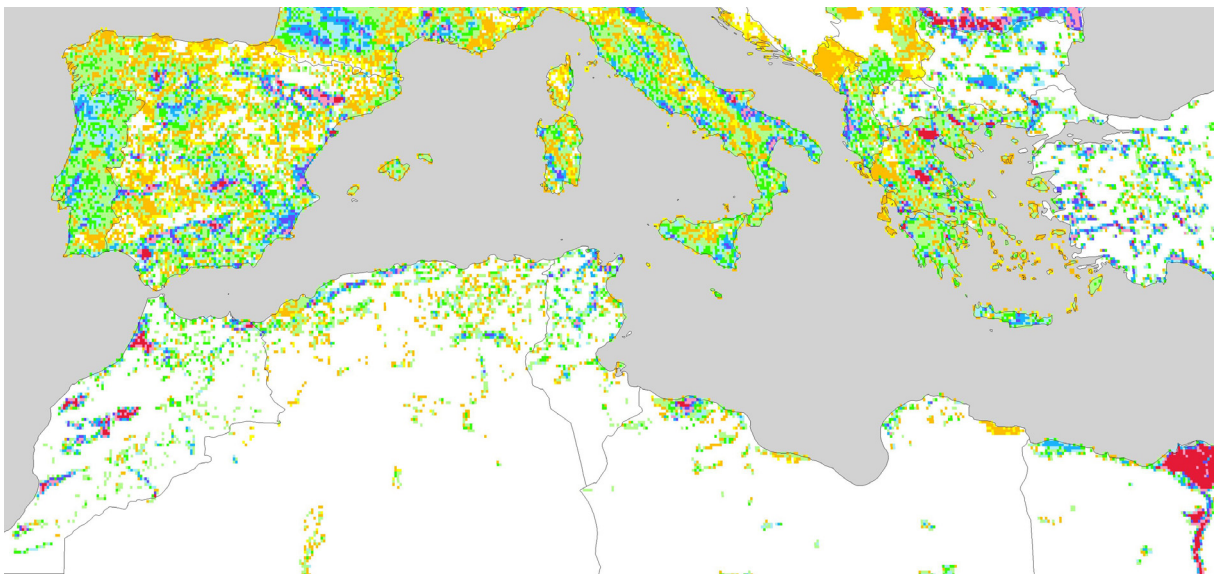


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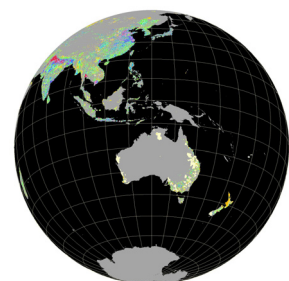
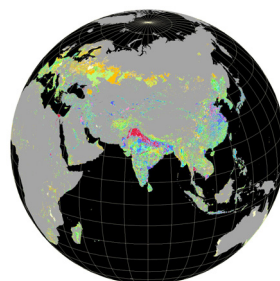
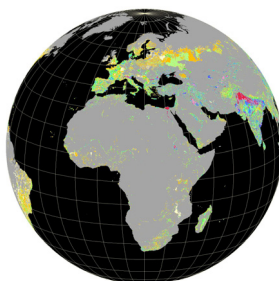
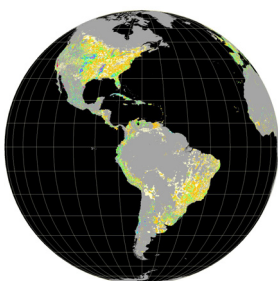
Irrigation in Africa, Europe and Latin America

Update of the Digital Global Map of Irrigation Areas to Version 4



DOCUMENTATION

Stefan Siebert • Jippe Hoogeveen • Karen Frenken



Frankfurt Hydrology Paper



Land and Water
development division

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Irrigation in Africa, Europe and Latin America

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Preface

Agriculture is by far the largest water-use sector, accounting for about 70 percent of all water withdrawn worldwide from rivers and aquifers for agricultural, domestic and industrial purposes. In several developing countries, irrigation represents up to 95 percent of all water withdrawn, and it plays a major role in food production and food security. The agriculture development strategies of most of these countries depend on the possibility of maintaining, improving and expanding irrigated agriculture. However, as the pressure on water resources increases, irrigation is facing growing competition from other water-use sectors and becoming a threat to the environment in an increasing number of regions.

In the last decade, the international community has made major efforts to assess the different elements of the water balance and to predict current and future water needs for the different use sectors. However, considerable uncertainty remains concerning the extent and distribution of irrigated land in the world and on agricultural water use, therefore, making it difficult to monitor the irrigation sector adequately. Coverage of irrigated areas in the world, available in a geographical information system (GIS), is the single most important item of information needed to improve future global studies on water and food.

The first version of the Digital Global Map of Irrigated Areas was published in 1999 (see table). It consisted of a raster map with a resolution of 0.5 ° by 0.5 ° containing the percentage of the area that was equipped for irrigation around 1995, the so-called irrigation density. To further develop and improve the global GIS coverage of areas equipped for irrigation and to make it available to users in the international community, cooperation was established between the Johann Wolfgang Goethe University in Frankfurt am Main, Germany, and the Land and Water Development Division of the Food and Agriculture Organization of the United Nations (FAO).

Through this cooperation, the mapping project has been linked closely to the FAO global information system on water and agriculture, Aquastat. The Aquastat programme collects and disseminates data and information by country and by region. Its aim is to provide users interested in global, regional and national analysis (e.g. policy-makers, decision-makers and researchers) with the most accurate, reliable, consistent and up-to-date information available on water resources and agricultural water management. In order to make thorough analyses, the Aquastat programme collects data from many different sources including national water resources and irrigation master plans, statistics and yearbooks, FAO technical reports, and national and international surveys and reports made available by national and international research centres.

The data collected through the Aquastat programme have served as the main source for improving the overall quality and resolution of the Digital Global Map of Irrigated Areas. In addition, the methodology for producing the map has been improved substantially. This has made it possible to increase the spatial resolution of the map to 5 minutes, thus justifying the publication of an improved second version of the Digital Global Map of Irrigated Areas. For Version 2, updated maps of Latin America, Europe, Africa and Oceania have been published. The next step in improving the dataset was the inclusion of updates for the continent of Asia, and for North America. With this update to version 3, the map for the whole globe was generated by using the same methodology. Here we present the update to version 4 which incorporates improvements for the continents of Africa and Europe and for parts of Latin America as well. For the update the inventory of subnational irrigation statistics for the continent was compiled. The reference year for the update of the map is 2000.

Brief history of the Digital Global Map of Irrigation Areas

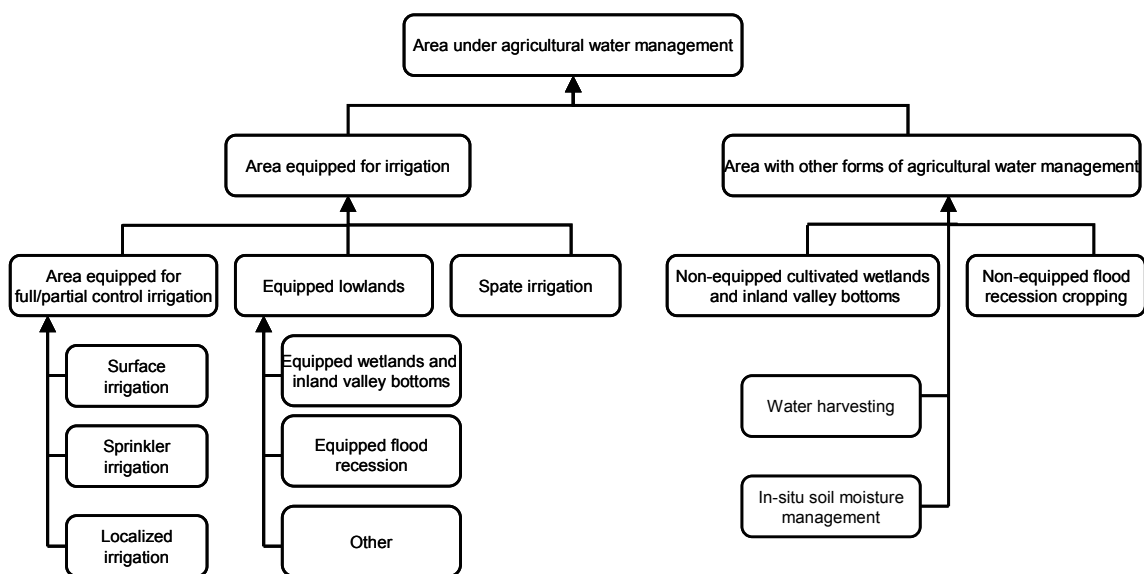
1999	Version 1	Digital Global Map of Irrigated Areas Version 1 published (resolution: 0.5 ° × 0.5 °). Döll, P. & Siebert, S. 1999. <i>A digital global map of irrigated areas</i> . Germany, Center for Environmental Systems Research, University of Kassel.
2001	Version 2	Cooperation was established between the project team of the Global Map of Irrigated Areas and the FAO Aquastat programme. As a result of this cooperation, the map-generation methodology was improved and an update of the continents of Latin America and Europe was made. The global grid resolution was increased to a grid of 5 arc-minutes and the map was made available to the general public as Version 2. Siebert, S. & Döll, P. 2001. <i>A digital global map of irrigated areas - an update for Latin America and Europe</i> . Germany, Center for Environmental Systems Research, University of Kassel.
2002	Version 2.1	Update of Africa and Oceania using the improved map-generation methodology described in Siebert & Döll (2001). Siebert, S., Döll, P. & Hoogeveen, J. 2002. <i>A digital global map of irrigated areas - an update for Africa and Oceania</i> . Germany, Center for Environmental Systems Research, University of Kassel, and Rome, FAO (available at http://www.fao.org/ag/agl/aglw/aquastat/irrigationmap/index.stm).
2004		The Global Map of Irrigated Areas project team at the University of Kassel moved to the Johann Wolfgang Goethe University in Frankfurt am Main, Germany.
2005	Version 2.2	Update of the continent of Asia using the map-generation methodology described in Siebert & Döll (2001). Siebert, S., Feick, S. & Hoogeveen, J. 2005. <i>A digital global map of irrigated areas - an update for Asia</i> . Frankfurt am Main, Germany, Johann Wolfgang Goethe University, and Rome, FAO.
2005	Version 3	Update of the map for North America, assessment of the map quality of map version 3 based on two indicators of map quality. Siebert, S., Döll, P., Hoogeveen, J., Faurès, J-M., Frenken, K. & Feick, S. 2005. <i>Development and validation of the global map of irrigation areas</i> . Hydrology and Earth System Sciences, 9, 535-547.
2006	Version 4	Update of the map for the continents of Africa and Europe and for parts of Latin America using the methodology described in Siebert et al. (2005). Siebert, S., Hoogeveen, J. & Frenken, K. 2006. <i>Irrigation in Africa, Europe and Latin America - Update of the Digital Global Map of Irrigation Areas to Version 4</i> . Frankfurt am Main, Germany, Johann Wolfgang Goethe University, and Rome, FAO (this publication).
The complete documentation of the Digital Global Map of Irrigation Areas is always available at: http://www.fao.org/ag/agl/aglw/aquastat/irrigationmap/index.stm . From this address, the map can also be downloaded.		

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This report was prepared by Stefan Siebert of the Hydrology Group of the Institute of Physical Geography at the University of Frankfurt am Main, Germany, with contributions from Jippe Hoogeveen and Karen Frenken of the Land and Water Development Division of the Food and Agriculture Organization of the United Nations (FAO). The Africover project of the Environment and Natural Resources Service, FAO, contributed important spatial information for 10 countries in the Eastern part of Africa. The Land and Water Documentation Centre, FAO, provided useful paper maps for most countries. The International Institute for Applied Systems Analysis (IIASA), the Satellite Applications Centre (CSIR) and Instituto Nacional de Estadística Geografía e Informática (INEGI) provided valuable data relating to irrigation and land use in the Russian Federation, South Africa and Mexico. Irrigation statistics for most of the European countries were provided by the Statistical Office of the European Communities (EUROSTAT). Valuable information on the present status of the irrigation sector in Central and Eastern Europe was derived from a comprehensive publication of the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) and the International Commission on Irrigation and Drainage (ICID). The study highly benefited from information provided by personal communication with scientists from many countries, in particular the authors would like to mention Mati Tonismae (Estonia), Heinz Sourell, Volker Ehlert and Ekkehard Fricke (Germany), Antanas Maziliauskas (Lithuania), Arturo Victoria Hernández (Mexico), Timo Kroon and Bart Schultz (Netherlands), Arnold Arnoldussen (Norway), Brane Maticic (Slovenia), José Antonio Rodríguez Alvarez (Spain) and Andre Mermoud (Switzerland). Several persons provided useful subnational information on irrigation during the preparation of the AQUASTAT country profiles for Africa: Albert Tonouhewa (Benin), Mohamed El Nahal (Egypt), Yibeltal Tiruneh (Ethiopia), Kadiatou Barry (Guinea), Humphrey Mwathe (Kenya), Nitiraj Toolsee (Mauritius), Yacoubi Soussane (Morocco), Marc Van Naiken (Seychelles), Pieter van Heerden (South Africa), Absalom Manyatsi (Swaziland), Abdelkader Hamdane (Tunisia), Angel Daka (Zambia), and Kennedy Mudima (Zimbabwe). The authors wish to acknowledge the assistance and support for the irrigation-mapping project provided by Petra Döll and Sebastian Feick of the University of Frankfurt, and Jean-Marc Faurès of FAO.

Glossary

In this section an overview is given on the meaning of the main variables presented in this report. In general the meaning of the variables in the report is the same as used in the AQUASTAT surveys of FAO. The irrigation areas reported on the irrigation map refer to the area defined below under “Area equipped for irrigation: total” and shown in the following diagram.



Unfortunately, an exception has to be made when statistics are derived from EUROSTAT since EUROSTAT uses some similar variables names that have however a different meaning. These differences are also described below in the last two definitions.

Cultivated area (ha)

Area under temporary (annual) and permanent crops. This refers to the physical area cultivated meaning that land which is cultivated twice a year is counted only once.

Area equipped for irrigation: Full control surface irrigation (ha)

Surface irrigation systems are based on the principle of moving water over the land by simple gravity in order to wet it, either partially or completely, before infiltration. They can be subdivided into furrow, borderstrip and basin irrigation (including submersion irrigation of rice). Surface irrigation does not refer to the method of transporting water from the source up to the field, which may be done by gravity or by pumping. Manual irrigation using buckets or watering cans should also be put here.

Area equipped for irrigation: Full control sprinkler irrigation (ha)

A sprinkler irrigation system consists of a pipe network through which water moves under pressure before being delivered to the crop via sprinkler nozzles. The system basically simulates

rainfall in that water is applied through overhead spraying. Therefore, these systems are also known as overhead irrigation systems.

Area equipped for irrigation: Full control localized irrigation (ha)

Localized irrigation is a system where the water is distributed under low pressure through a piped network, in a pre-determined pattern, and applied as a small discharge to each plant or adjacent to it. There are three main categories: drip irrigation (where drip emitters are used to apply water slowly to the soil surface), spray or microsprinkler irrigation (where water is sprayed onto the soil near individual plants or trees) and bubbler irrigation (where a small stream of water is applied to flood small basins or the soil adjacent to individual trees). To refer to localized irrigation, the following terms are also sometimes used: micro-irrigation, trickle irrigation, daily flow irrigation, drop-irrigation, sip irrigation and diurnal irrigation.

Area equipped for irrigation: Full control - total (ha)

This is the sum of surface irrigation, sprinkler irrigation and localized irrigation. The text uses indifferently the expressions “full control” and “full/partial control”.

Area equipped for irrigation: Equipped lowland areas (ha)

The land equipped for irrigation in lowland areas includes: (i) Cultivated wetland and inland valley bottoms (IVB), which have been equipped with water control structures for irrigation and drainage (intake, canals, etc.); (ii) Areas along rivers, where cultivation occurs making use of water from receding floods and where structures have been built to retain the receding water; (iii) Developed mangroves and equipped delta areas.

Area equipped for irrigation: Spate irrigation (ha)

Spate irrigation can also be referred to as floodwater harvesting. It is a method of random irrigation using the floodwaters of a normally dry watercourse or riverbed (wadi). These systems are in general characterized by a very large catchment upstream (200 ha - 50 km²) with a “catchment area: cultivated area” ratio of 100:1 to 10 000:1. There are two types of floodwater harvesting or spate irrigation: 1) floodwater harvesting within streambeds, where turbulent channel flow is collected and spread through the wadi in which the crops are planted; cross-wadi dams are constructed with stones, earth, or both, often reinforced with gabions; 2) floodwater diversion, where the floods - or spates - from the seasonal rivers are diverted into adjacent embanked fields for direct application. A stone or concrete structure raises the water level within the wadi to be diverted to the nearby cropping areas.

Area equipped for irrigation: total (ha)

Area equipped to provide water to crops. It includes areas equipped for full control irrigation, equipped lowland areas, and areas equipped for spate irrigation. It does not include non-equipped cultivated wetlands and inland valley bottoms or non-equipped flood recession cropping areas.

Area actually irrigated (ha)

The area which is actually irrigated at least once in a given year. Often, part of the equipped area is not irrigated for various reasons such as lack of water, absence of farmers, land degradation, damage and organizational problems. It only refers to physical areas, meaning that irrigated land that is cultivated twice a year is counted once.

Irrigation potential (ha)

Area of land which is potentially irrigable. Country/regional studies assess this value according to different methods, for example some consider only land resources suitable for irrigation, others consider land resources plus water availability, others include in their assessment

economic aspects (such as distance and/or difference in elevation between the suitable land and the available water) or environmental aspects, etc. Whatever the case, it includes the area already under agricultural water management.

Irrigable area (ha)

This term is used in the **EUROSTAT** statistics with the following meaning: The maximum area which could be irrigated in the reference year using the equipment and the quantity of water normally available on the holding. The meaning is therefore similar to the term *area equipped for irrigation* as used elsewhere in the report. However, the total irrigable area may differ from the sum of the areas provided with irrigation equipment since the equipment may be mobile and therefore utilisable on several fields in the course of a harvest year; capacity may also be restricted by the quantity of water available or by the period within which mobility is possible.

Irrigated area (ha)

In general this term refers in the report to the *area equipped for irrigation*. **EUROSTAT** however uses this term in the following meaning: Area of crops which have actually been irrigated at least once during the 12 months prior to the survey date. The definition used by EUROSTAT is therefore similar to the *area actually irrigated* as used elsewhere in the report.

Summary

The Land and Water Development Division of the Food and Agriculture Organization of the United Nations and the Johann Wolfgang Goethe University, Frankfurt am Main, Germany, are cooperating in the development of a global irrigation-mapping facility. This report describes an update of the Digital Global Map of Irrigation Areas for the continents of Africa and Europe as well as for the countries Argentina, Brazil, Mexico, Peru and Uruguay in Latin America. For this update, a new inventory of subnational irrigation statistics was compiled. The reference year for the statistics is 2000. Adding up the irrigated areas per country as documented in the report gives a total of 48.8 million ha while the total area equipped for irrigation at the global scale is 278.8 million ha. The total number of subnational units in the inventory used for this update is 16 822 while the number of subnational units in the global inventory increased to 26 909. In order to distribute the irrigation statistics per subnational unit, digital spatial data layers and printed maps were used. Irrigation maps were derived from project reports, irrigation subsector studies, and books related to irrigation and drainage. These maps were digitized and compared with satellite images of many regions. In areas without spatial information on irrigated areas, additional information was used to locate areas where irrigation is likely, such as land-cover and land-use maps that indicate agricultural areas or areas with crops that are usually grown under irrigation.

1. Data and methods

In this section of the report an overview of the methodologies used in the map generation (section 1.1) or to assess the map quality (section 1.2) is given. A more detailed description of the used methodology is given in Siebert et al. (2005), the assessment of map quality is additionally described in Appendix A. The compilation of the map of subnational unit boundaries used for this map update is described in section 1.3 while section 1.4 consists of a detailed country-wise documentation of the subnational irrigation statistics and of the geospatial data used in this update including the references to the sources of information.

1.1 MAPPING METHODOLOGY

The global map of irrigation areas was developed by combining sub-national irrigation statistics with geospatial information on the position and extent of irrigation schemes to compute the fraction of 5 arc minute cells that was equipped for irrigation, which is called *irrigation density*. The area equipped for irrigation for each of the sub-national units (e.g. districts, counties, provinces, governorates, river basins) is given and was taken from national census surveys and from reports available at FAO (through its AQUASTAT global water and agriculture information system), World Bank and other international organizations. In order to distribute the areas equipped for irrigation within the sub-national units, geospatial information on position and extent of irrigated areas was derived by digitizing irrigation maps available in reports of FAO, World Bank, irrigation associations or national ministries of agriculture. Additionally, information from several atlases or inventories based on remote sensing available in digital format was utilized. For most of the countries, more than one data source was used. As the relevance and reliability of the maps varies, it was necessary to decide which geospatial record should be used in a specific sub-national unit. This was realized by applying a priority level to each record. Only if the extent of all digitized irrigated areas with the highest priority level was smaller than the total irrigated area reported for the specific sub-national unit, also records with the second highest priority were considered. This distribution process was repeated down to the next lower priority level until the sum of irrigated area in the map was equal to the irrigated area in the sub-national statistics. In many sub-national units, lack of geospatial information on irrigation made it necessary to use indirect information to infer areas within the sub-national unit where irrigation is probable. Such information includes areas where the main irrigated crops are grown, or cultivated areas in very arid regions. For arid regions, remote sensing data were additionally used to verify the available maps.

1.2 ASSESSMENT OF MAP QUALITY

A common method to assess the quality of a macro-scale data set is to compare it with independent smaller-scale information at selected locations and then to draw conclusions with respect to the quality at these locations and in general. Here, however, a comparison to information collected at the ground would require to measure irrigated area of 5 arc minute by 5 arc minute grid cells (about 9 by 9 km at the equator), which is practically not feasible. Besides, any generalization would not be possible, as the map quality is different in each individual sub-national unit depending on the data sources used in the specific case.

Instead, to assess the quality of the Global Map of Irrigation Areas, two indicators were computed that take into account the geospatial information density. Indicator A (*IND_A*) represents the density of the used sub-national irrigation statistics while indicator B (*IND_B*) represents the density of the available geospatial records on position and extent of irrigated areas. Marks derived from the two indicators were combined to obtain a mark for the overall map quality for each country (Annex A). The overall map quality mark was downgraded for a country when it was found that sub-national statistics coming from different sources disagreed, when statistics were found to be incomplete or when geo-spatial information was found to be

out of date. Marks for the overall mapping quality in world regions or at global scale were computed as average of the marks for the overall quality at country level weighted by the irrigated area in the corresponding countries. A detailed description of the calculation of the two indicators is given in Annex A and in Siebert et al. (2005).

1.3 THE MAP OF SUBNATIONAL UNIT BOUNDARIES USED TO UPDATE THE GLOBAL MAP OF IRRIGATION AREAS TO VERSION 4

To make use of the collected subnational irrigation statistics it is necessary to compile a consistent map showing the boundaries of those statistical units. For the *national* boundaries, shape files indicating the boundaries in Latin America and Africa (FAO, 2005b) or Europe (ESRI, 2005) were combined. The boundaries of the *subnational* statistical units were derived for most of the countries from the same source. Exceptions are documented in Table 1.

TABLE 1
Sources of subnational unit boundaries

Country / Region	Source of subnational boundaries
Africa	
Guinea	Basin boundaries extracted from FAO (2001)
Mauritius	Regions digitized based on a map provided with the AQUASTAT country questionnaire
Morocco	Basin boundaries extracted from FAO (2001)
Namibia	Basin boundaries digitized from a map provided with the AQUASTAT country questionnaire
Nigeria	Basin boundaries extracted from FAO (2001)
Senegal	Basin boundaries extracted from FAO (2001)
Tanzania	District boundaries digitized from maps published as part of the 2002 population and housing census of the National Bureau of Statistics at http://www.tanzania.go.tz/census/regions.htm
Swaziland	Ecological Zones digitized from a map provided with the AQUASTAT country questionnaire
Uganda	Regions were defined based on a map provided with the AQUASTAT country questionnaire
Europe	
Bulgaria	ISC-branch boundaries digitized from a map produced by the Bulgarian Agency for Hydromelioration and published in Chehlarova-Simeonova et al. (2006)
Croatia	Central Bureau of Statistics (2006)
England	Office for National Statistics (2004)
Italy	ISTAT (2001)
Kosovo	Municipalities were digitized from a map available from the Statistical Office of Kosovo (http://www.ks-gov.net/esk/)
Malta	SALB Administrative Boundaries of Malta available at http://www3.who.int/whosis/gis/salb/salb_home.htm
Netherlands	GIS-polygon shapefile provided by T. Kroon, Rijkswaterstaat (RIZA) and compiled for the Droogtestudie Nederland (Hoogeveen et al., 2003)
Serbia	District boundaries digitized from maps available at http://en.wikipedia.org/wiki/Municipalities_of_Serbia
Spain	INE (1999)
Latin America	
Brazil	IBGE (1997)
Peru	For six provinces district boundaries were digitized based on maps available at http://www.inei.gob.pe/biblioineipub/bancopub/Est/Lib0392/indice.htm

1.4 SUBNATIONAL IRRIGATION STATISTICS AND GEOSPATIAL INFORMATION USED TO UPDATE THE GLOBAL MAP OF IRRIGATION AREAS TO VERSION 4

This section contains a country-wise documentation of subnational irrigation statistics and geospatial data used to update the global irrigation map and lists the references to the sources of information.

1.4.1 AFRICA

Algeria

Area equipped for irrigation is 569 418 ha [AL01]. The figure refers to year 2001. Area equipped for irrigation by province was computed by summing up irrigated areas in large schemes, irrigated area in small schemes and spate irrigation areas. The position and extent of the large irrigation schemes was derived from two maps [AL02], while the command area of these schemes in year 1999 stems from another report [AL03]. The total irrigated area assigned that way to the provinces summed up to 171 550 ha. 56 050 ha of spate irrigation area [AL01] were assigned to the provinces covering the Saharan Atlas mountains. About 33 000 ha of irrigated areas, of which about 11 000 ha are center pivot systems were digitized from satellite imagery and assigned to the xeric provinces of Adrar, GhardaSa and Tamanrasset. The remaining 308 818 ha of irrigated area were assumed to represent small scale irrigation schemes and assigned to the other provinces relative to statistics stored in the AQUASTAT database. These statistics per province refer to the situation in 1987 and summing up to 221 635 ha. Irrigated area per province estimated that way is documented in Table 2.

The shape of the boundaries of the 20 large irrigation schemes as digitized from two maps [AL02] was adjusted by using satellite imagery [AL04]. The positions of 77 small scale schemes (<500 ha) and 38 medium scale schemes (500 – 1000 ha) were digitized from the same two maps [AL02]. 250 ha irrigated area was assigned to each small scale scheme and 750 ha to each medium scale scheme respectively. Thus, the total irrigated area assigned to known irrigation schemes adds up to 219 300 ha. The remaining part of irrigated area was spread over cultivated land as digitized from satellite imagery [AL04].

TABLE 2
Irrigated area per province in Algeria

Province	Irrigated area 2001 (ha)	Province	Irrigated area 2001 (ha)
Adrar	23 000	GhardaSa	6 000
Ain Dafla	16 392	Guelma	2 607
Ain Tamouchent	1 999	Illizi	0
Alger	8 058	Jijel	1 275
Annaba	10 024	Khenchela	3 463
Batna	12 975	Laghouat	3 665
Bechar	5 442	Mascara	30 489
Bejaia	8 532	Media	5 591
Biskra	67 079	Mila	6 340
Blida	25 292	Mostaghanem	26 786
Borjboouairej	7 262	Msila	20 456
Bouira	12 218	Naama	1 129
Boumerdes	10 696	Oran	5 266
Chlef	38 211	Ouargla	10 492
Constantine	2 863	Oum El Bouaghi	13 637
Djelfa	1 742	Relizane	29 623
El Bayadh	1 400	Saida	16 683
El Oued	9 433	Setif	6 873
El Tarf	10 691	Sidi-Bel-Abbes	9 429

Province	Irrigated area 2001 (ha)	Province	Irrigated area 2001 (ha)
Skikda	6 880	Tipaza	33 080
Souk Ahras	6 009	Tissemisilt	5 646
Tamanrasset	4 000	Tizi-ouzou	5 799
Tebessa	4 180	Tlemcen	21 674
Tendouf	153	ALGERIA TOTAL	569 418
Tiaret	8 886		

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Angola

Area equipped for irrigation is estimated at about 80 000 ha. The figures refer to year 1975 but are believed to be still valid [AN01]. No sub-national irrigation statistics have been available.

Irrigated areas were distributed to 11 schemes indicated on an irrigation map [AN02] and to 7 schemes derived from an inventory of irrigation schemes [AN03]. Additionally a zone along the coastline and the southern border to Namibia, in which irrigation is concentrated, was digitized from the same map and irrigated areas were assigned to cultivated areas in that zone as digitized from satellite imagery [AN04].

References:

- [AN01]: **FAO**. 2005. *AQUASTAT country profile Angola*. FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.
- [AN02]: **MINADER, FAO, PNUD, Banque mondiale, PAM**. 2004. *Review of agricultural sector and food security strategy and investment priority setting (TCP/ANG/ 2907)* – Figure 1 of working paper n° 9: Irrigated agriculture development.
- [AN03]: **MINADER, FAO, PNUD, Banque mondiale, PAM**. 2004. *Review of agricultural sector and food security strategy and investment priority setting (TCP/ANG/ 2907)* – Annex 1 of working paper n° 15.
- [AN04]: **Earth Satellite Corporation**. 2004. *Landsat GeoCover (2000/ETM+) Edition Mosaics*, tiles 071-677, 071-678, 071-679, 071-680 and 071-687. Sioux Falls, USA, USGS (available at <http://glcfapp.umiacs.umd.edu:8080>).

Benin

Area equipped for irrigation per department (Table 3) is summing up to 12 258 ha [BE01]. The figures refer to year 2002 and comprise of 10 973 ha full control irrigation, of which 9349 ha in registered schemes and 1624 ha of informal irrigation, plus 1285 ha of equipped lowlands.

The location of 30 full/partial control schemes was digitized from two irrigations maps [BE02]. The command area of these schemes and the location and extent of 39 other schemes (mainly equipped wetlands) was derived from another report [BE03]. The command area of these 69 schemes is summing up to 10 621 ha. The remaining part of the irrigation area was assigned to the surrounding of large urban centres as digitized from satellite imagery [BE04].

TABLE 3
Irrigated area per department in Benin

Department	Irrigated area 2002 (ha)	Department	Irrigated area 2002 (ha)
Atakora	908	Oueme	1 862
Atlantique	1 328	Zou	6 074
Borgou	1 614	BENIN TOTAL	12 258
Mono	472		

References:

- [BE01]: **FAO**. 2005. *AQUASTAT country profile Benin*. FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.
- [BE02]: **Republique du Benin**. 1994. *Statistique sur l'hydraulique agricole et rurale – Donnees de base et cartes*. 30 pp. Report available in the AQUASTAT-library.
- [BE03]: **FAO**. 2003. *AQUASTAT – Benin. Enquete sur l'utilisation de l'eau pour l'agriculture et le developement rural au Benin*. Rapport General. Report available in the AQUASTAT-library.
- [BE04]: **Earth Satellite Corporation**. 2004. *Landsat GeoCover (2000/ETM+) Edition Mosaics*, tiles 071-202 and 071-203. Sioux Falls, USA, USGS (available at <http://glcfapp.umiacs.umd.edu:8080>).

Botswana

Area equipped for irrigation is reported to be 1438.6 ha [BO01]. The figures refer to year 2002. Irrigated area per region is documented in Table 4.

The location and command area of 11 irrigation projects was available from the FAO-irrigation map of Africa [BO02]. The command areas were summing up to 1855 ha and were scaled to meet the statistics reported for the specific regions. However, no irrigation project was known for the Francistown Region in the North-East of the country. Therefore two areas close to Francistown, that are likely to be irrigated (one of it is a center pivot scheme), were digitized from satellite imagery [BO03].

TABLE 4
Irrigated area per region in Botswana

Region	Irrigated area 2002 (ha)	Region	Irrigated area 2002 (ha)
Central Region	586.5	Southern Region	249.9
Francistown Region	208.3	Western Region	49.8
Gaborone Region	149.7	BOTSWANA TOTAL	1 438.6
North-West Region	194.4		

References:

- [BO01]: **FAO**. 2003. *Botswana. National irrigation policy and strategy – Irrigation situation analysis*. Report November 2003 (second draft) by Stephens T.F. TCP/BOT/0065 (A).
- [BO02]: **FAO**. 2006. *FAO irrigation project data base for Africa*. Database compiled from FAO (1987) and FAO (2005a) available at FAO AGLW. FAO, Rome, Italy.
- [BO03]: **Earth Satellite Corporation**. 2004. *Landsat GeoCover (2000/ETM+) Edition Mosaics*, tiles 071-694 and 071-695. Sioux Falls, USA, USGS (available at <http://glcfapp.umiacs.umd.edu:8080>).

Burkina Faso

Area equipped for irrigation was reported to be 25 000 ha. Full/partial control area was 18 600 ha in 2001 and equipped wetlands covered 6 400 ha in 1998 [BF01]. Sub-national statistics for full/partial control area summing up to 16 915 ha [BF02]. These statistics refer to year 1996 and obviously underestimate actual irrigated area in region Volta Noire (Mouhoun). The statistics reported for this region an irrigated area of 1705 ha although there are 3200 ha in one single

project (AMVS-project). Therefore area equipped for irrigation was increased in that region so that the country total is equal to the value reported for 2001 (18 600 ha). Equipped wetlands were assigned to the regions Hauts Bassins and Volta Noire (Mouhoun) based on the statistics derived from the AQUASTAT library for the year 1992. Total area equipped for irrigation per region as reported in Table 5 was then computed as the sum of full/partial control area and equipped wetland area.

The location and command area of 23 projects was derived from the FAO-irrigation map for Africa [BF03]. These areas got the highest priority in the distribution process. The command area of the registered schemes added up to 11 535 ha. The second highest priority was given to zones of private irrigation digitized from an irrigation map [BF04] and to areas classified as "irrigated agriculture" in the GLC2000 land cover map of Africa [BF05]. However, the area equipped for irrigation reported by the sub-national statistics was still larger in regions of Yatenga and Sud Ouest than the sum of the corresponding digitized areas. Therefore the remaining irrigated area was assigned to agricultural land in inland valley bottoms in the larger surrounding of registered irrigation schemes (Yatenga) as digitized from satellite imagery [BF06] or to areas classified as "croplands" or "croplands with open woody vegetation" in the GLC2000 land cover map of Africa (Sud Ouest) [BF05].

TABLE 5
Irrigated area per region in Burkina Faso

Region	f/p control area 2001 (ha)	Equipped wetlands 1998 (ha)	Total irrigated area (ha)
Centre	1 495	0	1 495
Centre Est	2 210	0	2 210
Centre Ouest	555	0	555
Est	580	0	580
Hauts Bassins	7 765	5 399	13 164
Nord Mossi (Centre Nord)	1 135	0	1 135
Sahel	270	0	270
Sud Ouest	325	0	325
Volta Noire (Mouhoun)	3 390	1 001	4 391
Yatenga (Nord)	875	0	875
BURKINA FASO TOTAL	18 600	6 400	25 000

References:

- [BF01]: **FAO**. 2005. *AQUASTAT country profile Burkina Faso*. FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.
- [BF02]: **Dioma K.S., Douamba T.D., Kambou N.F., Nombre A., Traore T.M.** 2003. *Stratégie nationale de développement durable de l'irrigation au Burkina Faso (Rapport provisoire)*. Ministère de l'agriculture, de l'hydraulique, des ressources halieutiques.
- [BF03]: **FAO**. 2006. *FAO irrigation project data base for Africa*. Database compiled from FAO (1987) and FAO (2005a) available at FAO AGLW. FAO, Rome, Italy.
- [BF04]: **World Bank**. 1998. *Pilot private irrigation development project*. Project appraisal document. Report No. 18692-BUR (available at <http://www-wds.worldbank.org>).
- [BF05]: **Mayaux, P., Bartholomé, E., Cabral, A., Cherlet, M., Defourny, P., Di Gregorio, A., Diallo, O., Massart, M., Nonguierma, A., Pekel, J.-F., Pretorius, C., Vancutsem, C., and Vasconcelos, M.** 2003. *The Land Cover Map for Africa in the Year 2000*. European Commission Joint Research Centre, available at: <http://www-gem.jrc.it/glc2000>).
- [BF06]: **Earth Satellite Corporation**. 2004. *Landsat GeoCover (2000/ETM+) Edition Mosaics*, tiles 071-190 and 071-203. Sioux Falls, USA, USGS (available at <http://glcfapp.umiacs.umd.edu:8080>).

Burundi

Area equipped for irrigation in Burundi is 21 430 ha [BU01]. The figures refer to the year 2000. No recent sub-national statistics on irrigated area have been available.

Irrigated area was assigned to specific grid cells by combining a database of irrigation projects in Africa [BU02], information on irrigated area per district representing the situation in year 1985 [BU03], indicative information on the location of irrigated areas as published in the AQUASTAT country profile [BU01], land cover information provided by the AFRICOVER project [BU04] and a map of micro-dams used in irrigation projects [BU05]. AFRICOVER lists two polygons of irrigated land cover type in the eastern part of the country. One was classified as irrigated sugar cane and the other one as irrigated herbaceous. 160 ha irrigated rice and 1450 ha irrigated sugar cane have been reported for the eastern part of the country [BU01]. Therefore these areas were assigned to the polygons derived from AFRICOVER. 2800 ha of irrigated land were assigned to 28 locations indicated on the map of micro-dams used for irrigation [BU05]. Information in the AQUASTAT country profile and the 1985-district data indicate that there exists much irrigation in l'Imbo plain (districts of Gihanga, Mpanda and Mutimbuzi). Irrigated area was thus distributed to areas in that region covered by herbaceous crops [BU04]. Additionally the FAO-irrigation project database lists some very large projects in upland areas adjacent to the l'Imbo plain. These projects are assumed to represent rice cultivation and irrigated areas was distributed to herbaceous crop areas [BU04] surrounding these projects.

References:

- [BU01]: **FAO**. 2005. *AQUASTAT country profile Burundi*. FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.
- [BU02]: **FAO**. 2006. *FAO irrigation project data base for Africa*. Database compiled from FAO (1987) and FAO (2005a) available at FAO AGLW. FAO, Rome, Italy.
- [BU03]: **PNUD/FAO**. 1985. *La mise en valeur hydro-agricole au Burundi. Etat actuel et stratégie pour l'avenir*. Rapport préparé par N. Van Leeuwen. Rome.
- [BU04]: **FAO**. 2005. *AFRICOVER, Burundi - Spatially Aggregated Multipurpose Landcover database*, FAO, Rome, Italy, <http://www.africover.org>, 13/12/2004.
- [BU05]: **World Bank, Ministère de l'agriculture et de l'élevage**. 2004. *Projet de rehabilitation et d'appui au secteur agricole du Burundi (PRASAB)*. Rapport d'étude sur l'analyse d'impact environnemental et social du projet (available at <http://www-wds.worldbank.org>).

Cameroon

Area equipped for irrigation is reported to be 25 654 ha. The figures refer to year 2000. Irrigated area per province as documented in Table 6 was computed by summing up the command areas of irrigation projects mentioned in the AQUASTAT-country profile [CA01].

The command area and position of seven irrigation projects was derived from the FAO irrigation map for Africa [CA02]. The total area equipped for irrigation of these schemes is 17 270 ha. The outlines of five schemes larger than 1000 ha were adjusted using satellite imagery [CA03]. According to the statements in the country profile [CA01] there are about 1000 ha irrigated area close to the Lagdo reservoir. The outlines of the scheme were digitized from satellite imagery [CA03]. Cultivated land in the surrounding of Garoua and in the provinces of Littoral and Sud-Ouest representing spate irrigation areas or banana plantations was digitized as well.

TABLE 6
Irrigated area per province in Cameroon

Province	Irrigated area 2000 (ha)	Province	Irrigated area 2000 (ha)
Adamaoua	0	Extreme Nord	14 079
Centre	0	Littoral and Sud-Ouest	5 430
Est	0	Nord	3 800

Province	Irrigated area 2000 (ha)	Province	Irrigated area 2000 (ha)
Nord-Ouest	2 200	Sud	0
Ouest	145	CAMEROON TOTAL	25 654

References:

- [CA01]: **FAO**. 2005. *AQUASTAT country profile Cameroon*. FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.
- [CA02]: **FAO**. 2006. *FAO irrigation project data base for Africa*. Database compiled from FAO (1987) and FAO (2005a) available at FAO AGLW. FAO, Rome, Italy.
- [CA03]: **Earth Satellite Corporation**. 2004. *Landsat GeoCover (2000/ETM+) Edition Mosaics*, tiles 071-213, 071-214, 071-227, 071-228 and 071-229. Sioux Falls, USA, USGS (available at <http://glcfapp.umiacs.umd.edu:8080>).

Cape Verde

Area equipped for irrigation is 2780 ha, while the area actually irrigated is 1821 ha. The figures refer to year 1997. Irrigation potential was estimated at 3109 ha in 1993. Irrigation potential and area actually irrigated were available per island and region [CV01]. Area equipped for irrigation per island and region as documented in Table 7 was estimated as *area actually irrigated + 0.7211 * (irrigation potential – area actually irrigated)* with exception of the regions Santa Catarina and Porto Novo. For these regions the area equipped for irrigation was set to the value reported for area actually irrigated because the irrigation potential reported for the year 1993 was lower than the area actually irrigated reported for 1997.

Irrigated area was assigned to grid cells according to the GLC2000 land cover map for Africa [CV02] considering all areas classified as "Croplands with open woody vegetation".

TABLE 7

Irrigated area per region and island in Cape Verde

Region	Island	Irrigation potential 1993 (ha)	Area actually irrigated 1997 (ha)	Area equipped for irrigation in this map (ha)
Boa Vista	Boa Vista	16	10	14
Brava	Brava	11	10	11
Fogo	Fogo	78	12	60
Maio	Maio	35	8	28
Sal	Sal	4	2	3
San Nicolau	San Nicolau	149	72	128
Praia	Santiago	355	151	298
Santa Catarina	Santiago	158	192	192
Santa Cruz	Santiago	494	212	415
Tarrafal	Santiago	202	103	174
	Santiago	1 209	658	1 079
Paul	Santo Antao	402	258	362
Porto Novo	Santo Antao	298	307	307
Ribeira Grande	Santo Antao	657	432	594
	Santo Antao	1 357	997	1 263
Sao Vicente	Sao Vicente	250	49	194
CAPE VERDE TOTAL		3 109	1 821	2 780

References:

- [CV01]: **Ministère de l'agriculture de l'élevage et de la sylviculture**. 1997. *Plan national directeur de l'irrigation – Cap Vert*.

[CV02]: **Mayaux, P., Bartholomé, E., Cabral, A., Cherlet, M., Defourny, P., Di Gregorio, A., Diallo, O., Massart, M., Nonguierna, A., Pekel, J.-F., Pretorius, C., Vancutsem, C., and Vasconcelos, M.** 2003. *The Land Cover Map for Africa in the Year 2000*. European Commission Joint Research Centre, (available at: <http://www-gem.jrc.it/glc2000>).

Central African Republic

Area equipped for irrigation is 135 ha [CR01]. The most recent statistics refer to year 1987. No sub-national statistics on irrigated area have been available.

Irrigated area was distributed to 6 projects with known location and command area as derived from the FAO irrigation project database for Africa [CR02]. Total command area reported for the six schemes was 160 ha and was therefore scaled to meet the country-totals of 135 ha.

References:

- [CR01]: **FAO.** 1996. *République centrafricaine – Suivi du Sommet mondial de l'alimentation – Projet de stratégie pour le développement agricole national – Horizon 2010*.
- [CR02]: **FAO.** 2006. *FAO irrigation project data base for Africa*. Database compiled from FAO (1987) and FAO (2005a) available at FAO AGLW. FAO, Rome, Italy.

Chad

Area equipped for irrigation was reported to be 30 273 ha [CH01]. The figures refer to year 2002. Irrigated area per region is documented in Table 8.

Irrigated area was distributed first to 6 large-scale schemes. The position and command area (in total 10 050 ha) of the schemes was taken from the FAO irrigation project database for Africa [CH02]. The remaining part of the irrigated area was assigned to zones of traditional or private irrigation and to palm groves as digitized from an irrigation map [CH03]. The outlines of the large scale schemes and of the digitized irrigation zones were adjusted using satellite imagery [CH04].

TABLE 8
Irrigated area per region in Chad

Region	Irrigated area 2002 (ha)	Region	Irrigated area 2002 (ha)
Batha	300	Logone-Occidental	0
Bilthine	0	Logone-Oriental	250
Bourkou Ennedi Tibesti (BET)	2 500	Mayo-Kebbi	3 660
Chari-Baguirmi	2 578	Moyen-Chari	3 700
Guera	130	Ouaddai	5 462
Kanem	543	Salamat	0
Lac	9 050	Tandjile	2 100
		CHAD TOTAL	30 273

References:

- [CH01]: **FAO.** 2005. *AQUASTAT country profile Chad*. FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.
- [CH02]: **FAO.** 2006. *FAO irrigation project data base for Africa*. Database compiled from FAO (1987) and FAO (2005a) available at FAO AGLW. FAO, Rome, Italy.
- [CH03]: **UN Division for Sustainable Development.** 2003. *The integrated plan for Chad's water development and management (SDEA). Chapter 1: Present situation of Chad's water development and management*, available at: http://www.un.org/esa/sustdev/tech_coop/sdea/).

[CH04]: **Earth Satellite Corporation**. 2004. *Landsat GeoCover (2000/ETM+) Edition Mosaics*, tiles 071-228, 071-229, 071-230, 071-231, 071-240, 071-241, 071-242 and 071-243. Sioux Falls, USA, USGS (available at <http://glcfapp.umiacs.umd.edu:8080>).

Comoros

Area equipped for irrigation is reported to be 130 ha [CM01]. The figures refer to year 1987. Irrigated area per island is documented in Table 9.

The 130 ha of area equipped for irrigation were assigned to 4 irrigation schemes with known position and extent as derived from the FAO irrigation project database for Africa [CM02].

TABLE 9
Irrigated area on the Comoros islands

Island	Irrigated area 1987 (ha)
Anjouan	40
Grand Comoros	5
Ile de Mayotte (France)	0
Mohéli	85
COMOROS TOTAL	130

References:

[CM01]: **FAO**. 2005. *AQUASTAT country profile Comoros*. FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.

[CM02]: **FAO**. 2006. *FAO irrigation project data base for Africa*. Database compiled from FAO (1987) and FAO (2005a) available at FAO AGLW. FAO, Rome, Italy.

Congo, Democratic Republic

Area equipped for irrigation is 10 500 ha [DC01]. The figures refer to year 1995. No sub-national statistics on the extent of irrigated lands have been available.

Irrigated area was assigned to areas in the western part of the country, that were classified as irrigated sugar cane in the AFRICOVER data set [DC02]. These areas are located close to two irrigation projects listed in the FAO irrigation project data base for Africa [DC03]. Additionally, 3760 ha irrigated area were assigned to projects that are listed in the same database and located near Bumba in the northern part of the country and near the boundaries to Burundi and Rwanda in the eastern part.

References:

[DC01]: **FAO**. 2004. *Suivi du sommet mondial de l'alimentation : 5 ans après - Eléments de stratégie nationale pour la sécurité alimentaire et le développement agricole - Horizon 2015 - République Démocratique du Congo*.

[DC02]: **FAO**. 2005. *AFRICOVER, DR Congo - Spatially Aggregated Multipurpose Landcover database*. FAO, Rome, Italy, available at <http://www.africover.org>, 13/12/2004.

[DC03]: **FAO**. 2006. *FAO irrigation project data base for Africa*. Database compiled from FAO (1987) and FAO (2005a) available at FAO AGLW. FAO, Rome, Italy.

Congo

Area equipped for irrigation is 2000 ha [CR01]. The figures refer to year 2003. No sub-national statistics on the extent of irrigated lands have been available.

Full/partial control irrigated area is 217 ha and located near the cities of Brazzaville and Pointe-Noire. The remaining area equipped for irrigation is lowland sugar cane cultivation near Nkayi [CR02]. Small-scale cultivated land near Brazzaville and Pointe-Noire and large-scale agriculture near Nkayi was digitized from satellite imagery [CR03].

References:

- [CR01]: **UNECA**. 2003. *Republic of Congo - National report on water resources development 2003*.
- [CR02]: **FAO**. 2005. *AQUASTAT country profile Congo*. FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.
- [CR03]: **Earth Satellite Corporation**. 2004. *Landsat GeoCover (2000/ETM+) Edition Mosaics*, tile 071-677. Sioux Falls, USA, USGS (available at <http://glcfapp.umiacs.umd.edu:8080>).

Côte d'Ivoire

Area equipped for irrigation is 72 750 ha. The figures refer to year 1994. Area in full/partial control areas is reported to be 47 750 ha while equipped wetlands cover 25 000 ha [CI01]. Equipped wetland as reported by the statistics for 10 regions [CI02] was 24 940 ha. The total area of 44 known irrigation schemes derived from the AQUASTAT irrigation project database [CI03] and from another irrigation map [CI04] is 39 605 ha and was also assigned to the 10 regions depending on the location of the schemes. To compute total area equipped for irrigation the figures per region were scaled to meet the country-totals of full/partial control area and the equipped wetland area respectively. Irrigated area per region is documented in Table 10.

Irrigated area was distributed to the 44 known projects. The outlines of the five largest schemes (total command area of these schemes is 30 000 ha) were then adjusted using satellite imagery [CI05]. The satellite images were also used to digitize cultivated areas along the main rivers and in lowlands. The remaining irrigated area was distributed to those digitized areas.

TABLE 10
Irrigated area per region in Côte d'Ivoire

Region	Irrigated area in equipped wetlands (ha)	Irrigated area in f/p control schemes	Total irrigated area in the map (ha)
Centre (Yamoussoukro)	2 518	585	3 229
Centre-Est (Abengourou)	2 358	0	2 364
Centre-Nord (Bouake)	2 205	11 200	15 714
Centre-Ouest (Daloa)	2 212	5 775	9 180
Nord (Korhoga)	3 949	9 170	15 014
Nord-Est (Bondoukou)	0	4 250	5 124
Nord-Ouest (Odiénne)	7 630	8 100	17 414
Ouest (Man)	1 952	0	1 957
Sud (Abidjan)	1 717	0	1 721
Sud-Ouest (San Pedro)	399	525	1 033
CÔTE D'IVOIRE TOTAL	24 940	39 605	72 750

References:

- [CI01]: **FAO**. 2005. *AQUASTAT country profile Côte d'Ivoire*, FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.
- [CI02]: **FAO**. 1999. *Côte d'Ivoire – Éléments de stratégie nationale de développement de la petite irrigation et plan d'action opérationnel. Document de travail 3: Valorisation de la production agricole*.
- [CI03]: **FAO**. 2006. *FAO irrigation project data base for Africa*. Database compiled from FAO (1987) and FAO (2005a) available at FAO AGLW. FAO, Rome, Italy.
- [CI04]: **Université Nationale de Côte d'Ivoire**. 1988. *Atlas régional du Nord-Est de la Côte d'Ivoire*. Planche 24 (opérations agricole).
- [CI05]: **Earth Satellite Corporation**. 2004. *Landsat GeoCover (2000/ETM+) Edition Mosaics*, tiles 071-176, 071-177, 071-178, 071-188, 071-189 and 071-190. Sioux Falls, USA, USGS (available at <http://glcfapp.umiacs.umd.edu:8080>).

Djibouti

Area equipped for irrigation is 1012 ha [DJ01]. The figures refer to year 1999. Irrigated area per region is documented in Table 11.

No spatial information was available related to the location and extent of irrigation schemes. Therefore cultivated land was digitized from satellite imagery [DJ02] and the irrigated area distributed to these digitized areas. This can be done, since all cultivation in Djibouti is irrigated.

TABLE 11
Irrigated area per region in Djibouti

Region	Irrigated area 1999 (ha)
Ali Sabieh	82
Dikhil	336
Djibouti	394
Obock	36
Tadjourah	164
DJIBOUTI TOTAL	1 012

References:

- [DJ01]: **FAO**. 2005. *AQUASTAT country profile Djibouti*, FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.
- [DJ02]: **Earth Satellite Corporation**. 2004. *Landsat GeoCover (2000/ETM+) Edition Mosaics*, tile 071-295. Sioux Falls, USA, USGS (available at <http://glcfapp.umiacs.umd.edu:8080>).

Egypt

Area equipped for irrigation was reported at 3 422 178 ha [EG01]. The figures refer to year 2002. Irrigated area per governorate is documented in Table 12.

Irrigated area was distributed within the governorates by using AFRICOVER data on land cover [EG02]. First irrigated area was assigned to polygons classified as completely covered by irrigated crops and in a second step (if necessary) to polygons classified as mixture between irrigated crops and other land cover. However, in some governorates the area reported as irrigated by the statistics was still larger than the total area of polygons classified by AFRICOVER as irrigated or partly irrigated. Therefore for the governorates of Port Said, Cairo, Ismailia, Suez, Fayoum and Gharbia the difference was assigned to areas adjacent to irrigated areas and classified as bare soil.

TABLE 12
Irrigated area per governorate in Egypt

Governorate	Irrigated area 2002 (ha)	Governorate	Irrigated area 2002 (ha)
Al Bar al Ahmar	0	As Ismailiyah (Ismailia)	87 945
Al Buhayrah (Behera)	623 825	As Suways (Suez)	7 998
Al Daqahliyah (Dakahlia)	268 254	Ash Sharqiyah (Sharkia)	333 729
Al Fayyum (Fayoum)	181 357	Aswan	61 674
Al Gharbiyah (Gharbia)	165 262	Asyut	141 719
Al Iskandariyah (Alexandria)	64 740	Beni Suwayf (Beni-Suef)	117 858
Al Jizah (Giza)	85 407	Bur Said (Port Said)	10 345
Al Minufiyah (Menoufia)	134 662	Dumyat (Damietta)	46 067
Al Minya (Menia)	202 978	Janub Sina (South Sinai)	3 394
Al Qahirah (Cairo)	8 062	Kafr-El-Sheikh	265 731
Al Qalyubiyah (Kalyoubia)	79 989	Matruh	135 296
Al Wadi/Al Jadid	49 999	Qina	158 055

Governorate	Irrigated area 2002 (ha)
Shamal Sina (North Sinai)	57 831
Suhaj	130 001

Governorate	Irrigated area 2002 (ha)
EGYPT TOTAL	3 422 178

References:

- [EG01]: **Ministry of Agriculture and Land Reclamation**. 2003. *Agricultural statistics, Volume 2, summer and Nili crops 2002*. Sector of Economic Affairs. Arab Republic of Egypt.
- [EG02]: **FAO**. 2005. *AFRICOVER, Egypt - Spatially Aggregated Multipurpose Landcover database*, FAO, Rome, Italy, <http://www.africover.org>, 13/12/2004.

Equatorial Guinea

Because of the climate conditions there is no irrigation in Equatorial Guinea [EQ01].

References:

- [EQ01]: **FAO**. 2005. *AQUASTAT country profile Equatorial Guinea*. FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.

Eritrea

Total area equipped for irrigation is 21 590 ha [ER01]. The figures relate to year 1993. No sub-national statistics for irrigated land were available.

540 ha irrigated area was assigned to the location of the Northern Horticulture Development Project as derived from the FAO irrigation project database for Africa [ER02]. Additionally irrigated area was assigned to all areas classified as irrigated by AFRICOVER [ER03]. These areas were classified into three categories:

- a) areas in which only irrigated crops are growing,
- b) areas having a mixture of rainfed and irrigated crops with irrigated crops as main crop,
- c) areas having a mixture of rainfed and irrigated crops with rainfed crops as main crop.

It was assumed, that the irrigation density in category b) is 67% of the density in category a) and that irrigation density in category c) is 33% of the density in category a).

References:

- [ER01]: **FAO**. 2005. *AQUASTAT country profile Eritrea*. FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 08/11/2005.
- [ER02]: **FAO**. 2006. *FAO irrigation project data base for Africa*. Database compiled from FAO (1987) and FAO (2005a) available at FAO AGLW. FAO, Rome, Italy.
- [ER03]: **FAO**. 2005. *AFRICOVER, Eritrea - Spatially Aggregated Multipurpose Landcover database*. FAO, Rome, Italy, <http://www.africover.org>, 13/12/2004.

Ethiopia

Area equipped for irrigation is 289 530 ha [ET01]. The figures refer to year 2001. Irrigated area per state is documented in Table 13.

Irrigated areas were localized by using the FAO irrigation project database for Africa [ET02] and a map of irrigation projects available from the AQUASTAT-library [ET03]. The irrigation schemes were then digitized by using satellite imagery [ET04]. Most of the medium- and large-scale projects and some regions in which small scale irrigation is present could be detected that way. The remaining irrigated area was assigned to arable land in irrigated regions as indicated on the FAO-map of irrigated areas in Africa [ET02].

TABLE 13
Irrigated area per state in Ethiopia

State	Irrigated area 2001 (ha)	State	Irrigated area 2001 (ha)
Addis Ababa	352	Harari	937
Afar	43 759	Oromia	112 487
Amhara	69 787	Somali	12 700
Benshangul-Gum	600	Southern	34 685
Dire Dawa	1 500	Tigray	12 607
Gambela	116	ETHIOPIA TOTAL	289 530

References:

- [ET01]: **FAO**. 2005. *AQUASTAT country profile Ethiopia*. Table 6. FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 11/11/2005.
- [ET02]: **FAO**. 2006. *FAO irrigation project data base for Africa*. Database compiled from FAO (1987) and FAO (2005a) available at FAO AGLW. FAO, Rome, Italy.
- [ET03]: **Unknown**. *Ethiopia – irrigation projects, dams and rivers*. Map available in the AQUASTAT-library.
- [ET04]: **Earth Satellite Corporation**. 2004. *Landsat GeoCover (2000/ETM+) Edition Mosaics*, tiles 071-266, 071-267, 071-268, 071-281, 071-282, 071-283, 071-293, 071-294, 071-295. Sioux Falls, USA, USGS (available at <http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp>).

Gabon

Area equipped for irrigation is 4450 ha [GA01]. The figures refer to year 1987. However, the figures were confirmed by a recently published report [GA02]. No sub-national statistics on the extent of irrigated lands have been available.

The locations of four irrigation areas were derived from the FAO-map of irrigated areas in Africa [GA03]. The irrigation schemes were then digitized by using satellite imagery [GA04].

References:

- [GA01]: **FAO**. 2005. *AQUASTAT country profile Gabon*, FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.
- [GA02]: **FAO**. 2004. *République du Gabon. Suivi du Sommet mondial de l'alimentation: Cinq ans après. Note sur la stratégie pour le développement agricole national – Horizon 2015*.
- [GA03]: **FAO**. 2006. *FAO irrigation project data base for Africa*. Database compiled from FAO (1987) and FAO (2005a) available at FAO AGLW. FAO, Rome, Italy.
- [GA04]: **Earth Satellite Corporation**. 2004. *Landsat GeoCover (2000/ETM+) Edition Mosaics*, tiles 071-213, 071-227, 071-673 and 071-677. Sioux Falls, USA, USGS (available at <http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp>).

Gambia

Area equipped for irrigation is 2149 ha [GM01]. The figures refer to year 1999. No sub-national statistics on the extent of irrigated lands have been available.

However the location and corresponding area equipped for irrigation of the existing four projects JPSP, RIDEP, SSWC and Lamin/Bakau horticulture is known [GM02]. The outlines of the largest scheme (JPSP) were digitized from satellite imagery [GM03], while the other schemes were incorporated as point features using the positions indicated on a map in [GM02].

References:

- [GM01]: **International Cooperation and Development Fund (ICDF)**. 1999. *Development of tidal irrigation in the Gambia*. In: ICDF. 1999 ICDF Annual Report – Special Report. 67-70.
- [GM02]: **Chancellor, F.** 1996. *Women in Irrigation: Case studies of schemes in the Gambia, Kenya and South Africa*. HR Wallingford, UK. Report no OD/TN 82.
- [GM03]: **Earth Satellite Corporation**. 2004. *Landsat GeoCover (2000/ETM+) Edition Mosaics*, tile 071-166. Sioux Falls, USA, USGS (available at <http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp>).

Ghana

The total area equipped for irrigation is at least 30 900 ha, of which 8587 ha public schemes [GH01], 10 413 ha private schemes [GH02] and at least 11 900 ha peri-urban irrigation around Kumasi [GH03]. The figures refer to year 2000.

No sub-national statistics on the extent of irrigated lands have been available, but the location and corresponding area equipped for irrigation of the existing 22 public irrigation schemes was available (GH01). The peri-urban irrigation was reported to appear in a 40 km radius around the city centre of Kumasi [GH03]. Additionally some peri-urban irrigation was assigned to the surrounding of Accra [GH02]. The location of the private schemes was unknown. Their corresponding irrigation area was assigned to areas which were classified as irrigable on a map available in the AQUASTAT library [GH04].

References:

- [GH01]: **Ghana Irrigation Development Authority (GIDA)**. 2001. *General information on public irrigation projects in Ghana*.
- [GH02]: **FAO**. 2005. *AQUASTAT country profile Ghana*, FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.
- [GH03]: **HR Wallingford**. 2002. *Informal irrigation in peri-urban areas. Institutional aspects and options for improvement*. KAR Project R7132.
- [GH04]: **Unknown**. 1985. *Existing and proposed irrigation projects in Ghana*. Map available in the AQUASTAT library.

Guinea

Area equipped for irrigation is 94 914 ha [GU01]. The figures refer to year 2001. Irrigated area per basin is documented in Table 14.

The location and command area for 13 irrigation schemes was derived from the FAO-map of irrigated areas in Africa [GU02]. The total irrigated area in these schemes is summing up to 6870 ha. The remaining irrigated area was distributed according to the GLC2000 land cover map for Africa [GU03] to areas classified as "Mangrove", "Irrigated cropland", "Mosaic of cropland and woody vegetation" or "Mosaic of forest and cropland". First it was made sure that 50 850 ha irrigated area was assigned to areas classified as "Mangrove" (see [GU01]). After area equipped for irrigation was assigned also to the other land cover types beginning with "Irrigated cropland", then "Mosaic of cropland and woody vegetation" and finally if necessary also to areas classified as "Mosaic of forest and cropland" with the lowest priority.

TABLE 14

Irrigated area per basin in Guinea

Basin	Irrigated area 2001 (ha)	Basin	Irrigated area 2001 (ha)
Bafing	700	Faleme	0
Bakoy	0	Gambie	354
Baoule	0	Konkoure	26 132
Cavalla	0	Mafou	8 255
Cestas	0	Milo	6 715
Corubal	18 050	Moa	0

Basin	Irrigated area 2001 (ha)	Basin	Irrigated area 2001 (ha)
Niandan	4 500	Scarcies	14 255
Niger	6 183	Sewa	0
Saint Paul	0	Tinkisso	7 770
Sankarani	2 000	GUINEA TOTAL	94 914
Sassandra	0		

References:

- [GU01]: **FAO**. 2005. *AQUASTAT country profile Guinea*, FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.
- [GU02]: **FAO**. 2006. *FAO irrigation project data base for Africa*. Database compiled from FAO (1987) and FAO (2005a) available at FAO AGLW. FAO, Rome, Italy.
- [GU03]: **Mayaux, P., Bartholomé, E., Cabral, A., Cherlet, M., Defourny, P., Di Gregorio, A., Diallo, O., Massart, M., Nonguierma, A., Pekel, J.-F., Pretorius, C., Vancutsem, C., and Vasconcelos, M.** 2003. *The Land Cover Map for Africa in the Year 2000*. European Commission Joint Research Centre, available at: <http://www-gem.jrc.it/glc2000>).

Guinea Bissau

Area equipped for irrigation is 22 558 ha [GB01]. The figures refer to year 1996. No sub-national statistics on the extent of irrigated lands have been available.

202.5 ha of irrigated area was first assigned to three known projects (Carantabà, Contubuol and Bafatà) as mentioned in the country profile [GB01]. The remaining fraction of full/partial control area (8359.5 ha) was assigned to areas along the Geba river [GB01] as digitized from satellite imagery [GB02]. The 13 996 ha of irrigated area reported to be in mangroves [GB01] was assigned to land locked areas classified as "Mangrove" or "Irrigated cropland" in the GLC2000 land cover dataset for Africa [GB03].

References:

- [GB01]: **FAO**. 2005. *AQUASTAT country profile Guinea Bissau*, FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.
- [GB02]: **Earth Satellite Corporation**. 2004. *Landsat GeoCover (2000/ETM+) Edition Mosaics*, tile 071-166. Sioux Falls, USA, USGS (available at <http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp>).
- [GB03]: **Mayaux, P., Bartholomé, E., Cabral, A., Cherlet, M., Defourny, P., Di Gregorio, A., Diallo, O., Massart, M., Nonguierma, A., Pekel, J.-F., Pretorius, C., Vancutsem, C., and Vasconcelos, M.** 2003. *The Land Cover Map for Africa in the Year 2000*. European Commission Joint Research Centre, available at: <http://www-gem.jrc.it/glc2000>).

Kenya

Area equipped for irrigation is 103 203 ha [KE01]. The figures refer to year 2003. Irrigated area per province is documented in Table 15.

The irrigated was first assigned to projects as indicated by the FAO project database [KE02] and additionally 20 ha of irrigated area was assigned to each project identified by using a map of irrigation schemes [KE03]. The remaining area was distributed to areas that were classified by AFRICOVER as irrigated, rice or coffee [KE04]. Additionally irrigated area was digitized from satellite imagery [KE05] for some areas where irrigation is known to be practised (map in [KE01]). This procedure worked fine for six of the eight provinces. For the Western province only 563 ha irrigated area were reported by the statistics but according to the geographical records there should be more (Table 15). The FAO project database lists three projects of together 1685 ha irrigated land for this province and additionally 98 schemes were identified on the map of irrigation schemes in Kenya. Thus we would expect to find about 4000

ha irrigated area there. However, to be consistent to the statistics it was decided to distribute 421 ha to the three large projects derived from the FAO project database (25 % of their command area) and the remaining irrigated area was distributed to the 98 small scale schemes (about 1.4 ha to each of them). In contrast, the statistics reported 5803 ha irrigated area for the North Eastern province, while no schemes could be identified there. Because there is also no irrigated crop land, rice or coffee according to AFRICOVER, it was decided to distribute the irrigated area over other cultivated land as derived from AFRICOVER [KE06]. One reason for the differences in spatial data and statistics may be that during the last decade there has been a rapid increase in irrigation development, in particular also in the North Eastern province. This development is very likely not enough reflected in the spatial data used here.

TABLE 15

Irrigated area as reported by the statistics [KE01], sum of irrigated area in the FAO irrigation project database [KE02], number of projects identified on the irrigation scheme map [KE03] and area of polygons extracted from AFRICOVER or satellite imagery in provinces of Kenya.

Province	Irrigated area according to the statistics in year 2003 (ha)	Irrigated area in FAO project database (ha)	Number of projects on the irrigation scheme map (-)	Area of polygons extracted from AFRICOVER or digitized from satellite imagery (ha)
Central	49 200	5 700	106	300 609
Coast	6 661	3 480	112	32 991
Eastern	13 986	940	210	224 816
Nairobi	2 000	0	1	11 830
North Eastern	5 803	0	0	35 463
Nyanza	8 575	675	189	47 891
Rift Valley	16 415	575	229	87 542
Western	563	1 685	98	4 763
KENYA TOTAL	103 203	11 370	945	745 905

References:

- [KE01]: **FAO**. 2005. *AQUASTAT country profile Kenya*. FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 12/11/2005.
- [KE02]: **FAO**. 2006. *FAO irrigation project data base for Africa*. Database compiled from FAO (1987) and FAO (2005a) available at FAO AGLW. FAO, Rome, Italy.
- [KE03]: **Unknown**. *Irrigation schemes in Kenya*. Map available in the AQUASTAT-library.
- [KE04]: **FAO**. 2005. *AFRICOVER, Kenya - Spatially Aggregated Multipurpose Landcover database*, FAO, Rome, Italy, <http://www.africover.org>, 13/12/2004.
- [KE05]: **Earth Satellite Corporation**, 2004. *Landsat GeoCover (2000/ETM+) Edition Mosaics*, tiles 071-266, 071-281, 071-698 and 071-705. Sioux Falls, USA, USGS (available at <http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp>).
- [KE06]: **FAO**. 2005. *AFRICOVER, Kenya - Thematic Agriculture Aggregation*, FAO, Rome, Italy, <http://www.africover.org>, 13/12/2004.

Lesotho

Area equipped for irrigation is 2638 ha [LE01]. The figures refer to year 1999. Irrigated area per district is documented in Table 16.

The location and extent of 6 irrigation schemes covering 570 ha were derived from the FAO irrigation project data base for Africa [LE02]. Additionally 17 areas classified as "Cultivated: temporary - commercial irrigated" covering 726 ha in total were derived from a land cover database for South Africa [LE03]. Areas classified as "Cultivated: temporary - commercial dryland", "Cultivated: temporary - semi-commercial/subsistence dryland", "Improved grassland" or "Herbland" were derived from the same data set. Irrigated area was

assigned to those areas using the priorities documented in Table 17, if the areas were located in four zones marked as irrigated on the FAO irrigation map for Africa [LE02]. For the district of Leribe also areas outside these zones were considered.

TABLE 16
Irrigated area per district in Lesotho

District	Irrigated area 1999 (ha)	District	Irrigated area 1999 (ha)
Berea	0	Mothotlong	0
Butha-Buthe	30	Qacha's Nek	0
Leribe	993	Quting	535
Mafeteng	605	Thaba Tseka	0
Maseru	225	LESOTHO TOTAL	2 638
Mohale's Hoek	250		

TABLE 17
Priority levels used to distribute irrigated area within the districts of Lesotho

Data set	Attribute	Priority
[LE02]	Irrigation project (point feature)	6
[LE03]	Cultivated: temporary - commercial irrigated	6
[LE03]	Cultivated: temporary - commercial dryland	5
[LE03]	Improved grassland	4
[LE03]	Herbland	4
[LE03]	Cultivated: temporary - semi-commercial/subsistence dryland	3

References:

- [LE01]: **FAO and World Bank**. 1999. *Lesotho smallholders irrigation initiative. Exploratory Mission Report*.
- [LE02]: **FAO**. 2006. *FAO irrigation project data base for Africa*. Database compiled from FAO (1987) and FAO (2005a) available at FAO AGLW. FAO, Rome, Italy.
- [LE03]: **Thompson, M.W.** 1999. *South African national land cover data set*. Council for Scientific and Industrial Research (CSIR), Satellite Applications Centre. CD-ROM, available at: <http://www.sac.co.za>.

Liberia

Area equipped for irrigation is 2100 ha [LI01]. The figures refer to year 1987. No up-to-date information or sub-national information on irrigated areas in Liberia is available.

Irrigated area was assigned to areas which were classified as "Mosaic forest / cropland" in the GLC2000 land cover dataset for Africa [LI02] and which additionally were located within three zones marked as irrigated on the FAO irrigation map for Africa [LI03].

References:

- [LI01]: **FAO**. 2005. *AQUASTAT country profile Liberia*, FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.
- [LI02]: **Mayaux, P., Bartholomé, E., Cabral, A., Cherlet, M., Defourny, P., Di Gregorio, A., Diallo, O., Massart, M., Nonguierma, A., Pekel, J.-F., Pretorius, C., Vancutsem, C., and Vasconcelos, M.** 2003. *The Land Cover Map for Africa in the Year 2000*. European Commission Joint Research Centre, available at: <http://www.gem.jrc.it/glc2000>.
- [LI03]: **FAO**. 2006. *FAO irrigation project data base for Africa*. Database compiled from FAO (1987) and FAO (2005a) available at FAO AGLW. FAO, Rome, Italy.

Libya

Area equipped for irrigation is reported to be about 470 000 ha, while area actually irrigated was estimated at 316 000 ha [LB01]. The figures refer to year 2000. Irrigated area per municipality as documented in Table 18 was estimated for the year 1999 considering only infrastructure that is still functioning [LB02]. The total area added up to 360 500 ha. However, it was also stated, that the study may underestimate the real extent of private irrigation, which is dominant in Libya. Therefore area equipped for irrigation in private schemes was scaled so that the total area equipped for irrigation meets the figures reported for the whole country for year 2000 (Table 18).

The position and extent of the public irrigation schemes was digitized from maps published in [LB02]. The command area of these schemes was also given in these report and summed up to about 88 000 ha. Additionally, some irrigated areas were digitized from maps published in [LB03] and from a map belonging to the AQUASTAT country profile [LB01]. These areas were assumed to represent the major areas of private irrigation. The shape of the boundaries of all digitized irrigation areas were improved by using satellite imagery [LB04].

TABLE 18
Irrigated area per municipality in Libya

Municipality	Irrigated area estimated based on survey [LB02] (ha)	Irrigated area in 2000 as used in this study (ha)	Municipality	Irrigated area estimated based on survey [LB02] (ha)	Irrigated area in 2000 as used in this study (ha)
Ajdabiya (Agedabia)	30 000	44 350	Gharyan	15 000	16 511
Al Aziziyah	40 000	47 323	Misurata	6 000	10 851
Al Fatah	10 000	13 106	Murzuq	15 000	18 347
Al Jabal Al Akhdar	5 000	6 553	Nuqat Al Khams	2 000	2 621
Al Jufrah	10 000	11 959	Sabha	5 000	11 890
Al Khoms	5 000	6 241	Sawfajjin (Sofuljeen)	15 000	16 180
Al Kufrah	12 000	21 339	Surt (Sirte)	2 000	2 621
Ash Shati	15 000	17 815	Tarhunah	10 000	13 106
Awbari (Ubari)	20 000	24 371	Tripoli (Tarabulus)	70 000	90 408
Az Zawia (Azzawiya)	40 000	50 936	Tubruq (Tobruk)	500	655
Banghazi	20 000	26 211	Yafran (Yefren)	1 000	1 311
Darnah	5 000	6 553	Zeletin (Zliten)	2 000	2 190
Ghadamis	5 000	6 553	LIBYA TOTAL	360 500	470 000

References:

- [LB01]: **FAO**. 2005. *AQUASTAT country profile Libyan Arab Jamahiriya*, FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.
- [LB02]: **Palas, P., and Salem, O.** 2000. *Water resources utilisation and management of the Socialist People Arab Jamahiriya*. 65 pp. Report available in the AQUASTAT-library.
- [LB03]: **Schliephake, K.** 1993. Libyens Bewässerung und der "Große künstliche Fluß". In H. Popp & K. Rother, eds. *Die Bewässerungsgebiete im Mittelmeerraum*, pp. 185-192. Passau, Germany, Passavia Universitätsverlag.
- [LB04]: **Earth Satellite Corporation**, 2004. *Landsat GeoCover (2000/ETM+) Edition Mosaics*, tiles 071-217, 071-218, 071-219, 071-231, 071-232, 071-233, 071-242, 071-243, 071-244 and 071-245. Sioux Falls, USA, USGS (available at <http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp>).

Madagascar

Area equipped for irrigation is 1 086 291 ha [MD01]. The figures refer to year 2000. Irrigated area per province as documented in Table 19 is based on figures reported for the year 1992. The

equipped area per province for this year added up to 1 087 000 ha in total and was scaled so that the sum fits to the national value reported for the year 2000.

The location and command area of 38 irrigation schemes was derived from the FAO irrigation map for Africa [MD02]. The total command area of these schemes was 154 520 ha. 13 polygons representing other irrigation areas were derived from the same map. The location of 158 irrigation projects was derived from another irrigation map [MD03]. The boundaries from 14 other irrigation areas were digitized from a map published in [MD04]. In the next step cultivated areas were digitized from satellite imagery [MD05] if they were located inside the polygons digitized before or around the points representing irrigation projects. Those areas that were marked as irrigated on the irrigation maps and additionally also found to be cultivated got the highest priority in the distribution process. Additionally some irrigation was also distributed to the other areas to represent widespread small scale irrigation.

TABLE 19
Irrigated area per province in Madagascar

Province	Irrigated area 2000 (ha)
Antananarivo	216 178
Antsiranana	115 064
Fianarantsoa	202 325
Mahajanga	226 526
Toamasina	183 747
Toliary	142 451
MADAGASCAR TOTAL	1 086 291

References:

- [MD01]: **FAO**. 2005. *AQUASTAT country profile Madagascar*, FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.
- [MD02]: **FAO**. 2006. *FAO irrigation project data base for Africa*. Database compiled from FAO (1987) and FAO (2005a) available at FAO AGLW. FAO, Rome, Italy.
- [MD03]: **O.N.E.** (unknown). *Les perimeters irrigués*. Map showing the location of the GPI and PPI projects, available in the AQUASTAT library.
- [MD04]: **Achtnich, W.** 1980. *Bewässerungslandbau*. Verlag Eugen Ulmer, Stuttgart, Germany.
- [MD05]: **Earth Satellite Corporation**, 2004. *Landsat GeoCover (2000/ETM+) Edition Mosaics*, tiles 071-714, 071-715, 071-716, 071-717, 071-720, 071-721 and 071-722. Sioux Falls, USA, USGS (available at <http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp>).

Malawi

Area equipped for irrigation is 56 390 ha [MW01]. The figures refer to year 2002. Irrigated area per district was available for the 25 550 ha of formal irrigation only and neglected informal irrigation and parts of the small-scale irrigation. Therefore these sub-national statistics were not used in this study.

The location and command area of 16 irrigation schemes was derived from the FAO irrigation map for Africa [MW02]. The total irrigated area of these projects was 15 855 ha. The outlines of the two largest schemes (Sucoma and Dwanga) with a command area of 13 000 ha were digitized from Satellite Imagery [MW03]. The satellite images were also used in the background to digitize cultivated areas near Nkota-Kota, Mulanje and Thyolo representing the areas of irrigated sugar cane, coffee or tea mentioned in the AQUASTAT country profile [MW01]. The remaining irrigated area (about 8 000 ha of small scale rice and vegetable growing areas) was assigned to areas classified as "cropland" in the GLC2000 land cover dataset for Africa [MW04].

References:

- [MW01]: **FAO**. 2005. *AQUASTAT country profile Malawi*, FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.
- [MW02]: **FAO**. 2006. *FAO irrigation project data base for Africa*. Database compiled from FAO (1987) and FAO (2005a) available at FAO AGLW. FAO, Rome, Italy.
- [MW03]: **Earth Satellite Corporation**, 2004. *Landsat GeoCover (2000/ETM+) Edition Mosaics*, tiles 071-699, 071-700 and 071-701. Sioux Falls, USA, USGS (available at <http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp>).
- [MW04]: **Mayaux, P., Bartholomé, E., Cabral, A., Cherlet, M., Defourny, P., Di Gregorio, A., Diallo, O., Massart, M., Nonguierma, A., Pekel, J.-F., Pretorius, C., Vancutsem, C., and Vasconcelos, M.** 2003. *The Land Cover Map for Africa in the Year 2000*. European Commission Joint Research Centre, available at: <http://www-gem.jrc.it/glc2000>).

Mali

Area equipped for irrigation is 235 791 ha [ML01]. The figures refer to year 2000. Table 4 in the same report lists the different types of water managed areas per region. However, figures for managed wetlands are not given separately for equipped and non-equipped areas. To estimate total area equipped for irrigation per region it was assumed therefore, that the 60 000 ha of non-equipped wetlands are located in regions of Segou, Mopti and Tombouctou only and that the ratio of equipped versus non-equipped wetlands is the same for all three regions. Irrigated area per region as estimated this way is documented in Table 20.

The outlines of the irrigated areas of the country were digitized from a irrigation map present in the AQUASTAT library [ML02]. The command area of 6 very large schemes covering 51 635 ha in total was derived from the FAO irrigation map for Africa [ML03]. The shapes of the boundaries of the digitized irrigation areas were improved by using satellite imagery [ML04].

TABLE 20
Irrigated area per region in Mali

Region	Irrigated area 2000 (ha)	Region	Irrigated area 2000 (ha)
Gao	14 461	Segou	97 564
Kayes	2 353	Sikasso	11 417
Kidal	0	Tombouctou	35 747
Koulikoro	23 525	MALI TOTAL	235 791
Mopti	50 724		

References:

- [ML01]: **FAO**. 2005. *AQUASTAT country profile Mali*, FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.
- [ML02]: **Ministere de l'Agriculture de l'Elevage et de la Peche**. 2003. *Carte d'Irrigation du Mali par Regions Hydrauliques*. Direction Nationale de L'Aménagement et de L'Equipement Rural (DNAER). Map available in the AQUASTAT library.
- [ML03]: **FAO**. 2006. *FAO irrigation project data base for Africa*. Database compiled from FAO (1987) and FAO (2005a) available at FAO AGLW. FAO, Rome, Italy.
- [ML04]: **Earth Satellite Corporation**, 2004. *Landsat GeoCover (2000/ETM+) Edition Mosaics*, tiles 071-178, 071-179, 071-180, 071-190, 071-191, 071-192, 071-204 and 071-205. Sioux Falls, USA, USGS (available at <http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp>).

Mauritania

Area equipped for irrigation is 45 012 ha, of which 40 261 ha are located along the Senegal river and 4751 ha irrigated land is located in 218 oases [MA01]. The figures refer to year 1994. Irrigated area per region is documented in Table 21.

The irrigated areas along the Senegal river were digitized from a map published as part of the AQUASTAT country profile [MA02]. The oases were located using the Geographic Name Server of the US National Geospatial-Intelligence Agency (<http://gnswww.nga.mil/geonames/GNS/index.jsp>). The outlines of the irrigated areas were improved by digitizing cultivated areas along the Senegal river and around the oases by using satellite imagery [MA03].

TABLE 21

Irrigated area per region in Mauritania

Region	Irrigated area 1994 (ha)	Region	Irrigated area 1994 (ha)
Adrar	1 876	Hodh el Gharghi	184
Assaba	1 073	Inchiri	0
Brakna	4 200	Nouakchott	0
Dakhlet Nouadhibou	0	Tagant	913
Gorgol	7 458	Tiris Zemmour	0
Guidimaka	0	Trarza	28 603
Hodh el Gharbi	705	MAURITANIA TOTAL	45 012

References:

- [MA01]: **MDRE**. 1998. *Politiques et stratégies générales pour le développement du secteur rural – Horizon 2010*.
- [MA01]: **FAO**. 2005. *AQUASTAT country profile Mauritania*, FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.
- [MA03]: **Earth Satellite Corporation**, 2004. *Landsat GeoCover (2000/ETM+) Edition Mosaics*, tiles 071-167, 071-168, 071-179, 071-180 and 071-181. Sioux Falls, USA, USGS (available at <http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp>).

Mauritius

Area equipped for irrigation is 21 222 ha [MT01]. The figures refer to year 2002. Irrigated area per region is documented in Table 22.

Irrigated areas were digitized from a map available in the AQUASTAT library [MT02]. The command area of the operating schemes of the Irrigation Authority was also indicated on this map (in total 4571 ha). Irrigated area was also distributed to schemes classified as "operating projects by private sector". The remaining irrigated area was distributed to areas classified as "projects under design or construction" or "potential irrigable". For the Central district irrigated area was additionally assigned to cultivated areas as digitized from satellite imagery [MT03].

TABLE 22

Irrigated area per region in Mauritius

Region	Irrigated area 2002 (ha)
Centre	777
East	3 173
Northern	6 671
South	5 243
West	5 358
MAURITIUS TOTAL	21 222

References:

- [MT01]: **Central Statistics Office**. 2002. *Digest of agricultural statistics 2002* (available at <http://www.gov.mu/portal/sites/ncb/cso/list.htm>).
- [MT02]: **Unknown**. 2002. *Irrigation projects*. Map available in the AQUASTAT library.

[MT03]: **Earth Satellite Corporation**, 2004. *Landsat GeoCover (2000/ETM+) Edition Mosaics*, tile 071-729. Sioux Falls, USA, USGS (available at <http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp>).

Morocco

Area equipped for irrigation is 1 484 160 ha, including 26 000 ha of spate irrigation [MR01]. The figures refer to year 2004. Irrigated area per basin is documented in Table 23.

191 Irrigated areas for the northern part of the country were digitized from an irrigation map published in [MR02] while the main irrigated areas for the southern part were digitized from a map belonging to the AQUASTAT country profile [MR01]. For the northern part of the country additionally some irrigated areas were derived from the CORINE land cover database for Europe [MR03]. Finally the shapes of the boundaries of the digitized irrigation areas were improved by using satellite imagery [MR04].

TABLE 23

Irrigated area per basin in Morocco

Basin	Irrigated area 2004 (ha)
Bouregreg et côtes atlantiques	28 331
Loukkos et côtes méditerranéennes	63 600
Moulouya	155 451
Oum Rbiaâ et côtes Jadida Safi	478 448
Sebou	333 156
Souss-Massa et côtes Agadir - Tiznit	140 996
Sud-Atlasiques	125 243
Tensift et côt. Safi - Essaouira	158 935
MOROCCO TOTAL	1 484 160

References:

- [MR01]: **FAO**. 2005. *AQUASTAT country profile Morocco*, FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.
- [MR02]: **Popp, H.** 1993. Morocco's "policy of dams" and its consequences for irrigation agriculture (in german). In H. Popp & K. Rother, eds. *Die Bewässerungsgebiete im Mittelmeerraum*, pp. 161-164. Passau, Germany, Passavia Universitätsverlag.
- [MR03]: **EEA**. 1999. *Corine land cover (CLC1990)*, available at <http://dataservice.eea.europa.eu/dataservice/>.
- [MR04]: **Earth Satellite Corporation**, 2004. *Landsat GeoCover (2000/ETM+) Edition Mosaics*, tiles 071-169, 071-181, 071-182, 071-183, 071-193, 071-194 and 071-195. Sioux Falls, USA, USGS (available at <http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp>).

Mozambique

Area equipped for irrigation is 118 120 ha [MZ01]. The figures refer to the period 2001-2003. Irrigated area per province is documented in Table 24.

The location of 159 small scale irrigation projects (command area < 50 ha), 77 medium scale irrigation projects (command area 50 – 500 ha) and 21 large scale irrigation projects (command area > 500 ha) was digitized from seven maps published in [MZ01]. The specific command area of the large projects was derived from the FAO irrigation map for Africa [MZ02]. The outlines of the five largest schemes (total command area about 66 000 ha) were then digitized from satellite imagery [MZ03], while the irrigated area of the other schemes was assigned to the positions of the projects as digitized from the maps.

TABLE 24
Irrigated area per province in Mozambique

Province	Irrigated area 2001-2003 (ha)	Province	Irrigated area 2001-2003 (ha)
Cabo Delgado	1 764	Niassa	608
Gaza	50 323	Sofala	24 220
Inhambane	1 285	Tete	1 895
Manica	2 067	Zambezia	10 848
Maputo	24 130	MOZAMBIQUE	118 120
Nampula	980	TOTAL	

References:

- [MZ01]: **Direcção nacional de hidraulica agricola (DNHA)**. 2003. *Síntese do Levantamento nacional dos regadios 2001 e 2003*. Ministry of Agriculture and Rural Development. Republic of Mozambique. Maputo.
- [MZ02]: **FAO**. 2006. *FAO irrigation project data base for Africa*. Database compiled from FAO (1987) and FAO (2005a) available at FAO AGLW. FAO, Rome, Italy.
- [MZ03]: **Earth Satellite Corporation**, 2004. *Landsat GeoCover (2000/ETM+) Edition Mosaics*, tiles 071-700, 071-701, 071-702, 071-703, 071-707 and 071-708. Sioux Falls, USA, USGS (available at <http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp>).

Namibia

Area equipped for irrigation is 7573 ha [NA01]. The figures refer to year 2002. Irrigated area per river basin was available for year 1999 and adds up to 7318 ha [NA02]. The statistics presented in both reports were combined to estimate area equipped for irrigation per basin for the year 2002 as documented in Table 25. Irrigated area for the following basins were derived from report [NA02]: Orange (2054 ha), Fish (2312 ha), Auob (33 ha), Nossob (67 ha), Swakop (174 ha), Omaruru (73 ha), Ugab (198 ha), Huab (38 ha) and Hoanib (64 ha). According to the project-based statistics reported in [NA01] irrigated area of Zambezi basin was set to 236 ha and that one of Okavango basin and its upstream sub-basins to 1350 ha. The total area equipped for irrigation as assigned that way adds up to 6599 ha and the remaining area of 974 ha was assigned to the Cunene basin and the Cuvelai area.

The location and command area of five large irrigation schemes was derived from the FAO irrigation map for Africa [NA03]. The shapes of the boundaries of the digitized irrigation areas were improved by using satellite imagery [NA04]. The total area equipped for irrigation in these schemes was reported to be 5350 ha. The remaining irrigated area was assigned to small scale irrigated areas fed by ground water as indicated on an irrigation map available in the AQUASTAT library.

TABLE 25
Irrigated area per basin in Namibia

Basin	Irrigated area 2002 (ha)	Basin	Irrigated area 2002 (ha)
Auob	33	Okavango	1 350
Cuando	0	Omaruru	73
Cumene and Cuvelai	974	Orange	2 054
Fish	2 312	South-West Coast	0
Hoanib	64	Swakop	174
Hoarusib	0	Trumib	0
Huab	38	Tsaris	0
Koichab	0	Tsauchab	0
Koigab	0	Tsondab	0
Kuiseb	0	Ugab	198
Nossob	67	Unjab	0

Basin	Irrigated area 2002 (ha)
Zambesi	236

Basin	Irrigated area 2002 (ha)
NAMIBIA TOTAL	7 573

References:

- [NA01]: **FAO**. 2005. *AQUASTAT country profile Namibia*, FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.
- [NA02]: **Windhoek Consulting Engineers (WCE)**. 2000. *Analysis of Present and Future Water Demand in Namibia*. Report available in the AQUASTAT library.
- [NA03]: **FAO**. 2006. *FAO irrigation project data base for Africa*. Database compiled from FAO (1987) and FAO (2005a) available at FAO AGLW. FAO, Rome, Italy.
- [NA04]: **Earth Satellite Corporation**, 2004. *Landsat GeoCover (2000/ETM+) Edition Mosaics*, tiles 071-680, 071-681, 071-682, 071-687, 071-688, 071-689 and 071-694. Sioux Falls, USA, USGS (available at <http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp>).

Niger

Area equipped for irrigation is 73 663 ha [NI01], of which about 60 000 ha are equipped wetlands. The figures refer to year 2005. Irrigated area per department was available for year 2002 and adds up to 67 323 ha [NI02]. Irrigated areas in the departments of Tillaberi and Tahoua were scaled so that the country-totals meet the figures as reported for the year 2005. Irrigated area per department is documented in Table 26.

The location and command area of 30 irrigation projects was derived from the FAO irrigation project data base for Africa [NI03]. The total area equipped for irrigation in these schemes is 7700 ha. Then irrigated area was also assigned to areas along the Niger river [NI01] and to cultivated areas on river valley bottoms as digitized from satellite imagery [NI04].

TABLE 26

Irrigated area per department in Niger

Department	Irrigated area 2005 (ha)
Agadez	3 371
Diffa	5 250
Dosso	1 285
Maradi	5 219

Department	Irrigated area 2005 (ha)
Tahoua	36 544
Tillaberi	18 284
Zinder	3 710
NIGER TOTAL	73 663

References:

- [NI01]: **FAO**. 2005. *AQUASTAT country profile Niger*, FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.
- [NI02]: **FAO**. 2002. *Niger – Stratégie nationale de développement de l'irrigation et de collecte des eaux de ruissellement*.
- [NI03]: **FAO**. 2006. *FAO irrigation project data base for Africa*. Database compiled from FAO (1987) and FAO (2005a) available at FAO AGLW. FAO, Rome, Italy.
- [NI04]: **Earth Satellite Corporation**, 2004. *Landsat GeoCover (2000/ETM+) Edition Mosaics*, tiles 071-203, 071-204, 071-205, 071-215, 071-216, 071-217, 071-229, 071-230 and 071-231. Sioux Falls, USA, USGS (available at <http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp>).

Nigeria

Area equipped for irrigation is 293 117 ha [NG01]. Recently published sub-national statistics were available for the schemes controlled by the River Basin Development Authority (RBDA) only [NG01]. Therefore irrigated area was assigned to river basins according to figures originating from the AQUASTAT-library and referring to 1993. The irrigated area in large and medium scale schemes adds up to 119 350 ha. Areas indicated as "Fadama type irrigation" account for 181 000 ha, which brings the total to 300 350 ha. Irrigated area was scaled so that

the country-totals meet the figures as reported for the year 2004. Irrigated area per river basin as estimated that way is documented in Table 27.

The location and extent of 65 public irrigation schemes was derived from a map and an inventory published in [NG01] and from the FAO irrigation project data base for Africa [NA02]. The total command area of these schemes was 81 103 ha. The boundaries of the 7 largest schemes (total irrigated area of these schemes was 69 750 ha) were digitized from satellite imagery [NG03]. The remaining irrigated area was assigned to cultivated land in valley bottoms of the large rivers as digitized from satellite imagery. [NG03].

TABLE 27

Irrigated area per basin in Nigeria

Basin	Irrigated area 2004 (ha)	Basin	Irrigated area 2004 (ha)
East Coast	1 776	Niger (South)	9 623
Lake Chad	139 498	Upper Benue	30 615
Lower Benue	19 919	West Coast	4 118
Niger (Central)	31 971	NIGERIA TOTAL	293 117
Niger (North)	55 598		

References:

- [NG01]: **Enplan Group**. 2004. *Review of the Public Irrigation Sector in Nigeria*. Draft Final Report of Project UTF/046/NIR/UTF.
- [NG02]: **FAO**. 2006. *FAO irrigation project data base for Africa*. Database compiled from FAO (1987) and FAO (2005a) available at FAO AGLW. FAO, Rome, Italy.
- [NG03]: **Earth Satellite Corporation**, 2004. *Landsat GeoCover (2000/ETM+) Edition Mosaics*, tiles 071-201, 071-202, 071-203, 071-213, 071-214, 071-215, 071-228 and 071-229. Sioux Falls, USA, USGS (available at <http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp>).

Réunion

Area equipped for irrigation is 13 000 ha [RE01]. The figures refer to year 2005. No sub-national information on areas equipped for irrigation was available, but it was reported that irrigation is mainly related to sugar cane cultivation and that about 80% of the irrigated area is located in the southern part of the island [RE02].

Irrigated areas were digitized from irrigation maps published in [RE02], [RE03] and [RE04]. The shapes of the boundaries of the digitized irrigation areas were improved by using satellite imagery [RE05].

References:

- [RE01]: **AGRESTE**. 2005. *Memento Agricole 2005. La Réunion*. http://www.agreste.agriculture.gouv.fr/ulf/agreste/votre_region/D97405C01.pdf, 28/02/2006.
- [RE02]: **Saque, C., Fusillier, J.-L., Choisis, J.-P.** 2003. Canne à sucre, état des lieux : irrigation et diversification. Institut National de la Statistique et des Études Économiques (INSEE), *Revue économie de La Réunion* 114, pp. 15-17 (available at: http://www.insee.fr/fr/insee_regions/reunion/publi/accueil_public.htm).
- [RE03]: **Centre National de la Recherche Scientifique**. 1975. *Atlas des Départements Français d' Outre-Mer, I – La Réunion*.
- [RE04]: **Achtnich, W.** 1980. *Bewässerungslandbau*. Verlag Eugen Ulmer, Stuttgart, Germany.
- [RE05]: **Earth Satellite Corporation**, 2004. *Landsat GeoCover (2000/ETM+) Edition Mosaics*, tile 071-729. Sioux Falls, USA, USGS (available at <http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp>).

Rwanda

Area equipped for irrigation is 8500 ha [RW01]. The figures refer to year 2000. No sub-national information on areas equipped for irrigation was available.

The location and command area of 6 irrigation projects was derived from the FAO irrigation map for Africa [RW02]. The total area equipped for irrigation in these schemes is 2005 ha. The remaining irrigated area was assigned to polygons classified as irrigated by the FAO-AFRICOVER data base [RW03].

References:

[RW01]: **FAO**. 2005. *AQUASTAT country profile Rwanda*, FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.

[RW02]: **FAO**. 2006. *FAO irrigation project data base for Africa*. Database compiled from FAO (1987) and FAO (2005a) available at FAO AGLW. FAO, Rome, Italy.

[RW03]: **FAO**. 2005. *AFRICOVER, Rwanda - Spatially Aggregated Multipurpose Landcover database*, FAO, Rome, Italy, <http://www.africover.org>, 13/12/2004.

Sao Tome and Principe

Area equipped for irrigation is 9 700 ha [ST01]. The figures refer to year 1991. No sub-national information on areas equipped for irrigation was available.

The area equipped for irrigation was assigned to the North-Eastern part of the Sao Tome island which was reported to receive the lowest amount of annual precipitation and to temporary suffer from a precipitation deficit [ST01].

References:

[ST01]: **FAO**. 2005. *AQUASTAT country profile Sao Tome and Principe*, FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.

Senegal

Area equipped for irrigation is 119 680 ha [SE01]. The figures refer to year 2002. No sub-national information on areas equipped for irrigation was available. However, based on statistics in reports [SE02] and [SE03] 19 180 ha irrigated area were assigned to Casamance basin, 10 000 ha to West Coast basins (Saloum, Sine and Car Car), 600 ha to Senegal oriental (Gambia basin) and the remaining 89 900 ha were assigned to the Senegal river basin.

The location and extent of 7 large scale irrigation schemes (in total 15 500 ha) was derived from the FAO irrigation map for Africa [SE04]. Additionally, cultivated land close to the Senegal river, in the Niayes zone and along the other major rivers was digitized from satellite imagery [SE05]. The remaining area equipped for irrigation was assigned to these areas.

References:

[SE01]: **FAO**. 2005. *AQUASTAT country profile Senegal*, FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.

[SE02]: **FAO**. 1999. *Sénégal – Stratégie de développement de la petite irrigation et plan d'action*. 99/025 CP-SEN.

[SE03]: **Association Régionale de l'Irrigation et du Drainage en Afrique de l'Ouest et du Centre**. 2003. *Compte-rendu de l'atelier de lancement du projet APPIA au Sénégal*.

[SE04]: **FAO**. 2006. *FAO irrigation project data base for Africa*. Database compiled from FAO (1987) and FAO (2005a) available at FAO AGLW. FAO, Rome, Italy.

[SE05]: **Earth Satellite Corporation**, 2004. *Landsat GeoCover (2000/ETM+) Edition Mosaics*, tiles 071-166 and 071-167. Sioux Falls, USA, USGS (available at <http://gicfapp.umiacs.umd.edu:8080/esdi/index.jsp>).

Seychelles

Area equipped for irrigation is 260 ha [SY01]. The figures refer to year 2003. However, sub-national statistics on irrigated area per district added up to 362 ha [SY02] and were downscaled

to meet the country-totals. Irrigated area per district as computed that way is documented in Table 28.

Information on the location of irrigation projects of the country was not available. Since the islands are also very small it was decided to distribute irrigated land equally inside the districts.

TABLE 28
Irrigated area per district and island of the Seychelles

District	Island	Irrigated area 2003 (ha)
La Digue	La Digue	2
Anse aux Pins and Au Cap	Maher Island	11
Anse Boileau	Maher Island	52
Anse Royale	Maher Island	12
Grand Anse Maher	Maher Island	73
Maher Island (other districts)	Maher Island	53
Port Glaud	Maher Island	12
	Maher Island	214
Praslin Island	Praslin Island	44
Other districts		0
SEYCHELLES TOTAL		260

References:

- [SY01]: **FAO**. 2005. *AQUASTAT country profile Seychelles*, FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.
- [SY02]: **Talma, W. and Bonne, G.** 2001. *Farmers on state land*. Ministry of Agriculture and Marine Resources.

Sierra Leone

Area equipped for irrigation is 29 360 ha [SL01]. The figures refer to year 1992. No sub-national information on areas equipped for irrigation was available.

The location of 14 irrigation projects was derived from the FAO irrigation map for Africa [SL02]. The related command area was given for 5 schemes and was summing up to 2030 ha. The remaining irrigated area was assigned to cultivated land in mangroves or along the major rivers as digitized from satellite imagery [SL03].

References:

- [SL01]: **FAO**. 2005. *AQUASTAT country profile Sierra Leone*, FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.
- [SL02]: **FAO**. 2006. *FAO irrigation project data base for Africa*. Database compiled from FAO (1987) and FAO (2005a) available at FAO AGLW. FAO, Rome, Italy.
- [SL03]: **Earth Satellite Corporation**, 2004. *Landsat GeoCover (2000/ETM+) Edition Mosaics*, tiles 071-165, 071-166 and 071-177. Sioux Falls, USA, USGS (available at <http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp>).

Somalia

Area equipped for irrigation is 200 000 ha. The figures refer to year 1984 but it is believed that the figures are still valid today [SO01]. No sub-national information on areas equipped for irrigation was available.

Irrigated area was assigned to 14 irrigation projects according to their command area as reported by the FAO irrigation map for Africa [SO02]. The total command area of these schemes was 23 315 ha. Additionally irrigated area was assigned to all areas classified as irrigated by AFRICOVER [SO03]. These areas were grouped into three categories:

- a) areas in which only irrigated crops are growing,
- b) areas having a mixture of rainfed and irrigated crops with irrigated crops as main crop,
- c) areas having a mixture of rainfed and irrigated crops with rainfed crops as main crop.

It was assumed, that the irrigation density in category b) is 67% of the density in category a) and that irrigation density in category c) is 33% of the density in category a).

References:

- [SO01]: **FAO**. 2005. *AQUASTAT country profile Somalia*, FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.
- [SO02]: **FAO**. 2006. *FAO irrigation project data base for Africa*. Database compiled from FAO (1987) and FAO (2005a) available at FAO AGLW. FAO, Rome, Italy.
- [SO03]: **FAO**. 2005. *AFRICOVER, Somalia - Spatially Aggregated Multipurpose Landcover database*. FAO, Rome, Italy, <http://www.africover.org>, 13/12/2004.

South Africa

Area equipped for irrigation is 1 498 000 ha [SA01]. The figures refer to year 2000 and are derived from a remote sensing based national land cover inventory [SA02]. Sub-national information on irrigated area is available and documented in Table 29 but refers also to this land cover inventory. Thus, to avoid a replication of information, these statistics have not been used to compile the irrigation map.

Area equipped for irrigation was assigned to grid cells by using the areas classified as irrigated in the land cover inventory. The irrigated areas were scaled so that the country totals meet exactly the figures (1 498 000 ha) presented in the AQUASTAT database.

TABLE 29
Irrigated area in provinces of South Africa as presented by [SA02]

Province	Commercial irrigated, permanent (ha)	Commercial irrigated, temporary (ha)	Area equipped for irrigation 1999 total (ha)
Eastern	11 070	179 995	191 065
Free State	46	68 764	68 810
Gauteng	18	16 330	16 348
KwaZulu / Natal	2 747	131 974	134 722
Mpumalanga	18 498	116 977	135 475
North West	706	114 094	114 801
Northern Cape	34 759	130 181	164 940
Northern	58 704	160 617	219 321
Western Cape	290 204	162 325	452 529
SOUTH AFRICA TOTAL	416 753	1 081 257	1 498 010

References:

- [SA01]: **FAO**. 2005. *AQUASTAT country profile South Africa*, FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.
- [SA02]: **Thompson, M.W.** 1999. *South African national land cover database project*. CSIR. Data set on CD-ROM, available at: <http://www.sac.co.za>

Sudan

Area equipped for irrigation is 1 863 000 ha [SU01]. The figures refer to year 2000. No sub-national statistics on areas equipped for irrigation were available.

Irrigated areas were derived from the AFRICOVER land cover data base [SU02]. However, it was found that several large irrigation schemes were not detected as irrigated by the land cover classification (e.g. Gash Delta, Tokar Delta, Aweil). Others were found to be incomplete. Therefore the missing schemes were derived from the FAO irrigation map for

Africa [SU03] or digitized from another irrigation map [SU04]. The shapes of the boundaries of the digitized irrigation areas were improved by using satellite imagery [SU05].

References:

- [SU01]: **FAO**. 2005. *AQUASTAT country profile Sudan*, FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.
- [SU02]: **FAO**. 2005. *AFRICOVER, Sudan - Spatially Aggregated Multipurpose Landcover database*. FAO, Rome, Italy, <http://www.africover.org>, 13/12/2004.
- [SU03]: **FAO**. 2006. *FAO irrigation project data base for Africa*. Database compiled from FAO (1987) and FAO (2005a) available at FAO AGLW. FAO, Rome, Italy.
- [SU04]: **unknown**. *Sudan. Irrigated and rainfed projects – hydropower project*. Map at scale 1 : 4 Mio, available in the AQUASTAT-library.
- [SU05]: **Earth Satellite Corporation**, 2004. *Landsat GeoCover (2000/ETM+) Edition Mosaics*, tiles 071-201, 071-202, 071-203, 071-213, 071-214, 071-215, 071-228 and 071-229. Sioux Falls, USA, USGS (available at <http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp>).

Swaziland

Area equipped for irrigation is 49 843 ha [SW01]. The figures refer to year 2000. Sub-national statistics on irrigated area per ecological zone as documented in Table 30 add up to 49 860 ha [SW02] and were scaled to meet the country totals as reported by AQUASTAT.

Areas equipped for irrigation were digitized from a map published in [SW02] or derived from the South-African land cover data base [SW03]. The shapes of the boundaries of the digitized irrigation areas were improved by using satellite imagery [SW04].

TABLE 30
Irrigated area per ecological zone in Swaziland

Ecological Zone	Irrigated area 2000 (ha)	Irrigated area in this map (ha)
Highveld	50	50
Lowveld	41 900	41 886
Lubombo Plateau	10	10
Middleveld	7 900	7 897
SWAZILAND TOTAL	49 860	49 843

References:

- [SW01]: **FAO**. 2005. *AQUASTAT country profile Swaziland*, FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.
- [SW02]: **Riddell, P. J. and Manyatsi, A. M.** 2003. *Water use challenges and opportunities in the Swaziland agricultural sector*. FAO / Government of Swaziland, TCP/SWA/2801(A).
- [SW03]: **Thompson, M.W.** 1999. *South African national land cover database project*. CSIR. Data set on CD-ROM, available at: <http://www.sac.co.za>
- [SW04]: **Earth Satellite Corporation**, 2004. *Landsat GeoCover (2000/ETM+) Edition Mosaics*, tile 071-703. Sioux Falls, USA, USGS (available at <http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp>).

Tanzania

Area equipped for irrigation is 184 330 ha [TA01]. The figures refer to year 2002. Irrigated area per district was computed based on an inventory of irrigation schemes and is documented in Table 31 [TA02].

Irrigated area was assigned first to 517 irrigation projects derived from the FAO irrigation map for Africa [TA03] or digitized from another irrigation map [TA04]. The remaining irrigated area was assigned to areas classified as cultivated by the FAO AFRICOVER land cover data base ([TA05], [TA06]) using the priorities given in Table 32.

TABLE 31
Irrigated area per district and region in Tanzania

District	Region	Irrigated area 2002 (ha)	District	Region	Irrigated area 2002 (ha)
Arumeru	Arusha	38 182	Liwale + Ruangwa	Lindi	25
Arusha	Arusha	500	Nachingwea	Lindi	6
Karatu	Arusha	2 273		Lindi	1 231
Mbulu	Arusha	1 240	Babati	Manyara	3 905
Monduli	Arusha	864	Hanang	Manyara	741
Ngorongoro	Arusha	0	Kiteto	Manyara	0
	Arusha	43 059	Simanjiro	Manyara	1 502
Ilala	Dar-Es-Salaam	0		Manyara	6 148
Kinondoni	Dar-Es-Salaam	0	Bunda	Mara	20
Temeke	Dar-Es-Salaam	0	Musoma (rural + urban)	Mara	0
	Dar-Es-Salaam	0	Serengeti	Mara	0
			Tarime	Mara	26
				Mara	46
Dodoma (rural + urban)	Dodoma	250	Chunya	Mbeya	339
Kondoa	Dodoma	257	Ileje	Mbeya	136
Kongwa	Dodoma	204	Kyela	Mbeya	180
Mpwapwa	Dodoma	1 301	Mbarali	Mbeya	31 559
	Dodoma	2 012	Mbeya (rural + urban)	Mbeya	2 670
Iringa (rural + urban)	Iringa	4 115	Mbozi	Mbeya	50
Kilolo	Iringa	0	Rungwe	Mbeya	305
Ludewa	Iringa	480		Mbeya	35 239
Makete	Iringa	0	Kilombero	Morogoro	6 106
Mufindi	Iringa	62	Kilosa	Morogoro	11 403
Njombe	Iringa	881	Morogoro (rural + urban)	Morogoro	5 903
	Iringa	5 538	Mvomero	Morogoro	0
Biharamulo	Kagera	0	Ulanga	Morogoro	52
Bukoba (rural + urban)	Kagera	0		Morogoro	23 464
Karagwe	Kagera	0	Masasi	Mtwara	0
Muleba	Kagera	0	Mtwara (rural + urban)	Mtwara	100
Ngara	Kagera	15	Newala	Mtwara	500
	Kagera	15	Tandahimba	Mtwara	110
Kasulu	Kigoma	1 100		Mtwara	710
Kibondo	Kigoma	1 470	Geita	Mwanza	200
Kigoma (rural + urban)	Kigoma	770	Kwimba	Mwanza	200
	Kigoma	3 340	Magu	Mwanza	70
Hai	Kilimanjaro	8 054	Misungwi	Mwanza	3
Moshi (rural + urban)	Kilimanjaro	21 731	Mwanza	Mwanza	62
Mwanga	Kilimanjaro	4 485	Sengerema	Mwanza	0
Rombo	Kilimanjaro	0	Ukerewe	Mwanza	0
Same	Kilimanjaro	11 368		Mwanza	535
	Kilimanjaro	45 638	Pemba	Pemba	0
Lake Victoria	Lake Victoria	0	Bagamoyo	Pwani	768
Kilwa	Lindi	0	Kibaha	Pwani	325
Lindi (rural + urban)	Lindi	1 200	Kisarawe	Pwani	0
			Mafia	Pwani	0

District	Region	Irrigated area 2002 (ha)	District	Region	Irrigated area 2002 (ha)
Mkuranga	Pwani	0	Manyoni	Singida	0
Rufiji	Pwani	40	Singida (rural and urban)	Singida	0
	Pwani	1 133		Singida	0
Mpanda	Rukwa	4 222	Igunga	Tabora	1 180
Nkasi	Rukwa	0	Nzega	Tabora	660
Sumbawanga (rural + urban)	Rukwa	614	Sikonge	Tabora	0
	Rukwa	4 836	Tabora (rural)	Tabora	0
Mbinga	Ruvuma	100	Tabora (urban)	Tabora	0
Songea	Ruvuma	68	Urambo	Tabora	0
Tunduru	Ruvuma	30		Tabora	1 840
	Ruvuma	198	Handeni	Tanga	0
Bariadi	Shinyanga	0	Korogwe	Tanga	5 478
Bukombe	Shinyanga	20	Lushoto	Tanga	3 148
Kahama	Shinyanga	40	Muheza	Tanga	0
Kishapu	Shinyanga	0	Pangani	Tanga	0
Maswa	Shinyanga	210	Tanga	Tanga	0
Meatu	Shinyanga	0		Tanga	8 626
Shinyanga (rural + urban)	Shinyanga	110	Zanzibar	Zanzibar	342
	Shinyanga	380	TANZANIA TOTAL		184 330
Iramba	Singida	0			

TABLE 32

Priorities used to assign irrigated area to the areas classified as cultivated in the AFRICOVER data base for Tanzania.

Attribute	Priority
Sugar cane	5
Rice	5
Tree or shrub crop	4
Herbaceous crop	4
Tree or shrub crop (60% polygon area)	3
Herbaceous crop (60% polygon area)	3
Tree or shrub crop (40% polygon area)	2
Herbaceous crop (40% polygon area)	2
Tree or shrub crop (15% polygon area)	1
Herbaceous crop (15% polygon area)	1

References:

- [TA01]: **FAO**. 2005. *AQUASTAT country profile United Republic of Tanzania*, FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.
- [TA02]: **Ministry of Agriculture and Food Security (MAFS) and Japan International Cooperation Agency (JICA)**. 2002. *The Study on the National Irrigation Master Plan in the United Republic of Tanzania*. Prepared by Nippon Koei CO. Ltd. and Nippon Giken Inc.
- [TA03]: **FAO**. 2006. *FAO irrigation project data base for Africa*. Database compiled from FAO (1987) and FAO (2005a) available at FAO AGLW. FAO, Rome, Italy.
- [TA04]: **Unknown**. *Distribution of irrigation schemes on irrigation development potential map*. Map available in the AQUASTAT library.
- [TA05]: **FAO**. 2005. *AFRICOVER, Tanzania - Spatially Aggregated Multipurpose Landcover database*. FAO, Rome, Italy, <http://www.africover.org>, 13/12/2004.

[TA06]: **FAO**. 2005. *AFRICOVER, Tanzania - Thematically Aggregated Multipurpose Landcover database*. FAO, Rome, Italy, <http://www.africover.org>, 13/12/2004.

Togo

Area equipped for irrigation is 7300 ha [TO01]. The figures refer to year 1996. No sub-national statistics on areas equipped for irrigation were available. Sub-national statistics were available for the full/partial control areas only (2300 ha), but were missing for equipped wetlands (5000 ha). Therefore the sub-national statistics could not be used.

Irrigated area was assigned to 6 irrigation projects (point data) as derived from the FAO irrigation map for Africa [TO02]. The total area equipped for irrigation in these schemes was 2900 ha. The remaining area was assigned to 4 irrigation areas (polygon data) derived from the same map.

References:

- [TO01]: **FAO**. 2005. *AQUASTAT country profile Togo*, FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.
 [TO02]: **FAO**. 2006. *FAO irrigation project data base for Africa*. Database compiled from FAO (1987) and FAO (2005a) available at FAO AGLW. FAO, Rome, Italy.

Tunisia

Area equipped for irrigation is 394 063 ha [TU01]. The figures refer to year 2000. Irrigated area per governorate is documented in Table 33.

The location and command area of 18 small scale irrigation projects was derived from the FAO irrigation map for Africa [TU02] while the large scale irrigation areas were digitized from several irrigation maps ([TU03], [TU04] and [TU05]). Finally the shapes of the boundaries of the digitized irrigation areas were improved by using satellite imagery [TU06].

TABLE 33
Irrigated area per governorate in Tunisia

Governorate	Irrigated area 2000 (ha)	Governorate	Irrigated area 2000 (ha)
Al-Kaf	12 480	Medenine	1 961
Ariana	36 354	Monastir	4 861
Beja	18 012	Nabul	41 825
Ben Arous (Tunis Sud)	10 400	Saghuan	8 730
Bizerte	21 098	Sfax	11 460
Dschunduba	29 310	Sidi Bu Said	46 152
Gabes	9 430	Siliana	12 652
Gafsa	17 452	Susa	6 506
Kairouwan	51 375	Tataouine	4 635
Kasserine	18 823	Tozeur	8 070
Kebili	15 909	Tunis	771
Mahdia	5 797	TUNISIA TOTAL	394 063

References:

- [TU01]: **DGPDIA - S/D STAT**. 2000. *Résultats de l'enquête sur les périmètres irrigués en intensif*. Ministère de l'Agriculture, de l'Environnement et des Ressources en Eau.
 [TU02]: **FAO**. 2006. *FAO irrigation project data base for Africa*. Database compiled from FAO (1987) and FAO (2005a) available at FAO AGLW. FAO, Rome, Italy.
 [TU03]: **Achenbach, H.** 1994. Tunesien – Zur Konkurrenz der Wassernutzung und der wasserabhängigen Wirtschaftszweige. In H. Popp & K. Rother, eds. *Die Bewässerungsgebiete im Mittelmeerraum*, map on p. 167. Passau, Germany, Passavia Universitätsverlag.
 [TU04]: **Unknown**. *Irrigation areas of Tunisia*, map available from the AQUASTAT library.

- [TU05]: **Framji, K., Garg, B., Luthra, S.** (1983): *Irrigation and Drainage in the World*, Volume III, p. 1366, ICID, New Delhi, India.
- [TU06]: **Earth Satellite Corporation**, 2004. *Landsat GeoCover (2000/ETM+) Edition Mosaics*, tiles 071-219 and 071-220. Sioux Falls, USA, USGS (available at <http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp>).

Uganda

Area equipped for irrigation is 9150 ha [UG01]. The figures refer to year 1998. Irrigated area per region is documented in Table 34. The sub-national statistics for full or partial control irrigation [UG02] add up to 5580 ha, while equipped lowlands (3570 ha) originate from the map of irrigated areas in Africa [UG03].

The location and command area of 15 irrigation projects was derived from the FAO irrigation map for Africa [UG03]. The total area equipped for irrigation in these schemes was 8120 ha. The remaining area was assigned to areas classified as irrigated, rice or sugar cane in the FAO AFRICOVER data base [UG04].

TABLE 34

Irrigated area per region in Uganda

Region	Irrigated area 1998 (ha)
Central	850
Eastern	4 610
Northern	480
Western	3 210
UGANDA TOTAL	9 150

References:

- [UG01]: **FAO**. 2005. *AQUASTAT country profile Uganda*, FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.
- [UG02]: **IPTRID**. 1998. *Irrigation sub-sector review, Uganda*. Draft Report.
- [UG03]: **FAO**. 2006. *FAO irrigation project data base for Africa*. Database compiled from FAO (1987) and FAO (2005a) available at FAO AGLW. FAO, Rome, Italy.
- [UG04]: **FAO**. 2005. *AFRICOVER, Uganda - Spatially Aggregated Multipurpose Landcover database*. FAO, Rome, Italy, <http://www.africover.org>, 13/12/2004.

Zambia

Area equipped for irrigation is 155 912 ha [ZA01]. The figures refer to year 2002. Irrigated area per province is documented in Table 35.

The location and command area of 12 irrigation projects was derived from the FAO irrigation map for Africa [ZA02]. The total area equipped for irrigation in these schemes was 15 757 ha. The location of 14 additional schemes was digitized from an irrigation map [ZA03]. For the provinces of Copperbelt, Central Lusaka and Southern many center pivot schemes were digitized from satellite imagery [ZA04]. The satellite imagery was also used to assign the remaining irrigated area to cultivated land in large river valleys or in the surrounding of existing irrigation schemes.

TABLE 35

Irrigated area per province in Zambia

Province	Irrigated area 2002 (ha)	Province	Irrigated area 2002 (ha)
Central	27 200	Lusaka	22 100
Copperbelt	27 800	North Western	576
Eastern	31 510	Northern	1 500
Lake Mweru	0	Southern	37 074
Luapula	5 552	Western	2 600

Province	Irrigated area 2002 (ha)
ZAMBIA TOTAL	155 912

References:

- [ZA01]: **Ministry of Agriculture and Cooperatives**. 2002. *Strategic Plan for Irrigation Development 2002 - 2006*. Draft strategy paper. 33 pages.
- [ZA02]: **FAO**. 2006. *FAO irrigation project data base for Africa*. Database compiled from FAO (1987) and FAO (2005a) available at FAO AGLW. FAO, Rome, Italy.
- [ZA03]: **Unknown**. *Irrigation Projects*. Map available in the AQUASTAT library.
- [ZA04]: **Earth Satellite Corporation**, 2004. *Landsat GeoCover (2000/ETM+) Edition Mosaics*, tiles 071-686, 071-687, 071-692, 071-693, 071-694, 071-699, 071-700 and 071-701. Sioux Falls, USA, USGS (available at <http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp>).

Zimbabwe

Area equipped for irrigation is 173 513 ha [ZI01]. The figures refer to year 1999. Irrigated area per province adds up to 173 412 ha [ZI02]. The remaining 101 ha were assigned to Bulawayo and Harare, because no statistics for these areas were available. Irrigated area per province is documented in Table 36.

The location and command area of 33 irrigation projects was derived from the FAO irrigation map for Africa [ZI03]. The total area equipped for irrigation in these schemes was 3830 ha. The remaining irrigated area was assigned to center pivot schemes as digitized from satellite imagery [ZI04] or to cultivated land in the surrounding of center pivot schemes.

TABLE 36
Irrigated area per province in Zimbabwe

Province	Irrigated area 1999 (ha)	Province	Irrigated area 1999 (ha)
Bulawayo	11	Masvingo	38 772
Harare	90	Matabeleland North	2 243
Manicaland	53 756	Matabeleland South	4 990
Mashonaland Central	22 174	Midlands	8 962
Mashonaland East	9 458	ZIMBABWE TOTAL	173 513
Mashonaland West	33 057		

References:

- [ZI01]: **FAO**. 2005. *AQUASTAT country profile Zimbabwe*, FAO, Rome, <http://www.fao.org/ag/agl/aglw/aquastat/countries/index.stm>, 28/02/2006.
- [ZI02]: **Ministry of Lands, Agriculture and Rural Resettlement**. 2002. *Report on the status of irrigation development in Zimbabwe*. Report available in the AQUASTAT library.
- [ZI03]: **FAO**. 2006. *FAO irrigation project data base for Africa*. Database compiled from FAO (1987) and FAO (2005a) available at FAO AGLW. FAO, Rome, Italy.
- [ZI04]: **Earth Satellite Corporation**, 2004. *Landsat GeoCover (2000/ETM+) Edition Mosaics*, tiles 071-694, 071-695, 071-701 and 071-702. Sioux Falls, USA, USGS (available at <http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp>).

1.4.2 EUROPE

Albania

Area equipped for irrigation was about 420 000 ha at the beginning of the 1990's [AL01], [AL02] and declined to 340 000 ha at present [AL03], [AL04]. However, the area actually used for irrigation is much lower. It was reported to be 316 000 ha in 1991 [AL02], but because many areas faced an urgent need for rehabilitation it declined to smaller than 80 000 ha in 1994 [AL03]. Due to intensive rehabilitation works the area actually used for irrigation increased again to 120 000 ha in 1996 and about 250 000 ha in 1998 [AL05]. Area equipped for irrigation per district as given for the year 1993 (in total 416 977 ha, [AL01]) was scaled so that the country totals meet the value of 340 000 ha reported to be still present. Area equipped for irrigation computed that way is documented in Table 37.

To distribute irrigated area within the districts irrigated area was assigned to all polygons classified as cultivated land in the CORINE land cover 2000 database for Europe using the priority levels documented in Table 38. The result of this assignment has been in good agreement to other maps showing irrigation infrastructure in Albania ([AL07], [AL08]).

TABLE 37

Irrigated area per district in Albania

District	Irrigated area (ha)	District	Irrigated area (ha)
Berat	11 849	Lezhë	14 339
Bulquizë	1 794	Librazhd	4 645
Delvinë	7 105	Lushnjë	31 866
Devoll	9 741	Malesia e Madhe	8 235
Dibër	12 904	Mallakastër	4 378
Durrës	13 629	Mat	4 689
Elbasan and Pequin	20 766	Mirditë	3 392
Fier	30 119	Përmet	4 122
Gjirokastër	10 759	Pogradec	5 288
Gramsh	4 185	Pukë	2 891
Has	1 943	Sarandë	8 048
Kavajë	11 603	Shkodër	19 333
Kolonjë	4 834	Skrapar	2 617
Korçë	19 001	Tepelenë	2 975
Krujë	7 962	Tiranë	14 565
Kuçovë	3 661	Tropojë	5 425
Kukës	5 152	Vlorë	18 920
Laç	7 265	ALBANIA TOTAL	340 000

TABLE 38

Priorities used to assign irrigated area to the areas classified as cultivated in the CORINE land cover 2000 data base for Albania

Attribute	Priority
Permanently irrigated land	7
Non-irrigated arable land	6
Fruit trees and berry plantations	6
Olive groves	6
Complex cultivation patterns	6
Pastures	5
Land principally occupied by agriculture, with significant areas of natural vegetation	5

References:

- [AL01]: **World Bank**. 1994. *Albania – irrigation rehabilitation project*. Staff Appraisal Document, Report no. 12609-ALB, Worldbank, Washington, US (available at <http://www.worldbank.org>).
- [AL02]: **FAO**. 1992. *Albania – irrigation subsector review*. Report no. 93/92 CP-ALB 4 SR, FAO Investment Centre, Rome, Italy.
- [AL03]: **World Bank**. 2003. *Water resources management in South Eastern Europe*. Vol. II: Country water notes and water fact sheets. Worldbank, Washington, US (available at <http://www.worldbank.org>).
- [AL04]: **FAO**. 2006. *FAO AQUASTAT database*, available at <http://www.fao.org/ag/agl/aglw/aquastat/database/index.stm>, 28/02/2006.
- [AL05]: **World Bank**. 1999. *Albania – second irrigation rehabilitation project*. Project Appraisal Document, Report no. 19242-ALB, Worldbank, Washington, US (available at <http://www.worldbank.org>).
- [AL06]: **EEA**. 2005. *Corine land cover 2000 – vector by country (CLC2000), version 1*. (available at: <http://dataservice.eea.europa.eu/dataservice/metadetails.asp?id=667>).
- [AL07]: **Toepfer, H.** 1993. Die Bewässerungslandwirtschaft und Nahrungsmittelproduktion in Albanien. Irrigation map (Figure 1) on p. 107, *In* H. Popp & K. Rother, eds. *Die Bewässerungsgebiete im Mittelmeerraum*, Passau, Germany, Passavia Universitätsverlag.
- [AL08]: **National Environmental Agency**. 1994. *Albanian State of the Environment Report: 1993-1994*. Map: Water reservoir and irrigation areas, available at: <http://enrin.grida.no/htmls/albania/soe/htmls/94/html/alba0.htm>, 07/07/2006.

Andorra

No sub-national statistics or maps on irrigated areas have been available for Andorra. However, 150 ha were classified to be permanently irrigated in the 1990-version of the Corine land cover data base for Europe. These areas were extracted and assumed to represent the area equipped for irrigation of Andorra.

References:

- [AN01]: **EEA**. 1999. *Corine land cover 1990 – vector by country (CLC1990), version 1*. (available at: <http://dataservice.eea.europa.eu/dataservice/metadetails.asp?id=188>).

Austria

Area equipped for irrigation in three NUTS-regions as documented in Table 39 was computed by selecting for each region the maximum irrigable area in the years 1995, 1997, 2000 and 2003 as reported by EUROSTAT [AU01]. The total area equipped for irrigation of the country computed that way was summing up to 97 480 ha. A total area equipped for irrigation of almost 100 000 ha was also confirmed by another report [AU02]. The area actually irrigated was 45 720 ha in 1995 [AU01].

By far the most irrigated area is concentrated in five irrigation areas in Lower Austria (Marchfeld, Weinviertel, Tullnerfeld, Südliches Wiener Becken and Krems). The outlines of these areas were digitized from a map published in [AU03]. In the next step arable land and vineyards located within these irrigation areas were extracted from the Corine land cover 2000 database for Europe [AU04]. 40 000 ha irrigated area was assigned to arable land located on the lower terrace of the Marchfeld scheme since it was reported that the arable land (in total 41 000 ha) is almost completely equipped for irrigation there [AU03]. Another 3400 ha irrigated land was assigned to vineyards located within the 5 irrigation areas mentioned above. The location and outlines of irrigation areas belonging to water use cooperatives in the Marchfeld scheme was digitized from another irrigation map published in [AU03] and 6200 ha irrigated area was assigned to these polygons. The majority of irrigated area belonging to cooperatives is located on the upper terrace of the Marchfeld scheme. Finally the location and extent of 6 irrigation areas located in other regions of Austria was digitized from maps published in [AU03], [AU05]

and [AU06] and arable land and pastures located within these polygons were extracted from the Corine land cover 2000 database for Europe [AU04]. The remaining part of irrigated area was assigned to the extracted arable land (in all irrigation areas) or pasture (only in irrigation areas outside Lower Austria).

TABLE 39
Irrigated area per NUTS-1 region in Austria

NUTS region	Area equipped for irrigation (ha) ¹	Area actually irrigated 1995 (ha)
Ostösterreich	90 460	42 200
Südösterreich	2 770	1 090
Westösterreich	4 250	2 430
AUSTRIA TOTAL	97 480	45 720

¹: maximum of irrigable area reported by [AU01] for period 1995 - 2000

References:

- [AU01]: **Statistical Office of the European Communities (EUROSTAT)**. 2006. *Irrigation by regions*. Online data base (available at <http://epp.eurostat.ec.europa.eu>), 07/07/2006.
- [AU02]: **Neudorfer, W.** 2003. Recommendations for irrigation water – new Austrian guidelines. *Journal of Applied Irrigation Science* 38(02), 163-172.
- [AU03]: **Katzmayer, H. and Rennert, G.** 2003. Bewässerung in Niederösterreich. *Bericht von der Fachtagung der DLG-Arbeitsgruppe Feldeberegnung Juli 2003*, 13 pp., available at: <http://www.fachverband-feldeberegnung.de/basisinfo.htm>, 07/07/2006.
- [AU04]: **EEA**. 2005. *Corine land cover 2000 – vector by country (CLC2000), version 1*. (available at: <http://dataservice.eea.europa.eu/dataservice/metadetails.asp?id=667>).
- [AU05]: **Framji, K., Garg, B. and Luthra, S.** 1981. *Irrigation and drainage in the world*, Volume I, map on p. 82, ICID, New Delhi, India.
- [AU06]: **Achtnich, W.** 1980. *Bewässerungslandbau*. map on p. 25, Ulmer, Stuttgart, 621 pp.

Belarus

Area equipped for irrigation reached its maximum in the 1980's at 163 000 ha and declined after to 149 000 ha in 1990, 131 000 ha in 1993 [BS01] and 115 000 ha in 2003 [BS02]. However, because of organizational, economic and technical reasons the irrigation schemes are not operating at full capacity. It can be assumed that the area actually used for irrigation is much lower now compared to the situation in 1990 because irrigation water use declined strongly from 63 Mio m³ in 1985 and 67.3 Mio m³ in 1990 to 5 Mio m³ in 2000 and 11.7 Mio m³ in 2003 [BS03]. No sub-national statistics on area equipped for irrigation have been available. Instead of it, sub-national statistics on irrigation water use for the years 1985 and 1990 [BS03] were used to estimate area equipped for irrigation per oblast. The fraction of irrigation water use in each oblast was assumed to represent also the fraction of irrigated land situated in the related oblasts. Area equipped for irrigation per oblast estimated that way is documented in Table 40.

Maps showing the location of irrigation schemes were not available. Since it was reported, that irrigation takes place only in excessively drained areas it was decided to distribute irrigated land to cropland and pastures in lowlands along the major rivers. Additionally irrigated areas were assigned to cultivated land in the Polesye region because it was reported that most of the drainage work was concentrated in that area. Cropland and pasture areas were derived from the GLC2000 data base for Northern Eurasia [BS04]. Cells classified as humid grassland, cropland or cropland / grassland were extracted from this land cover data set if located on river valley bottoms.

TABLE 40
Irrigation water use and estimated irrigated area per oblast in Belarus

Oblast	Irrigation water use 1985 (Mm ³)	Irrigation water use 1990 (Mm ³)	Area equipped for irrigation (estimated, ha)
Brest	13.0	18.0	27 983
Vitebsk	5.0	3.7	7 853
Gomel	24.0	19.0	38 815
Grodno	3.0	4.5	6 770
Minsk	10.0	14.7	22 296
Minsk City	0.0	0.0	0
Mogilyov	6.0	6.5	11 283
BELARUS TOTAL	61.0	66.4	115 000

References:

- [BS01]: **FAO**. 1999. *Irrigation in the countries of the former Soviet Union*. FAO, Rome, Italy.
- [BS02]: **Apatski, A. N., Schislyonok, V. N., Kalinin, M. Y. and Pakhomov, A. V.** 2003. *State of water resources of the Republic of Belarus 2003*. Online publication available at: <http://enrin.grida.no/htmls/belarus/water2003en/FrontPage.htm>, 07/07/2006.
- [BS03]: **Ministry of Natural Resources and Environmental Protection**. 2003. *Environmental conditions in the Republic of Belarus*. Online publication available at: <http://www.nd.minpriroda.by/eng/index.htm>, 12/07/2006.
- [BS04]: **Bartalev, S.A., Belward, A.S., Erchov, D.V., Isaev, A.S., Bartholomé, E., Gond, V., Vogt, P., Achard, F., Zubkov, A.M., Mollicone, D., Yu Savin, I., Fritz, S., Repina, G., Hartley, A.** 2003. *The land cover map for Northern Eurasia for the year 2000*. GLC2000 database, European Commission Joint Research Centre, available at <http://www-gem.jrc.it/glc2000>.

Belgium

The irrigable area of the country as reported by EUROSTAT for the years 1990, 1993, 1995, 1997, 2000 and 2003 varied between 17 880 ha (1990) and 35 110 ha (1997) [BE01]. The irrigable area was reported for two regions: Région de Bruxelles-Capitale/Brussels Hoofdstedelijk Gewest and Vlaams Gewest in the northern part and Wallone in the Southern part of the country. Area equipped for irrigation was computed by selecting the maximum irrigable area for both of the regions during the period 1997 – 2003 (Table 41). The total area equipped for irrigation estimated that way is 35 170 ha, most of it located in the northern part of the country.

Maps showing the location of irrigation schemes were not available. Area equipped for irrigation was distributed to cultivated land [BE02] in regions of coarse soil [BE03] using the priorities documented in Table 42.

TABLE 41
Area equipped for irrigation per NUTS-1 region in Belgium

NUTS region	Irrigable area 1997 (ha)	Irrigable area 2000 (ha)	Irrigable area 2003 (ha)	Area equipped for irrigation in the global map (ha)
Région de Bruxelles-Capitale/Brussels Hoofdstedelijk Gewest and Vlaams Gewest	32 030	29 460	19 020	32 030
Wallone	3 080	3 140	2 790	3 140
BELGIUM TOTAL	35 110	32 600	21 810	35 170

TABLE 42

Priorities used to assign irrigated area to cultivated areas on coarse soil in Belgium

Attribute in Corine land cover 2000 data base	Attributes in soil map	Priority
Non-irrigated arable land (211) or complex cultivation patterns (242)	SLTXCL = 1 and SLTXCL2 = 1	6
Non-irrigated arable land (211) or complex cultivation patterns (242)	SLTXCL = 1 and SLTXCL2 > 1	5
Fruit trees and berry plantations (222) or pastures (231) or land principally occupied by agriculture, with significant areas of natural vegetation (243)	SLTXCL = 1 and SLTXCL2 = 1	5

: SLTXCL represents the soil texture class of the main soil type, while SLTXCL2 is the soil texture class of an associated soil; a soil texture class of 1 is assigned to soils having less than 18% clay content and more than 65% sand content.

References:

- [BE01]: **Statistical Office of the European Communities (EUROSTAT)**. 2006. *Irrigation by regions*. Online data base (available at <http://epp.eurostat.ec.europa.eu>), 07/07/2006.
- [BE02]: **EEA**. 2005. *Corine land cover 2000 – vector by country (CLC2000), version 1*. (available at: <http://dataservice.eea.europa.eu/dataservice/metadetails.asp?id=667>).
- [BE03]: **The Commission of the European Communities, Directorate General for Agriculture, Coordination of Agricultural Research**. 1985. *Soil Map of the European Communities at 1:1 000 000*. The Office for Official Publications of the European Communities, ISBN 92-825-5427-9, L-2985 Luxembourg, 124 pages (modified version available in digital format as data set GNV153 at <http://www.grid.unep.ch/data/>, 07/07/2006).

Bosnia Herzegovina

Irrigation potential for Bosnia Herzegovina was estimated at 74 000 ha, but only 4630 ha are equipped for irrigation [BH01]. The irrigated area of the country is concentrated in three irrigation systems:

- Ljubuški and Ljubuški Polje (2800 ha),
- Trebinje and Trebinjsko Polje (650 ha) and
- Dubrava Plateau [BH02].

The boundaries of the irrigation systems were digitized from a map published in [BH03]. Irrigated area was assigned to all areas within the digitized polygons that were classified in the Corine 2000 land cover database for Europe [BH04] as non-irrigated arable land (211), fruit trees and berry plantations (222), complex cultivation patterns (242) or land principally occupied by agriculture, with significant areas of natural vegetation (243).

References:

- [BH01]: **Civil Society Promotion Center**. 2002. *Environment in Bosnia and Herzegovina 2002*. Report available online at: <http://enrin.grida.no/htmls/bosnia/bosnia2002/index.html>, 07/07/2006.
- [BH02]: **Bosna-S Oil Services Company**. 2002. *Bosnia and Herzegovina Small Scale Commercial Agricultural Development Project*. Environmental assessment. Report available at: <http://www-wds.worldbank.org/>, 07/07/2006.
- [BH03]: **World Bank**. 2003. *Bosnia and Herzegovina Small Scale Commercial Agricultural Development Project*. Project appraisal document. Report No: 25519-BiH, available at: <http://www-wds.worldbank.org/>, 07/07/2006.
- [BH04]: **EEA**. 2005. *Corine land cover 2000 – vector by country (CLC2000), version 1*. (available at: <http://dataservice.eea.europa.eu/dataservice/metadetails.asp?id=667>).

Bulgaria

Area equipped for irrigation was 1 288 000 ha in 1990 [BG01] but declined later to 673 000 ha in 1995 [BG02] and 545 160 ha in 2003 [BG03]. Even stronger was the decline in the area actually used for irrigation. While in 1985 about 1 014 000 ha of cultivated land was irrigated the area actually irrigated declined to 842 000 ha in 1989 [BG01], to about 100 000 ha in the

period 1992-1996 [BG02] and to about 40 000 ha nowadays [BG04]. Large parts of the irrigation infrastructure constructed before 1990 deteriorated because of the break up of large farms and the lack of finance for restructuring irrigation systems to meet the needs of small farmers [BG05]. The restructuring of the irrigation sector makes it difficult to estimate the area equipped for irrigation. The equipment at the former pumping stations is missing almost everywhere and a significant part of the canals is destroyed [BG04]. Thus it depends on the definitions used whether areas are still classified as equipped for irrigation or not and one can find different numbers for the extent of irrigated areas in the statistics. EUROSTAT for example reported for 2003 an irrigable area of 124 490 ha and an area actually irrigated of 79 370 ha [BG06].

In 2002 the hydraulic infrastructure for 537 558 ha irrigated land in 235 irrigation systems was managed by the Irrigation Systems Co. (ISC) and 3351 ha in five systems by the Hydro-melioratzii Ltd. Sevlievo (HMS). Both are trade companies. In contrast 4251 ha were managed by newly created irrigation associations [BG03]. Area equipped for irrigation per branch of the ISC is documented in Table 43.

The outlines of the major irrigation areas of the country were digitized from an irrigation map published in [BG01] to distribute irrigated areas within the branches of the ISC. Irrigated area was assigned to all polygons of the Corine land cover 2000 data base [BG07] that were located within the digitized irrigation areas and that were classified as non-irrigated arable land (211), rice fields (213), vineyards (221), fruit trees and berry plantations (222) or complex cultivation patterns (242) using the priority levels documented in Table 44.

TABLE 43
Area equipped for irrigation per ISC branch and river basin in Bulgaria

ISC branch	River basin	Area equipped for irrigation 2003 (ha)
Burgas	Black Sea	17 841
Varna	Black Sea	15 588
	Black Sea	33 429
Montana	Danube	19 724
Pleven	Danube	34 840
Rousse	Danube	47 057
Shumen	Danube	32 885
Sofija	Danube	22 245
Targovishte	Danube	20 967
Veliko Turnovo	Danube	23 058
Vidin	Danube	12 458
Vratza	Danube	37 427
	Danube	250 660
Haskovo	East Aegean	30 502
Pazardjik	East Aegean	23 841
Plovdiv	East Aegean	51 181
Plovdiv South	East Aegean	25 349
Sliven	East Aegean	26 569
Stara Zagora	East Aegean	36 005
Yambol	East Aegean	23 197
	East Aegean	216 643
Dupnitsa	West Aegean	11 487
Gotse Delchev	West Aegean	5 951
Pernik	West Aegean	13 380
Sandanski	West Aegean	13 611
	West Aegean	44 428

ISC branch	River basin	Area equipped for irrigation 2003 (ha)
BULGARIA TOTAL		545 160

TABLE 44

Priorities used to assign irrigated area to the areas classified as cultivated in the CORINE land cover 2000 data base for Bulgaria

Attribute	Priority
Rice fields	7
Non-irrigated arable land	6
Fruit trees and berry plantations	6
Vineyards	6
Complex cultivation patterns	6

References:

- [BG01]: **FAO**. 1991. *Bulgaria. Irrigation subsector review*. FAO Investment Centre, Report No: 109/91 CP-BUL 2, Rome, Italy.
- [BG02]: **Öko Inc. Budapest**. 2001. *Agricultural water management policies in Bulgaria, Hungary, Romania and Slovakia. Final report*. Budapest, Hungary, 35 pp.
- [BG03]: **Ministry of Agriculture and Forestry**. 2004. *Rural development project. Study on irrigation tariffs and subsidy*. Sofia, Bulgaria, 63 pp., available at: <http://www.mzgar.government.bg/>, 07/07/2006.
- [BG04]: **Chehlarova-Simeonova, S., Yusuf, S., Florov, V. and Ninova, M.** 2006. Country report from Bulgaria. In: Dirksen, W. and Huppert, W. (ed.). *Irrigation sector reform in Central and Eastern European countries*. Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), Eschborn, Germany, 41-102.
- [BG05]: **World Bank**. 2003. *Water resources management in South Eastern Europe. Vol. II – Country water notes and water fact sheets*. Washington, United States, available at: <http://www-wds.worldbank.org/>, 07/07/2006.
- [BG06]: **Statistical Office of the European Communities (EUROSTAT)**. 2006. *Irrigation by regions*. Online data base (available at <http://epp.eurostat.ec.europa.eu>), 07/07/2006.
- [BG07]: **EEA**. 2005. *Corine land cover 2000 – vector by country (CLC2000), version 1*. (available at: <http://dataservice.eea.europa.eu/dataservice/metadetails.asp?id=667>).

Croatia

Area equipped for irrigation is 5790 ha [CR01]. Sub-national irrigation statistics as compiled by the Agricultural Census 2003 were available for the area actually irrigated during season 2002-2003 and were summing up to 5000 ha [CR02]. These statistics were scaled so that the sum in the whole country is equal to the value reported for the area equipped for irrigation. Area equipped for irrigation per county computed that way is documented in Table 45, while the corresponding irrigated area for 546 communes is available as part of the online-documentation of the global irrigation map at <http://www.fao.org/ag/agl/aglw/aquastat/irrigationmap/index.stm>.

Irrigated area was distributed within the municipalities by assigning area equipped for irrigation to cultivated land as classified by the Corine 2000 land cover data base for Europe [CR03]. The highest priority was given to polygons classified as permanently irrigated land (212) while olive groves (223) and pastures (231) got the lowest priority (Table 46).

TABLE 45

Area equipped for irrigation per county in Croatia

County	Irrigated area 2002 - 2003 (ha)	County	Irrigated area 2002 - 2003 (ha)
Bjelovar-Bilogora	44	Istria	298
City of Zagreb	211	Karlovac	21
Dubrovnik-Neretva	1 046	Koprivnica-Križevci	82

County	Irrigated area 2002 - 2003 (ha)	County	Irrigated area 2002 - 2003 (ha)
Krapina-Zagorje	6	Slavonski Brod-Posavina	108
Lika-Senj	1	Split-Dalmatia	1 143
Međimurje	280	Varaždin	496
Osijek-Baranja	362	Virovitica-Podravina	546
Požega-Slavonia	130	Vukovar-Sirmium	194
Primorje-Gorski kotar	15	Zadar	556
Šibenik-Knin	70	Zagreb	128
Sisak-Moslavina	52	CROATIA TOTAL	5 790

TABLE 46
Priorities used to assign irrigated area to the areas classified as cultivated in the CORINE land cover 2000 data base for Croatia

Attribute	Priority
Permanently irrigated land	7
Non-irrigated arable land	6
Fruit trees and berry plantations	6
Vineyards	6
Complex cultivation patterns	6
Land principally occupied by agriculture, with significant areas of natural vegetation	5
Olive groves	4
Pastures	4

References:

- [CR01]: **ICID**. *Country profile Croatia*. ICID, New Delhi, India, 12 pp., available at: http://www.icid.org/index_e.html, 07/07/2006.
- [CR02]: **Central Bureau of Statistics**. 2004. *Agricultural Census 2003*. Zagreb, Croatia, available at: <http://www.dzs.hr/>, 07/07/2006.
- [CR03]: **EEA**. 2005. *Corine land cover 2000 – vector by country (CLC2000), version 1*. (available at: <http://dataservice.eea.europa.eu/dataservice/metadetails.asp?id=667>).

Cyprus

The extent of irrigable lands in the part of Cyprus under government control has been reported as being 45 452 ha in 2003, while the area actually irrigated was reported to be 35 931 ha [CP01]. The irrigated area in the Turkish-occupied northern part of the island was estimated by digitizing a land-use map [CP02] and by calculating the sum of the digitized area. Irrigated area per district is shown in Table 47. Thus, the area equipped for irrigation for the entire island was estimated to be 55 813 ha.

Irrigated areas were extracted from the Corine 2000 land cover data base for Europe [CP03] or digitized from a land-use map produced in 1975 [CP02]. This map also shows irrigated areas outside the current government-controlled area. In addition, eleven government schemes were digitized from a recent inventory [CP04].

TABLE 47
Area equipped for irrigation per district in Cyprus

District	Irrigated area (ha)
Ammochostos	11 500
Keryneia	1 400
Larnaka	9 117
Lefkosia	18 000
Lemesos	7 383

District	Irrigated area (ha)
Pafos	8 413
CYPRUS TOTAL	55 813

References:

- [CP01]: **Republic of Cyprus**. 2004. *Census of agriculture 2003 – preliminary results*. Statistical Service, Republic of Cyprus (available at <http://www.mof.gov.cy>).
- [CP02]: **Savvides, L.** 1975. *Land use map of Cyprus – Scale 1:250 000*. Nicosia.
- [CP03]: **EEA**. 2005. *Corine land cover 2000 – vector by country (CLC2000), version 1*. (available at: <http://dataservice.eea.europa.eu/dataservice/metadetails.asp?id=667>).
- [CP04]: **Savvides, L., Dörflinger, G. & Alexandrou, K.** 2001. *Reassessment of the island's water resources and demand – the assessment of water demand of Cyprus*, Figure 7. Nicosia, Ministry of Agriculture, Natural Resources and Environment, FAO.

Czech Republic

During the last century irrigation infrastructure was built on about 155 000 ha of agricultural land. The area equipped for irrigation was at its maximum in the period 1995-1997 at 132 401 ha. The area weighted average age of the irrigation systems is 26 years [CZ01]. The area actually irrigated was largest in 1988 (99 115 ha) and declined later to about 48 000 ha at the beginning of the 1990s, about 35 000 ha in the mid 90s and 16 238 ha in 1997 [CZ02]. 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). EUROSTAT reported areas actually irrigated of 16 870 ha in 2003 and 17 320 ha in 2005 [CZ03]. The low figures of area actually irrigated in the last ten years indicate that a large part of the former irrigation infrastructure seems to be dead and no longer useable. Therefore area equipped for irrigation was estimated for eight regions by choosing the maximum of the irrigable areas as reported by EUROSTAT for the years 2003 and 2005 [CZ03]. Area equipped for irrigation per region estimated that way is summing up to 50 590 ha and is shown in Table 48.

The main irrigation areas of the country were digitized from an irrigation map. The map showed areas in operation, areas under construction and planned irrigation areas [CZ04]. Additionally a large irrigation area was digitized in the surrounding of Znojmo in South Moravia [CZ05]. Irrigated area was then assigned to cultivated land extracted from the Corine 2000 land cover data base for Europe [CZ06] using the priorities shown in Table 49. In the regions of Jihozápad and Střední Morava irrigated area was assigned to all areas classified as vineyards (221), fruit trees and berry plantations (222) or complex cultivation patterns (242) because none of the digitized irrigation areas was located within these regions.

TABLE 48

Area equipped for irrigation per NUTS-1 region in the Czech Republic

NUTS region	Irrigable area 2003 (ha)	Irrigable area 2005 (ha)	Area equipped for irrigation in global map (ha)
Praha	90	260	260
Střední Čechy	10 860	12 180	12 180
Jihozápad	1 410	810	1 410
Severozápad	9 340	8 350	9 340
Severovýchod	4 380	3 600	4 380
Jihovýchod	21 120	20 540	21 120
Střední Morava	1 620	1 090	1 620
Moravskoslezsko	280	210	280
CZECH REPUBLIC TOTAL	49 100	47 040	50 590

TABLE 49

Priorities used to assign irrigated area to cultivated areas in the Czech Republic

Attribute in Corine land cover 2000 data base	Status of digitized irrigation areas (1970's)	Priority
Non-irrigated arable land (211) or vineyards (221) or fruit trees and berry plantations (222) or complex cultivation patterns (242)	"operating" or "under construction"	7
Vineyards (221) or fruit trees and berry plantations (222) or complex cultivation patterns (242)	"planned"	7
Non-irrigated arable land (211)	"planned"	6
Vineyards (221) or fruit trees and berry plantations (222) or complex cultivation patterns (242)	-	5

References:

- [CZ01]: Štastná, M., Miškovský, J., Čermák, J., Doležal, F., Zavadil, J. & Spitz, P. 2006. Country report from Czech Republic. In: Dirksen, W. and Huppert, W. (ed.). *Irrigation sector reform in Central and Eastern European countries*. Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), Eschborn, Germany, 103-118.
- [CZ02]: Miskovsky, J. 2002. Privatisation of irrigation systems in the Czech Republic. *EWRG letter* 12, 3-6.
- [CZ03]: Statistical Office of the European Communities (EUROSTAT). 2006. *Irrigation by regions*. Online data base (available at <http://epp.eurostat.ec.europa.eu>), 07/07/2006.
- [CZ04]: Framji, K.K., Garg, B.C. & Luthra, S.D.L. 1981. *Irrigation and drainage in the world*. Third edition. Vol. I, p. 304. New Delhi, ICID.
- [CZ05]: Ministry of Agriculture. 2004. General information about water management in the Czech Republic. Prague, Czech Republic, 14 pp., available at: <http://www.mze.cz>, 19/07/2006.
- [CZ06]: EEA. 2005. *Corine land cover 2000 – vector by country (CLC2000), version 1*. (available at: <http://dataservice.eea.europa.eu/dataservice/metadetails.asp?id=667>).

Denmark

The irrigable area of Denmark was 476 000 ha in 1997, 446 920 ha in 2000 and 448 820 ha in 2003, while the area irrigated at least once in a year was 201 480 ha in 2003 [DK01]. It was assumed, that the area equipped for irrigation is 476 000 ha and thus similar to the maximum of the irrigable areas reported for the period 1997-2003. No sub-national irrigation statistics were available.

Maps showing the location of irrigation areas in Denmark were not available but it was reported that irrigation is mainly used in horticulture or to grow semi-intensive or intensive field crops like maize, potatoes and sugar beets on coarse textured or shallow soils ([DK02], [DK03]). Irrigated area was therefore assigned to all regions of coarse soil texture [DK04] classified as non-irrigated arable land (211), fruit trees and berry plantations (222) or complex cultivation patterns (242) in the Corine 2000 land cover data base for Europe [DK05]. The priority levels used are shown in Table 50. It was furthermore assumed that the density of irrigated areas in priority 5 regions is three times larger than the irrigation density in polygons of priority 4. As result 351 168 ha irrigated area were assigned to polygons of priority 5 and 124 832 ha to polygons of priority 4.

TABLE 50

Priorities used to assign irrigated area to cultivated areas on coarse textured soil in Denmark

Attribute in Corine land cover 2000 data base	Attributes in soil map*	Priority	Area (ha)
Non-irrigated arable land (211) or fruit trees and berry plantations (222) or complex cultivation patterns (242)	SLTXCL = 1 and SLTXCL2 = 1	5	984 530
Non-irrigated arable land (211) or fruit trees and berry plantations (222) or complex cultivation patterns (242)	SLTXCL = 1 and SLTXCL2 > 1 or SLTXCL > 1 and SLTXCL2 = 1	4	1 049 937

*: SLTXCL represents the soil texture class of the main soil type, while SLTXCL2 is the soil texture class of an associated soil; a soil texture class of 1 is assigned to soils having less than 18% clay content and more than 65% sand content.

References:

- [DK01]: **Statistical Office of the European Communities (EUROSTAT)**. 2006. *Irrigation by regions*. Online data base (available at <http://epp.eurostat.ec.europa.eu>), 07/07/2006.
- [DK02]: **Baldock, D., Caraveli, H., Dwyer, J., Einschütz, S., Petersen, J.E., Sumpsi-Vinas, J., Varela-Ortega, C.** 2000. *The environmental impacts of irrigation in the European Union*. A report to the Environment Directorate of the European Commission, 147 pp., available at: <http://ec.europa.eu/environment/agriculture/>, 07/07/2006.
- [DK03]: **Danish Environmental Protection Agency**. 2004. *Nature & Environment 2003 – Theme: Water in Denmark*. Online report available at: http://www.mst.dk/homepage/default.asp?Sub=http://www.mst.dk/udgiv/Publications/2004/87-7614-3805/html/helepubl_eng.htm#kap01_eng, 07/07/2006.
- [DK04]: **The Commission of the European Communities, Directorate General for Agriculture, Coordination of Agricultural Research**. 1985. *Soil Map of the European Communities at 1:1 000 000*. The Office for Official Publications of the European Communities, ISBN 92-825-5427-9, L-2985 Luxembourg, 124 pages (modified version available in digital format as data set GNV153 at <http://www.grid.unep.ch/data/>, 07/07/2006).
- [DK05]: **EEA**. 2005. *Corine land cover 2000 – vector by country (CLC2000), version 1*. (available at: <http://dataservice.eea.europa.eu/dataservice/metadetails.asp?id=667>).

Estonia

Area equipped for irrigation reached its maximum by the end of the 1970s (14 000 ha), but was reduced to 3680 ha in 1995 due to the liquidation of the kolkhoz and sovkhoz [EE01]. Today 1362.7 ha are still equipped for irrigation [EE02], but the area actually used for irrigation maybe lower. It was reported that irrigation was only used on 600 ha of agricultural land in 1999 [EE03]. Area equipped for irrigation per county for the years 1996 and 2005 ([EE04], [EE02]) is shown in Table 51. The figures given for 2005 were used here to compile the global irrigation map.

Maps showing the location of irrigation areas in Estonia were not available, but it was reported that irrigation is mainly used to grow vegetables or to water pastures [EE01]. While the irrigation of pastures was practiced traditionally, the irrigation of early potatoes is mentioned explicitly in a more recent report [EE05]. It was therefore decided to assign 80% of the area still equipped for irrigation to polygons classified as non-irrigated arable land (211) or complex cultivation patterns (242) in the Corine 2000 land cover data base for Europe [EE06] and to assign the remaining irrigated area to polygons classified as pastures (231) in the same data base.

TABLE 51
Area equipped for irrigation per county in Estonia

County	Area equipped for irrigation 1996 (ha)	Area equipped for irrigation 2005 (ha)	County	Area equipped for irrigation 1996 (ha)	Area equipped for irrigation 2005 (ha)
Harjumaa	782	0	Raplamaa	476	417.0
Hiiumaa	31	0	Saaremaa	0	0
Ida-virumaa	295	0	Tartumaa	490	256.0
Järvamaa	65	0	Valgamaa	0	0
Jogevamaa	520	378.0	Viljandimaa	0	311.7
Läänemaa	0	0	Vorumaa	121	0
Lääne-virumaa	495	0	ESTONIA	3 680	1 362.7
Polvamaa	405	0	TOTAL		
Pärnumaa	0	0			

References:

- [EE01]: **FAO**. 1999. *Irrigation in the countries of the former Soviet Union*. FAO, Rome, Italy.
- [EE02]: Area equipped for irrigation per county on 01/01/2005, data provided by **Mati Tonismae**, Chairman of ICID National Committee of Estonia (ESTICID) and Head of the Bureau of Infrastructure, Ministry of Agriculture on 21/02/2006.
- [EE03]: **Baldock, D., Caraveli, H., Dwyer, J., Einschütz, S., Petersen, J.E., Sumpsi-Vinas, J. & Varela-Ortega, C.** 2000. *The environmental impacts of irrigation in the European Union*. A report to the Environment Directorate of the European Commission, 147 pp., available at: <http://ec.europa.eu/environment/agriculture/>, 07/07/2006.
- [EE04]: **FAO**. 1998. *Estonia - sustainable water management strategies for the land drainage and irrigation sector*. Field document, Report No: TCP/EST/5612, Rome, Italy.
- [EE05]: **Kucera, L. & Genovese, G. (ed.)**. 2004. *Crop monographies on Central European countries – MOCA Study*. Joint Research Centre of the European Commission, Directorate General, Institute for the Protection and Security of the Citizen, Agriculture & Fisheries Unit, Ispra, Italy, available at: http://agrifish.jrc.it/marsstat/Crop_Yield_Forecasting/MOCA/INDEX.HTM, 07/07/2006.
- [EE06]: **EEA**. 2005. *Corine land cover 2000 – vector by country (CLC2000), version 1*. (available at: <http://dataservice.eea.europa.eu/dataservice/metadetails.asp?id=667>).

Finland

The irrigable area of Finland was reported to be 103 800 ha in 2003 [FI01]. It was assumed that the irrigable area reported by EUROSTAT also represents the area equipped for irrigation. Area equipped for irrigation per region is shown in Table 52. Most of the irrigated area is located in the southern region. The area actually irrigated is however much lower, in dry summers about 20 000 – 40 000 ha are irrigated [FI02]. The main irrigated crops are vegetables, potatoes and beets ([FI02], [FI03]).

Maps showing the location of irrigation areas in Finland were not available. Therefore area equipped for irrigation was assigned to all areas classified as non-irrigated arable land (211) in the Corine 2000 land cover database for Europe [FI04].

TABLE 52

Area equipped for irrigation per NUTS-1 region in Finland

NUTS region	Area equipped for irrigation 2003 (ha)
Itä-Suomi	10 870
Etelä-Suomi, Åland	56 160
Länsi-Suomi	29 400
Pohjois-Suomi	7 370
FINLAND TOTAL	103 800

References:

- [FI01]: **Statistical Office of the European Communities (EUROSTAT)**. 2006. *Irrigation by regions*. Online data base (available at <http://epp.eurostat.ec.europa.eu>), 07/07/2006.
- [FI02]: **Baldock, D., Caraveli, H., Dwyer, J., Einschütz, S., Petersen, J.E., Sumpsi-Vinas, J. & Varela-Ortega, C.** 2000. *The environmental impacts of irrigation in the European Union*. A report to the Environment Directorate of the European Commission, 147 pp., available at: <http://ec.europa.eu/environment/agriculture/>, 07/07/2006.
- [FI03]: **Sierla, J.** 2006. *Water resources management and agriculture in Finland*. Summary report available at the web-page of the Finnish National Committee of the ICID (FINCID) at: <http://www.salaojakeskus.fi/fincid/indexeng.htm>, 07/07/2006.
- [FI04]: **EEA**. 2005. *Corine land cover 2000 – vector by country (CLC2000), version 1*. (available at: <http://dataservice.eea.europa.eu/dataservice/metadetails.asp?id=667>).

France

The irrigable area of the country increased steadily from 2 099 700 ha in 1990 to 2 510 410 ha in 1995 and 2 723 700 ha in 2003. The area actually irrigated was lower but increased also from 1 484 840 ha in 1990 to 1 629 580 ha in 1995 and 1 938 730 ha in 2003 [FR01]. According to the agricultural census 2000 the main irrigated crops were maize (56% of the irrigated area), vegetables and potatoes (12% of irrigated area) and fruits and vines (9% of the irrigated area) [FR02]. Area equipped for irrigation was estimated by selecting the maximum of the irrigable area as reported by the EIDER data base by department for the years 1997, 2000 and 2003 [FR03]. For the year 2003 data were available for only 46 of the 96 departments which may lead to an underestimation of the area equipped for irrigation in the remaining 50 departments. Area equipped for irrigation by region and department estimated that way is summing up to 2 906 081 ha and is shown in Table 53.

Area equipped for irrigation was distributed within the departments by combining cultivated areas as derived from the Corine 2000 land cover data base for Europe [FR04] and a map published in [FR02] showing the percentage of cultivated land that is irrigated by canton. It was assumed that the density of area equipped for irrigation within the departments is relative to the density of area actually irrigated computed that way. Furthermore, by using the priority levels shown in Table 54 it was considered that irrigation is mainly concentrated on arable land in France. The irrigation map for France compiled that way was found to be in good agreement to irrigation maps published in the literature ([FR05], [FR06]).

TABLE 53

Area equipped for irrigation per department and region in France

Department	Region	Area equipped for irrigation 1997 (ha)	Area equipped for irrigation 2000 (ha)	Area equipped for irrigation 2003 (ha)	Area equipped for irrigation in global map (ha)
Bas-Rhin	Alsace	26 007	20 654	21 295	26 007
Haut-Rhin	Alsace	47 321	45 766	42 169	47 321
	Alsace	73 328	66 420	63 464	73 328
Dordogne	Aquitaine	44 403	46 790	45 314	46 790
Gironde	Aquitaine	45 137	42 067	44 604	45 137
Landes	Aquitaine	124 685	114 431	116 679	124 685
Lot-et-Garonne	Aquitaine	114 466	115 343	114 349	115 343
Pyrénées-Atlantiques	Aquitaine	33 811	33 139	31 085	33 811
	Aquitaine	362 502	351 770	352 031	365 766
Allier	Auvergne	19 380	18 781	n.a.	19 380
Cantal	Auvergne	4 040	2 420	n.a.	4 040
Haute-Loire	Auvergne	2 579	2 429	n.a.	2 579
Puy-de-Dôme	Auvergne	22 614	17 897	20 798	22 614
	Auvergne	48 613	41 527	47 130	48 613
Calvados	Basse-Normandie	3 998	5 151	n.a.	5 151
Manche	Basse-Normandie	4 570	3 868	n.a.	4 570
Orne	Basse-Normandie	292	726	n.a.	726
	Basse-Normandie	8 860	9 745	n.a.	10 447
Côte-d'Or	Bourgogne	28 532	20 843	n.a.	28 532
Nièvre	Bourgogne	9 600	9 111	n.a.	9 600
Saône-et-Loire	Bourgogne	4 167	5 952	n.a.	5 952
Yonne	Bourgogne	9 442	9 914	n.a.	9 914
	Bourgogne	51 741	45 820	n.a.	53 998
Côtes-d'Armor	Bretagne	4 389	2 853	n.a.	4 389
Finistère	Bretagne	12 617	11 737	n.a.	12 617

Department	Region	Area equipped for irrigation 1997 (ha)	Area equipped for irrigation 2000 (ha)	Area equipped for irrigation 2003 (ha)	Area equipped for irrigation in global map (ha)
Ille-et-Vilaine	Bretagne	9 878	7 410	n.a.	9 878
Morbihan	Bretagne	11 415	14 671	n.a.	14 671
	Bretagne	38 299	36 671	41 464	41 555
Cher	Centre	37 166	37 198	n.a.	37 198
Eure-et-Loir	Centre	137 568	144 595	150 319	150 319
Indre	Centre	25 934	22 744	n.a.	25 934
Indre-et-Loire	Centre	26 392	33 644	30 899	33 644
Loiret	Centre	180 762	180 658	188 063	188 063
Loir-et-Cher	Centre	76 787	68 463	69 622	76 787
	Centre	484 609	487 302	502 715	511 945
Ardennes	Champagne-Ardenne	1 341	2 800	n.a.	2 800
Aube	Champagne-Ardenne	20 456	30 918	n.a.	30 918
Haute-Marne	Champagne-Ardenne	145	280	n.a.	280
Marne	Champagne-Ardenne	29 095	33 356	n.a.	33 356
	Champagne-Ardenne	51 037	67 354	n.a.	67 354
Corse-du-Sud	Corse	3 296	3 424	2 642	3 424
Haute-Corse	Corse	16 245	16 785	14 825	16 785
	Corse	19 541	20 209	17 467	20 209
Doubs	Franche-Comté	523	109	n.a.	523
Haute-Saône	Franche-Comté	2 950	827	n.a.	2 950
Jura	Franche-Comté	9 504	8 797	n.a.	9 504
Territoire-de-Belfort	Franche-Comté	87	27	n.a.	87
	Franche-Comté	13 064	9 760	9 768	13 064
Eure	Haute-Normandie	9 151	9 741	n.a.	9 741
Seine-Maritime	Haute-Normandie	292	705	n.a.	705
	Haute-Normandie	9 443	10 446	n.a.	10 446
Essonne	Île-de-France	11 228	14 088	15 247	15 247
Hauts-de-Seine	Île-de-France	3	22	n.a.	22
Paris	Île-de-France	0	0	0	0
Seine-et-Marne	Île-de-France	35 252	39 162	n.a.	39 162
Seine-St-Denis	Île-de-France	207	306	290	306
Val-d'Oise	Île-de-France	681	1 771	n.a.	1 771
Val-de-Marne	Île-de-France	151	256	236	256
Yvelines	Île-de-France	6 714	8 169	n.a.	8 169
	Île-de-France	54 236	63 774	68 120	64 933
Aude	Languedoc-Roussillon	46 606	31 854	40 572	46 606
Gard	Languedoc-Roussillon	66 634	35 005	38 253	66 634
Hérault	Languedoc-Roussillon	32 237	28 556	34 616	34 616
Lozère	Languedoc-Roussillon	1 665	2 217	n.a.	2 217
Pyrénées-Orientales	Languedoc-Roussillon	17 596	17 349	17 009	17 596

Department	Region	Area equipped for irrigation 1997 (ha)	Area equipped for irrigation 2000 (ha)	Area equipped for irrigation 2003 (ha)	Area equipped for irrigation in global map (ha)
	Languedoc-Roussillon	164 738	114 981	131 981	167 669
Corrèze	Limousin	3 229	3 299	n.a.	3 299
Creuse	Limousin	351	272	n.a.	351
Haute-Vienne	Limousin	2 906	1 390	n.a.	2 906
	Limousin	6 486	4 961	n.a.	6 556
Meurthe-et-Moselle	Lorraine	89	264	n.a.	264
Meuse	Lorraine	269	98	n.a.	269
Moselle	Lorraine	69	129	n.a.	129
Vosges	Lorraine	95	75	n.a.	95
	Lorraine	522	566	n.a.	757
Ariège	Midi-Pyrénées	20 203	17 485	19 514	20 203
Aveyron	Midi-Pyrénées	12 602	11 919	n.a.	12 602
Gers	Midi-Pyrénées	112 642	109 954	104 091	112 642
Haute-Garonne	Midi-Pyrénées	79 139	68 364	65 173	79 139
Hautes-Pyrénées	Midi-Pyrénées	39 627	35 499	36 266	39 627
Lot	Midi-Pyrénées	16 722	14 814	13 403	16 722
Tarn	Midi-Pyrénées	28 687	35 853	66 816	66 816
Tarn-et-Garonne	Midi-Pyrénées	80 105	78 861	81 802	81 802
	Midi-Pyrénées	389 727	372 749	363 339	429 553
Nord	Nord-Pas-de-Calais	12 256	15 328	n.a.	15 328
Pas-de-Calais	Nord-Pas-de-Calais	19 540	27 168	n.a.	27 168
	Nord-Pas-de-Calais	31 796	42 496	52 431	42 496
Loire-Atlantique	Pays-de-la-Loire	28 220	22 048	20 478	28 220
Maine-et-Loire	Pays-de-la-Loire	69 279	73 139	76 471	76 471
Mayenne	Pays-de-la-Loire	7 083	5 813	n.a.	7 083
Sarthe	Pays-de-la-Loire	33 895	35 014	33 804	35 014
Vendée	Pays-de-la-Loire	69 350	77 018	86 885	86 885
	Pays-de-la-Loire	207 827	213 032	220 408	233 673
Aisne	Picardie	33 086	25 369	n.a.	33 086
Oise	Picardie	25 214	21 382	n.a.	25 214
Somme	Picardie	48 736	66 888	72 271	72 271
	Picardie	107 036	113 639	129 319	130 571
Charente	Poitou-Charentes	36 542	38 776	42 343	42 343
Charente-Maritime	Poitou-Charentes	97 535	95 374	97 711	97 711
Deux-Sèvres	Poitou-Charentes	36 134	42 468	45 671	45 671
Vienne	Poitou-Charentes	48 306	57 129	58 186	58 186
	Poitou-Charentes	218 517	233 747	243 911	243 911
Alpes-de-Haute-Provence	Provence-Alpes-Côte d'Azur	25 495	22 497	22 293	25 495
Alpes-Maritimes	Provence-Alpes-Côte d'Azur	2 205	1 461	n.a.	2 205
Bouches-du-	Provence-Alpes-	91 270	85 721	85 512	91 270

Department	Region	Area equipped for irrigation 1997 (ha)	Area equipped for irrigation 2000 (ha)	Area equipped for irrigation 2003 (ha)	Area equipped for irrigation in global map (ha)
Rhône	Côte d'Azur				
Hautes-Alpes	Provence-Alpes-Côte d'Azur	16 519	17 114	15 528	17 114
Var	Provence-Alpes-Côte d'Azur	9 558	8 565	n.a.	9 558
Vaucluse	Provence-Alpes-Côte d'Azur	43 286	33 917	33 064	43 286
	Provence-Alpes-Côte d'Azur	188 333	169 275	166 953	188 928
Ain	Rhône-Alpes	20 322	20 337	22 285	22 285
Ardèche	Rhône-Alpes	12 320	10 733	11 243	12 320
Drôme	Rhône-Alpes	68 635	64 264	73 126	73 126
Haute-Savoie	Rhône-Alpes	1 927	1 312	n.a.	1 927
Isère	Rhône-Alpes	34 057	28 299	30 429	34 057
Loire	Rhône-Alpes	13 712	17 055	19 219	19 219
Rhône	Rhône-Alpes	15 257	13 781	14 835	15 257
Savoie	Rhône-Alpes	2 118	1 661	n.a.	2 118
	Rhône-Alpes	168 348	157 442	173 769	180 309
FRANCE TOTAL		2 698 603	2 633 686	2 695 657	2 906 081

TABLE 54
Priorities used to assign irrigated area to the areas classified as cultivated in the CORINE land cover 2000 data base for France

Attribute	Priority
Permanently irrigated land	7
Rice fields	7
Non-irrigated arable land	6
Fruit trees and berry plantations	6
Complex cultivation patterns	6
Vineyards	5
Olive groves	5
Pastures	5
Land principally occupied by agriculture, with significant areas of natural vegetation	5

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Germany

Surveys of the German Sprinkler Association undertaken in the years 1995 and 2001 indicate that about 500 000 ha are equipped for sprinkler irrigation in Germany ([GE01], [GE02]). An area of about 5 000 ha is under micro irrigation (mainly drip irrigation in vineyards). In the north-eastern part of the country there are about 600 000 ha of equipped lowlands. Combined drainage / subsurface irrigation facilities were installed there to manage peat soils and groundwater near sandy sites. Surface irrigation methods are not used anymore [GE03]. Irrigation is mainly practiced on arable land and in most irrigation areas only specific crops in a crop rotation are irrigated (e.g. potatoes, sugar beets, maize, vegetables). Therefore the area actually irrigated was only 236 797 ha in 1998 and 220 907 ha in 2002. Arable crops covered about 79% of the irrigation area, horticulture 17% and perennial crops about 4% ([GE04], [GE05]). Sub-national statistics on area equipped for irrigation were compiled from different sources because official statistics do not exist in Germany. The main source of information was the survey of the German Sprinkler Association undertaken in 2001 that provided figures for the 16 federal states [GE02]. For the federal state of Niedersachsen, where about 47% of the irrigated area is concentrated, statistics per county were provided by the local branch of the Sprinkler Association [GE06] while statistics for Sachsen-Anhalt, also on the county level, were derived from the literature [GE07]. The figures for the federal state of Hessen were replaced by statistics taken from a recently published report [GE08]. The original statistics on area equipped for irrigation and are actually irrigated by federal state are shown in Table 55 while the figures used to compile the irrigation map are shown in Table 56. The total area equipped for irrigation in Germany was 496 871 ha. Irrigation in equipped lowlands was neglected because it was reported, that operation and maintenance of the subsurface irrigation systems were drastically reduced during the transformation process of irrigated agriculture in Eastern Germany. Thus the water use statistics also do not account for these systems. There are initiatives to reactivate the systems of ditches, control structures, weirs and pumping stations because under the climatic conditions there is a high requirement for water retention and impounded water irrigation on cultivated grassland in north-eastern Germany. However, the focus is more on the protection of the peat soils and wetlands than on increasing agricultural production [GE03].

Irrigation areas within the sub-national units were located and digitized using maps and information taken from the literature ([GE08]-[GE14]). Irrigated area was assigned to cultivated land derived from the Corine 2000 land cover data base for Europe [GE15] located within the digitized polygons. However, for some regions irrigation maps were not available (e.g. Saarland). Therefore, in the western part of the country, irrigated area was also assigned to arable land on coarse soils [GE16].

TABLE 55

Area equipped for irrigation and area actually irrigated per state in Germany

State	Area equipped for irrigation 1995 (ha)	Area equipped for irrigation 2001 (ha)	Area actually irrigated 1998 (ha)	Area actually irrigated 2002 (ha)
Baden Württemberg	20 000	20 000	12 686	9 965
Bayern	35 000	35 000	7 401	6 351
Berlin	n.a.	200	113	234
Brandenburg	20 200	25 000	7 412	11 509
Bremen	0	0	53	11
Hamburg	0	0	1 010	840
Hessen	45 000	45 000	27 105	28 007
Mecklenburg-Vorpommern	12 500	15 000	5 161	5 473
Niedersachsen	233 500	235 000	120 454	92 718
Nordrhein Westfalen	35 000	35 000	23 141	15 043
Rheinland Pfalz	25 800	25 800	15 871	14 911
Saarland	170	170	126	188

State	Area equipped for irrigation 1995 (ha)	Area equipped for irrigation 2001 (ha)	Area actually irrigated 1998 (ha)	Area actually irrigated 2002 (ha)
Sachsen	26 600	15 000	1 574	2 307
Sachsen Anhalt	56 900	20 000	9 431	28 660
Schleswig Holstein	5 450	5 450	2 824	2 725
Thüringen	15 000	15 000	2 435	1 965
GERMANY TOTAL	531 120	491 620	236 797	220 907

TABLE 56

Area equipped for irrigation per county and state in Germany

County	State	Area equipped for irrigation in global map (ha)	County	State	Area equipped for irrigation in global map (ha)
	Baden-Württemberg	20 000		Sachsen	15 000
	Bayern	35 000	Altmarkkreis Salzwedel	Sachsen-Anhalt	4 325
	Berlin	250	Anhalt-Zerbst	Sachsen-Anhalt	2 647
	Brandenburg	25 000	Aschersleben-Staßfurt	Sachsen-Anhalt	302
	Bremen	53	Bernburg	Sachsen-Anhalt	428
	Hamburg	1 010	Bitterfeld	Sachsen-Anhalt	496
	Hessen	33 230	Bördekreis	Sachsen-Anhalt	1 446
	Mecklenburg-Vorpommern	15 000	Burgenlandkreis	Sachsen-Anhalt	152
Celle	Niedersachsen	24 061	Dessau	Sachsen-Anhalt	0
Diepholz	Niedersachsen	2 200	Halberstadt	Sachsen-Anhalt	3 386
Emsland and Grafschaft Bentheim	Niedersachsen	10 000	Halle an der Saale	Sachsen-Anhalt	0
Gifhorn	Niedersachsen	53 420	Jerichower Land	Sachsen-Anhalt	985
Hannover	Niedersachsen	23 850	Köthen	Sachsen-Anhalt	3 266
Helmstedt	Niedersachsen	1 200	Magdeburg	Sachsen-Anhalt	0
Lüchow-Dannenberg	Niedersachsen	16 554	Mansfelder Land	Sachsen-Anhalt	113
Lüneburg	Niedersachsen	16 306	Merseburg-Querfurt	Sachsen-Anhalt	169
Other counties of Niedersachsen	Niedersachsen	2 500	Ohrekreis	Sachsen-Anhalt	1 625
Peine	Niedersachsen	11 000	Quedlinburg	Sachsen-Anhalt	99
Rotenburg	Niedersachsen	2 260	Saalkreis	Sachsen-Anhalt	90
Soltau-Fallingb.ostel	Niedersachsen	9 570	Sangerhausen	Sachsen-Anhalt	79
Stade	Niedersachsen	3 263	Schönebeck	Sachsen-Anhalt	1 952
Uelzen	Niedersachsen	57 534	Stendal	Sachsen-Anhalt	3 366
Verden	Niedersachsen	8 500	Weißenfels	Sachsen-Anhalt	7
	Niedersachsen	242 218	Wernigerode	Sachsen-Anhalt	180
	Nordrhein-Westfalen	35 000	Wittenberg	Sachsen-Anhalt	3 548
	Rheinland-Pfalz	25 800		Sachsen-Anhalt	28 660
	Saarland	200		Sachsen-Anhalt	5 450
				Thüringen	15 000
			GERMANY TOTAL		496 871

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Greece

The area reported to be irrigable increased in Greece from 1 130 570 ha in 1990 to 1 235 300 ha in 1995 and 1 521 600 ha in 2003. The area actually irrigated also increased from 932 980 ha in 1990 to 1 142 180 ha in 1995 and 1 294 400 ha in 2003 [GR01]. Area equipped for irrigation was computed by selecting the maximum of the irrigable area as reported by the EUROSTAT for 13 regions and for the years 1997, 2000 and 2003 [GR01]. The island of Crete was further subdivided in four districts because irrigation statistics could be obtained from the literature [GR02]. Area equipped for irrigation by region computed that way is summing up to 1 544 530 ha and is shown in Table 57.

Irrigated area was assigned first to all areas classified as "Permanently irrigated land" (212) or "Rice fields" (213) by the Corine 2000 land cover database for Europe [GR03].

658 386 ha were distributed in total that way. Additionally other irrigation areas were digitized from an irrigation map [GR04] or from a land use map published in an atlas [GR05]. Cultivated land located within the digitized polygons was extracted from the Corine land cover data base and 432 250 ha of irrigated land were assigned to these areas. Finally, the remaining fraction of the area equipped for irrigation was assigned to cultivated land located outside the digitized polygons by using the priorities shown in Table 58. In this process it was assumed that the irrigation density in polygons of priority 4 is only 10% of the irrigation density in polygons of priority 5. Polygons of priority 4 represent pastures, marginal areas and olive groves and thus areas that are usually not irrigated in Greece. An exception was made for the island of Crete. It was reported that more than 40% of the olive groves are irrigated there today [GR06]. Therefore polygons classified as olive groves and located at Crete got the higher priority level 5.

TABLE 57

Area equipped for irrigation per NUTS-1 region in Greece

NUTS region	Area irrigable 1997 (ha)	Area irrigable 2000 (ha)	Area irrigable 2003 (ha)	Area equipped for irrigation in global map (ha)
Anatoliki Makedonia, Thraki	186 710	188 490	211 390	211 390
Kentriki Makedonia	318 780	311 030	347 900	347 900
Dytiki Makedonia	30 680	44 570	53 360	53 360
Thessalia	294 570	263 840	271 630	294 570
Ipeiros	34 630	42 320	50 910	50 910
Ionia Nisia	2 260	2 610	5 930	5 930
Dytiki Ellada	100 680	116 650	147 520	147 520
Stereia Ellada	120 740	137 950	143 830	143 830
Peloponnisos	82 560	93 260	127 840	127 840
Attiki	8 990	13 620	15 000	15 000
Voreio Aigaio	4 900	6 060	9 030	9 030
Notio Aigaio	9 260	8 100	14 440	14 440
Kriti	81 970	92 800	122 810	122 810
GREECE TOTAL	1 276 740	1 321 300	1 521 600	1 544 530

TABLE 58

Priorities used to assign irrigated area to the areas located outside the digitized irrigation areas and classified as cultivated in the CORINE land cover 2000 data base for Greece

Attribute	Priority
Non-irrigated arable land	5
Fruit trees and berry plantations	5
Annual crops associated with permanent crops	5
Complex cultivation patterns	5
Vineyards	5
Olive groves*	4
Pastures	4
Land principally occupied by agriculture, with significant areas of natural vegetation	4

* : Olives groves got priority 5 if located in Crete.

References:

- [GR01]: **Statistical Office of the European Communities (EUROSTAT)**. 2006. *Irrigation by regions*. Online data base (available at <http://epp.eurostat.ec.europa.eu>), 07/07/2006.
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- [GR06]: **Institute of Olive Tree and Subtropical Plants**. 2003. *General Info*. Report available on the web-page of the National Agricultural Research Foundation (NAGREF), available at: <http://www.nagref-cha.gr/endocs/general.html>, 27/07/2006.

Hungary

In Hungary the area equipped for irrigation reached its maximum in 1974 at 451 000 ha when the barrage at Kisköre and a dam in Békés were put into operation [HU01]. The area still equipped for irrigation is lower today but the statistics differ significantly dependent on the reference year and the source of information. The irrigable area of the country as reported by EUROSTAT or the Central Statistics Office was 308 110 ha in 2000 [HU02] and about 242 170 ha in 2003 [HU02], [HU03], while statistics of the National Water Authority indicate an area equipped for irrigation of 235 500 ha in 2000 and 208 400 ha in 2003 [HU01]. According to the latter statistics the area equipped for irrigation declined each year within the period 1998 (264 300 ha) to 2004 (159 100 ha). Differences also exist in the statistics referring to the area actually irrigated. EUROSTAT reported an area actually irrigated of 67 100 ha in 2000 and 148 690 ha in 2003 [HU02]. In contrast, the National Water Authority reported actual irrigation areas of 125 300 ha in 2000 and 115 200 ha in 2003 [HU01]. Because of the given uncertainties area equipped for irrigation was estimated for this study by selecting for each county the maximum of the areas reported as irrigable (Central Statistics Office, year 2003) or equipped for irrigation (National Water Authority, years 2001, 2002 and 2004). The total area equipped for irrigation estimated that way is summing up to 292 147 ha. Area equipped for irrigation per county is shown in Table 59.

Polygons, showing the irrigation system of Hungary, were digitized from an irrigation map published in an atlas [HU04] and combined to polygons of cultivated land as extracted from the Corine 2000 land cover database for Europe [HU05] by using the priority levels shown in Table 60.

TABLE 59

Area equipped for irrigation per county and region in Hungary

County	Region	Area equipped for irrigation in global map (ha)	County	Region	Area equipped for irrigation in global map (ha)
Budapest	Central Hungary	3 117	Jász-Nagykun-Szolnok	Northern Great Plain	43 084
Pest	Central Hungary	8 122	Szabolcs-Szatmár-Bereg	Northern Great Plain	11 963
	Central Hungary	11 239		Northern Great Plain	91 301
Fejér	Central Transdanubia	12 492	Borsod-Abaúj-Zemplén	Northern Hungary	6 963
Komárom-Esztergom	Central Transdanubia	1 790	Heves	Northern Hungary	6 820
Veszprém	Central Transdanubia	4 276	Nógrád	Northern Hungary	360
	Central Transdanubia	18 558		Northern Hungary	14 143
Hajdú-Bihar	Northern Great Plain	36 254	Bács-Kiskun	Southern Great	25 179

County	Region	Area equipped for irrigation in global map (ha)	County	Region	Area equipped for irrigation in global map (ha)
	Plain			Southern Transdanubia	33 205
Békés	Southern Great Plain	37 545	Győr-Moson-Sopron	Western Transdanubia	26 123
Csongrád	Southern Great Plain	31 888	Vas	Western Transdanubia	1 593
	Southern Great Plain	94 612	Zala	Western Transdanubia	1 373
Baranya	Southern Transdanubia	23 709		Western Transdanubia	29 089
Somogy	Southern Transdanubia	4 972			
Tolna	Southern Transdanubia	4 524			
				HUNGARY TOTAL	292 147

TABLE 60

Priorities used to assign irrigated area to cultivated areas in Hungary

Attribute in Corine land cover 2000 data base	Location within polygons of the digitized irrigation areas	Priority
Rice fields (213)	Yes or No	7
Non-irrigated arable land (211) or vineyards (221) or fruit trees and berry plantations (222) or complex cultivation patterns (242)	Yes	6
Pastures (231) or land principally occupied by agriculture, with significant areas of natural vegetation (243)	Yes	5
Non-irrigated arable land (211) or vineyards (221) or fruit trees and berry plantations (222) or complex cultivation patterns (242)	No	4

References:

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- [HU04]: **Hungarian Academy of Sciences & Ministry of Agriculture and Food**. 1989. *National Atlas of Hungary*. Map on p. 208. Cartographia, Budapest, Hungary, 389 pp.
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Iceland

No data on irrigation in Iceland were available. However, there exists some vegetable production on Iceland, e.g. cucumbers and tomatoes [IC01]. The total harvested vegetable area was 77 ha in 2003 [IC02]. Because of the climatic conditions on Iceland it can be assumed that most of this production is coming from greenhouses what also would indicate that there might be some irrigation. For this study it was nevertheless assumed that there is no irrigation in Iceland.

References:

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[IC02]: **FAO**. 2006. FAOSTAT – FAO Statistical Databases, available at: <http://faostat.fao.org/>, 31/07/2006.

Ireland

The irrigated area in Ireland is about 1100 ha and consists of about 500 ha early potatoes, 500 ha vegetables and 100 ha strawberries in plastic tunnels. Most of the irrigated area is located in the southern, eastern and south-eastern regions of the country [IR01]. No sub-national statistics on irrigated area have been available for Ireland. Therefore the potato growing area of the counties located in the south, east or south-east was extracted from the Agricultural Census 2000 [IR02] and it was assumed that the irrigated area is proportional to the potato growing area (in total 2122 ha). Area equipped for irrigation estimated that way is shown in Table 61.

Area equipped for irrigation was equally distributed over all polygons classified as non-irrigated arable land (211) or complex cultivation patterns (242) in the Corine 2000 land cover database for Europe [IR03].

TABLE 61

Potato cropping area and estimated area equipped for irrigation per county in Ireland

County	Potato cropping area 2000 (ha)	Area equipped for irrigation in global map (ha)
Carlow	10	5.2
Cork	309	160.2
Dublin	1 204	624.1
Kildare	24	12.4
Kilkenny	90	46.7
Meath	263	136.3
Waterford	40	20.7
Wexford	166	86.0
Wicklow	16	8.3
IRELAND TOTAL	2 122	1 100.0

: only counties in Southern, South-Eastern and Eastern regions considered

References:

- [IR01]: **Baldock, D., Caraveli, H., Dwyer, J., Einschütz, S., Petersen, J.E., Sumpsi-Vinas, J. & Varela-Ortega, C.** 2000. *The environmental impacts of irrigation in the European Union*. A report to the Environment Directorate of the European Commission, 147 pp., available at: <http://ec.europa.eu/environment/agriculture/>, 07/07/2006.
- [IR02]: **Central Statistics Office Ireland**. 2002. *Census of Agriculture Main Results, June 2000*. Dublin, Ireland, 96 pp., available at: http://www.cso.ie/releasespublications/pr_agrifishpubshardcopies.htm, 31/07/2006.
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Italy

According to EUROSTAT the irrigable area of Italy was 3 855 920 ha in 2000 and 3 977 210 ha in 2003, while the area actually irrigated was 2 453 460 ha in 2000 and 1 846 880 ha in 2003 [IT01]. The results of the 5th agricultural census, undertaken in growing season 2000-2001 and reported for the 8101 communities are similar. The irrigable area is summing up to 3 892 202 ha, while the area actually used for irrigation is summing up to 2 471 379 ha [IT02]. It was assumed, that the irrigable area by community as reported by the agricultural census also represents the area equipped for irrigation. Area equipped for irrigation and the area actually irrigated by province and by region is shown in Table 62. Area equipped for irrigation by community is available as part of the online-documentation of the global irrigation map at <http://www.fao.org/ag/agl/aqlw/aquastat/irrigationmap/index.stm>.

Area equipped for irrigation was distributed within the communities to cultivated areas as extracted from the Corine 2000 land cover database for Europe [IT03] by using the priority levels shown in Table 63. The resulting irrigation map for Italy was found to agree well with irrigation maps published in the literature [IT04] – [IT06].

TABLE 62
Irrigated area per province and region in Italy

Province	Region	Area equipped for irrigation 2000 (ha)	Area actually irrigated 2000 (ha)
L'Aquila	Abruzzo	21 693	12 330
Teramo	Abruzzo	14 267	7 299
Pescara	Abruzzo	12 232	5 225
Chieti	Abruzzo	11 167	5 142
	Abruzzo	59 358	29 995
Potenza	Basilicata	28 061	9 335
Matera	Basilicata	52 579	32 990
	Basilicata	80 640	42 325
Cosenza	Calabria	49 814	27 306
Catanzaro	Calabria	18 435	10 849
Reggio di Calabria	Calabria	21 300	15 083
Crotone	Calabria	22 206	10 370
Vibo Valentia	Calabria	5 492	3 374
	Calabria	117 247	66 983
Caserta	Campania	48 714	33 352
Benevento	Campania	10 625	6 115
Napoli	Campania	16 078	13 821
Avellino	Campania	6 671	3 480
Salerno	Campania	43 217	29 647
	Campania	125 305	86 415
Piacenza	Emilia Romagna	73 468	41 771
Parma	Emilia Romagna	64 997	26 603
Reggio nell'Emilia	Emilia Romagna	66 835	29 381
Modena	Emilia Romagna	66 027	23 131
Bologna	Emilia Romagna	76 680	23 610
Ferrara	Emilia Romagna	141 411	68 269
Ravenna	Emilia Romagna	56 236	27 666
Forlì-Cesena	Emilia Romagna	17 288	10 070
Rimini	Emilia Romagna	2 631	1 876
	Emilia Romagna	565 573	252 377
Udine	Friuli	51 450	36 405
Gorizia	Friuli	9 888	4 275
Trieste	Friuli	95	66
Pordenone	Friuli	30 443	22 457
	Friuli	91 876	63 202
Viterbo	Lazio	44 560	17 873
Rieti	Lazio	5 803	2 356
Roma	Lazio	35 644	15 783
Latina	Lazio	48 023	30 443
Frosinone	Lazio	16 057	7 598
	Lazio	150 088	74 053
Imperia	Liguria	4 094	3 310
Savona	Liguria	3 725	2 488

Province	Region	Area equipped for irrigation 2000 (ha)	Area actually irrigated 2000 (ha)
Genova	Liguria	1 449	714
La Spezia	Liguria	2 124	718
	Liguria	11 391	7 230
Varese	Lombardia	686	420
Como	Lombardia	565	456
Sondrio	Lombardia	1 608	1 316
Milano	Lombardia	62 893	53 031
Bergamo	Lombardia	37 282	29 738
Brescia	Lombardia	114 472	99 346
Pavia	Lombardia	137 985	118 159
Cremona	Lombardia	134 364	105 084
Mantova	Lombardia	161 271	105 541
Lecco	Lombardia	285	267
Lodi	Lombardia	53 106	44 394
	Lombardia	704 517	557 752
Pesaro e Urbino	Marche	9 430	4 429
Ancona	Marche	11 437	5 450
Macerata	Marche	15 812	7 617
Ascoli Piceno	Marche	12 879	7 703
	Marche	49 559	25 199
Campobasso	Molise	17 318	9 931
Isernia	Molise	3 563	1 881
	Molise	20 881	11 812
Torino	Piemonte	101 685	74 213
Vercelli	Piemonte	91 924	87 340
Novara	Piemonte	49 287	45 702
Cuneo	Piemonte	137 520	105 768
Asti	Piemonte	4 506	2 548
Alessandria	Piemonte	56 467	33 221
Biella	Piemonte	7 344	6 758
Verbano-Cusio-Ossola	Piemonte	315	268
	Piemonte	449 047	355 817
Foggia	Puglia	163 516	87 474
Bari	Puglia	97 510	71 948
Taranto	Puglia	47 125	35 404
Brindisi	Puglia	35 744	24 894
Lecce	Puglia	45 723	29 094
	Puglia	389 617	248 814
Sassari	Sardegna	42 246	11 018
Nuoro	Sardegna	24 401	9 706
Cagliari	Sardegna	67 027	24 964
Oristano	Sardegna	32 033	16 626
	Sardegna	165 707	62 314
Trapani	Sicilia	23 930	19 796
Palermo	Sicilia	17 724	13 370
Messina	Sicilia	13 807	9 634
Agrigento	Sicilia	26 214	17 814
Caltanissetta	Sicilia	9 341	7 662
Enna	Sicilia	4 387	3 328

Province	Region	Area equipped for irrigation 2000 (ha)	Area actually irrigated 2000 (ha)
Catania	Sicilia	47 413	40 882
Ragusa	Sicilia	30 060	20 745
Siracusa	Sicilia	36 161	27 813
	Sicilia	209 036	161 044
Massa-Carrara	Toscana	1 802	801
Lucca	Toscana	7 417	3 562
Pistoia	Toscana	4 355	3 501
Firenze	Toscana	6 248	3 029
Livorno	Toscana	14 335	5 697
Pisa	Toscana	9 136	3 499
Arezzo	Toscana	16 578	9 057
Siena	Toscana	16 834	7 317
Grosseto	Toscana	34 581	10 670
Prato	Toscana	318	152
	Toscana	111 603	47 286
Bolzano-Bozen	Trento, Aldo-Adige	40 478	38 025
Trento	Trento, Aldo-Adige	21 296	19 742
	Trento, Aldo-Adige	61 774	57 768
Perugia	Umbria	60 258	29 157
Terni	Umbria	6 669	2 960
	Umbria	66 927	32 117
	Valle Aosta	26 212	23 623
Verona	Veneto	119 760	90 538
Vicenza	Veneto	47 690	30 982
Belluno	Veneto	159	122
Treviso	Veneto	72 511	48 659
Venezia	Veneto	64 174	38 116
Padova	Veneto	51 259	28 653
Rovigo	Veneto	80 292	28 184
	Veneto	435 845	265 253
ITALY TOTAL		3 892 202	2 471 379

TABLE 63

Priorities used to assign irrigated area to areas classified as cultivated in the CORINE land cover 2000 data base for Italy

Attribute	Priority
Permanently irrigated land (212)	7
Rice fields (213)	7
Non-irrigated arable land (211)	6
Fruit trees and berry plantations (222)	6
Annual crops associated with permanent crops (241)	6
Complex cultivation patterns (242)	6
Vineyards (221) [†]	5
Olive groves (223)	5
Pastures (231)	5
Land principally occupied by agriculture, with significant areas of natural vegetation (243)	5

[†] : Priority level 6 was assigned to vineyard areas if located in the regions of Molise, Puglia, Sicilia, Trento, Alto Adige or Valle d'Aosta .

References:

- [IT01]: **Statistical Office of the European Communities (EUROSTAT)**. 2006. *Irrigation by regions*. Online data base (available at <http://epp.eurostat.ec.europa.eu>), 07/07/2006.
- [IT02]: **ISTAT**. 2002. *5° Censimento Generale dell' Agricoltura*. Online database available at: <http://censagr.istat.it/>, 11/01/2006.
- [IT03]: **EEA**. 2005. *Corine land cover 2000 – vector by country (CLC2000), version 1*. (available at: <http://dataservice.eea.europa.eu/dataservice/metadetails.asp?id=667>).
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- [IT06]: **Framji, K.K., Garg, B.C. & Luthra, S.D.L.** 1981. *Irrigation and drainage in the world*. Third edition. Vol. II, p. 702. New Delhi, ICID.

Latvia

Area equipped for irrigation was about 20 000 ha in 1995, all of it sprinkler irrigation [LV01]. However, the restructuring of the agricultural sector caused a strong decline of the area equipped for irrigation. According to EUROSTAT the irrigable area was 560 ha in 2000, 1150 ha in 2003 and 790 ha in 2005 [LV02]. Areas equipped with sprinkler irrigation infrastructure were reported by district for the year 2001 and were summing up to 569 ha [LV03]. The sprinkler irrigation areas by district were scaled so that the country totals were equal to the maximum irrigable area as reported by EUROSTAT (1150 ha). Area equipped for irrigation by district estimated that way is shown in Table 64.

The main irrigated crops are vegetables, potatoes, sugar beets and strawberries [LV01], [LV04]. Since irrigation maps were not available for Latvia, irrigated area was assigned to polygons as extracted from the Corine 2000 land cover database for Europe [LV05] classified as non-irrigated arable land (211), fruit trees and berry plantations (222) or complex cultivation patterns (242).

TABLE 64
Irrigated area per district in Latvia

District	Area equipped for irrigation in global map (ha)	District	Area equipped for irrigation in global map (ha)
Aizkraukles	168	Ludzas	24
Alūksnes	0	Madonas	12
Balvu	0	Ogres	63
Bauskas	91	Preiļi	0
Cēsu	20	Rēzeknes	77
Daugavpils	93	Rīgas	205
Dobeles	191	Saldus	0
Gulbenes	0	Talsu	0
Jelgavas	0	Tukuma	2
Jūrkabpils	2	Valkas	2
Krāslavas	4	Valmieras	164
Kuldīgas	26	Ventspils	4
Liepājas	0	LATVIA TOTAL	1 150
Limbāņu	2		

References:

- [LV01]: **FAO**. 1999. *Irrigation in the countries of the former Soviet Union*. FAO, Rome, Italy.

- [LV02]: **Statistical Office of the European Communities (EUROSTAT)**. 2006. *Irrigation by regions*. Online data base (available at <http://epp.eurostat.ec.europa.eu>), 07/07/2006.
- [LV03]: **Central Statistical Bureau of Latvia**. 2002. Results of 2001 Agricultural Census. Online data base available at: <http://data.csb.lv/EN/Database/Agriculture/Agriculture.asp>, 01/08/2006.
- [LV04]: **Kucera, L. & Genovese, G. (ed.)**. 2004. *Crop monographies on Central European countries – MOCA Study*. Joint Research Centre of the European Commission, Directorate General, Institute for the Protection and Security of the Citizen, Agriculture & Fisheries Unit, Ispra, Italy, available at: http://agrifish.jrc.it/marsstat/Crop_Yield_Forecasting/MOCA/INDEX.HTM, 07/07/2006.
- [LV05]: **EEA**. 2005. *Corine land cover 2000 – vector by country (CLC2000), version 1*. (available at: <http://dataservice.eea.europa.eu/dataservice/metadetails.asp?id=667>).

Liechtenstein

Reports, maps or statistical data indicating that irrigation would exist in Liechtenstein were not available. Therefore it was assumed that there is no irrigation.

Lithuania

The area equipped for irrigation was 42 700 ha in 1990, the largest part of the irrigation infrastructure (29 900 ha) was located on meadows and pastures [LI01]. As private owners started working on small plots there was no need anymore for large scale irrigation infrastructure. Therefore area equipped for irrigation declined to 9247 ha in 1995 [LI01], 8122 ha in 1998 [LI02] and 4416.3 ha in 2005 [LI03]. 3920.9 ha of the area equipped for irrigation are located on artificial drained land [LI03]. Area equipped for irrigation by oblast and raion is shown in Table 65.

Today the main irrigated crops are potatoes and vegetables [LI04]. Since irrigation maps were not available for Lithuania, irrigated area was assigned to polygons as extracted from the Corine 2000 land cover database for Europe [LI05] classified as non-irrigated arable land (211) or complex cultivation patterns (242).

TABLE 65

Irrigated area per oblast and raion in Lithuania

Raion	Oblast	Area equipped for irrigation 2005 (ha)	Raion	Oblast	Area equipped for irrigation 2005 (ha)
Alytaus	Alytus	89.0		Klaipeda	490.0
Druskininkai	Alytus	0.0	Marijampole	Marijampole	0.0
Lazdiju	Alytus	0.0	Marijampoles	Marijampole	0.0
Varenos	Alytus	0.0	Sakiu	Marijampole	352.0
	Alytus	89.0	Vilkaviskio	Marijampole	0.0
Birstonas	Kaunas	0.0		Marijampole	352.0
Jonavos	Kaunas	289.0	Birzu	Panevezys	372.0
Kaisiadoriu	Kaunas	0.0	Kupiskio	Panevezys	178.0
Kaunas	Kaunas	0.0	Panevezio	Panevezys	525.5
Kauno	Kaunas	0.0	Pasvalio	Panevezys	0.0
Kedainiu	Kaunas	299.8	Rokiskio	Panevezys	0.0
Prienu	Kaunas	0.0		Panevezys	1 075.5
Raseiniu	Kaunas	0.0	Akmenes	Siauliai	127.6
	Kaunas	588.8	Joniskio	Siauliai	242.0
Klaipedos	Klaipeda	150.0	Kelmes	Siauliai	0.0
Kretingos	Klaipeda	100.0	Pakruojo	Siauliai	0.0
Palanga	Klaipeda	0.0	Radviliskio	Siauliai	277.0
Siltues	Klaipeda	240.0	Siauliai	Siauliai	0.0
Skuodo	Klaipeda	0.0	Siauliu	Siauliai	0.0

Raion	Oblast	Area equipped for irrigation 2005 (ha)	Raion	Oblast	Area equipped for irrigation 2005 (ha)
	Siauliai	646.6	Utenos	Utena	0.0
Jurbarko	Taurage	200.0	Zarasu	Utena	0.0
Silales	Taurage	133.0		Utena	0.0
Taurages	Taurage	0.0	Salcininky	Vilnius	180.0
	Taurage	333.0	Sirvinty	Vilnius	148.0
Mazeikiu	Telsiai	0.0	Svencioniu	Vilnius	198.6
Plunges	Telsiai	0.0	Traky	Vilnius	181.8
Telsiu	Telsiai	0.0	Ukmerges	Vilnius	0.0
	Telsiai	0.0	Vilniaus	Vilnius	133.0
Anyksciu	Utena	0.0		Vilnius	841.4
Ignalinos	Utena	0.0		LITHUANIA	4 416.3
Moletu	Utena	0.0		TOTAL	

References:

- [LI01]: **FAO**. 1999. *Irrigation in the countries of the former Soviet Union*. FAO, Rome, Italy.
- [LI02]: **ICID**. unknown. *Country profile Lithuania*. Lithuanian National Committee of ICID, 13 pp., available at <http://www.icid.org>, 14/02/2006.
- [LI03]: **Ministry of Agriculture**. 2005. Register of Land equipped for irrigation on 01/01/2005, data table provided by **Dr. Antanas Maziliauskas**, President of the Lithuanian National Committee of ICID on 09/03/2006.
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Luxembourg

In Luxembourg only some small scale vegetable production is irrigated [LU01], but irrigation statistics were not available. 36 ha vegetable production was reported for Luxembourg and year 2002 [LU02]. It was assumed that 75% of the vegetable production is irrigated, which results in an estimate of 27 ha for the area equipped for irrigation.

Irrigation maps were not available for Luxembourg. Instead of it, area equipped for irrigation was assigned to polygons extracted from the Corine 2000 land cover database for Europe [LU03] classified as non-irrigated arable land (211) or complex cultivation patterns (242) that were located within polygons indicating coarse soil (sltxtcl = 1) as extracted from a European soil map [LU04].

References:

- [LU01]: **Baldock, D., Caraveli, H., Dwyer, J., Einschütz, S., Petersen, J.E., Sumpsi-Vinas, J. & Varela-Ortega, C.** 2000. *The environmental impacts of irrigation in the European Union*. A report to the Environment Directorate of the European Commission, 147 pp., available at: <http://ec.europa.eu/environment/agriculture/>, 07/07/2006.
- [LU02]: **Ministere de l'Agriculture, de la Viticulture et du Développement rural**. 2005. *L'agriculture luxembourgeoise en chiffres*. Service d'économie rurale, Luxembourg, 33 pp., available at: http://www.statistiques.public.lu/fr/publications/thematiques/Entreprises/Agriculture_en_chiffres/index.html, 07/07/2006.
- [LU03]: **EEA**. 2005. *Corine land cover 2000 – vector by country (CLC2000), version 1*. (available at: <http://dataservice.eea.europa.eu/dataservice/metadetails.asp?id=667>).
- [LU04]: **The Commission of the European Communities, Directorate General for Agriculture, Coordination of Agricultural Research**. 1985. *Soil Map of the European*

Communities at 1:1 000 000. The Office for Official Publications of the European Communities, ISBN 92-825-5427-9, L-2985 Luxembourg, 124 pages (modified version available in digital format as data set GNV153 at <http://www.grid.unep.ch/data/07/07/2006>).

Macedonia, the former Yugoslav Republic of

Area under irrigation in the former Yugoslav Republic of Macedonia is 163 700 ha of which sprinkler systems cover about 100 000 ha and surface irrigation methods 63 700 ha. However, most of the systems are in poor condition. Additionally parts of this area has been lost to urbanization, other parts never received water. It is reported, that 32% of the irrigation distribution system is completely out of use, 22% faces serious deterioration, 19% moderate deterioration and only 27% is fully serviceable. Thus, the actual extent of area equipped for irrigation is about 127 800 ha [MA01]. No sub-national irrigation statistics have been available.

41 irrigation areas located in the country were digitized from an irrigation map [MA02]. The area equipped for irrigation was reported for the 8 largest schemes (in total 104 449 ha). The corresponding area equipped for irrigation was assigned to agricultural land as extracted from the Corine 2000 land cover database for Europe [MA03] located within the digitized polygons. Polygons were extracted from the Corine database if classified as non-irrigated arable land (211), permanently irrigated land (212), rice fields (213), vineyards (221), fruit trees and berry plantations (222), pastures (231), annual crops associated with permanent crops (241), complex cultivation patterns (242) or land principally occupied by agriculture, with significant areas of natural vegetation (243).

References:

- [MA01]: **Vukelic, Z., Jankovic, J.T. & Kondinski, I.** 2006. Country report from Macedonia. In: Dirksen, W. and Huppert, W. (ed.). *Irrigation sector reform in Central and Eastern European countries*. Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), Eschborn, Germany, 251-328.
- [MA02]: **Ministry of Agriculture, Forestry and Water Supply.** 2005. *Irrigation systems*. Online documentation available at: <http://www.water.org.mk/plavo/currentstructures/Irrigation.htm>, 26/04/2005.
- [MA03]: **EEA.** 2005. *Corine land cover 2000 – vector by country (CLC2000)*, version 1. (available at: <http://dataservice.eea.europa.eu/dataservice/metadetails.asp?id=667>).

Malta

Area equipped for irrigation was 2300 ha in 2003, while the area actually used for irrigation was 2130 ha in the same year [MT01]. Sub-national irrigation statistics on the community level collected in the year 2001 reported an area equipped for irrigation of 1509 ha [MT02]. The area equipped for irrigation by community was scaled so that the country totals are equal to the value reported for the year 2003 (2300 ha). Area equipped for irrigation per community and locality computed that way is shown in Table 66.

To distribute area equipped for irrigation within the communities, irrigated area was assigned to polygons extracted from the Corine 2000 land cover data base for Europe [MT03] classified as non-irrigated arable land (211), permanently irrigated land (212), vineyards (221), pastures (231), complex cultivation patterns (242) or land principally occupied by agriculture, with significant areas of natural vegetation (243).

TABLE 66
Irrigated area per community and locality in Malta

Community	Locality	Area equipped for irrigation in global map (ha)	Community	Locality	Area equipped for irrigation in global map (ha)
Fontana and Rabat (Victoria)	Gozo and Comino	18.8	Ghasri	Gozo and Comino	8.4

Community	Locality	Area equipped for irrigation in global map (ha)	Community	Locality	Area equipped for irrigation in global map (ha)
Ghajnsielem	Gozo and Comino	14.5		Habour	
Gharb	Gozo and Comino	2.2	Birzebbugia	South Eastern	13.7
Kercem	Gozo and Comino	21.9	Ghaxaq	South Eastern	8.9
Munxar	Gozo and Comino	0.2	Gudja	South Eastern	30.6
Nadur	Gozo and Comino	42.4	Kirkop	South Eastern	2.3
Qala	Gozo and Comino	3.1	Marsaxlokk	South Eastern	38.9
San Lawrenz	Gozo and Comino	10.8	Marsascala	South Eastern	47.9
Sannat	Gozo and Comino	2.1	Mqabba	South Eastern	2.9
Xaghra	Gozo and Comino	51.6	Qrendi	South Eastern	23.6
Xewkija	Gozo and Comino	4.1	Safi	South Eastern	13.9
Zebbug (Gozo)	Gozo and Comino	25.4	Zejtun	South Eastern	72.5
	Gozo and Comino	205.6	Zurrieq	South Eastern	22.7
Gharghur	Northern	4.3		South Eastern	277.8
Mellieha	Northern	278.7	Birgu, Bormla and Isla	Southern Harbour	0.3
Mgarr	Northern	173.4	Fgura	Southern Harbour	1.2
Mosta	Northern	55.4	Floriana	Southern Harbour	0.0
Naxxar	Northern	41.0	Kalkara	Southern Harbour	13.5
San Pawl Il-Bahar	Northern	318.5	Luqa	Southern Harbour	9.5
	Northern	871.3	Marsa	Southern Harbour	2.4
Birkirkara	Northern Harbour	3.0	Paola	Southern Harbour	2.2
Gzira and Ta' Xbiex	Northern Harbour	0.2	Tarxien and Santa Lucija	Southern Harbour	5.2
Hamrun and Pieta	Northern Harbour	0.0	Valletta	Southern Harbour	0.0
Msida	Northern Harbour	0.9	Xghajra and Zabbar	Southern Harbour	211.7
Pembroke	Northern Harbour	0.0		Southern Harbour	246.0
Qormi	Northern Harbour	79.7	Attard	Western	29.8
San Giljan	Northern Harbour	2.3	Balzan and Lija	Western	6.4
San Gwann	Northern Harbour	6.8	Dingli	Western	81.8
Santa Venera	Northern Harbour	11.9	Iklin	Western	0.0
Sliema	Northern Harbour	0.0	Mdina and Rabat (Malta)	Western	294.4
Swieqi	Northern Harbour	7.0	Siggiewi	Western	124.2
	Northern	111.8	Zebbug (Malta)	Western	51.0
				Western	587.6
			MALTA TOTAL		2 300.0

References:

- [MT01]: **Statistical Office of the European Communities (EUROSTAT)**. 2006. *Irrigation by regions*. Online data base (available at <http://epp.eurostat.ec.europa.eu>), 07/07/2006.
- [MT02]: **National Statistics Office**. 2004. *Agriculture and fisheries 2002*. Valletta, Malta, 175 pp., available at: <http://www.nso.gov.mt>, 07/07/2006.

[MT03]: **EEA**. 2005. *Corine land cover 2000 – vector by country (CLC2000), version 1*. (available at: <http://dataservice.eea.europa.eu/dataservice/metadetails.asp?id=667>).

Moldova

Area equipped for irrigation was 312 000 ha in 1994 [MO01] but declined later to 302 100 ha in 2000 and 280 800 ha in 2002 [MO02]. In this study the value for 2002 (280 800 ha) is used as area equipped for irrigation. The area actually irrigated was about 190 000 ha in 1995 [MO03] but water use statistics published by the National Bureau of Statistics [MO04] indicate, that the area actually irrigated is lower nowadays. No sub-national irrigation statistics have been available.

The irrigation schemes of the country were digitized from an irrigation map [MO05] and the area equipped for irrigation was equally distributed over the digitized polygons.

References:

- [MO01]: **FAO**. 1999. *Irrigation in the countries of the former Soviet Union*. FAO, Rome, Italy.
- [MO02]: **National Bureau of Statistics**. 2006. *Agriculture (1997 – 2004 years)*. Online publication available at: <http://www.statistica.md/>, 13/02/2006.
- [MO03]: **FAO**. 1997. *Moldova – Irrigation rehabilitation project*. Annex 2: irrigation engineering. FAO, Rome, Italy.
- [MO04]: **National Bureau of Statistics**. 2005. *Agriculture (1995 – 2004 years)*. Online publication available at: <http://www.statistica.md/>, 30/08/2005.
- [MO05]: **Catrinescu, V., Calasnic, A. & Melian, R.** 1999. Irrigation in Moldova. In: European Regional Working Group (ERWG) of the ICID. *ERWG letter 7*, 1-4.

Monaco

It was assumed that irrigated agriculture does not exist in this urban centre.

Montenegro, Republic of

No statistics on area equipped for irrigation have been available. However, the maximum of the area actually irrigated during the period 2001 - 2005 was reported at 2115 ha for year 2005 [MN01]. It was assumed that this area also represents the area equipped for irrigation. No subnational statistics have been available.

Since irrigation maps have not been available for the Republic of Montenegro and the Kosovo area and the Corine 2000 land cover database for Europe did also not cover this region yet, it was decided to distribute irrigated land to areas extracted from the GLC2000 regional product for Europe [MN02] and classified there as "cultivated and managed".

References:

- [MN01]: **Statistical Office of the Republic of Montenegro**. 2006. *Statistical Yearbook 2006*. MONSTAT, Podgorica, Montenegro, 346 pp.
- [MN02]: **Hartley, A.** 2006. *The land cover map for Europe for the year 2000*. GLC2000 database, European Commission Joint Research Centre, available at <http://www-gem.jrc.it/glc2000>.

Netherlands

Area equipped for irrigation was available at the municipality level [NL01] and was summing up to 475 098 ha. However, for 19 out of the 544 municipalities the database had no data. After replacing these no-data-values by data using the reported irrigation densities in neighbouring municipalities total area equipped for irrigation was summing up to 476 315 ha. Area actually irrigated is varying from year to year depending on the specific climate in the reference year. In the wet growing season 1998/1999 area actually irrigated was only 123 300 ha while it was 308 700 ha in the dry growing season 1996/1997 [NL02]. Area equipped for irrigation by

province is shown in Table 67, while the data at the municipality level are available as part of the online-documentation of the global irrigation map at <http://www.fao.org/ag/agl/aglw/aquastat/irrigationmap/index.stm>.

The main irrigated crops in the Netherlands are grass, maize, potatoes and vegetables [NL02]. Irrigated area was therefore assigned to polygons extracted from the Corine 2000 land cover database for Europe [NL03] classified as non-irrigated arable land (211), pastures (231), complex cultivation patterns (242) or land principally occupied by agriculture, with significant areas of natural vegetation (243).

TABLE 67
Irrigated area per province in the Netherlands

Province	Area equipped for irrigation (ha)	Province	Area equipped for irrigation (ha)
Drenthe	22 798	Overijssel	48 440
Flevoland	28 596	Utrecht	14 734
Friesland	21 777	Zeeland	4 467
Gelderland	78 109	Zuid-Holland	16 591
Groningen	19 497	NETHERLANDS TOTAL	476 315
Limburg	50 218		
Noord-Brabant	139 738		
Noord-Holland	31 350		

References:

- [NL01]: GIS-polygon shapefile provided by **Timo Kroon**, Rijkswaterstaat (RIZA) on 27/02/2006 and compiled for the Droogtestudie Nederland [NL02].
- [NL02]: **Hoogeveen, M.W., van Bommel, K.H.M. & Cotteleer, G.** 2003. *Berekening in land- en tuinbouw. Rapport voor de Droogtestudie Nederland*. Rapport 3.03.02, LEI, Den Haag, Netherlands, 64 pp., available at: <http://www.lei.wur.nl/nl/publicaties+en+producten/leipublicaties/?n=3.03.02, 02/08/2006>.
- [NL03]: **EEA.** 2005. *Corine land cover 2000 – vector by country (CLC2000), version 1.* (available at: <http://dataservice.eea.europa.eu/dataservice/metadetails.asp?id=667>).

Norway

Area equipped for irrigation was increasing in Norway from 68 815 ha in 1979 to 90 670 ha in 1989 and 134 396 ha in 1999 [NO01]. Irrigation is mainly practiced on soils of low or moderate water holding capacity in South-East Norway in locations east of the mountains trapping rain water. However, in some isolated valleys in the inland the yearly amount of precipitation is down to 320 mm. Here agriculture (cereals/grass) is not possible without irrigation. The main irrigated crops are berries, vegetables, cereals, potatoes and grass [NO02]. Area equipped for irrigation by county is shown in Table 68.

A inventory of soil properties on agricultural land [NO03] was used to distribute area equipped for irrigation within the counties. The inventory does not cover entire Norway but the largest part of the areas used for agricultural production. Among many other soil properties the inventory provides the water holding capacity of the topsoil (upper 60 cm) in four classes. Irrigated area was assigned to all soils of low water holding capacity (<50 mm) and to soils of moderate water holding capacity (50 – 90 mm). In total 77 845 ha of irrigated area were assigned to those soil regions. The remaining part of area equipped for irrigation was assigned to cultivated areas in regions not covered by the soil inventory and to soils of higher water holding capacity. Polygons for the cultivated land were extracted from a digital data set also available from the Norwegian Institute of Land Inventory [NO04]. This data set had lower resolution but covered the entire country.

TABLE 68
Irrigated area per county in Norway

County	Area equipped for irrigation 1999 (ha)	County	Area equipped for irrigation 1999 (ha)
Østfold	12 472	Hordaland	3 113
Akershus and Oslo	8 169	Sogn og Fjordane	7 552
Hedmark	25 242	Møre og Romsdal	2 036
Oppland	26 668	Sør-Trøndelag	1 645
Buskerud	13 261	Nord-Trøndelag	2 500
Vestfold	12 325	Nordland	1 257
Telemark	4 242	Troms	603
Aust-Adger	3 339	Finnmark	479
Vest-Adger	3 330	NORWAY TOTAL	134 396
Rogaland	6 164		

References:

- [NO01]: **Statistics Norway**. 2003. *Census of agriculture 1999*. Report No. NOS C 746, Oslo - Kongsvinger, Norway, 202 pp., available at: http://www.ssb.no/english/subjects/10/04/10/nos_jt1999_en/, 07/07/2006.
- [NO02]: **Arnold Arnoldussen**, Norwegian Institute of Land Inventory (NIJOS), personal communication.
- [NO03]: **Norwegian Institute of Land Inventory (NIJOS)**. 2006. *Jordsmonndatabasen, Vanlagringsevne per commune*. Maps in GIS-format available online at: <http://www.nijos.no/index.asp?topExpand=&subExpand=&menuid=1000523&strUrl=1002320i&context=14>, 03/08/2006.
- [NO04]: **Norwegian Institute of Land Inventory (NIJOS)**. 2006. *Arealressurskart AR 2000*. Map in GIS-format available online at: <http://www.nijos.no/index.asp?topExpand=&subExpand=&menuid=1000458&strUrl=1002109i&context=17>, 03/08/2006.

Poland

The extent of irrigated land reached its maximum in Poland in 1975 (408 700 ha) and declined later to 301 500 ha in 1990, 201 100 ha in 1995 and 83 292 ha in 2003. Sub-surface irrigation of permanent grasslands in wetlands and inland valley bottoms in combined drainage / irrigation schemes is dominant in Poland. The area of ameliorated grasslands is about 1 931 000 ha and about 25% of the drained grasslands are equipped with hydraulic structures that would in general allow to irrigate them. However, in 2004 only 89 000 ha of grasslands were classified as irrigable. The corresponding figures for arable land listed only 5300 ha, mainly by micro-irrigation [PL01]. In contrast, the statistics published by EUROSTAT indicate that the extent of both, irrigable and actually irrigated area started recently to increase again. The irrigable area of Poland was reported at 98 420 ha in 2003 and 124 200 ha in 2005 while the area actually irrigated was 46 910 ha in 2003 and 70 450 ha in 2005 [PL02]. Because of the given uncertainties area equipped for irrigation was estimated for this study by selecting for each province the maximum of the areas reported as irrigable for the years 2003 and 2005. Area equipped for irrigation by province is shown in Table 69 and is summing up to 134 050 ha.

To distribute irrigated areas within the provinces, pasture areas were extracted from the Corine 2000 land cover database for Europe [PL03]. Additionally the major irrigation areas of the country were digitized from irrigation maps [PL04], [PL05]. Then irrigated area was assigned to all pasture polygons within the digitized irrigation areas or to pasture polygons that were located along the major rivers of the country.

TABLE 69
Irrigated area per province in Poland

Province	Irrigable area 2003 (ha)	Irrigable area 2005 (ha)	Area equipped for irrigation in global irrigation map (ha)
Dolnoslaskie	5 890	4 520	5 890
Kujawsko-Pomorskie	11 780	11 810	11 810
Lódzkie	9 630	12 330	12 330
Lubelskie	2 810	4 670	4 670
Lubuskie	4 050	6 100	6 100
Malopolskie	610	1 140	1 140
Mazowieckie	11 740	25 140	25 140
Opolskie	1 170	670	1 170
Podkarpackie	620	190	620
Podlaskie	3 380	1 740	3 380
Pomorskie	8 300	6 670	8 300
Slaskie	960	880	960
Swietokrzyskie	760	530	760
Warminsko-Mazurskie	9 820	24 040	24 040
Wielkopolskie	15 730	16 560	16 560
Zachodniopomorskie	11 180	7 230	11 180
POLAND TOTAL	98 430	124 220	134 050

References:

- [PL01]: **Labeledzki, L., Kuzniar, A., Lipinski, J. & Mioduszewski, W.** 2006. Country report from Poland. In: Dirksen, W. and Huppert, W. (ed.). *Irrigation sector reform in Central and Eastern European countries*. Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), Eschborn, Germany, 329-384.
- [PL02]: **Statistical Office of the European Communities (EUROSTAT)**. 2006. *Irrigation by regions*. Online data base (available at <http://epp.eurostat.ec.europa.eu>), 07/07/2006.
- [PL03]: **EEA**. 2005. *Corine land cover 2000 – vector by country (CLC2000), version 1*. (available at: <http://dataservice.eea.europa.eu/dataservice/metadetails.asp?id=667>).
- [PL04]: **Framji, K.K., Garg, B.C. & Luthra, S.D.L.** 1981. *Irrigation and drainage in the world*. Third edition. Vol. II, p. 1115. New Delhi, ICID.
- [PL05]: **Achtnich, W.** 1980. *Bewässerungslandbau*. Map on p. 26, Ulmer, Stuttgart, Germany.

Portugal

According to the data reported by EUROSTAT irrigated area in Portugal was decreasing during the last 15 years. While area equipped for irrigation was 877 690 ha in 1990, it decreased to 796 540 ha in 1995 and 791 990 ha in 2000. For the year 2003 the reported irrigable area was even much lower at 674 800 ha. The same trend was reported for the year actually irrigated, which was 631 120 ha in 1990 but only 248 040 ha in 2003 [PT01]. The agricultural census undertaken in 1999 reported an area equipped for irrigation of 792 008 ha and an area actually used for irrigation of 606 213 ha [PT02]. These census data were also used in this study because the area equipped for irrigation was reported down to 306 NUTS III units. Area equipped per NUTS II region and is shown in Table 70, while the corresponding areas by NUTS III division are available as part of the online-documentation of the global irrigation map at <http://www.fao.org/ag/agl/aglw/aquastat/irrigationmap/index.stm>.

In order to distribute irrigated areas within the municipalities, irrigation areas were extracted from a digital land use map at the scale 1 : 250 000 [PT03] and from the Corine 2000 land cover database for Europe [PT04]. The large-scale irrigation areas shown on an irrigation map of the country [PT05] were represented very well that way. 421 805 ha irrigated areas were assigned in total to polygons extracted from the two digital data sets. The remaining irrigated

area was assigned to polygons also extracted from the Corine 2000 land cover database for Europe [PT04] but classified as rainfed agriculture. The priority levels used thereby are shown in Table 71. Since the Corine 2000 database did not cover the island of Madeira, cultivated land was digitized from satellite imagery [PT06] and irrigated areas were assigned to the digitized polygons.

TABLE 70
Irrigated area per NUTS-2 region in Portugal

NUTS-2 region	Area equipped for irrigation 1999 (ha)	NUTS-2 region	Area equipped for irrigation 1999 (ha)
Açores	0	Entre Douro e Vouga	7 632
Alentejo Central	42 675	Grande Lisboa	9 185
Alentejo Litoral	40 289	Grande Porto	16 717
Algarve	30 013	Lezíria do Tejo	85 981
Alto Alentejo	39 974	Madeira	4 751
Alto Trás-os-Montes	68 884	Médio Tejo	16 519
Ave	23 844	Minho-Lima	25 692
Baixo Alentejo	39 357	Oeste	22 605
Baixo Mondego	26 619	Península de Setúbal	21 927
Baixo Vouga	20 156	Pinhal Interior Norte	10 080
Beira Interior Norte	30 058	Pinhal Interior Sul	4 359
Beira Interior Sul	25 546	Pinhal Litoral	9 937
Cávado	28 168	Serra da Estrela	9 241
Cova da Beira	23 507	Tâmega	46 245
Dão-Lafões	37 828	PORTUGAL TOTAL	792 008
Douro	24 219		

TABLE 71
Priorities used to assign irrigated area to polygons classified as rainfed agriculture in the CORINE land cover 2000 data base for Portugal

Attribute	Priority
Non-irrigated arable land (211)	5
Fruit trees and berry plantations (222)	5
Annual crops associated with permanent crops (241)	5
Complex cultivation patterns (242)	5
Vineyards (221)	4
Olive groves (223)	4
Pastures (231)	4
Land principally occupied by agriculture, with significant areas of natural vegetation (243)	4

References:

- [PT01]: **Statistical Office of the European Communities (EUROSTAT)**. 2006. *Irrigation by regions*. Online data base (available at <http://epp.eurostat.ec.europa.eu>), 07/07/2006.
- [PT02]: **Instituto Nacional de Estatística**. 2003. *Recenseamento Geral da Agricultura 1999. Principais Resultados por Região Agrária*. Data are available online at: http://www.ine.pt/prodserv/Rga/publicacaopdf_ra.htm, 25/08/2005.
- [PT03]: **Instituto Geográfico Português**. 2001. *Carta de Ocupação de solo de 1990*. Digital data set available at: <http://www.igeo.pt/IGEO/portugues/Frameset-gegeo.htm>, 08/08/2005.
- [PT04]: **EEA**. 2005. *Corine land cover 2000 – vector by country (CLC2000), version 1*. (available at: <http://dataservice.eea.europa.eu/dataservice/metadetails.asp?id=667>).
- [PT05]: **Freund, B.** 1993. *Entwicklung und Perspektiven der Bewässerungswirtschaft in Portugal*. In H. Popp & K. Rother, eds. *Die Bewässerungsgebiete im Mittelmeerraum*, Passau, Germany, Passavia Universitätsverlag, 9-16.

[PT06]: **Earth Satellite Corporation**. 2004. *Landsat GeoCover (2000/ETM+) Edition Mosaics*, tile 071-170. Sioux Falls, USA, USGS (available at <http://glcfapp.umiacs.umd.edu:8080>).

Romania

The total agricultural land reclaimed for irrigation reached its maximum in 1996 at 3 210 000 ha and declined later to 3 176 000 ha in 2003 [RO01]. Depending on the source of information the figures on area actually irrigated vary considerably (Table 72). However, the statistics agree that from 1991 onwards a large part of the irrigation infrastructure was not used anymore. The minimum extent of the actually used irrigation areas was reported for the period 1998-2000 when less than 10% of the reclaimed irrigation area was irrigated (Table 72). At this time a program started to establish water user's associations and to transfer the on-farm irrigation infrastructure to them. Additionally an irrigation rehabilitation program, supported by the World Bank, started in regions of high crop water requirements. As a consequence of these activities the area actually used for irrigation was increasing again. Nevertheless it is very unlikely that all the former irrigation areas will be re-activated within the next years. A study carried out in 1994 with the support of the World Bank for example clearly indicated that irrigation is not economic in the higher terraces, even if agriculture redevelops, and should be discontinued so as not to waste further resources [RO02]. This, and the fact that a large part of the irrigation infrastructure has not been used for a long time shows that it is not useful to consider all the reclaimed irrigation area still as equipped for irrigation. EUROSTAT reported the irrigable area for the year 2003 at 1 510 830 ha [RO03], which is about half of the area developed in former times. These figures might refer to the so called 'area declared prepared for irrigation', which was 2 121 238 ha in 1999, 1 502 642 ha in 2000, 900 678 ha in 2001 and 1 222 000 ha in 2002 [RO02]. For this study area equipped for irrigation was taken out of a table published in [RO01] listing the total area of schemes in counties where water user's associations are established (as per 31/12/2004). The statistics were given for 24 counties covering by far the largest part of the former irrigation zones and were summing up to 2 021 911 ha. Area equipped for irrigation for the other counties was estimated based on a map published in the same report showing the former reclaimed irrigation areas. The total area equipped for irrigation computed that way for the 17 counties missing in the statistics was 127 992 ha which gives a total sum of 2 149 903 ha for the whole country. Area equipped for irrigation by county is shown in Table 73.

Area equipped for irrigation was assigned to polygons extracted from the Corine 2000 land cover database for Europe [RO04] that were located within the digitized irrigation areas and that were classified as non-irrigated arable land (211), permanently irrigated land (212), rice fields (213), vineyards (221), fruit trees and berry plantations (222), pastures (231), complex cultivation patterns (242) or land principally occupied by agriculture, with significant areas of natural vegetation (243).

TABLE 72

Irrigation statistics for Romania in the period 1990-2003 (1000 ha)

Source / year	Area reclaimed for irrigation		----- Area actually irrigated -----	
	NLRA (2004) in [RO01]	[RO05]	[RO02]	NLRA (2004) in [RO01]
1990	3169			2218
1992	3200	450		509
1993		520		
1994	3200	420		794
1995	3205	498		
1996	3210	367		623
1997		249		
1998	3180	440		235

Source / year	Area reclaimed for irrigation		----- Area actually irrigated -----	
	NLRA (2004) in [RO01]	[RO05]	[RO02]	NLRA (2004) in [RO01]
1999			85	
2000	3175		216	216
2001			327	
2002	3177			489
2003	3176			568

TABLE 73

Irrigated area per county in Romania

County	Area equipped for irrigation in global map (ha)	County	Area equipped for irrigation in global map (ha)
Alba	4 204	Harghita	0
Arad	24 178	Hunedoara	5 622
Arges	6 644	Ialomita	168 585
Bacau	16 179	Iasi	33 824
Bihor	2 964	Maramures	0
Bistrita-Nasaud	0	Mehedinti	78 810
Botosani	1 497	Mures	1 183
Braila	330 056	Neamt	3 735
Brasov	1 851	Olt	159 916
Bucuresti	10 081	Prahova	5 263
Buzau	34 336	Sălaj	0
Calarasi	147 447	Satu Mare	4 613
Caras-Severin	617	Sibiu	1 563
Cluj	5 880	Suceava	4 687
Constanta	255 731	Teleorman	231 963
Covasna	4 329	Timis	12 622
Dîmbovita	23 931	Tulcea	32 296
Dolj	252 065	Vaslui	16 937
Galati	136 825	Vîlcea	6 700
Giurgiu	84 915	Vrancea	37 291
Gorj	562	ROMANIA TOTAL	2 149 903

References:

- [RO01]: **Nicolaescu, I., Buhociu, L., Condruz, R., Suciu, G.-I., Paraschiv, D. & Boeru, M.** 2006. Country report from Romania. In: Dirksen, W. and Huppert, W. (ed.). *Irrigation sector reform in Central and Eastern European countries*. Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), Eschborn, Germany, 385-462.
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- [RO05]: **Öko Inc. Budapest.** 2001. *Agricultural water management policies in Bulgaria, Hungary, Romania and Slovakia. Final report*. Budapest, Hungary, 35 pp.

Russian Federation

The area equipped for irrigation of the whole Russian Federation covered 6 120 000 ha in 1990 [RU01] but declined later to 5 114 000 ha in 1995, 4 868 000 ha in 1997 [RU02] and 4 454 100 ha in 2003 [RU03]. 1 015 600 ha of the irrigated areas are also equipped with drainage facilities. The area actually irrigated was about 3 430 000 ha in 2003 [RU03]. Several national programs, partly already accepted by the parliament, document efforts to rehabilitate large parts of the irrigation infrastructure and to reclaim new irrigation areas in the near future. In fact the latest statistics indicate that area equipped for irrigation is already increasing again in Russia [RU03]. Sub-national irrigation statistics have been available for the year 1997 [RU02]. Area equipped for irrigation in the oblasts Kalmykia, Krasnodar, Stavropol, Astrakhan and Volgograd, where about 27% of the Russian irrigation area is concentrated, were replaced by more recent statistics referring to the situation in year 2003 [RU03]. In the sub-national statistics the area equipped for irrigation was missing for the Chechen oblast. The missing value was replaced by the area reported recently for the year 2002 (138 000 ha, <http://www.chechnyafree.ru/index.php?section=diaryeng&rowid=2674&query=irrigation>). After this replacement area equipped for irrigation per oblast was summing up to 4 899 900 ha, out of which 4 002 900 ha were located in the European part of the country and 897 000 ha in the Asian part. Area equipped for irrigation by oblast in the European part of the country is shown in Table 74.

The irrigated areas and arable land were derived from a land-use map [RU04] provided by the International Institute for Applied Systems Analysis. In the more northern parts of Russia, only a few areas are classified as irrigated. Therefore, irrigated areas were also distributed to other agricultural areas using the priorities as documented in Table 75. Irrigated area was first distributed only to cells with a priority of 7, then to cells with a priority of 6, and so on until the sum of the distributed irrigated area was equal to the irrigated area of the specific oblast as derived from the statistics.

TABLE 74

Irrigated area per oblast in the European part of Russia

Oblast	Area equipped for irrigation in global map (ha)	Oblast	Area equipped for irrigation in global map (ha)
Adygea	27 000	Kursk	45 000
Arkhangel'sk	1 000	Leningrad	25 000
Astrakhan'	186 600	Lipetsk	58 000
Bashkortosan	65 000	Mari El	15 000
Belgorod	57 000	Mordovia	45 000
Bryansk	6 000	Moscow	143 000
Chechen	138 000	Murmansk	0
Chuvasia	24 000	Nenetsia	0
Dagestan	387 000	Nizhniy Novgorod	26 000
Ingush	23 000	Novgorod	2 000
Ivanovo	9 000	Orel	7 000
Kabardino-Balkaria	130 000	Orenburg	88 000
Kaliningrad	2 000	Penza	68 000
Kalmykia	44 400	Perm'	17 000
Kaluga	18 000	Permyakij	0
Karachay-Cherkessia	20 000	Pskov	3 000
Karelia	0	Rostov	325 000
Kirov	8 000	Ryazan'	34 000
Komi	0	Samara	179 000
Kostroma	3 000	Saratov	258 000
Krasnodar	394 500	Severo-Ossetinsk	77 000

Oblast	Area equipped for irrigation in global map (ha)	Oblast	Area equipped for irrigation in global map (ha)
Smolensk	2 000	Vladimir	34 000
Stavropol'	351 700	Volgograd	256 700
Tambov	53 000	Vologda	4 000
Tatarstan	169 000	Voronezh	90 000
Tula	20 000	Yaroslavl'	8 000
Tver'	6 000	Zemlya Frantsa-Iosifa	0
Udmurtia	22 000	RUSSIA (EUROPEAN PART) TOTAL	4 002 900
Ul'yanovsk	28 000		

TABLE 75
Priorities assigned to specific land uses to distribute irrigated areas within oblasts in the European part of Russia

Dataset	Attribute information	Priority
RU04	Irrigated cropland	7
RU04	Irrigated cropland (more than 50%) combined with multiyear plantation	7
RU04	Irrigated meadows	7
RU04	Irrigated multiyear plantation	7
RU04	Irrigated multiyear plantation (more than 50%) combined with irrigated cropland	7
RU04	Cropland	6
RU04	Cropland (more than 50%) combined with forest	6
RU04	Cropland (more than 50%) combined with improved forage land, forest and bushes	6
RU04	Cropland (more than 50%) combined with multiyear plantation	6
RU04	Cropland (more than 50%) combined with natural and improved forage land	6
RU04	Cropland (more than 50%) combined with natural forage land	6
RU04	Cropland (more than 50%) combined with natural forage land and forest	6
RU04	Desert and semi-desert combined with cropland (up to 20%)	6
RU04	Improved forage land combined with cropland (up to 20%)	6
RU04	Multiyear plantation	6
RU04	Multiyear plantation (more than 50%) combined with cropland	6
RU04	Forest combined with cropland (up to 20%) and natural meadow forage land	5
RU04	Forest combined with natural forage land and cropland (up to 20%)	5
RU04	Meadow and meadow-steppe combined with cropland (up to 30%) and forest	5
RU04	Meadow and meadow-steppe combined with cropland (up to 30%), forest and bogs	5
RU04	Meadow and meadow-steppe combined with cropland (up to 30%), forest and solonchaks	5
RU04	Meadows combined with improved meadows, forest and cropland (up to 30%)	5
RU04	Natural forest forage land combined with cropland (up to 20%)	5
RU04	Natural meadow forage land combined with cropland (up to 20%) and forest	5
RU04	Park forest and bushes combined with cropland (up to 20%)	5
RU04	Park forest and bushes combined with cropland (up to 20%) and bogs	5
RU04	Sparse forest and open woodland combined with cropland (up to 20%)	5
RU04	Steppe combined with cropland (up to 20%)	5
RU05	Little used in agriculture	4

References:

- [RU01]: **FAO**. 1999. *Irrigation in the countries of the former Soviet Union*. FAO, Rome, Italy.
- [RU02]: **Goscomstat**. 1998. *Environment protection in Russia*. Moscow.
- [RU03]: **Kireycheva, L.V., Glazunova, I.V. & Belova, I.V.** 2006. Country report from Russia. In: Dirksen, W. and Huppert, W. (ed.). *Irrigation sector reform in Central and Eastern European countries*. Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), Eschborn, Germany, 463-524.

[RU04]: **Stolbovoi, V. & McCallum, I.** 2002. *Land resources of Russia*, map 'Land Use'. Version 1.1. CD-ROM. Laxenburg, Austria, IIASA, available at <http://www.iiasa.ac.at>, 29/07/2004.

San Marino

It was assumed that irrigated agriculture does not exist in San Marino.

Serbia

Under the former Federal Republic of Yugoslavia, about 120 000 ha of agricultural land were equipped for irrigation in 288 schemes in Serbia Montenegro [SE01], while in the Kosovo area about 68 000 ha were equipped for irrigation [SE02]. However, at present only about 35 000 ha of schemes are fully operational in Serbia and 47 000 ha are partially functional. This is caused for example by the shortage of markets, redistribution of the Kombinats, adverse farmer financial positions, deterioration in the physical systems, land ownership problems, legal changes and institutional weakness [SE01]. In the Kosovo region the area equipped for irrigation dropped to 23 000 ha in 1999 due to the devastation of war and the lack of maintenance. Thanks to donor contribution about 51 000 ha were under irrigation again in 2002 [SE03] and the actual extent of the irrigation schemes was given at 77 000 ha [SE02]. The area actually used for irrigation was 39 110 ha in Serbia in year 2003 [SE04] and about 33 000 ha in Kosovo in year 2004 [SE05]. The sub-national irrigation statistics as shown in Table 76 were compiled from two different sources. For Serbia area equipped for irrigation by region was assumed to be represented by the maximum of the area intended to be used for irrigation in the period 2001-2005 [SE06]. The total area was summing up to 86 311 ha. For the Kosovo, the actually irrigated area as derived from the agricultural household survey 2004 by municipality [SE05] was scaled to meet the figures for the total area equipped for irrigation in the entire region (77 000 ha).

Since irrigation maps have not been available for Serbia and the Kosovo area and the Corine 2000 land cover database for Europe did also not cover this region yet, it was decided to distribute irrigated land to areas extracted from the GLC2000 regional product for Europe [SE07] and classified there as "cultivated and managed".

TABLE 76
Irrigated area per district and main region in Serbia

District	Main region	Area equipped for irrigation in global map (ha)	District	Main region	Area equipped for irrigation in global map (ha)
Borski	Central Serbia	10 000	Zajecarski	Central Serbia	1 158
Branicevski	Central Serbia	629	Zlatiborski	Central Serbia	0
Grad Beograd	Central Serbia	0	Central Serbia		40 010
Jablanicki	Central Serbia	1 330	Decan	Kosovo	5 544
Kolubarski	Central Serbia	1 250	Dragash	Kosovo	231
Macvanski	Central Serbia	14 700	Ferizai	Kosovo	2 156
Moravicki	Central Serbia	0	Fushe Kosovo	Kosovo	2 002
Nisavski	Central Serbia	4 000	Gjakova	Kosovo	3 311
Pcinjski	Central Serbia	273	Gjilan	Kosovo	3 696
Pirotski	Central Serbia	2 000	Glogoc	Kosovo	3 773
Podunavski	Central Serbia	3 650	Istog	Kosovo	4 543
Pomoravski	Central Serbia	1 020	Kachanik	Kosovo	1 771
Rasinski	Central Serbia	0	Kamenica	Kosovo	2 849
Raski	Central Serbia	0	Kline	Kosovo	1 617
Sumadijski	Central Serbia	0	Leposavic	Kosovo	2 772
Toplicki	Central Serbia	0	Lipjan	Kosovo	2 926

District	Main region	Area equipped for irrigation in global map (ha)	District	Main region	Area equipped for irrigation in global map (ha)
Malisheva	Kosovo	847	Zubin Potok	Kosovo	847
Mitrovica	Kosovo	1 001	Zvecan	Kosovo	1 309
Novo Brde	Kosovo	308		Kosovo	77 000
Obiliq	Kosovo	1 001	Juzno-banatski	Voivodina	6 760
Peje	Kosovo	6 853	Juzno-backi	Voivodina	3 000
Podujevo	Kosovo	4 312	Severno-banatski	Voivodina	21 000
Prishtina	Kosovo	3 234	Severno-backi	Voivodina	1 441
Prizren	Kosovo	2 772	Sremski	Voivodina	10 000
Rahovec	Kosovo	4 466	Srednje-banatski	Voivodina	2 500
Shterpce	Kosovo	2 310	Zapadno-backi	Voivodina	1 600
Shtime	Kosovo	1 078		Voivodina	46 301
Skenderaj	Kosovo	1 463		SERBIA TOTAL	163 311
Suha Reka	Kosovo	3 003			
Viti	Kosovo	2 156			
Vushtrii	Kosovo	2 849			

References:

- [SE01]: **World Bank**. 2005. *Serbia irrigation and drainage rehabilitation project*. Project appraisal document. Report No: 32379-YF, available at: <http://www-wds.worldbank.org/>, 02/07/2006.
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- [SE05]: **Statistical Office of Kosovo**. 2005. *Agricultural household survey 2004*. Pristine, Kosovo, 32 pp., available at: <http://www.ks-gov.net/esk/>, 05/08/2006.
- [SE06]: **The Agriculture Inspection of the Republic of Serbia**. unknown. A survey of the arable agriculture land in the Republic of Serbia intended for irrigation (for the period 2001-2005). Table 1.1 in: Ministry for the Protection of the Natural Resources and Environment. 2001. *State of the Environment in 2000 and priorities in 2001+ for Serbia*. Online publication available at: <http://enrin.grida.no/htmls/yugo/serb/index.htm>, 05/08/2006.
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Slovak Republic

Irrigation infrastructure was constructed on 308 200 ha of agricultural land [SK01]. The area actually used for irrigation was 158 000 ha in 1992, 142 000 ha in 1994, 99 000 ha in 1995 and reached a minimum with 70 000 ha in the period 1996-1998 [SK02]. After this period area actually used for irrigation was larger again and was reported at 110 665 ha in 2001 [SK03] and 104 550 ha in 2003 [SK04]. The irrigable area was 225 310 ha in 2001 [SK03] which means that parts of the former infrastructure cannot be used anymore. Area equipped for irrigation by region is shown in Table 77.

The main irrigation areas of the country were digitized from an irrigation map. The map showed areas in operation, areas under construction and planned irrigation areas of the former

Czechoslovakia [SK05]. Irrigated area was then assigned to cultivated land extracted from the Corine 2000 land cover data base for Europe [SK06] using the priorities shown in Table 78. In the regions of Zilina and Presov irrigated area was assigned to all areas classified as vineyards (221), fruit trees and berry plantations (222) or complex cultivation patterns (242) because none of the digitized irrigation areas was located within these regions.

TABLE 77
Irrigated area per region in the Slovak Republic

Region	Area equipped for irrigation 2001 (ha)	Area actually irrigated 2001 (ha)
Bratislava	25 260	14 539
Trnava	94 040	50 725
Trenčín	9 111	2 706
Nitra	71 190	33 823
Žilina	1 032	866
Banská Bystrica	13 498	5 008
Prešov	861	592
Košice	10 318	2 406
SLOVAK REPUBLIC TOTAL	225 310	110 665

TABLE 78
Priorities used to assign irrigated area to cultivated areas in Slovakia

Attribute in Corine land cover 2000 data base	Status of digitized irrigation areas (1970's)	Priority
Non-irrigated arable land (211) or vineyards (221) or fruit trees and berry plantations (222) or complex cultivation patterns (242)	"operating" or "under construction"	7
Non-irrigated arable land (211) or vineyards (221) or fruit trees and berry plantations (222) or complex cultivation patterns (242)	"planned"	6
Vineyards (221) or fruit trees and berry plantations (222) or complex cultivation patterns (242)	-	5

References:

- [SK01]: **Slovak National Committee of ICID**. unknown. *Slovak Republic*. ICID country profile available at: http://icid.org/index_e.html, 07/07/2003.
- [SK02]: **Óko Inc. Budapest**. 2001. *Agricultural water management policies in Bulgaria, Hungary, Romania and Slovakia. Final report*. Budapest, Hungary, 35 pp.
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Slovenia

The area equipped for irrigation was 6500 ha in 1995, most of it located in the Savinja valley, Podravje region and Vipava valley [SI01]. After a severe drought (1992-1993) a National Irrigation Program was prepared and based on a feasibility study undertaken by the World Bank (1997-1999) the development of an additional irrigation area of 10 000 ha was suggested [SI02]. The total area equipped for irrigation is now 15 643 ha in Slovenia [SI03]. It is necessary to draw attention to the fact that the irrigated area of the country is underestimated in the official statistical yearbook [SI04] and in the statistics reported by EUROSTAT [SI05] as well. The

reason maybe that most of the irrigation facilities are of very small extent and many of them operate without any authorization for water withdrawal [SI02].

No updated sub-national irrigation statistics have been available, but, instead of it, a rather detailed map showing the location and extent of the single irrigation areas [SI06]. Area equipped for irrigation was distributed equally over the polygons digitized from this map.

References:

- [SI01]: **World Bank**. 1997. *Slovenia – Irrigation project*. Working paper 3: Water resources and irrigation in Slovenia. Report available in the AQUASTAT library.
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- [SI03]: **Maticic, B.** (President of Slovenian National Committee on Irrigation and Drainage), personal communication.
- [SI04]: **Statistical Office of the Republic of Slovenia**. 2006. *Statistical Yearbook of the Republic of Slovenia 2005*. Online publication available at: http://www.stat.si/letopis/index_letopis_en.asp, 06/08/2006.
- [SI05]: **Statistical Office of the European Communities (EUROSTAT)**. 2006. *Irrigation by regions*. Online data base (available at <http://epp.eurostat.ec.europa.eu>), 07/07/2006.
- [SI06]: Map, provided by **Prof. Dr. Maticic** (President of Slovenian National Committee on Irrigation and Drainage) on 13/04/2006 showing the location and extent of the Slovenian irrigation schemes.

Spain

Area equipped for irrigation was 2 540 310 ha in 1990 and increased then to 2 891 050 ha in 1995, 3 478 050 ha in 2000 and 3 828 110 ha in 2003. A similar trend was observed for the area actually irrigated that was reported at 2 433 700 ha in 1990, 2 609 920 ha in 1995, 3 235 510 ha in 2000 and 3 437 370 ha in 2003 [SP01]. Sub-national statistics were derived from the Agricultural Census 1999 for the 326 municipalities [SP02]. Area equipped for irrigation by province and by region is shown in Table 79, while the corresponding areas by municipality are available as part of the online-documentation of the global irrigation map at <http://www.fao.org/ag/agl/aglw/aquastat/irrigationmap/index.stm>. The total area equipped for irrigation as reported by the census in 1999 was 3 575 494 ha, while the area actually irrigated was 3 315 600 ha. However, the sum of area equipped for irrigation as reported for the single municipalities, which is similar to the area incorporated in the new version of the global irrigation map, was 3 575 488 ha. The difference of 6 ha compared to the value reported at the national scale may reflect rounding errors and was thus neglected.

Four data sets were combined to distribute irrigated area within the municipalities. First, irrigated areas were extracted from two digital data sets covering Andalusia and the Ebro river drainage basin ([SP03], [SP04]). Polygons extracted from these data sets got the highest priority of 8 in the distribution process because both data sets are regional products associated by a lot of additional information collected at the ground (e.g. type of irrigation, water sources etc.). The second highest priority level of 7 was assigned to irrigation areas additionally extracted from irrigation maps covering entire Spain [SP05]. Priority level of 6 was assigned to areas classified as permanently irrigated land (212) or rice fields (213) in the Corine 2000 land cover database for Europe [SP06], but not present in the data sets [SP04] or [SP05]. Finally irrigated area was also assigned to 77 908 ha agricultural land classified as rainfed agriculture in the Corine database, because the area equipped for irrigation reported by the census statistics was still larger in the related 52 municipalities than the total irrigated area assigned to the irrigation schemes before.

TABLE 79
Irrigated area per province and autonomous region of Spain

Province	Comunidades Autonomas	Area equipped for irrigation 1999 (ha)	Area actually irrigated 1999 (ha)
Almería	Andalucía	58 457	52 476
Cádiz	Andalucía	51 376	50 102
Córdoba	Andalucía	98 589	92 290
Granada	Andalucía	103 339	100 325
Huelva	Andalucía	35 158	33 351
Jaén	Andalucía	196 181	194 142
Málaga	Andalucía	50 377	48 502
Sevilla	Andalucía	267 590	261 363
	Andalucía	392 657	382 737
Huesca	Aragón	194 341	176 363
Teruel	Aragón	26 728	24 041
Zaragoza	Aragón	185 257	177 281
	Aragón	297 338	285 763
Asturias	Asturias	1 748 966	1 683 868
Cantabria	Cantabria	2 845 287	2 730 053
Ávila	Castilla y León	37 034	35 187
Burgos	Castilla y León	24 936	21 210
León	Castilla y León	128 006	117 078
Palencia	Castilla y León	60 193	46 989
Salamanca	Castilla y León	45 109	39 043
Segovia	Castilla y León	21 686	17 137
Soria	Castilla y León	14 802	10 438
Valladolid	Castilla y León	101 325	95 893
Zamora	Castilla y León	59 117	55 916
	Castilla y León	492 209	438 892
Albacete	Castilla-La Mancha	149 207	140 995
Ciudad Real	Castilla-La Mancha	209 225	184 294
Cuenca	Castilla-La Mancha	46 512	37 311
Guadalajara	Castilla-La Mancha	15 757	15 265
Toledo	Castilla-La Mancha	97 877	91 069
	Castilla-La Mancha	475 760	450 533
Barcelona	Cataluña	10 874	10 272
Girona	Cataluña	29 611	25 816
Lérida	Cataluña	143 704	140 311
Tarragona	Cataluña	64 132	61 019
	Cataluña	248 322	237 418
Alicante	Comunidad Valencia	96 376	84 454
Castellón de la Plana	Comunidad Valencia	50 877	48 449
Valencia	Comunidad Valencia	157 743	150 663
	Comunidad Valencia	304 997	283 565
Badajoz	Extremadura	147 085	140 492
Cáceres	Extremadura	98 926	95 439
	Extremadura	246 011	235 931
La Coruña	Galicia	15 800	15 341
Lugo	Galicia	21 693	21 141
Orense	Galicia	19 710	18 421

Province	Comunidades Autonomas	Area equipped for irrigation 1999 (ha)	Area actually irrigated 1999 (ha)
Pontevedra	Galicia	20 320	18 815
	Galicia	77 522	73 718
Baleares	Islas Baleares	21 716	17 814
Las Palmas	Islas Canarias	9 300	9 195
Santa Cruz de Tenerife	Islas Canarias	21 072	18 601
	Islas Canarias	30 372	27 796
La Rioja	La Rioja	45 337	33 188
Madrid	Madrid	27 892	25 765
Melilla	Melilla	0	0
Murcia	Murcia	185 811	170 150
Navarra	Navarra	74 122	72 088
Alava	País Vasco	23 472	9 429
Guipúzcoa	País Vasco	447	445
Vizcaya	País Vasco	888	732
	País Vasco	24 807	10 606
SPAIN TOTAL		3 575 494	3 315 600

References:

- [SP01]: **Statistical Office of the European Communities (EUROSTAT)**. 2006. *Irrigation by regions*. Online data base (available at <http://epp.eurostat.ec.europa.eu>), 07/07/2006.
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Sweden

Area equipped for irrigation was 188 460 ha in 2003, while the area actually used for irrigation was 53 430 ha in the same year [SW01]. Area equipped for irrigation by region is shown in Table 80. Since these 8 regions are still pretty large and statistics on area equipped for irrigation were not available at higher resolution, statistics on irrigation water consumption [SW02] were used to downscale the irrigated area statistics to counties and municipalities. Irrigation water use reported by the statistics and related areas equipped for irrigation as estimated that way by municipality and county are shown in Table 81. It is very likely that this procedure introduced an unknown error since irrigation water use per unit area is varying. However, it helped to identify the main zones of high irrigation densities.

Irrigation maps were not available for Sweden. Instead of it area equipped for irrigation was assigned to polygons extracted from the Corine 2000 land cover database for Europe [SW03] using the priorities shown in Table 82.

TABLE 80
Irrigated area per NUTS-1 region in Sweden

NUTS-1 region	Area equipped for irrigation 2003	Area actually irrigated 2003
Stockholm	4 130	510
Östra Mellansverige	26 500	3 460
Sydsverige	78 340	31 440
Norra Mellansverige	7 530	920
Mellersta Norrland	1 740	230
Övre Norrland	2100	360
Småland med öarna	27440	9550
Västsverige	40690	6960
SWEDEN TOTAL	188 470	53 430

 TABLE 81
Irrigation water use and estimated irrigated area per municipality, county and NUTS-1 region of Sweden

Community	County	Region	Irrigation water use 1995 (1000 m ³)	Area equipped for irrigation in global map (ha)
Åre Kommun	Jämtlands Län	Mellersta Norrland	0	0
Berg Kommun	Jämtlands Län	Mellersta Norrland	8	55
Bräcke Kommun	Jämtlands Län	Mellersta Norrland	19	131
Härjedalen Kommun	Jämtlands Län	Mellersta Norrland	0	0
Krokom and Strömsund Kommun	Jämtlands Län	Mellersta Norrland	17	117
Östersund Kommun	Jämtlands Län	Mellersta Norrland	35	242
Ragunda Kommun	Jämtlands Län	Mellersta Norrland	0	0
	Jämtlands Län	Mellersta Norrland	79	545
Ånge Kommun	Västernorrlands Län	Mellersta Norrland	45	311
Härnösand Kommun	Västernorrlands Län	Mellersta Norrland	17	117
Kramfors Kommun	Västernorrlands Län	Mellersta Norrland	12	83
Örnsköldsvik Kommun	Västernorrlands Län	Mellersta Norrland	18	124
Sollefteå Kommun	Västernorrlands Län	Mellersta Norrland	39	269
Sundsvall Kommun	Västernorrlands Län	Mellersta Norrland	26	180
Timrå Kommun	Västernorrlands Län	Mellersta Norrland	16	110
	Västernorrlands Län	Mellersta Norrland	173	1 195
		Mellersta Norrland	252	1 740
Älvdalen Kommun	Dalarnes Län	Norra Mellansverige	0	0
Avesta Kommun	Dalarnes Län	Norra Mellansverige	211	400
Borlänge Kommun	Dalarnes Län	Norra Mellansverige	31	59
Falun Kommun	Dalarnes Län	Norra Mellansverige	126	239
Gagnef Kommun	Dalarnes Län	Norra Mellansverige	73	138
Hedemora Kommun	Dalarnes Län	Norra Mellansverige	186	352
Leksand, Malung and Mora Kommun	Dalarnes Län	Norra Mellansverige	16	30
Ludvika and Smedjebacken Kommun	Dalarnes Län	Norra Mellansverige	76	144
Orsa Kommun	Dalarnes Län	Norra Mellansverige	0	0
Rättvik Kommun	Dalarnes Län	Norra Mellansverige	58	110
Säter Kommun	Dalarnes Län	Norra Mellansverige	94	178

Community	County	Region	Irrigation water use 1995 (1000 m ³)	Area equipped for irrigation in global map (ha)
Vansbro Kommun	Dalarnes Län	Norra Mellansverige	88	167
	Dalarnes Län	Norra Mellansverige	959	1 816
Bollnäs Kommun	Gävleborgs Län	Norra Mellansverige	152	288
Gävle Kommun	Gävleborgs Län	Norra Mellansverige	123	233
Hofors Kommun	Gävleborgs Län	Norra Mellansverige	70	133
Hudiksvall Kommun	Gävleborgs Län	Norra Mellansverige	72	136
Ljusdal Kommun	Gävleborgs Län	Norra Mellansverige	30	57
Nordanstig Kommun	Gävleborgs Län	Norra Mellansverige	15	28
Ockelbo Kommun	Gävleborgs Län	Norra Mellansverige	12	23
Ovanåker Kommun	Gävleborgs Län	Norra Mellansverige	58	110
Sandviken Kommun	Gävleborgs Län	Norra Mellansverige	48	91
Söderhamn Kommun	Gävleborgs Län	Norra Mellansverige	17	32
	Gävleborgs Län	Norra Mellansverige	597	1 131
Årjäng and Eda Kommun	Värmlands Län	Norra Mellansverige	42	80
Arvika Kommun	Värmlands Län	Norra Mellansverige	263	498
Filipstad and Storfors Kommun	Värmlands Län	Norra Mellansverige	107	203
Forshaga Kommun	Värmlands Län	Norra Mellansverige	92	174
Grums and Kil Kommun	Värmlands Län	Norra Mellansverige	51	97
Hagfors Kommun	Värmlands Län	Norra Mellansverige	149	282
Hammarö and Karlstad Kommun	Värmlands Län	Norra Mellansverige	805	1 525
Kristinehamn Kommun	Värmlands Län	Norra Mellansverige	403	763
Munkfors Kommun	Värmlands Län	Norra Mellansverige	29	55
Säffle Kommun	Värmlands Län	Norra Mellansverige	418	792
Sunne Kommun	Värmlands Län	Norra Mellansverige	40	76
Torsby Kommun	Värmlands Län	Norra Mellansverige	21	40
	Värmlands Län	Norra Mellansverige	2 420	4 583
		Norra Mellansverige	3 976	7 530
Askersund Kommun	Örebro Län	Östra Mellansverige	256	403
Degerfors Kommun	Örebro Län	Östra Mellansverige	152	239
Hällefors Kommun	Örebro Län	Östra Mellansverige	22	35
Hallsberg Kommun	Örebro Län	Östra Mellansverige	212	334
Karlskoga Kommun	Örebro Län	Östra Mellansverige	119	187
Kumla Kommun	Örebro Län	Östra Mellansverige	35	55
Laxå Kommun	Örebro Län	Östra Mellansverige	153	241
Lekeberg and Örebro Kommun	Örebro Län	Östra Mellansverige	860	1 355
Lindesberg Kommun	Örebro Län	Östra Mellansverige	575	906
Ljusnarsberg Kommun	Örebro Län	Östra Mellansverige	0	0
Nora Kommun	Örebro Län	Östra Mellansverige	75	118
	Örebro Län	Östra Mellansverige	2 459	3 874
Åtvidaberg Kommun	Östergötlands Län	Östra Mellansverige	214	337
Boxholm Kommun	Östergötlands Län	Östra Mellansverige	79	124
Finspång Kommun	Östergötlands Län	Östra Mellansverige	256	403
Kinda Kommun	Östergötlands Län	Östra Mellansverige	572	901

Community	County	Region	Irrigation water use 1995 (1000 m ³)	Area equipped for irrigation in global map (ha)
Linköping Kommun	Östergötlands Län	Östra Mellansverige	624	983
Mjölby Kommun	Östergötlands Län	Östra Mellansverige	963	1 517
Motala Kommun	Östergötlands Län	Östra Mellansverige	1 153	1 817
Norrköping Kommun	Östergötlands Län	Östra Mellansverige	216	340
Ödeshög Kommun	Östergötlands Län	Östra Mellansverige	54	85
Söderköping Kommun	Östergötlands Län	Östra Mellansverige	144	227
Vadstena Kommun	Östergötlands Län	Östra Mellansverige	162	255
Valdemarsvik Kommun	Östergötlands Län	Östra Mellansverige	317	499
Ydre Kommun	Östergötlands Län	Östra Mellansverige	172	271
	Östergötlands Län	Östra Mellansverige	4 926	7 761
Eskilstuna Kommun	Södermanlands Län	Östra Mellansverige	630	993
Flen Kommun	Södermanlands Län	Östra Mellansverige	506	797
Gnesta	Södermanlands Län	Östra Mellansverige	996	1 569
Katrineholm Kommun	Södermanlands Län	Östra Mellansverige	533	840
Oxelösund Kommun	Södermanlands Län	Östra Mellansverige	0	0
Strängnäs Kommun	Södermanlands Län	Östra Mellansverige	486	766
Vingåker Kommun	Södermanlands Län	Östra Mellansverige	188	296
	Södermanlands Län	Östra Mellansverige	3 339	5 261
Älvkarleby and Tierp Kommun	Uppsala Län	Östra Mellansverige	369	581
Enköping Kommun	Uppsala Län	Östra Mellansverige	1 339	2 110
Habo Kommun	Uppsala Län	Östra Mellansverige	150	236
Östhammar Kommun	Uppsala Län	Östra Mellansverige	260	410
Uppsala Kommun	Uppsala Län	Östra Mellansverige	2 189	3 449
	Uppsala Län	Östra Mellansverige	4 307	6 786
Arboga Kommun	Västmanlands Län	Östra Mellansverige	108	170
Fagersta Kommun	Västmanlands Län	Östra Mellansverige	0	0
Hallstahammar Kommun	Västmanlands Län	Östra Mellansverige	167	263
Heby Kommun	Västmanlands Län	Östra Mellansverige	245	386
Köping Kommun	Västmanlands Län	Östra Mellansverige	221	348
Kungsör Kommun	Västmanlands Län	Östra Mellansverige	179	282
Norberg and Sala Kommun	Västmanlands Län	Östra Mellansverige	244	384
Skinnskatteberg and Surahammar Kommun	Västmanlands Län	Östra Mellansverige	38	60
Västerås Kommun	Västmanlands Län	Östra Mellansverige	587	925
	Västmanlands Län	Östra Mellansverige	1 789	2 819
		Östra Mellansverige	16 820	26 500
Älvsbyn and Arvidsjaur Kommun	Norrbottens Län	Övre Norrland	9	40
Arjeplog Kommun	Norrbottens Län	Övre Norrland	0	0
Boden Kommun	Norrbottens Län	Övre Norrland	46	205
Gällivare Kommun	Norrbottens Län	Övre Norrland	0	0
Haparanda Kommun	Norrbottens Län	Övre Norrland	8	36
Jokkmokk Kommun	Norrbottens Län	Övre Norrland	0	0
Kalix Kommun	Norrbottens Län	Övre Norrland	4	18
Kiruna Kommun	Norrbottens Län	Övre Norrland	0	0

Community	County	Region	Irrigation water use 1995 (1000 m ³)	Area equipped for irrigation in global map (ha)
Luleå Kommun	Norrbottens Län	Övre Norrland	22	98
Överkalix Kommun	Norrbottens Län	Övre Norrland	27	120
Övertorneå and Pajala Kommun	Norrbottens Län	Övre Norrland	40	178
Piteå Kommun	Norrbottens Län	Övre Norrland	70	311
	Norrbottens Län	Övre Norrland	226	1 006
Åsele Kommun	Västerbottens Län	Övre Norrland	17	76
Bjurholm and Nordmaling Kommun	Västerbottens Län	Övre Norrland	22	98
Dorotea and Vilhelmina Kommun	Västerbottens Län	Övre Norrland	10	44
Lycksele	Västerbottens Län	Övre Norrland	9	40
Malå Kommun	Västerbottens Län	Övre Norrland	0	0
Norsjö and Skellefteå Kommun	Västerbottens Län	Övre Norrland	86	383
Robertsfors and Umeå Kommun	Västerbottens Län	Övre Norrland	62	276
Vännäs Kommun	Västerbottens Län	Övre Norrland	18	80
Vindeln Kommun	Västerbottens Län	Övre Norrland	22	98
	Västerbottens Län	Övre Norrland	246	1 094
		Övre Norrland	472	2 100
Gotland Kommun	Gotlands Län	Småland med öarna	2 883	5 804
Aneby Kommun	Jönköpings Län	Småland med öarna	93	187
Eksjö Kommun	Jönköpings Län	Småland med öarna	239	481
Gislaved Kommun	Jönköpings Län	Småland med öarna	31	62
Gnosjö Kommun	Jönköpings Län	Småland med öarna	0	0
Jönköping Kommun	Jönköpings Län	Småland med öarna	966	1 945
Nässjö Kommun	Jönköpings Län	Småland med öarna	106	213
Sävsjö Kommun	Jönköpings Län	Småland med öarna	76	153
Tranås Kommun	Jönköpings Län	Småland med öarna	97	195
V Vetlanda Kommun	Jönköpings Län	Småland med öarna	189	380
Vaggeryd Kommun	Jönköpings Län	Småland med öarna	247	497
Värnamo Kommun	Jönköpings Län	Småland med öarna	350	705
	Jönköpings Län	Småland med öarna	2 394	4 819
Borgholm Kommun	Kalmar Län	Småland med öarna	403	811
Emmaboda Kommun	Kalmar Län	Småland med öarna	49	99
Högsby Kommun	Kalmar Län	Småland med öarna	95	191
Hultsfred Kommun	Kalmar Län	Småland med öarna	610	1 228
Kalmar Kommun	Kalmar Län	Småland med öarna	1 324	2 665
Mönsterås Kommun	Kalmar Län	Småland med öarna	402	809
Mörbylånga Kommun	Kalmar Län	Småland med öarna	1 707	3 436
Nybro Kommun	Kalmar Län	Småland med öarna	155	312
Oskarshamn Kommun	Kalmar Län	Småland med öarna	99	199
Torsås Kommun	Kalmar Län	Småland med öarna	913	1 838
Västervik Kommun	Kalmar Län	Småland med öarna	549	1 105
Vimmerby Kommun	Kalmar Län	Småland med öarna	391	787
	Kalmar Län	Småland med öarna	6 697	13 481
Älmhult Kommun	Kronobergs Län	Småland med öarna	171	344
Alvesta Kommun	Kronobergs Län	Småland med öarna	111	223

Community	County	Region	Irrigation water use 1995 (1000 m ³)	Area equipped for irrigation in global map (ha)
Lessebo and Uppvidinge Kommun	Kronobergs Län	Småland med öarna	92	185
Ljungby Kommun	Kronobergs Län	Småland med öarna	885	1 782
Markaryd Kommun	Kronobergs Län	Småland med öarna	57	115
Tingsryd Kommun	Kronobergs Län	Småland med öarna	151	304
Växjö Kommun	Kronobergs Län	Småland med öarna	190	382
	Kronobergs Län	Småland med öarna	1 657	3 336
		Småland med öarna	13 631	27 440
Botkyrka	Stockholms Län	Stockholms Län	157	373
Danderyd Kommun	Stockholms Län	Stockholms Län	0	0
Ekerö Kommun	Stockholms Län	Stockholms Län	499	1 186
Haninge Kommun	Stockholms Län	Stockholms Län	20	48
Järfälla and Upplands Väsby Kommun	Stockholms Län	Stockholms Län	4	10
Lidingö Kommun	Stockholms Län	Stockholms Län	0	0
Nacka Kommun	Stockholms Län	Stockholms Län	0	0
Norrtälje Kommun	Stockholms Län	Stockholms Län	300	713
Nykvarn Kommun	Stockholms Län	Stockholms Län	0	0
Nynäshamn Kommun	Stockholms Län	Stockholms Län	10	24
Österåker	Stockholms Län	Stockholms Län	109	259
Sigtuna Kommun	Stockholms Län	Stockholms Län	137	326
Södertälje Kommun	Stockholms Län	Stockholms Län	258	613
Sollentuna Kommun	Stockholms Län	Stockholms Län	0	0
Solna Kommun	Stockholms Län	Stockholms Län	0	0
Stockholm Kommun	Stockholms Län	Stockholms Län	0	0
Sundbyberg Kommun	Stockholms Län	Stockholms Län	0	0
Täby Kommun	Stockholms Län	Stockholms Län	0	0
Tyresö Kommun	Stockholms Län	Stockholms Län	0	0
Upplands-Bro Kommun	Stockholms Län	Stockholms Län	174	414
Vallentuna Kommun	Stockholms Län	Stockholms Län	69	164
	Stockholms Län	Stockholms Län	1 737	4 130
Karlshamn Kommun	Blekinge Län	Sydsverige	219	445
Karlskrona Kommun	Blekinge Län	Sydsverige	984	1 998
Olofström Kommun	Blekinge Län	Sydsverige	158	321
Ronneby Kommun	Blekinge Län	Sydsverige	987	2 004
Sölvesborg Kommun	Blekinge Län	Sydsverige	1 919	3 897
	Blekinge Län	Sydsverige	4 267	8 665
Ångelholm Kommun	Kristianstadt Län	Sydsverige	1 210	2 457
Åstorp Kommun	Kristianstadt Län	Sydsverige	342	695
Båstad Kommun	Kristianstadt Län	Sydsverige	2 873	5 834
Bromölla Kommun	Kristianstadt Län	Sydsverige	738	1 499
Hässleholm Kommun	Kristianstadt Län	Sydsverige	1 562	3 172
Klippan Kommun	Kristianstadt Län	Sydsverige	930	1 889
Kristianstad Kommun	Kristianstadt Län	Sydsverige	13 595	27 608
Örkelljunga and Perstorp Kommun	Kristianstadt Län	Sydsverige	31	63
Osby Kommun	Kristianstadt Län	Sydsverige	80	162
Östra Göinge	Kristianstadt Län	Sydsverige	534	1 084

Community	County	Region	Irrigation water use 1995 (1000 m ³)	Area equipped for irrigation in global map (ha)
Kommun				
Simrishamn Kommun	Kristianstadt Län	Sydsverige	709	1 440
Tommelilla Kommun	Kristianstadt Län	Sydsverige	560	1 137
	Kristianstadt Län	Sydsverige	23 164	47 040
Bjuv Kommun	Malmöhus Län	Sydsverige	56	114
Burlöv Kommun	Malmöhus Län	Sydsverige	12	24
Eslöv Kommun	Malmöhus Län	Sydsverige	933	1 895
Helsingborg Kommun	Malmöhus Län	Sydsverige	447	908
Höganäs Kommun	Malmöhus Län	Sydsverige	1 346	2 733
Höör Kommun	Malmöhus Län	Sydsverige	209	424
Hörby Kommun	Malmöhus Län	Sydsverige	113	229
Kävlinge Kommun	Malmöhus Län	Sydsverige	1 086	2 205
Landskrona Kommun	Malmöhus Län	Sydsverige	529	1 074
Lomma Kommun	Malmöhus Län	Sydsverige	171	347
Lund Kommun	Malmöhus Län	Sydsverige	1 298	2 636
Malmö Kommun	Malmöhus Län	Sydsverige	427	867
Sjöbo Kommun	Malmöhus Län	Sydsverige	1 271	2 581
Skurup Kommun	Malmöhus Län	Sydsverige	419	851
Staffanstorps Kommun	Malmöhus Län	Sydsverige	243	493
Svalöv Kommun	Malmöhus Län	Sydsverige	637	1 294
Svedala Kommun	Malmöhus Län	Sydsverige	302	613
Trelleborg Kommun	Malmöhus Län	Sydsverige	146	296
Vellinge Kommun	Malmöhus Län	Sydsverige	265	538
Ystad Kommun	Malmöhus Län	Sydsverige	1 236	2 510
	Malmöhus Län	Sydsverige	11 146	22 635
		Sydsverige	38 577	78 340
Ale and Lerum Kommun	Älvsborgs Län	Västsverige	6	13
Alingsås Kommun	Älvsborgs Län	Västsverige	35	75
Åmål Kommun	Älvsborgs Län	Västsverige	39	84
Bengtstors Kommun	Älvsborgs Län	Västsverige	42	90
Bollebygd and Borås Kommun	Älvsborgs Län	Västsverige	108	232
Dals-Ed Kommun	Älvsborgs Län	Västsverige	5	11
Färgelanda Kommun	Älvsborgs Län	Västsverige	76	164
Herrljunga Kommun	Älvsborgs Län	Västsverige	86	185
Lilla Edet and Trollhättan Kommun	Älvsborgs Län	Västsverige	22	47
Mark Kommun	Älvsborgs Län	Västsverige	169	364
Mellerud Kommun	Älvsborgs Län	Västsverige	788	1 696
Svenljunga Kommun	Älvsborgs Län	Västsverige	402	865
Tranemo Kommun	Älvsborgs Län	Västsverige	42	90
Ulricehamn Kommun	Älvsborgs Län	Västsverige	231	497
Vänersborg Kommun	Älvsborgs Län	Västsverige	362	779
Vårgårda Kommun	Älvsborgs Län	Västsverige	224	482
	Älvsborgs Län	Västsverige	2 637	5 675
Göteborg and Partille Kommun	Göteborgs och Bohus Län	Västsverige	72	155
Härryda Kommun	Göteborgs och Bohus	Västsverige	18	39

Community	County	Region	Irrigation water use 1995 (1000 m ³)	Area equipped for irrigation in global map (ha)
	Län			
Kungälv Kommun	Göteborgs och Bohus Län	Västsverige	8	17
Lysekil and Munkedal Kommun	Göteborgs och Bohus Län	Västsverige	12	26
Mölnadal Kommun	Göteborgs och Bohus Län	Västsverige	7	15
Öckerö Kommun	Göteborgs och Bohus Län	Västsverige	0	0
Orust Kommun	Göteborgs och Bohus Län	Västsverige	20	43
Sotenäs Kommun	Göteborgs och Bohus Län	Västsverige	18	39
Stenungsund and Tjörns Kommun	Göteborgs och Bohus Län	Västsverige	8	17
Strömstad Kommun	Göteborgs och Bohus Län	Västsverige	25	54
Tanum Kommun	Göteborgs och Bohus Län	Västsverige	86	185
Uddevalla Kommun	Göteborgs och Bohus Län	Västsverige	55	118
	Göteborgs och Bohus Län	Västsverige	329	708
Falkenberg Kommun	Hallands Län	Västsverige	1 191	2 563
Halmstad Kommun	Hallands Län	Västsverige	1 417	3 050
Hylte Kommun	Hallands Län	Västsverige	79	170
Kungsbacka Kommun	Hallands Län	Västsverige	113	243
Laholm Kommun	Hallands Län	Västsverige	4 430	9 534
Varberg Kommun	Hallands Län	Västsverige	653	1 405
	Hallands Län	Västsverige	7 883	16 966
Essunga and Grästorp Kommun	Skaraborgs Län	Västsverige	204	439
Falköping Kommun	Skaraborgs Län	Västsverige	225	484
Götene Kommun	Skaraborgs Län	Västsverige	1 449	3 119
Gullspång Kommun	Skaraborgs Län	Västsverige	124	267
Håbo Kommun	Skaraborgs Län	Västsverige	441	949
Hjo Kommun	Skaraborgs Län	Västsverige	742	1 597
Karlsborg Kommun	Skaraborgs Län	Västsverige	203	437
Lidköping Kommun	Skaraborgs Län	Västsverige	985	2 120
Mariestad Kommun	Skaraborgs Län	Västsverige	226	486
Mullsjö Kommun	Skaraborgs Län	Västsverige	92	198
Skara Kommun	Skaraborgs Län	Västsverige	770	1 657
Skövde Kommun	Skaraborgs Län	Västsverige	668	1 438
Tibro Kommun	Skaraborgs Län	Västsverige	94	202
Tidaholm Kommun	Skaraborgs Län	Västsverige	942	2 027
Töreboda Kommun	Skaraborgs Län	Västsverige	196	422
Vara Kommun	Skaraborgs Län	Västsverige	696	1 498
	Skaraborgs Län	Västsverige	8 057	17 340
		Västsverige	18 906	40 690
SWEDEN TOTAL			94 371	188 470

TABLE 82

Priorities used to assign irrigated area to polygons derived from the CORINE land cover 2000 data base for Sweden

Attribute	Priority
Non-irrigated arable land (211)	5
Fruit trees and berry plantations (222)	5
Complex cultivation patterns (242)	5
Pastures (231)	4
Land principally occupied by agriculture, with significant areas of natural vegetation (243)	4

References:

- [SW01]: **Statistical Office of the European Communities (EUROSTAT)**. 2006. *Irrigation by regions*. Online data base (available at <http://epp.eurostat.ec.europa.eu>), 07/07/2006.
- [SW02]: **Statistiska centralbyrån**. 1999. *Vattenuttag och vattenanvändningen i Sverige 1995*. Report No: Mi 27 SM 9901, Stockholm, Sweden, 67 pp.
- [SW03]: **EEA**. 2005. *Corine land cover 2000 – vector by country (CLC2000), version 1*. (available at: <http://dataservice.eea.europa.eu/dataservice/metadetails.asp?id=667>).

Switzerland

Information about irrigation in Switzerland is very scarce. According to information from Federal Office for Agriculture the total irrigated area is about 40 000 ha in Switzerland. About 26 000 ha are equipped for sprinkler irrigation, micro irrigation is installed on about 4000 ha and the remaining irrigation is done by gravity. The figures refer to year 2002 [SL01]. No sub-national irrigation statistics have been available.

Irrigation is mainly practiced in some parts of the Canton Valais along the Rhone river where annual precipitation is less than 600 mm (Prof. Mermoud, personal communication). The outlines of the corresponding irrigation area and some additional irrigation areas in other parts of Switzerland were digitized from an irrigation map [SL02]. Area equipped for irrigation was assigned to polygons extracted from the Corine 1990 land cover database [SL03] classified as arable land, permanent crops, pasture or heterogeneous agricultural areas and located within the digitized irrigation areas.

References:

- [SL01]: **Sautier, J.L.** 2005. *Irrigation in Switzerland – some data*. One page containing a summary of irrigation statistics for Switzerland, provided by Prof. Mermoud, Swiss National Committee on Irrigation and Drainage on 22/02/2006.
- [SL02]: **Framji, K.K., Garg, B.C. & Luthra, S.D.L.** 1981. *Irrigation and drainage in the world*. Third edition. Vol. III, p. 1306. New Delhi, ICID.
- [SL03]: **EEA**. 1999. *Corine land cover (CLC90), 250m version 06/1999*. (available at: <http://dataservice.eea.europa.eu/dataservice/metadetails.asp?id=188&i=1>).

Ukraine

Until 1992 irrigation infrastructure was installed on a total area of 2 624 000 ha. The highest construction rates of irrigation systems were registered between 1965 and 1985. After 1992 the construction of new irrigation systems was virtually stopped and several of the existing schemes went out of operation. While the area actually irrigated was still 2 291 600 ha in 1990, it declined to 1 845 100 ha in 1995, 1 402 700 ha in 1998 and only 543 300 ha in 2001. In 2002 area actually irrigated was 730 100 ha and in 2003 it was 731 400 ha [UE01]. The reported lack of government funds to provide for proper operation and maintenance of the irrigation canals (total length 59 300 km), pumping stations (in total 13 700) and other hydro-technical constructions (in total 475 000) indicates that the area actually irrigated will, at least in the near future, very likely not reach the extent observed in the beginning of the 1990s again. Sub-

national irrigation statistics were available for the year 1985 and were summing up to 2 395 500 ha [UE02]. This is very close to recent figures. It was reported that actually existing main and secondary level irrigation systems can provide watering on an area of 2 448 000 ha [UE03]. It was therefore decided to use the figures reported for the year 1985 without any changes. Area equipped for irrigation by oblast is shown in Table 83.

The irrigation schemes of the country were digitized from irrigation maps published in [UE03] and area equipped for irrigation was assigned to these digitized polygons.

TABLE 83
Irrigated area per oblast in Ukraine

Oblast	Area equipped for irrigation 1985 (ha)	Oblast	Area equipped for irrigation 1985 (ha)
Chernigivska	9 800	Mikolaivska	172 500
Chernivetska	16 100	Odessa	210 700
Crimea	333 000	Poltavska	44 300
Dnipropetrovska	245 300	Rivnenska	2 300
Donetska	204 600	Sevastopol City	0
Ivano-Frankivska	1 800	Sumska	24 800
Kharkivska	98 700	Ternopil'ska	8 300
Khersonska	416 000	Tsherkavska	47 900
Khmelnitska	4 100	Vinnicka	35 100
Kiiv City	0	Volynska	2 600
Kiivska	119 300	Zakarpatska	14 600
Kirovogradska	49 900	Zaporiska	229 400
Luganska	97 600	Zytomir'ska	6 800
Lvivska	0	UKRAINE TOTAL	2 395 500

References:

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United Kingdom

Irrigable area for the United Kingdom was reported at 267 110 ha for the year 1997 and 228 950 ha for the year 2003 [UK01]. The area actually irrigated for the territory of England, where about 98% of the total area equipped for irrigation is located, was 155 650 ha in the more dry year 1995 and 147 270 ha in the more wet year 2001 [UK02]. Area equipped for irrigation by region as reported for the year 2003 and used for this version of the global irrigation map is shown in Table 84. The main irrigated crops in UK are potatoes and vegetables, which account together for about 79% of the total irrigated area [UK02]. About 47% of the potato growing area and about 23% of the vegetable growing area in UK was irrigated in 2001 [UK03].

Irrigation maps were not available for the United Kingdom. Instead of it irrigated area per county was estimated by combining harvested crop area derived from the statistics [UK04] and crop specific ratios of irrigated crop area versus total crop area. These ratios were reported for 8 regions for the year 2001 [UK03]. The irrigated areas computed that way for the specific crops were summed up and the irrigated areas by county were scaled so that the total irrigated area by region was equal to the values reported for the area equipped for irrigation for the year

2003. Area equipped for irrigation by county as estimated that way is available as part of the online-documentation of the global irrigation map at <http://www.fao.org/ag/agl/aglw/aquastat/irrigationmap/index.stm>. The resulting irrigation densities by county were found to be in good agreement to the spatial distribution of irrigation water demand [UK03] and to densities of points of agricultural water abstractions [UK05].

Area equipped for irrigation was distributed within the counties by assigning irrigated area to polygons extracted from the Corine 2000 land cover database for Europe [UK06] classified as non-irrigated arable land (211), fruit trees and berry plantations (222) or complex cultivation patterns (242).

TABLE 84

Irrigated area per NUTS-1 region of the United Kingdom

NUTS-1 region	Area equipped for irrigation 2003 (ha)	NUTS-1 region	Area equipped for irrigation 2003 (ha)
North East	1 810	Eastern	106 880
North West (including Merseyside)	4 080	London, South East	17 450
Yorkshire and The Humber	23 610	South West	4 810
East Midlands	39 430	Wales	1 370
West Midlands	26 590	Scotland	0
		Northern Ireland	2 920
		UK TOTAL	228 950

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1.4.3 LATIN AMERICA

Argentina

Area equipped for irrigation in 1997 was reported at 2 328 829 ha, but 778 596 ha were under rehabilitation so that only 1 550 233 ha were actually used [AR01]. According to the agricultural census the area actually irrigated was 1 065 000 ha in 1970, 1 246 748 ha in 1988, 1 437 275 ha in 1995 [AR02] and 1 355 601 ha in 2002 [AR03]. Sub-national statistics were available by province and district but referred to the area actually irrigated. Area equipped for irrigation by province as shown in Table 85 was therefore estimated by selecting the maximum of the areas actually used for irrigation in the years 1995 and 2002 [AR02], [AR03], [AR04]. Total area equipped for irrigation estimated that way was summing up to 1 767 784 ha. Area equipped for irrigation by district was computed by scaling the area actually irrigated reported for the year 2002 [AR03] so that the sum of area actually irrigated by province was equal to the figures reported in Table 85. Area equipped for irrigation by district is available as part of the online-documentation of the global irrigation map at <http://www.fao.org/ag/agl/aglw/aquastat/irrigationmap/index.stm>.

To distribute irrigated area within the districts irrigated area was assigned to irrigated areas digitized from irrigation maps [AR05] and to areas classified as cropland in the GLC2000 land cover map for South America [AR06] located within polygons digitized from province maps showing the irrigation districts [AR07]. If districts were located completely outside the digitized irrigation zones, area equipped for irrigation was assigned to all cells classified as cropland.

TABLE 85
Irrigated area per province in Argentina

Provincia	Area actually irrigated 2002 derived from [AR03] in ha	Area actually irrigated 1995 derived from [AR02] in ha	Area actually irrigated 1995 derived from [AR04] in ha	Area equipped for irrigation in global map (ha)
Buenos Aires	166 483	101 254	176 500	176 500
Catamarca	61 848	64 304	24 100	64 304
Chaco	7 550	6 000	4 700	7 550
Chubut	18 155	34 449	26 404	34 449
Córdoba	93 835	55 000	55 863	93 835
Corrientes	59 014	68 000	55 334	68 000
Entre Ríos	71 736	109 000	89 250	109 000
Formosa	4 002	11 513	5 200	11 513
Jujuy	91 575	120 000	105 500	120 000
La Pampa	4 715	6 104	6 815	6 815
La Rioja	41 817	5 447	21 247	41 817
Mendoza	267 889	339 600	359 523	359 523
Misiones	170	n.a.	n.a.	170
Neuquén	15 798	17 700	10 417	17 700
Río Negro	72 784	120 659	135 171	135 171
Salta	118 898	150 000	140 000	150 000
San Juan	79 516	68 900	68 400	79 516
San Luis	18 575	4 571	9 385	18 575
Santa Cruz	3 841	1 850	5 467	5 467
Santa Fe	37 421	9 000	20 500	37 421
Santiago del Estero	53 954	85 000	142 823	142 823
Tierra del Fuego	0	n.a.	n.a.	0
Tucumán	66 025	58 924	87 634	87 634
ARGENTINA TOTAL	1 355 601	1 437 275	1 550 233	1 767 784

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Brazil

Area equipped for irrigation was reported to have increased from 2 656 280 ha in 1996 to 2 870 204 ha in 1998 [BR01] and 3 149 217 ha in 2001 [BR02]. Area equipped for irrigation by federal state for 2001 was taken from the same source [BR02]. For the downscaling to the municipality level irrigated areas were used as reported by the agricultural census undertaken in growing season 1995/96 [BR03]. Total area reported as irrigated by the census data base was summing up to 3 121 642 ha. Thus it can be assumed that the census publication overestimated the real extent of area equipped for irrigation at that time. Irrigation area by federal state and region reported by the census for the year 1995/1996 [BR03] and areas equipped for irrigation in 1996 and 2001 reported in [BR01] and [BR02] is shown in Table 86, while area equipped for irrigation downscaled to municipality level is available as part of the online-documentation of the global irrigation map at <http://www.fao.org/ag/agl/aglw/aquastat/irrigationmap/index.stm>.

Irrigated area was first assigned to irrigation schemes as digitized from several irrigation maps ([BR04] – [BR13]). The remaining irrigated area was assigned to cells classified on the GLC2000 land cover map for South America [BR14] as agriculture (intensive) or mosaics of agriculture and other land uses.

TABLE 86

Irrigated area per state and region in Brazil

State	Region	Irrigated area reported by census 1995/96 [BR03] (ha)	Area equipped for irrigation in 1996 as reported in [BR01] (ha)	Area equipped for irrigation in 2001 as reported in [BR02] (ha)
Distrito Federal	Centro-Oeste	12 591	9 940	10 998
Goiás	Centro-Oeste	115 908	106 500	150 943
Mato Grosso	Centro-Oeste	59 226	8 100	14 650
Mato Grosso do Sul	Centro-Oeste	73 228	55 600	81 480
	Centro-Oeste	260 953	180 140	258 071
Alagoas	Nordeste	156 992	7 500	70 082
Bahia	Nordeste	209 705	140 610	279 887
Ceará	Nordeste	108 998	77 030	72 613

State	Region	Irrigated area reported by census 1995/96 [BR03] (ha)	Area equipped for irrigation in 1996 as reported in [BR01] (ha)	Area equipped for irrigation in 2001 as reported in [BR02] (ha)
Maranhão	Nordeste	16 521	40 000	44 200
Paraíba	Nordeste	63 548	27 600	47 602
Pernambuco	Nordeste	118 400	85 000	91 980
Piauí	Nordeste	18 254	18 190	24 193
Rio Grande do Norte	Nordeste	45 778	14 490	17 783
Sergipe	Nordeste	13 691	18 040	45 332
	Nordeste	751 887	428 460	693 672
Acre	Norte	728	600	680
Amazonas	Norte	209	1 200	1 820
Amapá	Norte	9 119	100	1 910
Pará	Norte	4 797	6 260	6 980
Rondônia	Norte	1 041	100	4 600
Roraima	Norte	5 660	5 200	8 960
Tocantins	Norte	61 469	65 100	66 085
	Norte	83 023	78 560	91 035
Espírito Santo	Sudeste	92 695	39 500	91 250
Minas Gerais	Sudeste	322 679	260 020	313 956
Rio de Janeiro	Sudeste	74 761	72 000	36 033
São Paulo	Sudeste	439 054	450 000	468 400
	Sudeste	929 189	821 520	909 639
Paraná	Sul	46 890	55 000	51 750
Rio Grande do Sul	Sul	935 677	974 000	1 007 750
Santa Catarina	Sul	114 025	118 800	137 300
	Sul	1 096 592	1 147 800	1 196 800
BRAZIL TOTAL		3 121 644	2 656 480	3 149 217

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Mexico

Area equipped for irrigation was reported at 6 256 032 ha for the year 1997 [MX01]. Recently published statistics reported the area equipped for irrigation at 3 499 400 ha for the 88 irrigation districts (related to the situation in 2004) and at 2 955 500 ha for the 39 492 irrigation units (related to 1998) [MX02]. Area equipped for irrigation by province as shown in Table 87 was computed by summing up irrigated areas in irrigation districts and irrigation units belonging to the specific provinces. Total area equipped for irrigation computed that way was 6 435 800 ha. It should be mentioned that statistics derived from remote sensing products reported a much larger extent of irrigated agriculture. Digital land use and vegetation maps produced by INEGI detected about 6 992 027 ha irrigated land in the reference period 1979-1991 [MX03], 8 507 266 ha irrigated land in the reference period 1993-1999 [MX04] and 9 245 612 ha in the reference period 2002-2005 [MX05]. In most of the northern provinces irrigated area as detected in the remote sensing surveys would be larger than the irrigation potential reported by province [MX01]. It maybe that at least the last two remote sensing based land use maps ([MX04], [MX05]) overestimated the extent of irrigated agriculture. On the other hand census based statistics, as used here to compile this version of the global irrigation map, mainly account for the registered part of irrigated land located in irrigation districts and irrigation units and may therefore miss unregistered informal irrigation. Thus it can be assumed that the physically existing total amount of irrigated land is somewhere between the census based and remote sensing based estimates.

The digital land use map for the reference period 2002-2005 [MX05] and a digitized map showing the irrigation districts of the country [MX06] were used to distribute area equipped for irrigation within the provinces. First the area equipped for irrigation reported for the single irrigation districts was assigned to areas classified on the land use map as "Agricultura de Riego" and located within the digitized boundaries of the irrigation districts. In the second step the amount of irrigated area located in the irrigation units was assigned to areas classified on the land use map as "Agricultura de Riego" and located outside the digitized boundaries of the irrigation districts. In the provinces of Tlaxcala, Veracruz and Yucatan about 66 000 ha irrigated area were assigned to regions classified as "Agricultura de Temporal" and located in the surrounding of the irrigation districts because irrigated area reported in the statistics was larger than the irrigated area detected by the remote sensing based inventory.

TABLE 87
Irrigated area per province in Mexico

Province	Irrigated area 1998 in Unidas de Riego (ha)	Irrigated area 2004 in Distritos de Riego (ha)	Area equipped for irrigation in global map (ha)
Aguascalientes	54 200	11 900	66 100
Baja California	62 100	179 091	241 191
Baja California Sur	24 800	38 100	62 900
Campeche	19 000	29 500	48 500
Chiapas	56 100	36 500	92 600
Chihuahua	185 000	170 200	355 200
Coahuila	149 300	88 323	237 623
Colima	64 100	37 800	101 900
Distrito Federal	2 000	0	2 000
Durango	106 100	50 193	156 293
Guanajuato	291 600	123 600	415 200
Guerrero	39 300	62 700	102 000
Hidalgo	62 100	94 500	156 600

Province	Irrigated area 1998 in Unidas de Riego (ha)	Irrigated area 2004 in Distritos de Riego (ha)	Area equipped for irrigation in global map (ha)
Jalisco	161 600	95 600	257 200
Mexico	160 900	48 000	208 900
Michoacan	224 800	240 900	465 700
Morelos	24 000	33 700	57 700
Nayarit	55 400	43 200	98 600
Nuevo Leon	143 000	32 484	175 484
Oaxaca	52 600	48 500	101 100
Puebla	122 300	49 900	172 200
Queretaro	38 900	11 000	49 900
Quintana Roo	10 900	27 200	38 100
San Luis Potosi	101 300	34 858	136 158
Sinaloa	45 000	747 800	792 800
Sonora	128 000	530 509	658 509
Tabasco	15 100	0	15 100
Tamaulipas	174 400	494 472	668 872
Tlaxcala	29 700	4 200	33 900
Veracruz	96 400	85 670	182 070
Yucatan	37 500	9 700	47 200
Zacatecas	219 800	18 400	238 200
MEXICO TOTAL	2 957 300	3 478 500	6 435 800

References:

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Peru

Area equipped for irrigation was reported at 1 729 065 ha [PE01], while the area actually used for irrigation was 1 109 000 ha [PE02]. The figures originate from the last agricultural census and refer to year 1994. Area equipped for irrigation by department and province is shown in Table 88. Census statistics down to the district level were used for the departments of Arequipa, Ica, Lambayeque, Loreto, Madre de Dios, Moquegua, Tacna and Ucayali. The information is available as part of the online-documentation of the global irrigation map at <http://www.fao.org/ag/agl/aglw/aquastat/irrigationmap/index.stm>. The total area equipped for irrigation in the 461 statistical units considered in Peru was summing up to 1 729 069 ha. The small difference of 4 ha to the figures reported at the national scale obviously originated from rounding errors and was thus neglected.

Irrigated area was assigned to 19 projects indicated of an irrigation map of the region around Lake Titicaca [PE03]. Additionally cultivated areas along the arid coastal zone were digitized from satellite imagery [PE04] and area equipped for irrigation was assigned to these polygons. The remaining irrigated area was assigned to cells classified on the GLC2000 land

cover map for South America [PE05] as agriculture (intensive) or mosaics of agriculture and other land uses.

TABLE 88
Irrigated area per province and department in Peru

Province	Department	Area equipped for irrigation 1994 (ha)	Province	Department	Area equipped for irrigation 1994 (ha)
Bagua	Amazonas	5 926	La Union	Arequipa	6 109
Bagua Grande	Amazonas	16 703		Arequipa	112 166
Bongara	Amazonas	100	Cangallo	Ayacucho	6 649
Chachapoyas	Amazonas	832	Huamanga	Ayacucho	13 106
Condorcanqui	Amazonas	3	Huanta	Ayacucho	6 063
Luya	Amazonas	1 616	Lamar	Ayacucho	3 898
Rodriguez de Mendo	Amazonas	4	Lucanas	Ayacucho	26 625
	Amazonas	25 183	Huanca Sancos	Ayacucho	1 838
Aija	Ancash	4 218	Paranicochas	Ayacucho	11 841
Bolognesi	Ancash	9 525	Paucar del Sara Sara	Ayacucho	5 790
Carhuaz	Ancash	8 297	Sucre	Ayacucho	1 977
Casma	Ancash	10 622	Victor Fajardo	Ayacucho	3 889
Chacas	Ancash	595	Vilcas Huaman	Ayacucho	2 803
Corongo	Ancash	4 568		Ayacucho	84 478
Huaraz	Ancash	11 331	Cajabamba	Cajamarca	10 791
Huari	Ancash	7 172	Cajamarca	Cajamarca	21 402
Huarmey	Ancash	6 537	Celendin	Cajamarca	6 704
Huaylas	Ancash	14 005	Chota	Cajamarca	11 787
Luzuriaga	Ancash	1 398	Contumaza	Cajamarca	6 993
Ocos	Ancash	6 010	Cutervo	Cajamarca	3 786
Pallasca	Ancash	10 609	Hualgayoc	Cajamarca	4 381
Pomabamba	Ancash	1 183	Jaen	Cajamarca	16 464
Recuay	Ancash	4 066	San Ignacio	Cajamarca	7 943
San Antonio Raimondi	Ancash	1 998	San Marcos	Cajamarca	4 077
San Luis	Ancash	356	San Miguel	Cajamarca	18 898
Santa	Ancash	34 285	San Pablo	Cajamarca	5 171
Sihuas	Ancash	2 510	Santa Cruz	Cajamarca	4 118
Yuncay	Ancash	11 444		Cajamarca	122 515
	Ancash	150 727	Callao	Callao	1 242
Abancay	Apurimac	10 349	Acomayo	Cuzco	3 384
Andahuaylas	Apurimac	20 421	Anta	Cuzco	7 406
Aymaraes	Apurimac	5 920	Calca	Cuzco	4 548
Chincheros	Apurimac	6 441	Canas	Cuzco	3 237
Cotabambas	Apurimac	1 533	Canchis	Cuzco	6 591
Grau/Antabamba	Apurimac	4 833	Chumbivilcas	Cuzco	2 686
	Apurimac	49 497	Cuzco	Cuzco	2 809
Arequipa	Arequipa	30 394	Espinar	Cuzco	793
Camana	Arequipa	9 081	La Convencion	Cuzco	3 760
Caraveli	Arequipa	9 658	nn	Cuzco	0
Castilla	Arequipa	15 554	Paruro	Cuzco	4 242
Caylloma	Arequipa	24 461	Paucartambo	Cuzco	2 658
Condesuyos	Arequipa	4 604	Quispicanchis	Cuzco	6 290
Islay	Arequipa	12 305	Urubamba	Cuzco	5 393
				Cuzco	53 797

Province	Department	Area equipped for irrigation 1994 (ha)	Province	Department	Area equipped for irrigation 1994 (ha)
Acobamba	Huancavelica	344		Lambayeque	177 135
Angares	Huancavelica	2 534	Barranca	Lima	26 200
Castrovirreyna	Huancavelica	11 729	Cajatambo	Lima	4 759
Churcampa	Huancavelica	2 869	Canete	Lima	38 426
Huancavelica	Huancavelica	1 966	Canta	Lima	4 627
Huaytara	Huancavelica	25 742	Huaral	Lima	27 064
Tayacaja	Huancavelica	16 600	Huarochiri	Lima	11 079
	Huancavelica	61 784	Huaura	Lima	40 306
Ambo	Huanuco	9 148	Isla	Lima	0
Dos de Mayo	Huanuco	4 700	Lima	Lima	13 505
Huacaybamba	Huanuco	4 109	Oyon	Lima	4 967
Huamalies	Huanuco	2 886	Yauyos	Lima	12 204
Huanuco	Huanuco	25 460		Lima	183 136
Leoncio Prado	Huanuco	64	Alto Amazonas	Loreto	197
Maranon	Huanuco	2 085	Loreto	Loreto	5
Pachitea	Huanuco	6 390	Mariscal Ramon Castilla	Loreto	0
Puerto Inca	Huanuco	113	Maynas	Loreto	42
	Huanuco	54 954	Requena	Loreto	55
Chincha	Ica	28 745	Ucayali	Loreto	125
Ica	Ica	37 022		Loreto	423
Isla	Ica	0	Manu	Madre de Dios	12
Nazca	Ica	12 833	Tahuamanu	Madre de Dios	2
Palpa	Ica	6 067	Tambopata	Madre de Dios	36
Pisco	Ica	28 622		Madre de Dios	50
	Ica	113 288	General Sanchez Cerro	Moquegua	9 592
Chanchamayo	Junin	664	Ilo	Moquegua	516
Concepcion	Junin	7 186	Mariscal Nieto	Moquegua	7 217
Huancayo	Junin	16 364		Moquegua	17 325
Jauja	Junin	6 110	Daniel Carrion	Pasco	480
Junin	Junin	1 454	Oxapampa	Pasco	473
Satipo	Junin	234	Pasco	Pasco	707
Tarma	Junin	8 541		Pasco	1 661
Yauli	Junin	812	Ayabaca	Piura	35 616
	Junin	41 365	Huancabamba	Piura	33 042
Ascope	La Libertad	64 150	Isla	Piura	0
Bolivar	La Libertad	2 797	Morropon	Piura	31 264
Chepen	La Libertad	22 109	Paita	Piura	9 870
Julcan	La Libertad	6 689	Piura	Piura	38 650
Otuzco	La Libertad	26 863	Sechura	Piura	9 424
Pacasmayo	La Libertad	19 139	Sullana	Piura	19 052
Pataz	La Libertad	9 649	Talara	Piura	52
Sanchez Carrion	La Libertad	10 411		Piura	176 970
Santiago de Chuco	La Libertad	11 461	Amantani	Puno	0
Trujillo	La Libertad	37 604	Azangaro	Puno	3 515
	La Libertad	210 872	Carabaya	Puno	80
Chiclayo	Lambayeque	68 700	Chucuito	Puno	1 220
Ferrenafe	Lambayeque	24 802			
Lambayeque	Lambayeque	83 632			

Province	Department	Area equipped for irrigation 1994 (ha)	Province	Department	Area equipped for irrigation 1994 (ha)
El Collao	Puno	190	Rioja	San Martin	12 465
Huancane	Puno	383	San Martin	San Martin	1 979
Isla Taquile	Puno	0	Tocache	San Martin	617
Lampa	Puno	894		San Martin	29 191
Melgar	Puno	3 240	Candarave	Tacna	8 275
Moho	Puno	1 095	Jorge Basadre	Tacna	3 782
Puno	Puno	1 030	Tacna	Tacna	13 634
San Antonio de Putina	Puno	40	Taratra	Tacna	3 931
San Roman	Puno	2 093		Tacna	29 622
Sandia	Puno	279	Contralmirante Villar	Tumbes	879
Yunguyo	Puno	256	Tumbes	Tumbes	12 123
	Puno	14 313	Zarumilla	Tumbes	4 292
Bellavista	San Martin	4 460		Tumbes	17 294
El Dorado	San Martin	124	Atalaya	Ucayali	0
Huallagua	San Martin	179	Coronel Portillo	Ucayali	57
Lamas	San Martin	362	Padre Abad	Ucayali	25
Mariscal Caceres	San Martin	172	Purus	Ucayali	0
Moyobamba	San Martin	6 559		Ucayali	82
Picota	San Martin	2 275	PERU TOTAL		1 729 069

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Uruguay

Area equipped for irrigation was reported at 217 593 ha [UR01]. The figures originate from the agricultural census undertaken in year 2000. Irrigated areas reported by department for rice, citrus, wine, other fruits and horticulture were summed up to compute area equipped for irrigation by department. The total irrigated area of these crops was 197 492 ha. Area equipped for irrigation was scaled thereafter so that the sum of area equipped for irrigation at the national scale was equal to the figures reported by the census (217 593 ha). The resulting area equipped for irrigation by department is shown in Table 89.

Since maps showing the location of irrigation areas were not available irrigated area was assigned to all regions classified as agriculture (intensive) in the GLC2000 land cover classification for South America [UR02].

TABLE 89
Irrigated area per department in Uruguay

Department	Irrigated crop area reported in census 2000 (ha)	Area equipped for irrigation in global map (ha)
Artigas	25 727	28 346
Canelones	7 005	7 718
Cerro Largo	33 844	37 289
Colonia	479	528
Durazno	950	1 047
Flores	1	1
Florida	87	96
Lavalleja	6 051	6 667
Maldonado	251	277
Montevideo	2 990	3 294
Paysandú	5 121	5 642
Río Negro	679	748
Rivera	9 983	10 999
Rocha	25 027	27 574
Salto	11 379	12 537
San José	2 796	3 081
Soriano	432	476
Tacuarembó	15 119	16 658
Treinta y Tres	49 571	54 616
URUGUAY TOTAL	197 492	217 593

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2. Results and discussion

In this section of the report we present the new version 4 of the global map of irrigation areas and describe its main characteristics (section 2.1). The differences to the previous map version 3 are described and discussed (section 2.2) and the discussion (section 2.3) is mainly addressing the uncertainty of the used sub-national irrigation statistics for Eastern Europe.

2.1 AREA EQUIPPED FOR IRRIGATION AND MAP QUALITY IN MAP VERSION 4

The total area equipped for irrigation in map version 4 of the Global Map of Irrigation Areas is 278.8 Mha. About 68 % is located in Asia, 17 % in America, 9 % in Europe, 5 % in Africa and 1 % in Oceania. The largest values of irrigated area on the country level are those for India (57.3 Mha), China (53.8 Mha), the United States (27.9 Mha) and Pakistan (14.4 Mha). For countries that were updated in map version 4 irrigated area is largest in Mexico (6.4 Mha), Russia (4.9 Mha), Italy (3.9 Mha), Spain (3.6 Mha) and Egypt (3.4 Mha). The largest contiguous areas of high irrigation density are found in North India and Pakistan along the rivers Ganges and Indus, in the Hai He, Huang He and Yangtze basins in China, along the Nile river in Egypt and Sudan, in the Mississippi-Missouri river basin and in parts of California. Other areas of high irrigation density with regional importance are located along the Snake and Columbia rivers in the northwestern United States, along the western coasts of Mexico and Peru, in central Chile, in the rice growing areas along the border between Brazil and Uruguay, along the Danube and Po rivers in Europe, in the Euphrates-Tigris basin in Iraq and Turkey, the Aral sea basin including the Amu Darya and Syr Darya river basins, the Brahmaputra basin in China and Bangladesh, the Mekong delta in Vietnam, the plain around Bangkok in Thailand and the island of Java (Figure 2). The map quality at the global scale was assessed to be good (1.88) on a scale from 0 (excellent) to 5 (very poor). In the updated part of the map the quality is best in Southern Europe (1.35), Northern Africa (1.46) and Southern Africa (1.50) while it is worst in Western Africa (2.90) and Russia (4.00) (Figure 3, Table 90).

2.2 DIFFERENCES BETWEEN MAP VERSION 3 AND MAP VERSION 4

The incorporation of additional subnational irrigation statistics resulted in an increase of the number of subnational statistical units from 10 825 (map version 3) to 26 909 (map version 4).

TABLE 90

Changes of irrigated area, number of subnational units and map quality per region in map versions 3 and 4 of the Digital Global Map of Irrigation Areas

Region	Area equipped for irrigation (Mha)		Number of subnational statistical units		Mark of map quality	
	version 3	version 4	version 3	version 4	version 3	version 4
Central America	7.86	8.19	279	279	2.92	2.13
South America	10.10	11.50	196	6 082	2.79	2.25
Northern Africa	5.80	6.34	149	130	2.38	1.46
Western Africa	1.01	1.15	231	136	3.39	2.90
Eastern Africa	3.55	3.82	134	162	2.55	1.93
Southern Africa	1.88	2.14	93	76	3.85	1.50
Western Europe	2.13	2.28	29	643	3.97	2.32
Eastern Europe	7.56	6.88	18	873	2.91	2.36
Southern Europe	10.02	12.71	71	8 901	2.61	1.35
Russian Federation	4.88	4.90	88	90	4.00	4.00
WORLD	273.72	278.85	10 825	26 909	2.05	1.88

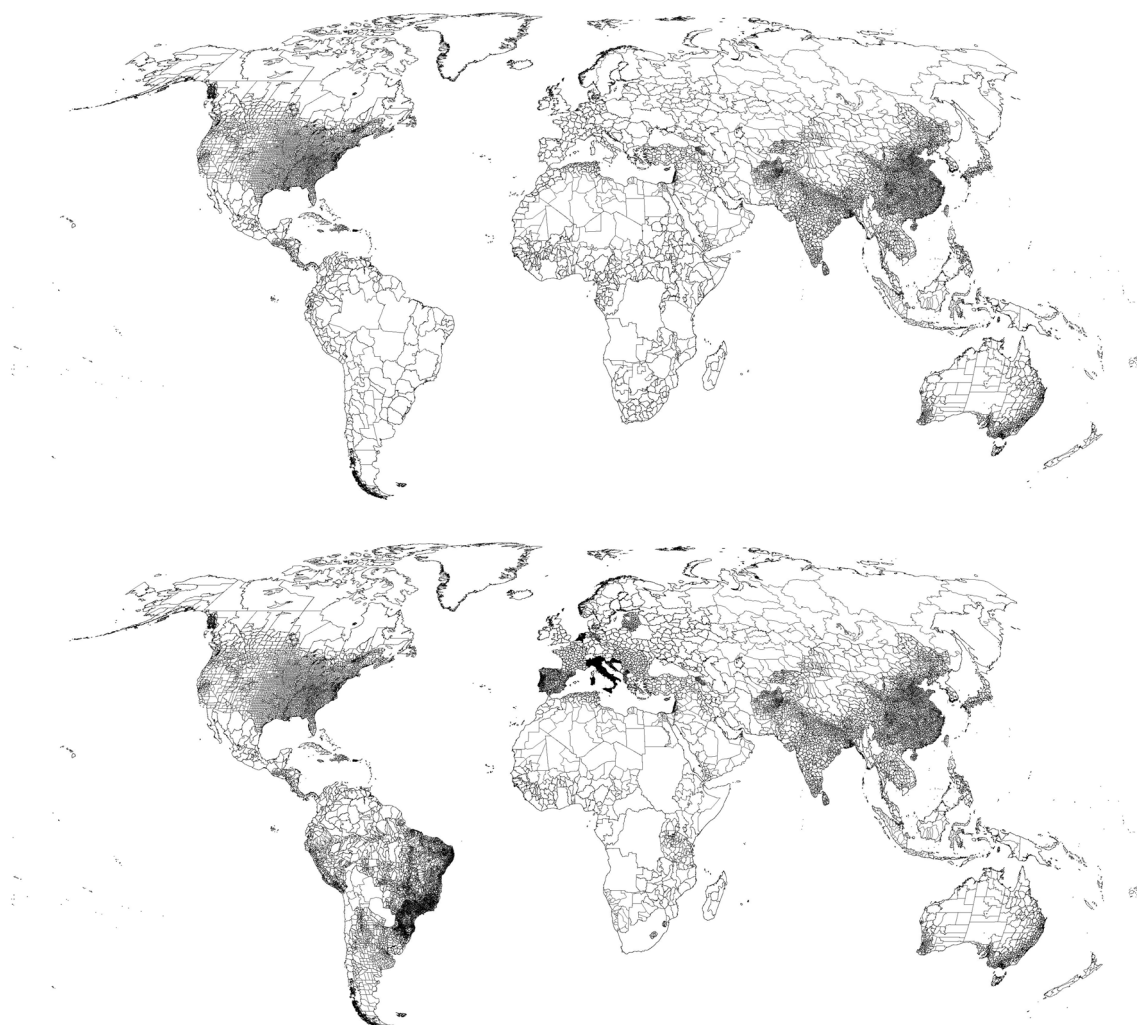


FIGURE 1
Map of administrative units consistent with collected subnational irrigation statistics used to develop the versions 3 (on top) and 4 (below) of the Digital Global Map of Irrigation Areas

The density of subnational irrigation statistics increased in particular in the European part of the map and for the countries updated in South America, while it decreased in some African regions (Figure 1, Table 90). Area equipped for irrigation increased in all regions except of Eastern Europe where it decreased (Figure 2, Table 90). The map quality was improved for all regions except of Russia. The fact that map quality was improved also for the African regions while the number of subnational units with irrigation statistics decreased in that region at the same time (Table 90) indicates that the improvements of map quality are mainly based on more geospatial information on the location and extent of irrigation schemes. The number of subnational statistical units decreased in parts of Africa because for some countries more recent data are only available at national level while older data were also available at sub-national level.

As one consequence of this update area equipped for irrigation was increasing in all the five countries in Latin America, in Africa it increased in 37 countries and decreased in 7 countries while in Europe it was increasing in 24 countries and decreasing in 9 countries (Table 90). Changing irrigated areas by country are not caused in any case by the change of the reference year in the irrigation statistics from about 1995 in map version 3 to 2000 in map

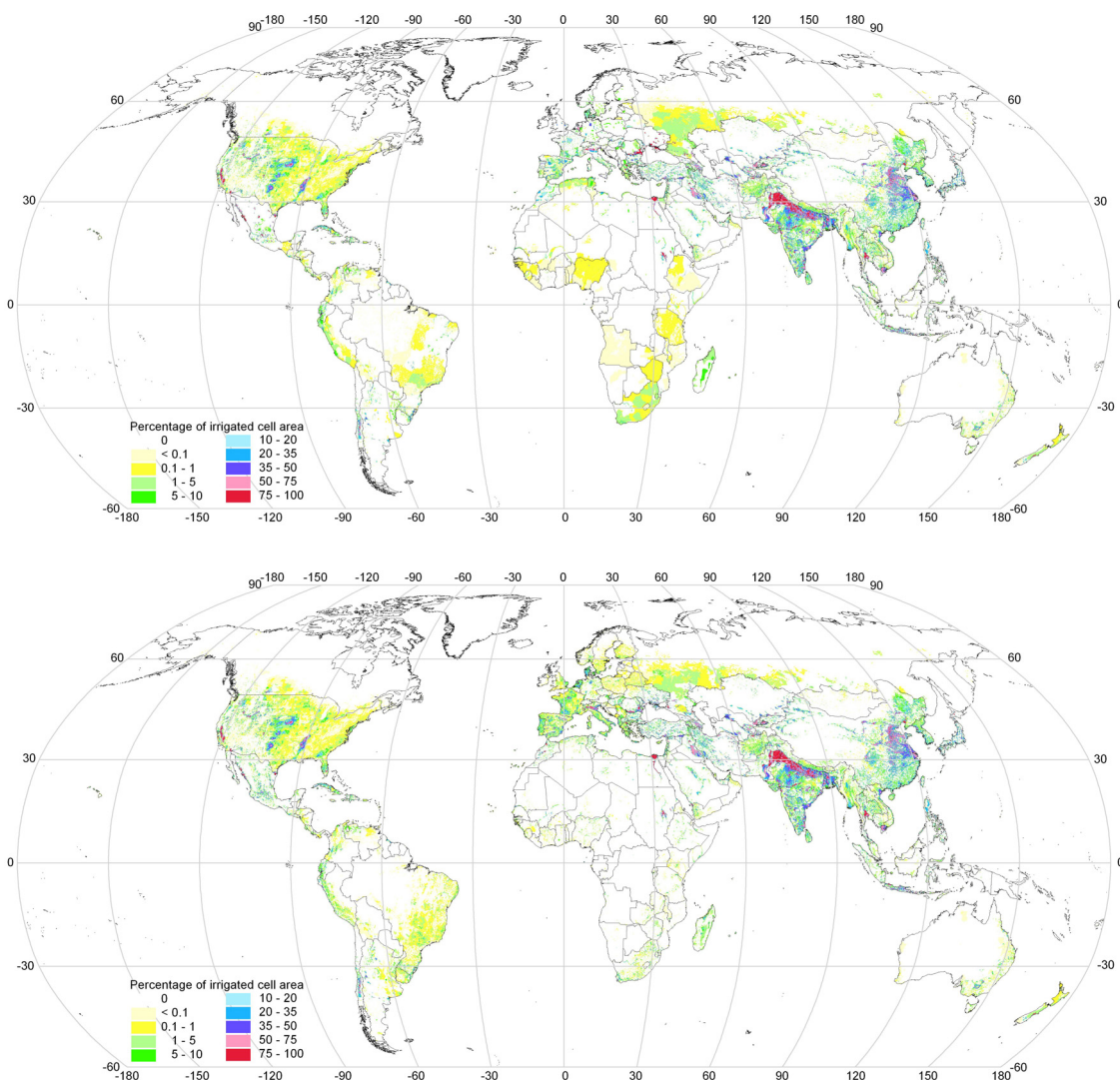


FIGURE 2
Versions 3 (on top) and 4 (below) of the Digital Global Map of Irrigation Areas showing the area under irrigation as percentage of surface area

version 4. In particular for many European countries the reason of the differences in irrigated area by country is the change of the source for the statistics. In map version 3 irrigation statistics were derived from FAOSTAT because AQUASTAT country profiles were not available for most of the European countries. The FAOSTAT data were replaced in map version 4 by subnational statistics provided by national statistical offices or EUROSTAT. It was found that the statistics provided by national offices or EUROSTAT differed for some countries significantly from the statistics provided by FAOSTAT.

The map quality as estimated using the two indicators described before was improved for 64 of the 103 countries located in updated parts of the map. However, for 7 countries the map quality was also assessed to be worse than before (Figure 3, Table 91), which may happen if more recent irrigation statistics became available for a country at the national scale while the statistics available before reported irrigated area at the subnational scale. Another reason maybe that the mark for the map quality had to be downgraded because of doubts on the reliability of the used information, for example because statistics from a new source were different from those existing before.

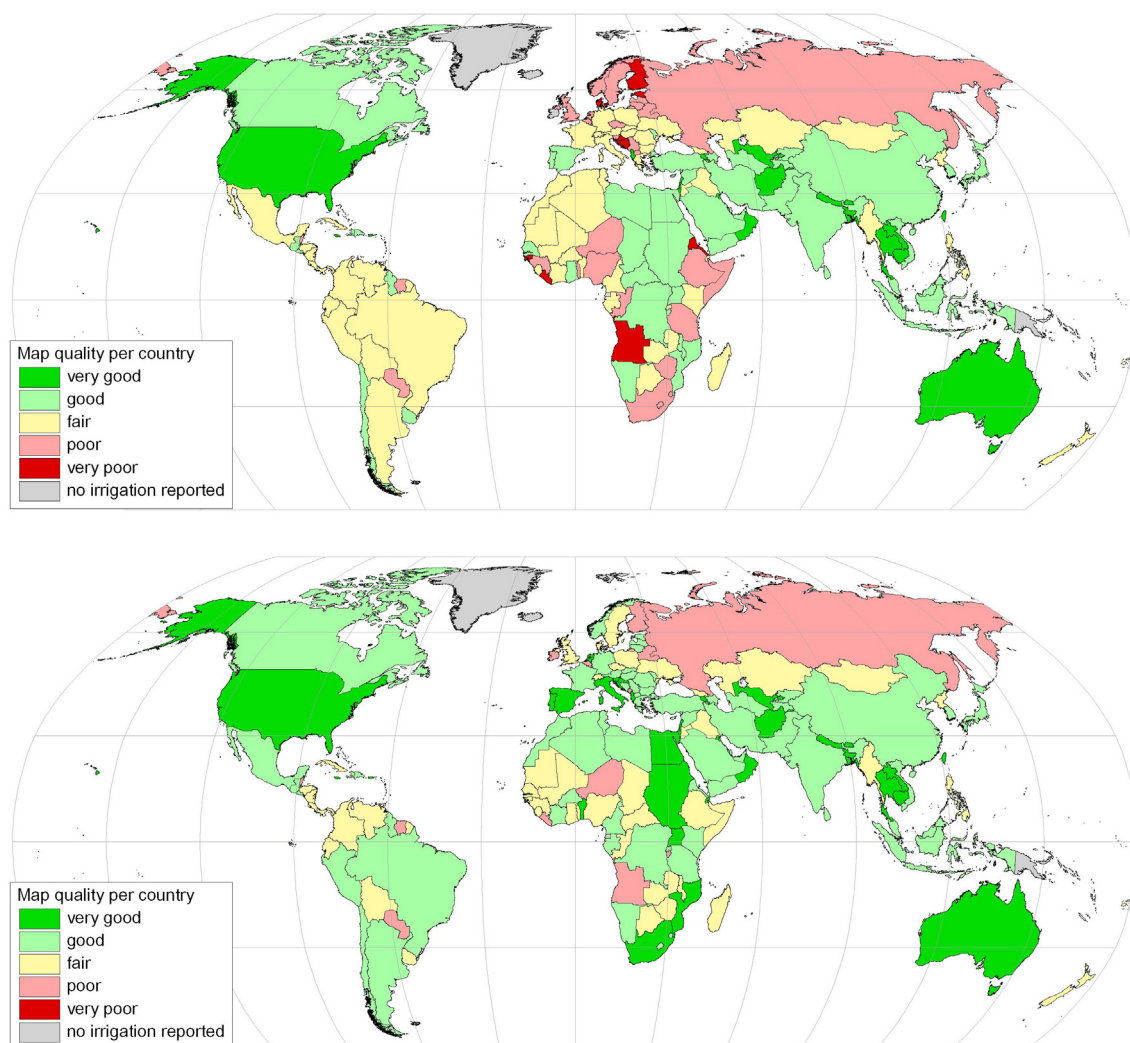


FIGURE 3
Assessment of map quality for each country in Versions 3 (on top) and 4 (below) of the Digital Global Map of Irrigation Areas

A visual interpretation of irrigation map versions 3 and 4 shows that the irrigated areas are more concentrated within specific cells in many African countries. This is the result of the use of more geo-spatial information newly available for many countries, e.g. data provided by FAO's AFRICOVER program. In contrast, irrigation is more widespread in many regions of Latin America (e.g. North-Eastern Brazil) or Europe. The reason for this effect is the use of subnational statistics at a high resolution. These statistics indicate that irrigation is not only practised in the main irrigation areas as known before. Instead of it at least some irrigation can be found in almost any populated area of these regions.

TABLE 91

Area equipped for irrigation and map quality by country for versions 3 and 4 of the Digital Global Map of Irrigation Areas, Total Area Available for Irrigation (TAAI) by country in version 2 of IWMI's Global Irrigated Area Map (Thenkabail et al., 2006)

Country	Area equipped for irrigation (ha)		Mark for map quality		TAAI (ha)
	Map version 3	Map version 4	Map version 3	Map version 4	IWMI GIAM 2
AFRICA					
Algeria	555 500	569 418	fair (3)	good (2)	138 198
Angola	75 000	80 000	very poor (5)	poor (4)	22 810
Benin	10 236	12 258	fair (3)	very good (1)	15 192
Botswana	1 381	1 439	fair (3)	fair (3)	5 363
Burkina Faso	24 331	25 000	fair (3)	good (2)	14 684
Burundi	14 400	21 430	good (2)	poor (4)	11 548
Cameroon	20 970	25 654	fair (3)	good (2)	53 793
Cape Verde	2 779	2 780	fair (3)	very good (1)	0
Central African Republic	135	135	good (2)	fair (3)	1 213
Chad	14 020	30 273	good (2)	fair (3)	24 686
Comoros	130	130	very good (1)	very good (1)	415
Congo Dem. Rep.	10 500	10 500	good (2)	good (2)	22 666
Congo	217	2 000	poor (4)	fair (3)	0
Cote d'Ivoire	72 750	72 750	fair (3)	good (2)	94 620
Djibouti	407	1 012	fair (3)	very good (1)	866
Egypt	3 245 650	3 422 178	good (2)	very good (1)	2 086 783
Equatorial Guinea	0	0	n.a.	n.a.	3 005
Eritrea	28 124	21 590	very poor (5)	good (2)	16 190
Ethiopia	160 785	289 530	poor (4)	fair (3)	179 682
Gabon	4 450	4 450	fair (3)	good (2)	0
Gambia	1 670	2 149	good (2)	very good (1)	39 778
Ghana	6 374	30 900	good (2)	fair (3)	60 614
Guinea	92 880	94 914	poor (4)	fair (3)	303 231
Guinea Bissau	17 115	22 558	very poor (5)	fair (3)	109 103
Kenya	66 610	103 203	fair (3)	good (2)	83 045
Lesotho	2 722	2 638	poor (4)	good (2)	5 431
Liberia	2 100	2 100	very poor (5)	poor (4)	442
Libya	360 500	470 000	good (2)	good (2)	216 115
Madagascar	1 087 000	1 086 291	fair (3)	fair (3)	70 356
Malawi	28 000	56 390	good (2)	fair (3)	3 275
Mali	191 470	235 791	fair (3)	fair (3)	58 389
Mauritania	49 200	45 012	fair (3)	fair (3)	18 870
Mauritius	17 500	21 222	very good (1)	very good (1)	5 024
Morocco	1 258 200	1 484 160	fair (3)	good (2)	980 306
Mozambique	116 715	118 120	good (2)	very good (1)	53 332
Namibia	6 142	7 573	good (2)	good (2)	10 041
Niger	66 480	73 663	poor (4)	poor (4)	4 622
Nigeria	300 350	293 117	poor (4)	fair (3)	194 048
Reunion	12 000	13 000	good (2)	good (2)	661
Rwanda	4 000	8 500	fair (3)	good (2)	67 983
Sao Tome and Principe	9 700	9 700	good (2)	very good (1)	0
Senegal	71 400	119 680	good (2)	fair (3)	205 909

Country	Area equipped for irrigation (ha)		Mark for map quality		TAAI (ha)
	Map version 3	Map version 4	Map version 3	Map version 4	IWMI GIAM 2
Seychelles	0	260	n.a.	very good (1)	0
Sierra Leone	29 360	29 360	fair (3)	fair (3)	22 071
Somalia	200 000	200 000	poor (4)	fair (3)	362 273
South Africa	1 270 000	1 498 000	poor (4)	very good (1)	784 336
Sudan	1 946 200	1 863 000	good (2)	very good (1)	1 655 761
Swaziland	67 400	49 843	poor (4)	good (2)	143 177
Tanzania	150 000	184 330	poor (4)	good (2)	47 976
Togo	7 008	7 300	poor (4)	fair (3)	21 917
Tunisia	384 943	394 063	fair (3)	good (2)	104 157
Uganda	9 120	9 150	good (2)	very good (1)	31 372
Zambia	46 400	155 912	fair (3)	fair (3)	748
Zimbabwe	116 577	173 513	poor (4)	fair (3)	4 505
EUROPE					
Albania	340 000	340 000	very good (1)	very good (1)	222 984
Andorra	150	150	good (2)	good (2)	0
Austria	46 000	97 480	fair (3)	good (2)	116 114
Belarus	115 000	115 000	poor (4)	poor (4)	79 442
Belgium	40 000	35 170	poor (4)	poor (4)	339 050
Bosnia and Herzegovina	2 000	4 630	very poor (5)	good (2)	10 670
Bulgaria	800 000	545 160	fair (3)	good (2)	1 278 137
Croatia	3 000	5 790	very poor (5)	very good (1)	35 690
Cyprus	55 813	55 813	good (2)	good (2)	6 851
Czech Republic	24 000	50 590	poor (4)	fair (3)	530 117
Denmark	476 000	476 000	very poor (5)	fair (3)	1 067 861
Estonia	4 000	1 363	very poor (5)	good (2)	24 053
Finland	64 000	103 800	very poor (5)	poor (4)	122 773
France	2 000 000	2 906 081	fair (3)	good (2)	2 392 733
Germany	531 120	496 871	fair (3)	good (2)	2 243 204
Greece	1 422 000	1 544 530	fair (3)	good (2)	903 007
Hungary	210 000	292 147	fair (3)	good (2)	226 338
Iceland	0	0	n.a.	n.a.	0
Ireland	0	1 100	n.a.	poor (4)	0
Italy	2 698 000	3 892 202	fair (3)	very good (1)	2 738 565
Latvia	20 000	1 150	poor (4)	good (2)	12 647
Liechtenstein	0	0	n.a.	n.a.	0
Lithuania	9 000	4 416	poor (4)	good (2)	54 132
Luxembourg	0	27	n.a.	good (2)	66
Macedonia, the former Yugoslav Republic of	55 000	127 800	poor (4)	good (2)	178 927
Malta	2 000	2 300	fair (3)	very good (1)	0
Moldova	307 000	307 000	good (2)	good (2)	285 993
Monaco	0	0	n.a.	n.a.	75
Montenegro, Republic of	n.a.	2 115	n.a.	poor (4)	10 611
Netherlands	565 000	476 315	poor (4)	very good (1)	851 187
Norway	127 000	134 396	poor (4)	good (2)	2 257
Poland	100 000	134 050	fair (3)	fair (3)	358 917
Portugal	632 000	792 008	good (2)	very good (1)	347 119
Romania	2 880 000	2 149 903	fair (3)	good (2)	2 284 667

Country	Area equipped for irrigation (ha)		Mark for map quality		TAAI (ha)
	Map version 3	Map version 4	Map version 3	Map version 4	IWMI GIAM 2
Russia	4 878 000	4 899 900	poor (4)	poor (4)	21 724 537
San Marino	0	0	n.a.	n.a.	1 268
Serbia	57 000	163 311	poor (4)	good (2)	170 062
Slovakia	174 000	225 310	fair (3)	good (2)	101 600
Slovenia	2 000	15 643	poor (4)	very good (1)	468
Spain	3 268 306	3 575 488	good (2)	very good (1)	3 297 105
Sweden	115 000	188 470	poor (4)	fair (3)	77 749
Switzerland	25 000	40 000	fair (3)	fair (3)	30 375
Ukraine	2 454 000	2 395 500	fair (3)	fair (3)	2 897 304
United Kingdom	142 687	228 950	poor (4)	fair (3)	928 027
LATIN AMERICA					
Argentina	1 437 275	1 767 784	fair (3)	good (2)	8 867 096
Brazil	2 656 284	3 149 217	fair (3)	good (2)	4 045 823
Mexico	6 104 956	6 435 800	fair (3)	good (2)	3 672 395
Peru	1 195 228	1 729 069	fair (3)	good (2)	340 094
Uruguay	181 200	217 593	good (2)	fair (3)	385 666

2.3 DISCUSSION OF MAP QUALITY

The assessment of map quality was mainly based on two indicators that take into account the geospatial information density (see section 1.2). While the density of the available information was quantified it was in general not possible to assess the reliability of the used information in a systematic way. The overall map quality mark was downgraded for a country when it was found that sub-national statistics coming from different sources disagreed, when statistics were found to be incomplete or when geo-spatial information was found to be out of date. However, this method implies that statistics, for example, are assumed to be reliable unless there are indications for the opposite. In praxis it is not possible to estimate the uncertainty of all the census survey results used as input for the map generation. Nevertheless it is possible to search actively for inconsistencies to other types of information. This is being done by FAO in the framework of their AQUASTAT surveys. Irrigation statistics are checked against other statistics (e.g. irrigation water use, crop production, water resources) for inconsistencies. The AQUASTAT surveys are available for countries in Africa, Asia, Latin America and the Caribbean, but not for most of the European countries. Therefore, we try to explore in the following section the irrigation statistics used for European countries to give some hints on possible uncertainties. The focus will be on the countries in Eastern Europe because it is known that the restructuring of the irrigation sector caused there dramatic changes in the extent of irrigated areas (see for example Dirksen and Huppert, 2006).

At the beginning of the 1990s the period of transition from a central planning economy to the market economy started in many countries in Central and Eastern Europe. The irrigation systems, although often of good quality, were designed on the basis of design criteria which do not fit to the changing requirements. For example most of the irrigation systems were designed to serve large areas and were not flexible enough to provide irrigation water to crops grown on smaller private fields after the land reform. As a consequence large parts of the former infrastructure were not used anymore and faced deterioration and damage. On the other hand there is still a requirement for irrigation in the former irrigation areas and thus the land users started to introduce new infrastructure. The statistics on areas equipped for irrigation count in some countries for both together, for land equipped with the old irrigation infrastructure (because it could potentially be reactivated) and for areas equipped with the new infrastructure. It is therefore a question of the used definitions whether areas can still be considered as

equipped for irrigation or not. According to the statistics, the total area reclaimed with irrigation facilities in Romania was 3 168 700 ha in 1990, 3 205 200 ha in 1995 and 3 177 100 ha in 2003, but only 6.8% of the available irrigation facilities were used in year 2000 (Nicolaiescu et al., 2006). Thus the statistics very likely account for a lot of "dead" infrastructure that should not be considered in the global irrigation map.

Table 92 lists the area equipped for irrigation around 1990, the area equipped for irrigation in the new version 4 of the global irrigation map and statistics for the area actually used for irrigation in the period 1990-2005 for 9 Central- and Eastern European countries. Average values are listed for the area actually irrigated if data were available for more than one year in the related period (e.g. 1991-1995). It is shown, that the area equipped for irrigation in the new map version 4 is lower for all countries compared to the equipped area in 1990. However, the area actually used for irrigation around year 2000 is again even much lower.

TABLE 92

Area equipped for irrigation around 1990, area equipped for irrigation in the new version 4 of the global irrigation map and statistics for the area actually used for irrigation in the period 1990-2005 for countries in Central and Eastern Europe

Country	Area equipped for irrigation (ha)		Area actually used for irrigation (ha)				
	around 1990	in version 4 of the global irrigation map	1990	1991-1995	1996-1999	2000-2003	2004-2005
Bulgaria	1 262 000	545 160	570 000	122 000	50 000	79 370	
Czech Republic	127 000	50 590	89 836	41 104	25 369	16 870	17 320
Germany	1 500 000	496 871			236 797	220 907	
Hungary	380 000	292 147		184 300	95 450	117 650	87 500
Poland	301 500	134 050				46 910	70 450
Romania	3 168 700	2 149 903	2 218 090	651 200	314 366	395 025	
Russia	6 120 000	4 899 900				3 430 000	
Slovak Republic	318 000	225 310		139 000	70 000	107 608	
Ukraine	2 624 000	2 395 500	2 291 600	1 845 100	1 429 800	724 350	

TABLE 93

Area equipped for irrigation and area actually irrigated in countries located in the Western part of Europe (for the source of the statistics see the country section 1.4)

Country	Year	Area equipped for irrigation (ha)	Area actually irrigated (ha)	Fraction of equipped area that was actually used for irrigation
Austria	1995	96 140	45 720	0.48
Austria	2003	90 420	34 230	0.38
Denmark	2003	448 820	201 480	0.45
France	1990	2 099 700	1 484 840	0.71
France	1995	2 510 410	1 629 580	0.65
France	2003	2 723 700	1 938 730	0.71
Germany	1998	531 120	236 797	0.45
Germany	2002	496 871	220 907	0.44
Greece	1990	1 130 570	932 980	0.83
Greece	1995	1 235 300	1 142 180	0.92
Greece	2003	1 521 600	1 294 400	0.85
Italy	1990	3 857 710	2 697 100	0.70
Italy	2000	3 892 202	2 471 379	0.63
Italy	2003	3 977 210	1 846 880	0.46
Netherlands	1997	476 315	308 700	0.65

Country	Year	Area equipped for irrigation (ha)	Area actually irrigated (ha)	Fraction of equipped area that was actually used for irrigation
Netherlands	1999	476 315	123 300	0.26
Netherlands	2000	476 315	160 500	0.34
Portugal	1990	877 690	631 120	0.72
Portugal	1999	792 008	606 213	0.77
Spain	1990	2 540 310	2 433 700	0.96
Spain	1995	2 891 050	2 609 920	0.90
Spain	1999	3 575 494	3 315 600	0.93
Spain	2003	3 828 110	3 437 370	0.90
Sweden	2003	188 460	53 430	0.28
England and Wales*	1984	189 310	140 630	0.74
England and Wales*	1990	202 620	164 470	0.81
England and Wales*	1992	218 550	107 940	0.49
England*	1995	194 000	155 650	0.80
England*	2001	282 960	147 270	0.52

*: Area likely to be irrigated in a dry year as reported in Weatherhead & Danert (2002) was assumed to represent area equipped for irrigation in England and Wales

In Europe it is common that in a specific year only parts of the irrigation infrastructure is used (see Table 93 for some countries in the Western part of Europe). In most regions of Europe irrigation is supplementary. This means that a major part of the crop water use comes from precipitation. In wet years it is possible in many regions to abstain from irrigation to avoid the related costs for water, labour and electricity. Additionally there is a trend to irrigate selectively only specific crops in the rotation (high value crops like vegetables, fruits or potatoes). The fraction of area equipped for irrigation that is actually being used is largest for the more arid Mediterranean countries like Spain or Greece with values between 0.80 and 0.95, decreases to 0.6 – 0.8 for a bit more humid countries like Italy or France, to 0.3 – 0.8 for countries like the Netherlands, Germany and UK in Western Europe and is lowest for the Scandinavian countries like Sweden. In contrast the year to year variations are largest for the more humid Western European countries (e.g. Netherlands).

When applying the fractions of area equipped for irrigation that is actually being used as observed for the countries in the Western part of Europe (Table 93) to countries in the Eastern part (Table 92) it can be shown that the reported statistics fit well to the expected values for countries like Poland, Slovakia or Germany. However, this procedure also indicates that the areas equipped for irrigation in Bulgaria, Romania and Ukraine might still be overestimated in the global irrigation map.

The area equipped for irrigation in map version 4 was also compared to the total area available for irrigation (TAAI) in the Irrigated Area Map of the World (1999) derived from remote sensing (GIAM 2) developed by researchers at IWMI (Thenkabail et al., 2006). It was found that there is hardly any agreement between the area equipped for irrigation reported by the statistics and used to develop map version 4 and the area available for irrigation per country as detected by the remote sensing data set (Table 91). In 61 of the 102 countries the area in one map is more than double than the area in the other map. Differences of less than 30% between both data sets are exceptional. Moreover we were not able to find any system behind the observed differences between both data sets. We believe therefore that the major reason for the differences at the country scale between both data sets for the regions of Europe and Africa is the fact that one constant irrigated area fraction was applied globally for each of the 28 classes in the GIAM map version 2.

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Appendix A

Calculation of indicators of map quality and related marks for map quality at the country, regional or global scale

Two country-specific indicators were developed to quantify the density of information used as input data sources: indicator A (IND_A) represents the density of the used subnational irrigation statistics while indicator B (IND_B) represents the density of the available geospatial records on position and extent of irrigated areas. Marks derived from the two indicators were combined to obtain a mark for the overall map quality for each country.

A possible indicator for the density of subnational irrigation statistics is the arithmetic mean of the size of the subnational units. However, there are some countries where irrigation is concentrated in some small subnational units while in other very large subnational units of the same country there is no or very little irrigation. To avoid that large subnational units without significant irrigation have a negative impact on indicator A, the size of each subnational statistical unit is weighted by the irrigation density in the subnational unit relative to the irrigation density in the entire country, and

$$IND_A_{country} = \frac{area_{country}}{\sum_{adm=1}^n (irridens_{adm} / irridens_{country})} \quad (1)$$

with

$$irridens_{adm} = \frac{irarea_{adm}}{area_{adm}} \quad (2)$$

where $IND_A_{country}$ is the average weighted size of the subnational units in the specific country (ha), $area_{country}$ is the surface area of the country (ha), $irridens_{adm}$ is the irrigation density in subnational unit adm (-), $irridens_{country}$ is the irrigation density in region the country (-), n is the number of subnational units in the country, $irarea_{adm}$ is the irrigated area in subnational unit adm (ha) and $area_{adm}$ is the surface area in subnational unit adm (ha).

Simplifying Eq. 1 results in

$$IND_A_{country} = \frac{irarea_{country}}{\sum_{adm=1}^n irridens_{adm}} \quad (3)$$

where $irarea_{country}$ is the total irrigated area in the country (ha).

IND_A would be equal the arithmetic mean of the size of subnational units in a country if the irrigation density would be the same in all subnational units of the country. If all irrigated area would be concentrated in only one subnational unit, IND_A would be equal to the size of this subnational unit. IND_A would be lower than the arithmetic mean of the size of the subnational units if the irrigation density is higher in small subnational units than in the larger subnational units.

The second indicator (IND_B) was developed to give an estimate on the density of geospatial information used to assign irrigated area to specific cells within the sub-national units. IND_B was computed as the fraction of irrigated area that could be assigned to specific grid cells by using geospatial records on the position and extent of known irrigation projects.

Depending on the computed indicator values, the marks excellent, very good, good, fair, poor or very poor were given to each country for both of the indicators IND_A and IND_B (Table A1). A mark for the overall quality was given assuming that the types of information that are reflected by the two indicators can replace each other. Thus, in general, the mark for the overall map quality was set to the better of the two marks given according to IND_A and IND_B . If, for example, the location and extent of almost all irrigation projects in a country is known then the overall quality of the map should be excellent independently from the mark

given according to the weighted size of subnational units. On the other hand, if the size of the subnational statistical units is very small (in an extreme case smaller than the map resolution of 5 arc minutes), the overall quality of the map should also be excellent even if there are no geospatial records on the position of irrigation schemes within the sub-national units available. Finally the mark for the overall map quality was downgraded when there were doubts regarding the reliability of the information used for a specific country.

Marks for the overall mapping quality in world regions or at global scale were computed by combining the marks for the overall quality of the map at country level and the irrigated area in the corresponding countries as:

$$m_{reg} = \frac{irarea_{v_good} + 2 * irarea_{good} + 3 * irarea_{fair} + 4 * irarea_{poor} + 5 * irarea_{v_poor}}{irarea_{reg}} \quad (4)$$

where m_{reg} is the overall quality of irrigation map in the whole region, $irarea_{v_good}$, $irarea_{good}$, $irarea_{fair}$, $irarea_{poor}$ and $irarea_{v_poor}$ represent the irrigated area of all countries in the region with very good, good, fair, poor or very poor map quality (ha) and $irarea_{reg}$ is the irrigated area in the whole region (ha).

TABLE A1

Assignment of marks dependent on the quantities of the map quality indicators for the weighted average size of subnational statistical units (*IND_A*) and the percentage of irrigated area assigned to grid cells by using geospatial records on position and extent of known irrigation schemes (*IND_B*)

Mark	Indicator <i>IND_A</i> (ha)	Indicator <i>IND_B</i> (%)
Excellent	< 100 000	90 - 100
Very good	100 000 – 250 000	70 - 90
Good	250 000 – 500 000	50 - 70
Fair	500 000 – 1 000 000	25 - 50
Poor	1 000 000 – 3 000 000	10 - 25
Very poor	> 3 000 000	< 10

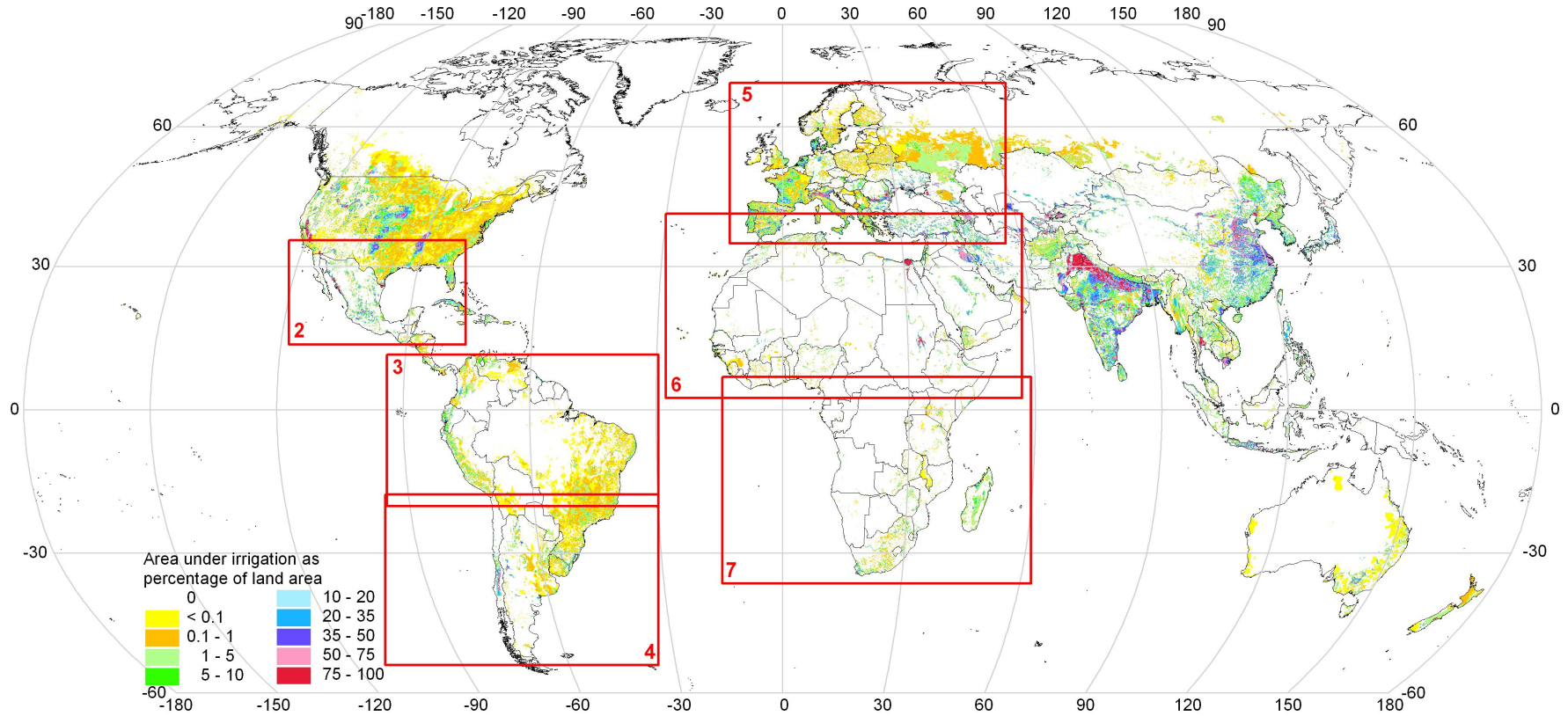
Appendix B

Maps

This appendix presents maps showing the percentage of the surface area equipped for irrigation in the new version 4 of the Digital Global Map of Irrigation Areas. The map resolution is 5 minutes (0.0833 degrees), equivalent to about 9×9 km at the equator. Map 1 shows the updated global irrigation map, while maps 2–7 show the irrigation maps for subregions of Latin America, Europe and Africa.

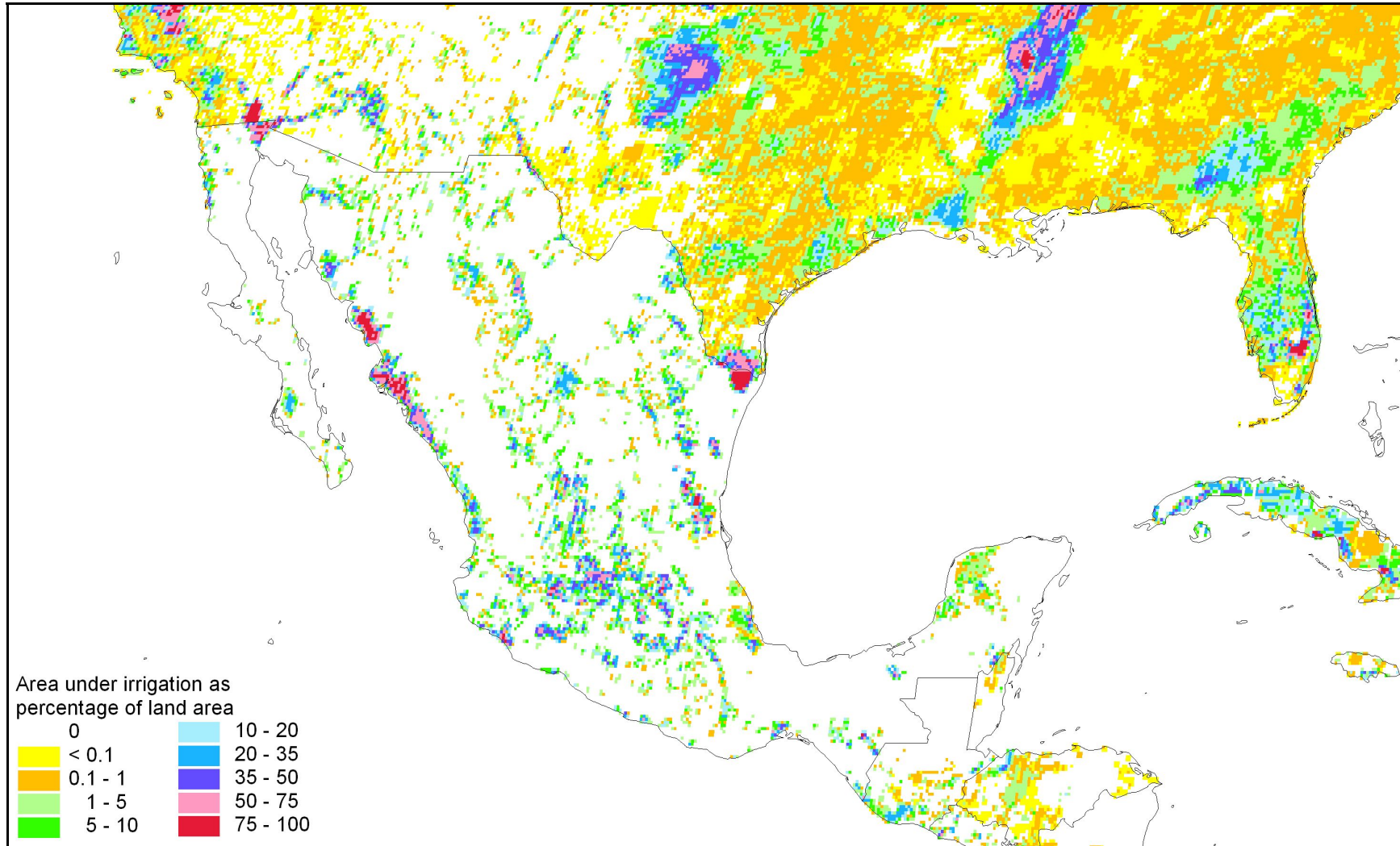
List of maps

Map no.	Map description
B1	Digital Global Map of Irrigation Areas showing percentage of surface area equipped for irrigation, Version 4, position and extent of maps 2–7 relative to the global map
B2	Percentage of surface area equipped for irrigation, Central America
B3	Percentage of surface area equipped for irrigation, Northern part of South America
B4	Percentage of surface area equipped for irrigation, Southern part of South America
B5	Percentage of surface area equipped for irrigation, Europe
B6	Percentage of surface area equipped for irrigation, Northern part of Africa
B7	Percentage of surface area equipped for irrigation, Southern part of Africa

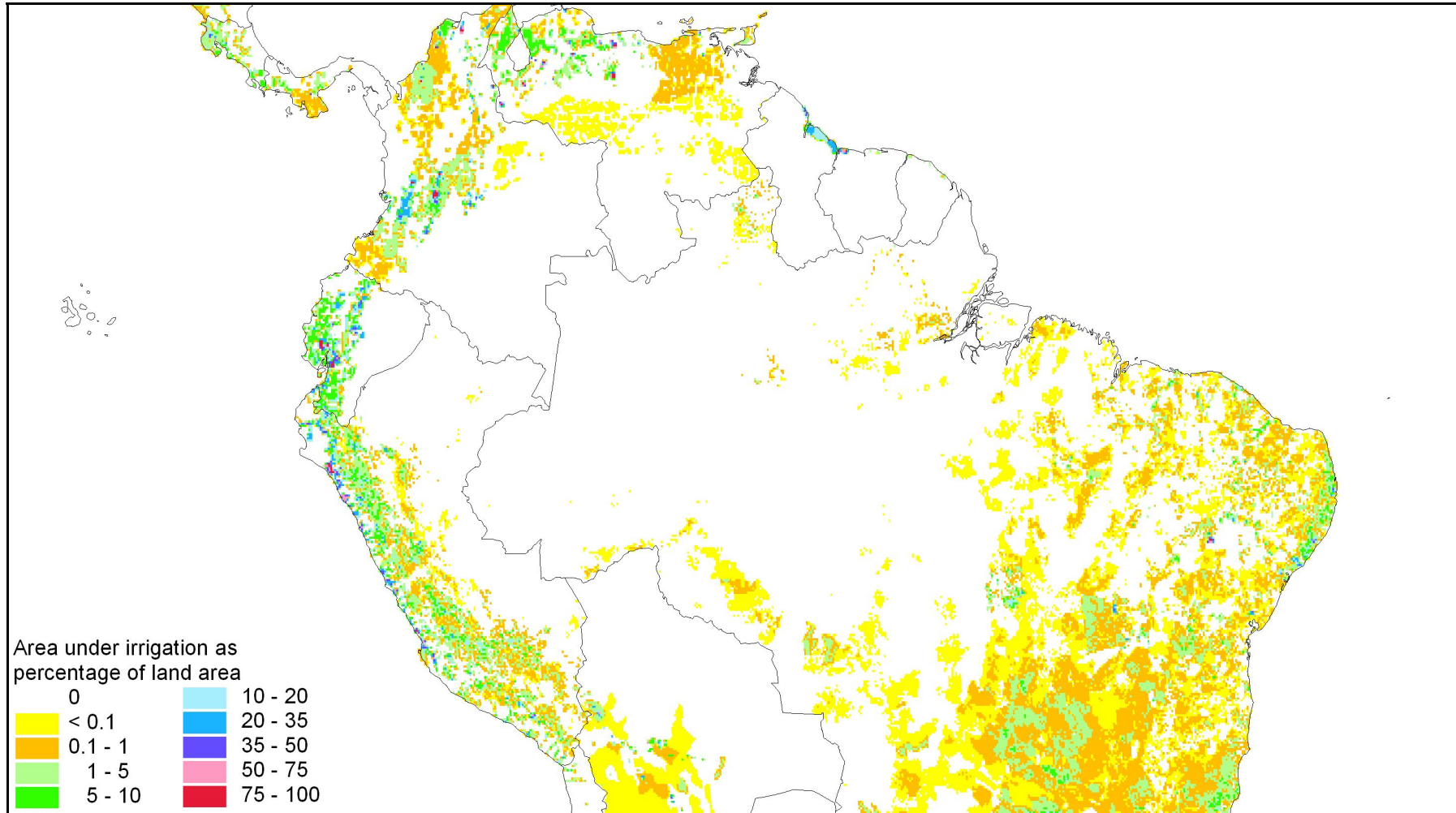


MAP B1

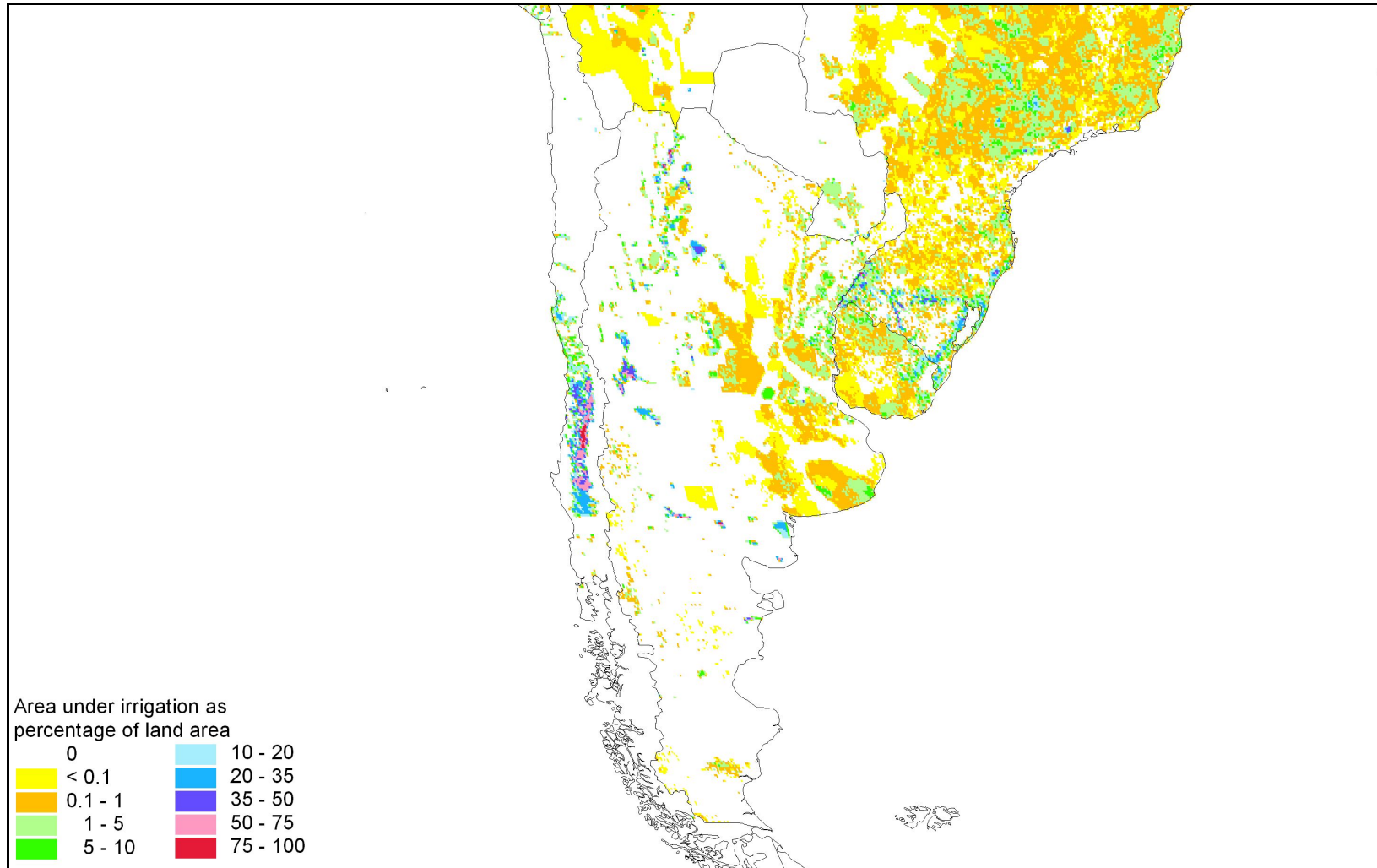
Digital Global Map of Irrigation Areas showing percentage of surface area equipped for irrigation, version 4 (December 2006), position and extent of maps 2–7 relative to the global map



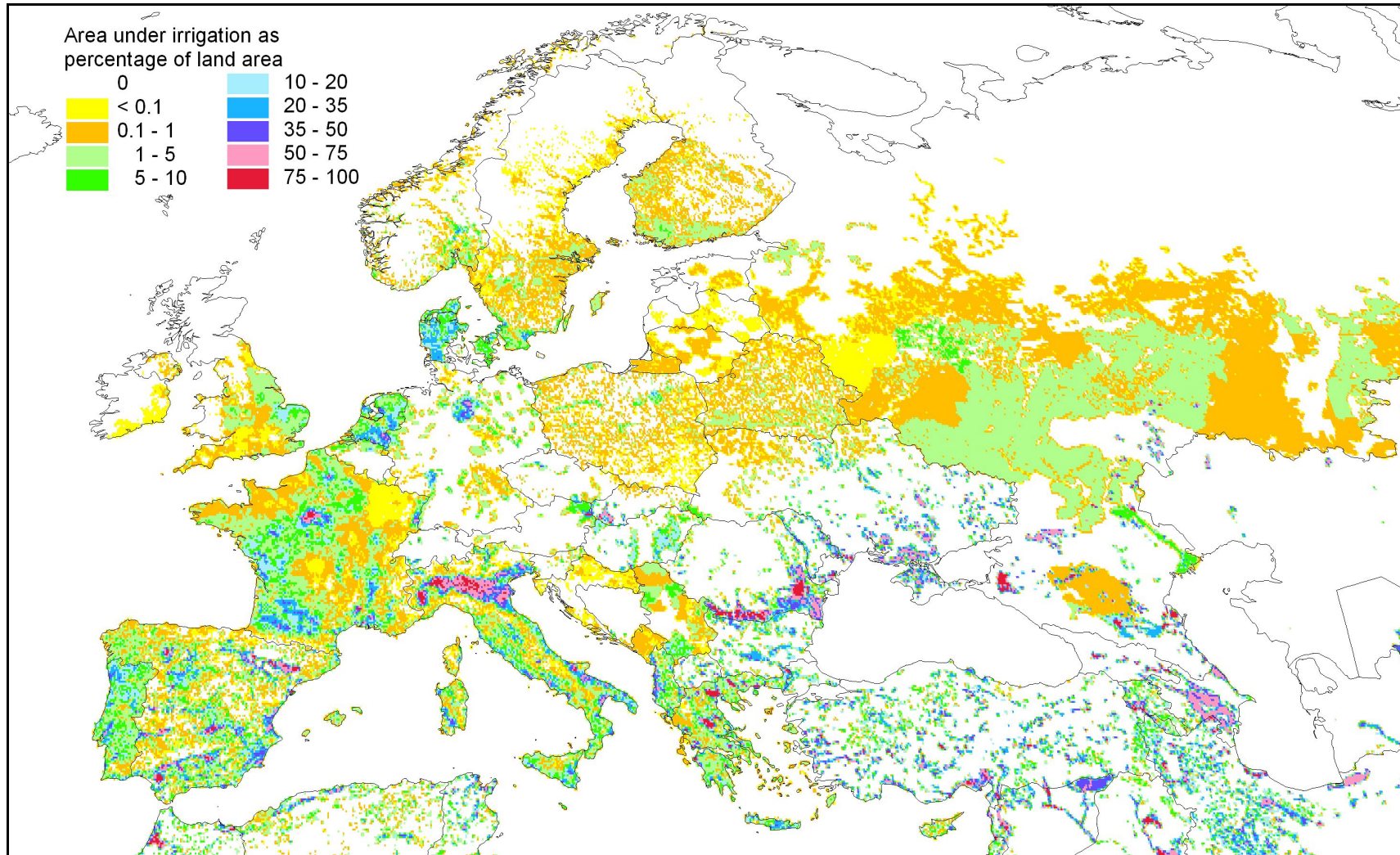
MAP B2
Percentage of surface area equipped for irrigation, Central America



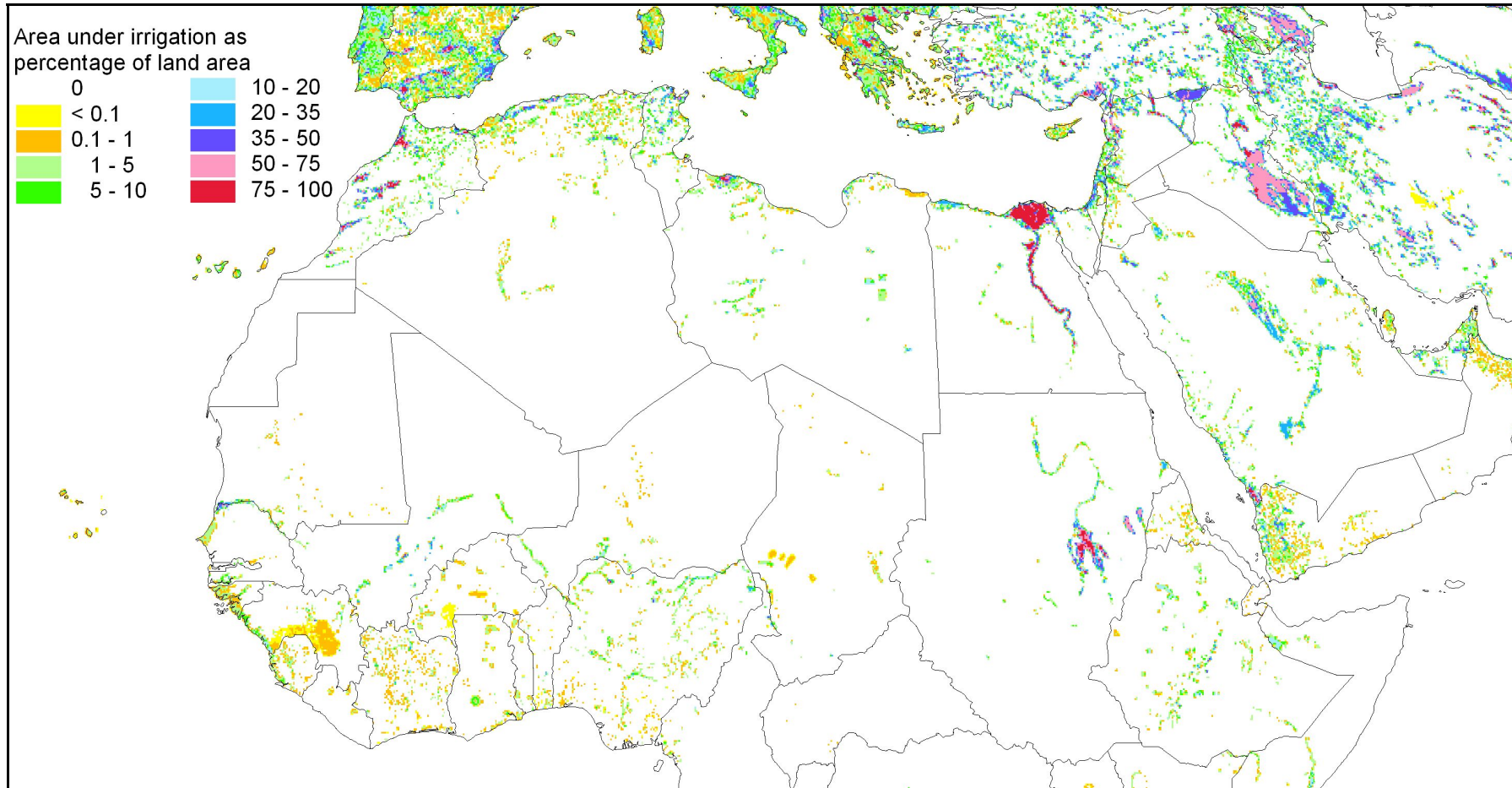
MAP B3
Percentage of surface area equipped for irrigation, Northern part of South America



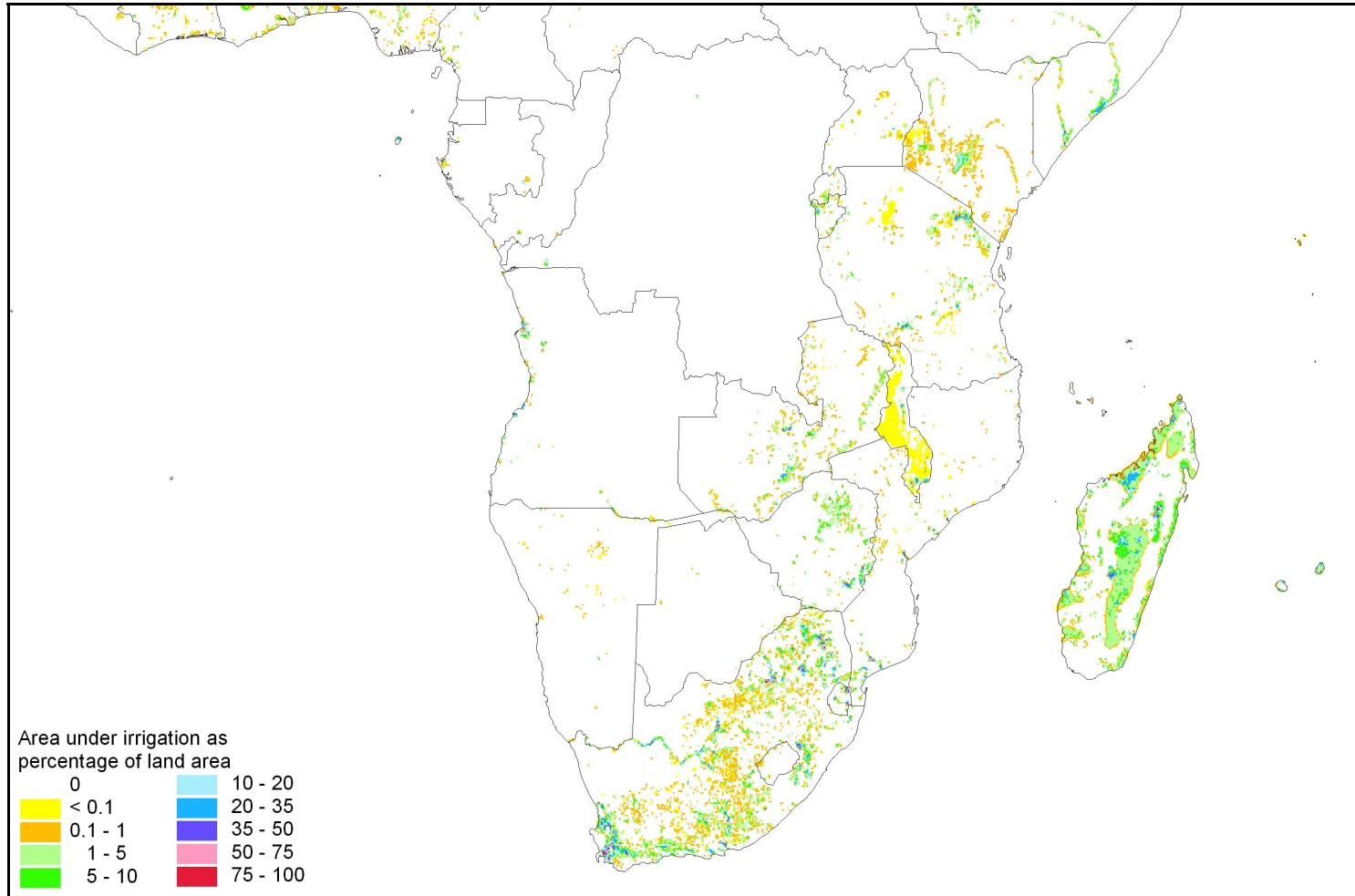
MAP B4
Percentage of surface area equipped for irrigation, Southern part of South America



MAP B5
Percentage of surface area equipped for irrigation, Europe



MAP B6
Percentage of surface area equipped for irrigation, Northern part of Africa



MAP B7
Percentage of surface area equipped for irrigation, Southern part of Africa