual spices) until October. Wheat is grown during two seasons: Durum wheat in the summer half from March to July, and winter wheat from November to June, assumed to be using other areas than durum wheat. Sugar cane is grown from March to December. Fruit tree orchards are assumed to be frost-irrigated and irrigated against water deficiency in summer. Fodder plants are assumed to be grown from May until October. Fodder grasses / managed grassland are assumed to be grown throughout the year and possibly actually irrigated in the summer.

Svalbard and Jan Mayen Islands

No irrigation due to climatic conditions unsuitable for outdoor horticulture agriculture was assumed on the islands of Svalbard and Jan Mayen.

Sweden

Irrigated area:

The EUROSTAT data (EUROSTAT, 2005) on irrigated area (equipped 188,470 ha and actually irrigated 52,440 ha) are for 2003. The crop list of EUROSTAT (durum wheat, maize, potatoes, sugar beet, sunflower, soybeans, fodder plants, fruit and berry orchards, citrus, and vines) lists zero values for all crops besides potatoes and sugar beets. (Achnich, 1980) mentions 53,000 ha irrigated area according to FAO in 1977, citing mainly intensive agriculture and horticulture. This list was extended with the crops grass, arable land and some vegetables cited for mainly southern Sweden and for 1999 by (Baldock *et al.*, 2000). In the same source, an irrigation intensity for particularly dry summers is cited for extensive / semi-intensive (20-30%) up to intensive (50-60%) cultures. It is assumed that the marketed vegetables are always grown on 100% area equipped for irrigation. Thus, for the very dry summer 2003, all harvested area from the FAOSTAT database (FAO, 2005d) of vegetables was taken to be irrigated (14,000 ha instead the harvested area of 16,000 ha for 2003), then 30% and 35% of the harvested area of potatoes and sugar beet, respectively were estimated to

be irrigated. A smaller share of fodder grasses / managed grassland (ca. 10% of harvested area) was assumed to be irrigated. Irrigated harvested area was calculated with a cropping intensity of 1, also for vegetables which were scaled to the FAOSTAT 2000 harvested area, as mentioned before.

Sub-national data on total irrigated areas are available by EUROSTAT.

Cropping seasons:

A short cropping season during summer from May to October was assumed. Vegetables start in protected conditions already in April. Fodder grasses / managed grassland are grown throughout the year and irrigated against dry conditions in summer.

Switzerland

Irrigated area:

No EUROSTAT data on irrigated area are available. Area equipped for irrigation (40,000 ha) was taken from the Global Map of Irrigation Areas version 4 (Siebert *et al.*, 2007) that uses the values cited by (Sautier, 2002), more or less in accordance with 30,000 ha in valley bottoms in southerly cantons of FAO for 1977 cited in (Achnich, 1980). The area actually irrigated for 2000 (12,500 ha) was estimated with a conservative 50% share of area equipped for irrigation, following a maximum area and crop list given for 1992 / 1997 in (BFS, 2001) and disaggregated according to its maximum share and relative values of (Achnich, 1980) mentioning fodder grasses / managed grassland, horticulture and vines as irrigated crops. Thus, all horticultural area was attributed to be irrigated vegetables (4,000 ha, ca. 40% of the harvested area for the year 2000 cited in the FAOSTAT database (FAO, 2005d), fruits as second important crop (ca. 7% of harvested area irrigated), followed by grapes / vine (10% irrigated). Assuming that fodder grasses / managed grassland is no longer the most important irrigation, an area of 1,000 ha was attributed in analogy to conditions in Germany and France to EUROSTAT listed maize (5% of harvested area), potatoes (ca. 7%), sugar beet (ca. 6%), maize for fodder (ca. 2.5%), fodder grasses / managed grassland (ca. 1%). Irrigated harvested area was calculated with a cropping intensity of 1, for vegetables an intensity of 2 was taken, assuming that part of the harvested area for the year 2000 from the FAOSTAT database was non-irrigated in the year 2000 (whereas with a cropping intensity of 2 all vegetables are irrigated in 2003).

Sub-national crop area data is not available from the mentioned sources besides the general hints of (Achnich, 1980).

Cropping seasons:

Most of the irrigated annual crops (maize, potatoes, and sugar beets) are cultivated from May to October. Vegetables are cultivated during two cropping seasons with equal lengths from March to June and from July to October). Permanent cultures are fruit orchards (potentially irrigated against frost), vines, and fodder grasses / managed grassland assumed to be irrigated during dry conditions in summer.

The former Yugoslav Republic of Macedonia

Irrigated area:

Current area equipped for irrigation is 127,800 ha (Vukelic *et al.*, 2006). The actually irrigated area 42,500 ha was calculated by using the values of the same source, 30,000 ha for a wet year and 80,000 ha for a dry year, with a 25% probability of a dry year. This is much less than the 126,617 ha specified by as currently used irrigated land of (MAKCID, 2005), identical with those given in (Public Water Management Enterprise "Water Management of Macedonia", 2006). The latter values are assumed to be values representing current active equipped areas. The 42,500 ha is distributed for the period 1998-2002 using a selection of major crops according to the list cited in (Vukelic *et al.*, 2006) and the harvested area from the FAOSTAT database (FAO, 2005d). Harvested area of rice (3,167 ha mean for 1998-2002) was assumed to be 100% irrigated and the remainder area distributed by estimated relative percentages based on harvested areas for the high-income crops vegetables (30%), grapes (15%), fruit orchards (15%), potatoes (10%), maize (10%), meadows (fodder grasses / managed grassland, 10%), sunflower (5%), and tobacco (5%) that are cited besides rice as crops in the FAOSTAT database (FAO, 2005d). Irrigated harvested area was estimated with a cropping intensity of 1, also for vegetables. The resulting harvested areas are, besides for rice, far less below those given in the FAOSTAT database (FAO, 2005d).

Sub-national data on irrigated areas are available from (Vukelic *et al.*, 2006) and (Public Water Management Enterprise "Water Management of Macedonia", 2006).

Cropping seasons:

Irrigation calendar is assumed to be similar in Macedonia, Serbia, Montenegro, and Kosovo. Irrigated crops are summer crops. Rice, sunflower and tobacco are grown from May to October, maize from April to September. Potatoes and vegetables are grown from April to October. Fruit orchards are assumed to be frost-irrigated and, like fodder grasses / managed grassland, irrigated against water deficiency in summer.

Turkey

Irrigated area:

Area equipped for irrigation for 1994 (4,185,910 ha) was taken from FAO AQUASTAT reports (FAO, 2005a) & (FAO, 1997c). The FAO crop calendar for irrigated crops (FAO, 2005b) provided the actually irrigated area (3,476,000 ha) for 1994 with crop-specific harvested areas of 16 individual crops. The vineyards on micro-irrigation plots by State hydraulic Works (DSI) cited in the AQUASTAT report were neglected, as no area was specified. The crop group "oil crops" was assumed to be olives. Cropping intensity is 1, also for vegetables. Nevertheless, the harvested areas from the FAOSTAT database (FAO, 2005d) are by far not reached.

Only national data are available.

Cropping seasons:

The crop calendar from (FAO, 2005b) was used. Main characteristics are cropping seasons during winter for (winter) wheat from November to May, and for barley and fodder crops from December to April. All the other crops are grown from June to October, besides sugar beet that is cultivated from May to October. Permanent citrus, fruit orchards and oil crop cultures are grown from January to December.

Ukraine

Irrigated area:

As area equipped for irrigation the 2,395,500 ha cited for 1985 for “oblast” level (Anonymous, 1985) are assumed to be still valid for the Global Map of Irrigation Areas version 4 (Siebert *et al.*, 2007). The figure is slightly less than the 2,605,000 ha equipped for irrigation in 1994 cited in the FAO AQUASTAT report on the Former Soviet Union (FAO, 1997b). Actually irrigated area in the period 1998-2002 was declining from ca. 1.4 Mha in 1997 and 1.45 Mha in 1998 to ca. 545,000 ha in 2001 and ca. 730,000 ha in 2002 and 2003 (Kovalenko *et al.*, 2006). The mean area of 1998-2002 (1,005,120 ha) was taken as the reference value, which is much less than the 2,413,000 ha actually irrigated area for 1990 cited in the FAO AQUASTAT report (FAO, 1997b). Relative percentages derived from absolute values for 1990 given there were used to calculate areas representative for the period 1998-2002. The results are in line with the dominant crops cereals, fodder crops and “technical crops” cited by (Aljiev *et al.*, 2005). The distribution of area of the classes in the AQUASTAT report to crops and subgroups of the own classification was done subtracting mean FAOSTAT harvested area for rice (21,190 ha) from the total actually irrigated area, and then applying the relative shares for the rest of the crop groups. Within the groups, relative shares based on relative percentages of harvested area from the FAOSTAT database (FAO, 2005d) were used for fodder crops, cereals, and “industrial crops”:

- Fodder crops (ca. 510,000 ha, ca. 52% of rest of irrigated areas besides rice) were taken to be 25% maize and 75% mixed grasses & legumes (assumed to be fodder grasses / managed grassland).
- For grain cereals (ca. 325,000 ha, ca. 33% of irrigated rest areas), only harvested areas equal or larger than 50,000 ha were considered, thus omitting sorghum that was assumed to need no irrigation at these locations. Slightly adapted percentages were: wheat 45%, barley 30%, maize 15%, rye 5%, and oats 5%. Furthermore, paddy rice (ca. 21,000 ha) was assumed to be 100% irrigated.
- Vegetables and potatoes (ca. 89,000 ha, 9% of irrigated rest areas) were distributed to the same share as given in the explicit data for the Russian Federation: 25% potatoes and 75% vegetables.
- The area of “technical/industrial crops” (ca. 59,000 ha, 6% of irrigated rest area) were distributed to the listed crops sunflower (50%), sugar beets (40%), and additionally to “Other annual crops” (10%).

For all of these mentioned crops, the assumed irrigated harvested areas were calculated with a cropping intensity of 1.

Only national data on irrigated areas and crops are available from the mentioned sources.

Cropping seasons:

The crop calendar of the Russian Federation was used. It is based on information for the Former Soviet Union as given in (USDA, 1994) and the assisting calendar for the Ukraine in FAO GIEWS (FAO, 2005c). Main characteristics are cropping seasons during winter for winter wheat and rye from September to August. Spring barley and maize are grown from May to October like sunflower, sugar beets, and potatoes. Other cereal crops (oats, millet, buckwheat, rice) are cultivated from May to August like vegetables and other annual crops. Mixed grasses and legumes (fodder grasses / managed grassland) are assumed to grown throughout the year, with possible irrigation during dry parts of the year.

United Kingdom of Great Britain and Northern Ireland

Irrigated area:

The EUROSTAT data (EUROSTAT, 2005) on equipped irrigated area (228,950 ha from sub-national data) are for 2003. Data of actually irrigated area of EUROSTAT (227,400 ha) for the dry year 2003 seems to overestimate the mean actually irrigated area, as only in Northern Ireland the actually irrigated area is cited to be less than the equipped area. As Wales and Northern Ireland contribute only 0.6% and 0.5% to the irrigation area according to EUROSTAT, it was decided to use the mean between the values of EUROSTAT and of (Weatherhead and Danert, 2002) for England for 2001 (147,270 ha), resulting in 187,205 ha actually irrigated area. EUROSTAT does not give hints on crops, which can be found as relative percentages for 8 sub-national regions in a study of the Cranfield University (Morris *et al.*, 2004): early potatoes (5%), maincrop potatoes (47%), sugar beet (7%), orchard fruit, small fruit, vegetables (27%), grass, cereals, and others (that were classified as other annual crops). Data of (Bazzani *et al.*, 2001) confirm the domination of potatoes in irrigation. The percentages given by (Morris *et al.*, 2004) for England and Wales were assumed to be valid also for Scotland (0 ha actually irrigated in 2003) and Northern Ireland (1,110 ha actually irrigated) and applied to the mean actually irrigated area. Cereal area was distributed to barley (33%) and wheat (67%) and neglecting rye, following the 1:2 relationship in harvested area from the FAOSTAT database (FAO, 2005d). Irrigated harvested area was calculated with a cropping intensity of 1.

Sub-national data on irrigated areas and crops for regions are available from (Morris *et al.*, 2004) and regional sums for old and new statistical regional units from EUROSTAT.

Cropping seasons:

Winter cereals (winter) wheat and (winter) barley are cultivated from November to June. Early potatoes and main crop potatoes are grown like vegetables between March and October. All the other crops are grown from May to October. Permanent cultures are grass (assumed fodder grasses / managed grassland) and fruit orchards (trees and small fruits) that are grown from January to December.

OCEANIA

American Samoa

No irrigation was reported for American Samoa.

Australia

Irrigated area:

The area equipped for irrigation was taken from the Global Map of Irrigation Areas version 4 (Siebert *et al.*, 2007). For the 8 states or national territories of Australia the total per state was scaled to the individual monthly maximum actually irrigated area when this area was larger than the original equipped area. They final values sum up to 2,316,106 ha for Australia as a whole, as compared to the initial value of roughly 2.06 Mha (Table K-16). The irrigated harvested areas for crop groups were taken from the national agricultural census for the year 2000 (ABS, 2002) (ABS, 2001). These sources give a distribution of the areas the level of the states (including Australian Capital Territory) for the following units:

Table K-16. Spatial units of Australia (states), and their area equipped for irrigation in hectares.

No.	Unit name (state)	Area equipped for irrigation
1	Australia_Australian Capital Territory	75
2	Australia_New South Wales	907,050
3	Australia_Northern Territories	6,001
4	Australia_Queensland	535,571
5	Australia_South Australia	157,029
6	Australia_Tasmania	61,202
7	Australia_Victoria	611,146
8	Australia_Western Australia	38,032

The crop list included the following classes: pasture, cereals, rice, other cereals, total cereals, vegetables for human consumption, fruit (including nuts), grapes, sugar cane for crushing, cotton, and “all other crops”. As a first step, the rounded values were scaled to the cited national total value (2,384,300 ha). It was decided to introduce subdivisions of the classes using crop information such as harvested area or number of trees from (ABS, 2002) in order to get more detailed class information with the following procedure:

- The pasture area for 1999 is subdivided on a national scale: annual pasture roughly 54% and perennial pasture roughly 46%. Nevertheless, the area was set to be fodder grasses / managed grassland used throughout the year, with the assumption that the equipment was there anyway and would be used at any time within a given year, according to specific meteorological conditions.
- For cereals, only New South Wales was set to have irrigated rice, as the reported total harvested area is only slightly higher than the irrigated rice area. It was assumed that the rest was rainfed rice, e.g. in Queensland. The area of “other cereals” was distributed to crop classes that were cited in the agricultural census using several assumptions: First of all it

was assumed that barley was cultivated as winter barley on a rainfed basis only, also possibly cultivated rye as well. The other crop classes “grain sorghum” (assumed to include sorghum for forage/silage/hay), maize, oats, triticale, and wheat were filled using assumptions on relative abundance per state, calculated as percentage of harvested area. Maize was assumed to be 100% irrigated besides in the state of Queensland (50%). Wheat is the crop with the highest rainfed and irrigated harvested area and is assumed to fill the rest of the irrigated “other cereals” area, with the largest irrigated area of an individual class after fodder grasses / managed grassland and rice (present in New South Wales).

- The area of potatoes was subtracted from the irrigated “vegetables for human consumption” area using the state-level percentage of potatoes of the total vegetable area as given in (ABS, 2002), as potatoes are contained in this class of the agricultural census.
- For the “all other crops” group it was assumed that they include peanuts (only present in Queensland, 50% irrigated), tobacco (100% irrigated), all citrus harvested area (mean harvested area for time period 1998-2002 from the FAOSTAT database (FAO, 2005d)) and a rest of unspecified other crops annual. The citrus area national total was distributed to the states via the relative abundance of the number of trees. In order to establish consistency with the tabulated, with the exception that negligible area (8 ha) of the Northern Territories was added to the number of Western Australia (802 ha), assuming that these trees were located in similar climate.

Finally, the rest of the actually irrigated area was determined for each state via subtracting the currently allocated area from the scaled state irrigated area. In the case of New South Wales and Tasmania, these areas have substantial values of ca. 22,000 and 12,000 ha, respectively.

The area for pasture (ca. 925,000 ha) is about half of the total irrigated harvested area, as expected from information of (Achnich, 1980). It is followed by cotton (ca. 430,000 ha), sugar cane (ca. 210,000 ha), rice (ca. 130,000 ha), grapes, fruits, wheat, vegetables (ca. 70,000 ha without potatoes).

Cropping seasons:

The crop calendar for irrigated crops for South Africa of FAO (FAO, 2005b) was used as a starting point and showed agreement with the seasons of given by (USDA, 1994) for most of Australia for winter wheat, winter barley (assumed to be not irrigated), and for eastern Australia (Queensland and northern New South Wales) for cotton, sorghum and sugar cane. For cotton, also data of (UNCTAD, 2006) were checked. The resulting crop calendar for irrigated crops was subdivided into the regions as defined by the aforementioned states. Nevertheless, it was assumed that the irrigation seasons were more or less the same for all of the states, as some crops (e.g. sorghum, cotton) are only present in a specific state. Thus, implicitly the calendar is valid. Winter wheat is grown as winter crop from June to November. Summer crops (maize, rice, sorghum, oats, triticale, peanuts, vegetables, potatoes and tobacco) were assumed to be the rest of the annual irrigated crops, and to be grown from December to April (sorghum until May). Cotton is grown from October to April. As permanent crops fodder grasses / managed grassland, sugar cane, citrus, grapes and fruit and nut trees are cultivated. A cropping intensity of 1 is assumed for all crops.

Cook Islands

No irrigation was reported for the Cook Islands.

Fiji

Irrigated area:

The area equipped for irrigation, 3,000 ha, was taken from the Global Map of Irrigation Areas version 4 (Siebert *et al.*, 2007). It is roughly confirmed by the agricultural profile of the World Resources Institute (WRI, 2006). The irrigated harvested area was assumed to be 100% of the equipped area. It was assumed to be totally used by vegetables according to data found at FAO (Chand, 2006).

Cropping seasons:

The crop calendar was established according the information given in (Chand, 2006), citing water deficit for the season of May until October and this being the favourite cropping season for vegetables, with a cropping intensity of 1.

French Polynesia

No irrigation was reported for French Polynesia.

Guam

Irrigated area:

The area equipped for irrigation is 312.42 ha according to United States Census (USDA and NASS, 2004c), roughly 60% of the utilised agricultural land. The actually irrigated area (312 ha), assumed to be the total equipped area, was distributed using cited harvested areas of crop groups and assigning irrigation according to the order of market values: fruit trees (assumed 100% irrigated, 59 ha), root crops (assumed 50% irrigated, 14 ha), pastures (assumed to be fodder grasses / managed grassland and 50% irrigated, 23 ha) and the rest to vegetables (213 ha). The areas given in acres were converted to hectares according to the conversion factor of 0.40468564224 ha per acre.

Cropping seasons:

The crop calendar like for the neighbouring Northern Mariana Islands was established like for the Philippines. Vegetables and root crops are grown from October to February. Permanent orchards are cultivated. All crops have a cropping intensity of 1.

Kiribati

No irrigation was reported for Kiribati.

Marshall Islands

No irrigation was reported for the Marshall Islands.

Micronesia (Federated States of)

No irrigation was reported for the Federated States of Micronesia.

Nauru

No irrigation was reported for the Nauru.

New Caledonia

No irrigation was reported for the New Caledonia.

New Zealand

Irrigated area:

The area equipped for irrigation, 577,882 ha, was taken from the Global Map of Irrigation Areas version 4 (Siebert *et al.*, 2007). The irrigated harvested areas for crop groups (in total roughly 380,000 ha) were taken from the national agricultural census for the year 2002 (Statistics New Zealand, 2003). The irrigated area for the crop group “cereals” was distributed to crops using mean harvested areas (1998-2002) from the FAOSTAT database (FAO, 2005d) as an indicator of existence and extent of crops. It was assumed that only maize was irrigated, but none of the other cereals (wheat and barley). It was assumed that the area given for vegetables did not include potatoes which were set to be only cultivated as rainfed crop. The area of “cut flowers and flower seed growing” was assumed to be permanently used. The area for pasture (roughly 300,000 ha) is by far dominating the irrigated areas (79% of them). Following are vegetables (roughly 26,000 ha), grapes (10,000 ha) and permanent cultures like fruit trees and berry orchards. Areas of “not distinctly specified activities of crops and plant growing”, and “services to agriculture” were assumed to be annual cultures. The crop groups “forestry” and “other” were not considered, as they were considered to be certainly or probably outside cropland.

Cropping seasons:

The crop calendar was assumed to be the same as for Australia. No winter crops are irrigated. Summer crops were assumed to be maize and other annual crops and to be grown from December to April. As permanent crops besides fodder grasses / managed grassland, fruit and berry orchards, grapes, citrus, and plant nurseries exist. A cropping intensity of 1 is present for all crops.

Niue

No irrigation was reported for Niue.

Norfolk Island

No irrigation was reported for Norfolk Island.

Northern Mariana Islands

Irrigated area:

The area equipped for irrigation according to the Global Map of Irrigation Areas version 4 (Siebert *et al.*, 2007) is 59 ha, whereas the United States Agricultural Census mentions 125 ha for the year 2002 (USDA and NASS, 2004d), roughly 50% of the harvested cropland (357 ha without pastures, pastures: 495 ha) utilised agricultural land. The actually irrigated area (125 ha), assumed to be the total equipped area according to the census was distributed using cited areas of crop groups and assigning irrigation according to the order of market values, excluding pasture: fruit trees (assumed 50% irrigated, 59 ha), root crops (assumed 50% irrigated, 18 ha) and the rest to vegetables (118 ha). The areas given in acres were converted to hectares according to the conversion factor of 0.40468564224 ha per acre.

Cropping seasons:

The crop calendar like for Guam was established from the one of the Philippines. Vegetables and root crops are grown from October to February. Permanent orchards are cultivated. All crops have a cropping intensity of 1.

Palau

No irrigation was reported for Palau.

Pitcairn

No irrigation was reported for Pitcairn.

Samoa

No irrigation was reported for Samoa, also called Western Samoa, which has to be distinguished from American Samoa.

Solomon Islands

No irrigation was reported for the Solomon Islands.

Tokelau

No irrigation was reported for Tokelau.

Tonga

No irrigation was reported for Tonga.

Tuvalu

No irrigation was reported for Tuvalu.

Vanuatu

No irrigation was reported for Vanuatu.

Wallis and Futuna Islands

No irrigation was reported for Wallis and Futuna Islands.

UNITS WITHOUT ATTRIBUTION TO A SPECIFIC CONTINENT

Small Islands

This unit comprises small islands in the Pacific and Indian Ocean without reported irrigation or known agricultural statistics. It was joined from the original units (in alphabetical order) of Baker Island, Glorioso Islands, Howland Island, Johnston Atoll, Paracel Islands, and Spratly Islands.

Antarctica, Rest of Islands

This unit comprises Antarctica and major islands without reported irrigation or known agricultural statistics. It was joined from the original units (in alphabetical order) of Antarctica, Bouvet Island, French Southern & Antarctic Lands, Guernsey, Heard Island & McDonald Islands, Jarvis Island, Jersey, Juan De Nova Island, Isle of Man (“Man, Isle of”), Midway Islands, South Georgia and the South Sandwich Islands, and Wake Island.

References

- ABS (2001): Agriculture 1999-2000. ABS Document, 7113.0.
- ABS (2002): Yearbook Australia 2002. ABS Document, 1301.0.
<http://www.abs.gov.au/AUSSTATS/abs@.nsf/94713ad445ff1425ca2...>
- Achtnich, Wolfram (1980): Bewässerungslandbau. agrotechnische Grundlagen der Bewässerungswirtschaft. Stuttgart, Ulmer.621.
- Agency for Statistics of Bosnia and Herzegovina (2001): "Statistical Bulletin 1 / 2001." Retrieved 2006-01-02, from <http://www.bhas.ba/eng/index2/index.htm>.
- Agency for Statistics of Bosnia and Herzegovina (2002): "Statistical Bulletin 4 / 2002." Retrieved 2006-01-02, from <http://www.bhas.ba/eng/index2/index.htm>.
- AGRESTE Réunion (2005): "La statistique agricole: Memento agricole 2005. La Réunion (Résultats 2004)." Retrieved 2006-05-04, from http://agreste.agriculture.gouv.fr/region_5/reunion_149/index.html.
- Aljiev, K.; Jatzik, N.; Kovalenko, P.; Mihajlov, Ju. and Zhovtonog, O. (2005): "International Commission on Irrigation and Drainage (ICID) Country Position Paper (Water for Food and Rural Development) "Ukraine"." Retrieved 2005-12-15, from http://www.icid.org/index_e.html.
- Anonymous (1985): Irrigated area per oblast in 1985. Data table in the AQUASTAT library.
- Arab Organization for Agricultural Development - Agricultural Information, Documentation and Statistics Center (2003a): Arab agricultural statistics yearbook 2002. <http://www.aoad.org>.
- Arab Organization for Agricultural Development - Agricultural Information, Documentation and Statistics Center (2003b): Arab agricultural statistics yearbook 2002: Table 14. <http://www.aoad.org>.
- Arab Organization for Agricultural Development - Agricultural Information, Documentation and Statistics Center (2003c): Arab agricultural statistics yearbook 2002: Table 16. <http://www.aoad.org>.
- Arnoldussen, Arnold H. (2006): Personal communication. S. Siebert. As, Norway.
- Asian Development Bank (1995): Agriculture sector program loan to the government of the Kyrgyz Republic. Project Preparation Technical Assistance, Annex 4 – Irrigation.
- Baldock, David; Caraveli, Helen; Dwyer, Janet; Einschütz, Silke; Petersen, Jan Erik; Sumpsi-Vinas, Jose and Varela-Ortega, Consuelo (2000): The environmental impacts of irrigation in the European Union. A report to the Environment Directorate of the European Commission by the Institute for European Environmental Policy (IEEP), London in association with the Polytechnical University of Madrid and the University of Athens. viii, 138.
- Bangladesh Bureau of Statistics (2004): "NDB Statistics, Zila Profile." Retrieved 2004-07-12, from <http://www.bbsgov.org>.
- Bazzani, Guido; Di Pasquale, Sabrina; Gallerani, Vittorio; Morganti, Sabina; Viaggi, Davide; Vecino, J. Berbel; López Baldovin, M. J.; Twite, Claire; Morris, Joe; Pinheiro, A.; Saravia, J. P. and Manos, Basil (2001): Characterization of irrigated agricultural systems according to sustainability and definition of representative farms in the different areas. Sustainability of European irrigated agriculture under Water Framework Directive and Agenda 2000 (WADI) - WADI document no. D6, D6: 45.

- BFS (2001): "Statistisches Lexikon der Schweiz, Table "Bodennutzung nach 74 Nutzungsklassen"."
- Brewer, Jeffrey (2001): IMT Country Profile: Albania. International E-mail Conference on Irrigation Management Transfer (IMT). Rome, FAO.
www.fao.org/ag/agl/aglw/waterinstitutions/docs/Albania.pdf.
- Bundesministerium für Verbraucherschutz, Ernährung und Landwirtschaft (2003): Statistisches Jahrbuch über Ernährung, Landwirtschaft und Forsten der Bundesrepublik Deutschland. Münster, Landwirtschaftsverlag.xxviii, 546.
- Cardille, Jeffrey A. and Foley, Jonathan A. (2003): "Agricultural land-use change in Brazilian Amazonia between 1980 and 1995: Evidence from integrated satellite and census data." Remote Sensing of Environment **87**: 551-562. <http://lba.cptec.inpe.br/lba/site/documentos/science/Jeffrey.pdf>. 10.1016/j.rse.2002.09.001.
- Central Bureau of Statistics (2003): Statistical abstract of Israel 2002. <http://www.cbs.gov.il>.
- Central Bureau of Statistics (2004): "National sample census of agriculture 2001/02." from <http://www.cbs.gov.np>.
- Chand, Kishore (2006): Gateway to Land and Water Information: Fiji national report.
http://www.fao.org/ag/agL/swlwpnr/reports/y_pa/z_fj/fj.htm.
- Chehlarova-Simeonova, Sonya (2001): IMT Country Profile: Bulgaria. International E-mail Conference on Irrigation Management Transfer (IMT). Rome, FAO.
www.fao.org/ag/agl/aglw/waterinstitutions/docs/Bulgaria.pdf.
- Chehlarova-Simeonova, Sonya; Yusuf, S.; Florov, V. and Ninova, M. (2006): Country report from Bulgaria. Irrigation sector reform in Central and Eastern European countries. W. Dirksen and W. Huppert. Eschborn, Germany, Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ): 41-102.
- Chinn, Wally R. (1999): "Irrigation: Western Canada's liquid asset." Canadian Agriculture at a Glance - 1999 Retrieved 2006-02-09, from <http://www.statcan.ca/english/kits/agric/water1.htm>.
- Christofidis, Demetrios (2002): "Irrigação, a fronteira hídrica na produção de alimentos [Irrigation, a limiting water frontier for the production of alimentary products]." ITEM (Irrigação & Tecnologia Moderna) **54**(2): 46-55. www.pivotvalley.com.br/valley/mestre/ITEM46.htm.
- Christofidis, Demetrios (2006): Água: Gênesis, gênero e sustentabilidade alimentar no Brasil [Water: Generation, characteristics and nutritional sustainability in Brazil]. Brasília.
www.pt.genderandwater.org/redir/content/download/2996/33129/file/AguaesustentabilidadealimentarBrasil1.pdf.
- Civil Society Promotion Center (2002): "Environment in Bosnia and Herzegovina 2002." Retrieved 2006-07-07, from <http://enrin.grida.no/htmls/bosnia/bosnia2002/index.html>.
- CNA (2005): "Síntesis de las Estadísticas del Agua en México." Edición 2005. Retrieved 2006-08-11, from <http://www.cna.gob.mx/eCNA/Espaniol/Directorio/Default.aspx>.
- CRCID (2005): "International Commission on Irrigation and Drainage (ICID) Country Position Paper (Water for Food and Rural Development) "Croatia"." Retrieved 2005-12-15, from http://www.icid.org/index_e.html.
- CROSTAT (2003): "Agricultural Census 2003." Retrieved 2006-01-02, from <http://www.dzs.hr/Eng/Agriculture/Census2003.htm>.

- CSO (2004): "Afghanistan Statistical Yearbook 1382 [2003]." Retrieved 2006-03-06, from <http://www.aims.org.af> & <http://www.cso.gov.af/>.
- Dabbagh, A. E. and Abderrahman, W. A. (1997): "Management of groundwater resources under various irrigation water use scenarios in Saudi Arabia." *Arabian Journal of Science and Engineering* **22**.
- De Réparaz, André (1993): Irrigation et agriculture irriguée dans les régions méditerranéennes françaises. *Die Bewässerungsgebiete des Mittelmeerraums*. H. Popp and K. Rother. Passau: 79-84.
- Department of Statistics (Jordan) (2004): "Irrigated and non-irrigated areas under tree crops, field crops and vegetables in 2000 (Table)." from <http://www.dos.gov.jo>.
- Department of Statistics and Sociology (2005): "Agriculture (1998-2004)." Retrieved before October 2005, from http://www.statistica.md/statistics/dat/654/en/Agricultura_1995_2004_en.htm.
- DHS (2006): "2006 Farmers' Market Nutrition Program (FMNP)." Retrieved 2006-05-22, from <http://www.wicworks.ca.gov/resources/farmermarket/StartUpPackageAgencies/23%20Crop%20Calendar.xls> & <http://www.wicworks.ca.gov/resources/farmermarket/StartUpPackageAgencies/3%20%202006%20Welcome%20letter.doc> & www.dhs.ca.gov.
- Direction générale Statistique et Information économique of Belgium (2004): "Recensement agricole de mai 2003." Retrieved 2007-08-30, from http://www.statbel.fgov.be/pub/d5/p501y2003_fr.pdf.
- Directorate-General of Budget, Accounting and Statistics, Taiwan (1997): General Report - 1995 Agricultural, forestry, fishery and husbandry survey: Table 16. Taipei, Taiwan Province of China. <http://www.dgbas.gov.tw>.
- Elshof, Albert J. (1990): Irrigated sawah and swamp - development potential and use. 7+22. Jakarta, Indonesia.
- ESCWA (1999): Evaluation of agricultural policies in selected ESCWA member countries: a case-study of Lebanon (Policy Analysis Matrix Approach, PAM), Table 9. New York, United States of America.
- European Commission - Directorate General (1996): Water resources management and agricultural production in the Central Asian Republics – Warmap Project. Vol. 4: Irrigated crop production systems. Tashkent.
- European Environment Agency (2000): "Corine land cover (CLC1990) 100 m - version 12/2000." Retrieved 2006-01-02, from <http://dataservice.eea.eu.int/dataservice/metadetails.asp?id=309>.
- EUROSTAT (2005): "Queen Tree - Irrigation by region." Retrieved 2005-09-14, from http://epp.eurostat.cec.eu.int/portal/page?_pageid=1996_45323734&_dad=portal&_schema=PORTAL&screen=welcomeref&open=/agric/agri/eurofarm/ef_2000/ef2_lu/ef2_luov&language=en&product=EU_agriculture_forestry_fisheries&root=EU_agriculture_forestry_fisheries&scrollto=0.
- EUROSTAT (2006): Irrigation by regions: Czech Republic, Statistical Office of the European Communities. <http://epp.eurostat.ec.europa.eu>.
- Fachverband Feldberegnung - Federal Sprinkler Irrigation Association (2001): "Data on irrigated areas in Germany." from <http://www.fachverband-feldberegnung.de/>.
- FAO (1992): Albania - Irrigation subsector review - Review mission. Report No. 93/92 CP-ALB 4 SR. Rome, Italy.

- FAO (1994): Agricultural development options review (phase I). Rome, Italy.
- FAO (1995a): Irrigation in Africa in figures. L'irrigation en Afrique en chiffres. FAO Water Reports, 7: 336. Rome, Italy.
- FAO (1995b): (Mongolia) Irrigation rehabilitation project. Working Paper 3. Rome, Italy.
- FAO (1997a): "AQUASTAT Survey on water use for agriculture and rural development - Country questionnaire: Japan."
- FAO (1997b): Irrigation in the countries of the former Soviet Union. FAO Water Reports, 15: 226. Rome, Italy.
- FAO (1997c): Irrigation in the Near East Region. FAO Water Reports, 9: 281. Rome, Italy.
- FAO (1999): Irrigation in Asia in Figures. FAO Water Reports, 18: 228. Rome.
- FAO (2000): El riego en América Latina y el Caribe en cifras - Irrigation in Latin America and the Caribbean in Figures. FAO Water Reports, 20: 348. Rome, Italy.
- FAO (2005a): "AQUASTAT Country Profiles." Retrieved 2005-12-06, from <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>.
- FAO (2005b): "AQUASTAT Review of agricultural water use per country - Irrigation cropping calendar per country." Retrieved 2005-09-19, from http://www.fao.org/ag/agl/aglw/aquastat/water_use/index.stm.
- FAO (2005c): "FAO GIEWS (Global Information and Early Warning System) - Cropping calendar." Retrieved 2005-11-15, from http://www.fao.org/giews/workstation/page.jsp?what=KIMS_MapResize&setting=-25&format=&GIEWS_Map=9&GIEWS_AxisIndex0=0&KIMS_Layer=.Administrative+Level+1&KIMS_Attribute=0.
- FAO (2005d): "FAOSTAT Database." Retrieved 2005-12-08, from <http://faostat.fao.org> (original: <http://faostat.fao.org/faostat/form?collection=Production.Crops.Primary&Domain=Production&servlet=1&hasbulk=0&version=ext&language=EN>).
- FAO (2005e): Irrigation in Africa in figures. AQUASTAT Survey – 2005. FAO Water Reports, 26: 89. Rome, Italy.
- GOSCOMSTAT (1998): Environment protection in Russia. Moscow.
- Government of Bahrain (2004): Statistical abstracts 2002: Table S20B. <http://www.bahrain.gov.bh>.
- Government of Pakistan - Statistics Division - Agricultural Census Organization (2003): "Agricultural census 2000 – Pakistan report." Retrieved 2006-02-20, from <http://www.statpak.gov.pk> & http://www.statpak.gov.pk/depts/aco/publications/agricultural_census2000/agricultural_census2000.html.
- GUS (2004): "Area of irrigated agricultural land and forest land (20 ha and more)." Retrieved unknown, from <http://www.stat.gov.pl/english/index.htm>.
- Helfand, Steven M. and Brunstein, Luis F. (2000): The Changing Structure of the Brazilian Agricultural Sector and the Limitations of the 1995/96 Agricultural Census. VII NEMESIS Seminar, IPEA, Rio de Janeiro, Brazil. www.nemesis.org.br/docs/steven3.pdf.

- Hoogeveen, M. W.; van Bommel, K. H. M. and Cotteleer, G. (2003): Beregening in land- en tuinbouw. Rapport voor de Droogtestudie Nederland. 3.03.02: i-iv, 64. Den Haag.
- Huettler, W. (1996): "Regionalisierte Wassernutzungsbilanz Oesterreich 1994 (Water Balance for the Austrian Provinces)." Oesterreichische Wasser- und Abfallwirtschaft (11/12): 301-310.
- IBGE (1997): Censo agropecuario 1995-1996. Rio de Janeiro, Brazil.
- IFEN (2005): Ensemble Intégré des Descripteurs de l'Environnement Régional (EIDER) - Version 2005. Orléans, France, Institut Français de l'Environnement (IFEN).
- INDEC (2002): "Censo Nacional Agropecuario 2002." from <http://www.indec.mecon.gov.ar/>.
- Infoplease (2005): "Infoplease - Andorra." Retrieved 2005-12-23, from <http://www.infoplease.com/ce6/world/A0803948.html>.
- Instituto Nacional de Estadística - Portugal (2001): "Recenseamento Geral da Agricultura 1999." Edition 2001. Retrieved 2006-01-09, from http://www.ine.pt/prodserv/Rga/index_rga.asp.
- Instituto Nacional de Estadística (2002): Censo Agrario 1999, Instituto Nacional de Estadística, Spain. <http://www.ine.es/inebase/index.html>.
- Instituto Nacional de Estadística e Informática (1996): III Censo Nacional Agropecuario - Perú. Perfil Agropecuario, 26. Lima, Peru. <http://www.inei.gob.pe>.
- IRRI (2005): "World rice statistics (WRS)." Retrieved 2005-12-01, from <http://www.irri.org/science/ricestat/index.asp>.
- ISTAT (2002): 5° Censimento Generale dell' Agricoltura (status 2000), Istituto Nazionale di Statistica (ISTAT). <http://censagr.istat.it/>.
- Japanese Society of Irrigation, Drainage and Reclamation Engineering (1995): Irrigation and drainage in Japan, 3rd edition. V+68. Tokyo.
- Junta de Andalucía - Consejería de Agricultura y Pesca (2000): "Anuario de Estadísticas Agrarias y Pesqueras de Andalucía 2000." Retrieved 2005-15-20, from <http://www.juntadeandalucia.es/agriculturaypesca/portal/opencms/portal/DGPAgraria/Estadisticas/estadisticasagrarias?entrada=perfil&tematica=271&perfil=260>.
- Katzmayer, Hans and Rennert, Gerhard (2003): Situation der Bewässerung in Niederösterreich 1994 [Irrigation in Lower Austria]. Fachtagung der DLG-Arbeitsgruppe Feldberegnung. <http://www.dlg.org/de/landwirtschaft/fachgremien/feldberegnung/fachtagung.html>.
- KCA (2003): "Statistics on land areas by municipalities and cadastral zones." Retrieved 2006-01-04, from <http://www.ks.gov.net/esk/>.
- Kireycheva, Liudmila V.; Glazunova, I.V. and Belova, I.V. (2006): Country report from Russia. Irrigation sector reform in Central and Eastern European countries. W. Dirksen and W. Huppert. Eschborn, Germany, Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ): 463-524.
- Kovalenko, Peter; Zhovtonog, Olga; Filipenko, Larisa; Kruchenyk, Vasiliy and Michailov, Juriy (2006): Country report from Slovenia. Irrigation sector reform in Central and Eastern European countries. W. Dirksen and W. Huppert. Eschborn, Germany, Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ): 607-667.

- Kroon, T. (2006): GIS-polygon shapefile, compiled for the Droogtestudie Nederland, Rijkswaterstaat (RIZA).
- Kucera, L. and Genovese, G. (2004): Crop monographies on Central European countries - MOCA Study. Ispra, Italy. http://agrifish.jrc.it/marsstat/Crop_Yield_Forecasting/MOCA/INDEX.HTM.
- Labedzki, Leszek; Kuzniar, Antoni; Lipinski, Jozef and Mioduszewski, Waldemar (2006): Polish Report. Irrigation sector reform in Central and Eastern European countries. With contributions from the ICID (International Commission on Irrigation and Drainage) National Committees of Bulgaria, Czech Republic, Germany, Hungary, Macedonia, Poland, Romania, Russia, Slovenia and Ukraine. W. Dirksen and W. Huppert. Eschborn, Germany, Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ): 329-384.
- Land Use Planning Project (1995): Land cover figures for Bhutan, working figures. Thimphu, Bhutan.
- Latvia, Central Statistical Bureau of (2002): Agricultural census 2001. T. I-30.
- Ligetvári, Ferenc; Cselótei, László; Kiss, Károly; Dimény, Judit; Szilárd, György; Takács-György, Katalin; Kis, Sándor; Helyes, Lajos; Pekár, Ferenc and Bozán, Csaba (2006): Country report from Hungary. Irrigation sector reform in Central and Eastern European countries. W. Dirksen and W. Huppert. Eschborn, Germany, Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ): 161-250.
- Lithuanian National Committee of ICID (2005): "International Commission on Irrigation and Drainage (ICID) Country Position Paper (Water for Food and Rural Development) "Lithuania"." Retrieved 2005-12-15, from http://www.icid.org/index_e.html.
- MAKCID (2005): "International Commission on Irrigation and Drainage (ICID) Country Position Paper (Water for Food and Rural Development) "Macedonia"." Retrieved 2005-12-15, from http://www.icid.org/index_e.html.
- Marin, Daniel (1986): Atlas Geográfico de la República Argentina. Buenos Aires, Nuevo Mundo.127.
- Marks, Hillary F. (1992): Food and Farming in the Fifteen Republics of the Former USSR. A Market Survey. Cambridge, UK, Woodhead Publishing Ltd.
- Mekong River Commission (2003): "People and environment atlas of the lower Mekong Basin." from <http://www.mrcmekong.org>.
- Ministère de l'agriculture de l'élevage et de la sylviculture (1997): Plan national directeur de l'irrigation - Cap Vert.
- Ministère de l'agriculture et du développement rural - Service d'économie rurale (2005): L'agriculture luxembourgeoise en chiffres 2005 (données disponibles au 1er avril 2005). (Agricultural data of Luxembourg, status: 1st April 2005). Luxembourg.
- Ministerio de Agricultura, Peru (2006): "Hidrometeorología - Riego y Drenaje - Estadísticas." Retrieved 2006-08-10, from http://www.portalagrario.gob.pe/hidro_drenaje_est.shtml.
- Ministerio de Ganadería, Agricultura y Pesca, Uruguay (2001): Censo Agropecuario 2000 Resultados definitivos, Vol. II. Montevideo, Uruguay. http://www.mgap.gub.uy/Dica/CENSO2000/censo_general_agropecuario_2000.htm.
- Ministry of Agriculture - Water Resources Utilisation Department, Myanmar: "Gross Irrigated Areas for 1994-1995."

- Ministry of Agriculture and Cooperatives, Zambia (2002): Strategic Plan for Irrigation Development 2002 - 2006. Draft strategy paper, Ministry of Agriculture and Cooperatives, Zambia: 33.
- Ministry of Agriculture and Forestry - Department of Planning - Statistics Division (2006): "Irrigated Area by Types of Irrigation." Retrieved 2006-03-09, from <http://www.maf.gov.la/index.html>.
- Ministry of Agriculture and Forestry - Department of Planning (2002): "Agricultural statistics yearbook 2002." from <http://www.agrostat-moa.gov.la>.
- Ministry of Agriculture and Forestry, Bulgaria (2004): Rural development project: Study on irrigation tariffs and subsidy, Ministry of Agriculture and Forestry, Sofia, Bulgaria: 63.
<http://www.mzgar.government.bg/>.
- Ministry of Agriculture and Forestry, South Korea (2003): "Agricultural and forestry statistical yearbook 2003." from <http://www.maf.go.kr>.
- Ministry of Agriculture, Forestry and Fisheries (1994): Status of agricultural land use in Japan.
- Ministry of Agriculture, Forestry and Fisheries, Japan (2001): "Statistics of Cultivated Land (as of August 1, 2001)."
- Ministry of Agriculture, Lithuania (2005): Register of land equipped for irrigation, status 2005-01-01, Ministry of Agriculture.
- Ministry of Internal Affairs and Communications - Statistics Bureau & Statistical Research and Training Institute (2006): "Japan Statistical Yearbook 2006." Retrieved 2006-03-15, from <http://www.stat.go.jp/english/data/nenkan/index.htm> & <http://www.stat.go.jp/english/data/nenkan/1431-07.htm>.
- Ministry of National Economy, Oman (2003): Statistical year book: Table 2.6.
<http://www.moneoman.gov.om>.
- Ministry of Planning, Statistics and Information Sector, Kuwait (2002): Annual statistical abstract 2001 (page 102). <http://www.mop.gov.kw>.
- Ministry of Planning, United Arab Emirates (2003): Statistical abstract 2001: Table 6.1.
<http://www.uae.gov.ae>.
- Miskovsky, J. (2001): "Privatisation of Irrigation Systems in the Czech Republic." ERWGLetter - Land and Water Management in Europe **12**: 3-6.
- Morris, Joe; Weatherhead, E. K.; Knox, J. W.; Vasilieou, K.; deVries, T. T.; Freeman, D.; Leiva, F. R. and Twite, Claire (2004): Summary country report: England and Wales. Sustainability of European irrigated agriculture under Water Framework Directive and Agenda 2000 (WADI): 28. Silsoe, Bedfordshire, UK. www.cranfield.silsoe.ac.uk.
- National Bureau of Statistics (2001): "China statistical yearbook 2001." from <http://chinadatacenter.org>.
- National Institute of Statistics - Romania (2006): "Dissemination of the 2002 General Agricultural Census results." Retrieved 2006-01-10, from http://www.insse.ro/GAC_eng/.
- National Irrigation Administration (1993): Corporate plan 1993-2002. Quezon City, Philippines.
- Neudorfer, Wolfgang (2003): "Empfehlungen für Bewässerungswasser - Neue Richtlinien in Österreich. Recommendations for irrigation water - New austrian guidelines." Zeitschrift für Bewässerungswirtschaft **38**(2): 163-172.

- Nicolaescu, Ion; Buhociu, Liviu; Condruz, Romică; Suciu, Gabriela-Ioana; Paraschiv, Daniela and Boeru, Mugur (2006): Country report from Romania. Irrigation sector reform in Central and Eastern European countries. W. Dirksen and W. Huppert. Eschborn, Germany, Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ): 103-118.
- Office of Agricultural Economics - Thailand (2005): "Agricultural statistics of Thailand 2003, crop year 2003/2004." Retrieved 2006-02-22, from <http://oae.go.th> & <http://www.oae.go.th/statistic/yearbook/2003/indexe.html>.
- Oklahoma State University (2006): "Oklahoma crop calendar 2001-2002." Retrieved 2006-05-18, from <http://oklahoma4h.okstate.edu/aitc/calendar/cropcal.html> & <http://www.agweb.okstate.edu/fourh/aitc/>.
- Palestinian National Authority - Palestinian Central Bureau of Statistics (2003): Statistical abstract of Palestine (4). <http://www.pcbs.gov.ps>.
- Palestinian National Authority - Palestinian Central Bureau of Statistics (2004): Agricultural Statistics 2003/2004. <http://www.pcbs.gov.ps/DesktopDefault.aspx?tabID=3758&lang=en>.
- Pfleger, Ingrid (2005): Wasserqualität für die Bewässerung in Thüringen. DLG-Fachtagung Feldberegnung 2005. Groß-Umstadt. <http://www.dlg.org/de/landwirtschaft/fachgremien/feldberegnung/fachtagung.html>.
- POCID (2005): "International Commission on Irrigation and Drainage (ICID) Country Position Paper (Water for Food and Rural Development) "Poland"." Retrieved 2005-12-15, from http://www.icid.org/index_e.html.
- Public Water Management Enterprise "Water Management of Macedonia" (2006): "Irrigation schemes." Retrieved 2006-01-02, from <http://www.water.org.mk/plavo/currentstructures/Irrigation.htm>.
- Republic of Armenia (1993): Irrigation subsector review and project identification. Report to FAO. Annex 1, Table 3. Report no. 79/93 CP – ARM2.
- Republic of Bulgaria - Council of Ministers (1999): National Agriculture and Rural Development Plan (NARDP) of the Republic of Bulgaria over the 2000 - 2006 period under the EU Special Accession Program for Agriculture and Rural Development (SAPARD). **Council of Ministers - Government Decision 726 of 22 November 1999**.
- Republic of Montenegro Statistical Office (2006): "Statistical Yearbook of the Republic of Montenegro 2006." Retrieved 2007-01-27, from <http://www.monstat.cg.yu/EngPublikacije.htm>.
- Riddell, P. J. and Manyatsi, A. M. (2003): Water use challenges and opportunities in the Swaziland agricultural sector. TCP/SWA/2801(A).
- Sautier, Jean-Luc (2002): Irrigation in Switzerland - some data. W. University. Bern, Bundesamt für Landwirtschaft.
- SCEES (2006): "Recensement agricole 2000 - L'inventaire - France métropolitaine, Tableau 3.1: Irrigation." Retrieved 2006-02-16, from <http://www.agreste.agriculture.gouv.fr/default.asp?rub=recensement&hauteur=475>.
- Secretaria de Recursos Hídricos and (ANA), Agência Nacional de Águas (2003): Plano Nacional de Recursos Hídricos [National Water Resources Plan], Documento base de referência, Minuta, Revisao 01.

- Serbia and Montenegro Statistical Office (2005): "Statistical Yearbook of Serbia and Montenegro 2005 (SY SCG 2005)." Retrieved 2006-01-04, from <http://www.szs.sv.gov.yu/english.htm>.
- Siebert, Stefan (2006): Personal communication. F. Portmann.
- Siebert, Stefan; Döll, Petra; Feick, Sebastian; Hoogeveen, Jippe and Frenken, Karen (2007): "Global map of irrigation areas."
- Siebert, Stefan; Feick, Sebastian; and Hoogeveen, Jippe (2005): Digital Global Map of Irrigated Areas - An Update for Asia. Frankfurt Hydrology Paper, 01.
- SKNC-ICID (2005): "International Commission on Irrigation and Drainage (ICID) Country Position Paper (Water for Food and Rural Development) "Slovakia"." from http://www.icid.org/index_e.html.
- SOK (2005, November 2005): "Agricultural Household Survey 2004." Series 2: Agriculture and Environment Retrieved 2006-01-04, from <http://www.ks.gov.net/esk/>.
- Štastná, Milada; Miškovský, Josef; Čermák, Jan; Doležal, František; Zavadil, Josef and Spitz, Pavel (2006): Country report from Czech Republic. Irrigation sector reform in Central and Eastern European countries. W. Dirksen and W. Huppert. Eschborn, Germany, Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ): 103-118.
- Statistical Centre of Iran (2004): "Iran statistical yearbook 1381 [2003]." from <http://eamar.sci.org.ir>.
- Statistical Office of the Republic of Slovenia (2002): "Agricultural Census Slovenia 2000." Series 15 Agriculture and Fishing, Publication No. 777 Retrieved 2006-01-09, from http://www.stat.si/eng/tema_okolje_kmetijstvo.asp.
- Statistical Office of the Republic of Slovenia (2006): "Statistical Yearbook 2005." Retrieved 2006-01-10, from http://www.stat.si/eng/tema_okolje_kmetijstvo.asp.
- Statistics Canada (2001): Table 8.1: Land inputs, by province, Census Agricultural Region (CAR) and Census Division (CD), 2000. Statistics Canada – Catalogue No. 95F0301XIE.
- Statistics New Zealand (2003): Agricultural Statistics 2002. ISSN 0110-4624. Wellington, New Zealand. <http://www.stats.govt.nz/analytical-reports/agriculture-statistics-2002/default.htm>.
- Statistisches Bundesamt - Federal Statistical Office (1998): Umwelt - Fachserie 19, Reihe 2.2 Wasserversorgung und Abwasserbeseitigung in der Industrie und in der Landwirtschaft. Wiesbaden, Statistisches Bundesamt - Federal Statistical Office. Umwelt - Fachserie 19, Reihe 2.2 Wasserversorgung und Abwasserbeseitigung in der Industrie und in der Landwirtschaft, Fachserie 19, Reihe 2.2.
- Statistisches Bundesamt - Federal Statistical Office (2004): Statistik der Wasserversorgung in der Landwirtschaft 2002. Wiesbaden, Statistisches Bundesamt - Federal Statistical Office.
- Stibig, H. J.; Upik, R.; Beuchle, R.; Hildanus; and Mubareka, S. (2003): "The land cover map for South East Asia in the year 2000. GLC2000 database." from <http://www.gvm.jrc.it>.
- Tonismae, Mati (2006): "Area equipped for irrigation, by county (status 01/01/2005)." Retrieved 2006-02-21.
- Troll, Carl and Paffen, Karlheinz (1964): "Karte der Jahreszeitenklimare der Erde [Map of seasonal climates of the earth]." Erdkunde **18**(1): 5-28.

- UNCTAD (2006): "Planting and harvesting times for cotton, by producing country." Retrieved 2006-07-27, from <http://r0.unctad.org/infocomm/anglais/cotton/crop.htm>.
- UNDP (2004): Water resources of Kazakhstan in the new millennium. Report No. UNDPKAZ 07. Almaty, Kazakhstan. <http://www.cagateway.org>.
- USAID (2002): "Irrigation improvements in Tajikistan. An overview of USAID activities in Central Asia." from <http://www.cagateway.org>.
- USDA (1994): Major world crop areas and climatic profiles. USDA Agricultural Handbook, No. 664: xii, 279. Washington, DC, United States of America. http://gcmd.nasa.gov/records/GCMD_USDA_NOAA_WORLD_CROP_AREAS.html.
- USDA (2006): "Monthly normal crop calendar." Retrieved 2006-05-18, from http://www.fas.usda.gov/pecad/weather/Crop_calendar/crop_cal.pdf & <http://www.pecad.fas.usda.gov/>.
- USDA and NASS (2004a): 2002 Census of Agriculture - Volume 1, Geographic Area Series, Part 51 - Summary and State Data: United States. AC-02-A-51. Washington, DC, United States of America. http://www.nass.usda.gov/Census_of_Agriculture/index.asp & <http://www.nass.usda.gov/census/census02/volume1/>.
- USDA and NASS (2004b): 2002 Census of Agriculture - Volume 1, Geographic Area Series, Part 52 - Puerto Rico. AC-02-A-52: 302. Washington, DC, United States of America. http://www.nass.usda.gov/Census_of_Agriculture/index.asp & <http://www.nass.usda.gov/census/census02/puertorico/cenpr02.pdf>.
- USDA and NASS (2004c): 2002 Census of Agriculture - Volume 1, Geographic Area Series, Part 53 - Guam. AC-02-A-53: 62. Washington, DC, United States of America. http://www.nass.usda.gov/Census_of_Agriculture/index.asp & <http://www.nass.usda.gov/census/census02/puertorico/cenpr02.pdf>.
- USDA and NASS (2004d): 2002 Census of Agriculture - Volume 1, Geographic Area Series, Part 56 - Commonwealth of the Northern Mariana Islands. AC-02-A-56: 52. Washington, DC, United States of America. http://www.nass.usda.gov/Census_of_Agriculture/index.asp & <http://www.nass.usda.gov/census/census02/cnmi/cnmi.pdf>.
- USDA and NASS (2004e): 2002 Census of Agriculture - Volume 1, Geographic Area Series, Parts 1 to 50 - State and County Data: Alabama to Wyoming. AC-02-A-1 to AC-02-A-50. Washington, DC, United States of America. http://www.nass.usda.gov/Census_of_Agriculture/index.asp & <http://www.nass.usda.gov/census/census02/volume1/>.
- Vukelic, Zvonimir; Jankovic, Jasminka Taseva and Kondinski, Ilija (2006): Country report from Macedonia. *Irrigation sector reform in Central and Eastern European countries*. W. Dirksen and W. Huppert. Eschborn, Germany, Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ): 251-328.
- Wang, Rusong; Ouyang, Zhiyun; Ren, Hongjun; and Min, Qingwen (1999): China Water Vision. The Eco-sphere of water, environment, life, economy & society.
- Weatherhead, E. K. and Danert, K. (2002): Survey of Irrigation of outdoor crops in 2001 - England. 4. Silsoe, Bedfordshire, UK. www.cranfield.silsoe.ac.uk.
- Wikipedia-Encyclopedia (2005a): "Andorra." Retrieved 2005-12-23, from <http://de.wikipedia.org/wiki/Andorra>.

- Wikipedia-Encyclopedia (2005b): "Chongqing." Retrieved 2006-02-09, from <http://en.wikipedia.org/wiki/Chongqing>.
- Wikipedia-Encyclopedia (2006): "Dunam." Retrieved 2006-06-12, from <http://en.wikipedia.org/wiki/Dunam>.
- World Bank - Rural Development, Water and Environment Department, Middle East and North Africa Region (1999): Republic of Yemen - agricultural strategy note. Table 1. World Bank Report No. 17973-YEM. <http://www-wds.worldbank.org>.
- World Bank (1994): Albania - Irrigation Rehabilitation Project - Staff Appraisal Report. World Bank Report No. 12609-ALB: i-iii, 139. Washington, D.C.
- World Bank (1995): Moldova Agriculture Sector Review. World Bank Report No. 12581-MD: i-viii, 130. Washington, D.C.
- World Bank (1996a): Republic of Kazakhstan - Irrigation and drainage improvement project - Staff Appraisal Report. World Bank Report No. 15379-KZ: i-v, 155, map. Washington, D.C.
- World Bank (1996b): Viet Nam – water resources sector review. World Bank Report No. 15041-VN: i-x, 151. Washington, D.C.
- World Bank (1997): Slovenia – Irrigation project. Working paper 3: Water resources and irrigation in Slovenia. 8. Washington, D.C.
- World Bank (1999): Albania - Second Irrigation and Drainage Rehabilitation Project - Project Appraisal Document on a proposed credit in the amount of SDR 17.7 million (U.S. equivalent \$24 million) to Albania for a second irrigation and drainage rehabilitation project. World Bank Report No. 19242 ALB: i-iii, 95. Washington, D.C.
- World Bank (2001): Irrigation and drainage community development project. Project appraisal document. World Bank Report No. 22042-GE. <http://www.worldbank.org>.
- World Bank (2003a): Azerbaijan - Irrigation distribution system and management improvement project. Project appraisal document on a proposed credit in the amount of SDR 25.7 million (U.S. \$35 million equivalent) to the Azerbaijan Republic. World Bank Report No. 25755-AZ: i-v, 108, map(s). Washington, D.C. <http://www.worldbank.org>.
- World Bank (2003b): Bosnia and Herzegovina - small-scale commercial agriculture development project. Project appraisal document on a proposed credit in the amount of SDR 8.7 million (US\$ 12.0 million equivalent) to Bosnia and Herzegovina for a small-scale commercial agriculture development project. World Bank Report No. 25519-BiH: i-iii, 95. Washington, D.C.
- World Bank (2003c): Water resources management in South Eastern Europe, Vol. II: Country water notes and water fact sheets.
- World Bank (2005): Serbia - Irrigation and Drainage Rehabilitation Project - Project Appraisal Document on a proposed credit in the amount of SDR 16.6 million (U.S. equivalent \$25 million) to Serbia and Montenegro for a Serbia irrigation and drainage rehabilitation project. World Bank Report No. 32379-YF: i-viii, 76, map. Washington, D.C.
- WRI (2006): "EarthTrends Country Profiles - Fiji - Agriculture and Food." Retrieved 2006-08-15, from <http://www.earthtrends.wri.org>.