China

GEOGRAPHY, CLIMATE AND POPULATION

Geography
The People’s Republic of China is located in the southeast of the Eurasian landmass, bordered by Mongolia and the Russian Federation to the north, the Democratic People’s Republic of Korea and the Pacific Ocean to the east, Viet Nam, the Lao People’s Democratic Republic, Myanmar, Bhutan, Nepal and India to the south, and Pakistan, Afghanistan, Tajikistan, Kyrgyzstan and Kazakhstan to the west. The average altitude in China ranges from over 4 000 m in the west to less than 100 m in the east. The total area is about 9.6 million km² and is composed of mountains (33 percent), plateaux (26 percent), valleys (19 percent), plains (12 percent) and hills (10 percent). For administrative purposes, China is divided into 23 provinces, 3 municipalities and 5 autonomous regions, in addition to the special administrative regions of Hong Kong and Macau.

In 2009, arable land was an estimated 110.0 million ha. Adding to this the 14.3 million ha under permanent crops gives a total cultivated area of 124.3 million ha (Table 1). Of the total cultivated land, around 86 percent was cropped for food. Of these food crops, 78 percent were cereals (rice, maize, wheat, barley, sorghum), 10 percent beans, 8 percent sweet potatoes and 4 percent other crops. Of the cereals, 36 percent was rice, 33 percent maize, 28 percent wheat, 3 percent barley and 1 percent sorghum.

Climate
Vast areas of east China and most of south China are affected by the East Asia monsoon climate. Mountains and plateaux prevent the monsoon from penetrating deeply into the northwest of the continent, resulting in low precipitation there. In winter, the mainland is generally under the influence of dry cold air masses from Siberia.

Mean annual precipitation is 645 mm (Table 2). In some regions of the southwest and in the coastal areas of the southeast, the mean annual precipitation exceeds 2 000 mm. It exceeds 1 000 mm to the south of the middle and lower reaches of the Yangtze river, flowing into the sea just north of Shanghai. It is between 400 and 900 mm in the Huai river basin, in the northern plains, northeast and central China. It is less than 400 mm in parts of northeast China and most of the hinterland in the northwest. And it is less than 25 mm in the Tarim river basin in the northwest (the longest inland river) and the Qaidam river basin in the west, of which one-third is desert. Precipitation is greater in the summer months, from April-May to July-August in the south and from June to September in the north.

China is conventionally divided into four main agro-climatic zones (Wang et al., 1999):

- The arid zone is located mainly in the inland river basins in the west and northwest. This zone is suitable for irrigated cotton, grains, vegetables and fruits. Livestock is the predominant land use.
- The semi-arid zone is located largely in the upper and middle reaches of the Huang
The text is not provided in the image. However, the map shows the boundaries and names of countries, regions, and cities in Asia. The map includes various labels and color-coding for different types of boundaries and geographical features, as indicated by the legend in the lower right corner of the map. The map also includes a disclaimer at the bottom right corner, which mentions that the designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.
China (Yellow) river basin in central China. The main irrigated crops are wheat, maize and cotton. Rainfed cropping occurs, but is generally marginal.

- The semi-humid zone is subject to both floods and droughts. The North East subzone (NE) comprises the Songhua-Liao river basin in the northeast of the country. Though potentially fertile, it has a short growing season and the western part of the NE plains suffer from waterlogging and alkaline soils. Major crops include wheat, maize and soybean, with rice grown primarily under irrigated conditions. The Huang-Huai-Hai subzone (HHH) comprises the North China plain and neighbouring areas. A longer growing season than the NE permits double cropping where irrigation is provided. Wheat is the main crop followed by maize, rice and other crops.

- The humid zone lies in the south and southwest. Rice is the predominant crop. The flood season lasts from July to September, but early or late season droughts can limit crop yields. The mid-lower Yangtze subzone has a subtropical climate allowing double cropping. The Zhu-Min subzone comprises the Zhu (Pearl) and southeast river basins. It has a tropical monsoon climate that allows year-round cropping. The mountainous South West subzone has a mixed tropical/subtropical climate, with rice dominant in the lowlands, and wheat and other grains in the highlands.

**Population**

Total population is about 1 366 million (2009), of which 54 percent are living in rural areas (Table 1). The average population density is 142 inhabitants/km². In 1996 the average

<table>
<thead>
<tr>
<th>TABLE 1</th>
<th>Basic statistics and population</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical areas</strong></td>
<td></td>
</tr>
<tr>
<td>Area of the country</td>
<td>2009</td>
</tr>
<tr>
<td>Cultivated area (arable land and area under permanent crops)</td>
<td>2009</td>
</tr>
<tr>
<td>- as % of the total area of the country</td>
<td>2009</td>
</tr>
<tr>
<td>- arable land (annual crops + temp fallow + temp meadows)</td>
<td>2009</td>
</tr>
<tr>
<td>- area under permanent crops</td>
<td>2009</td>
</tr>
<tr>
<td><strong>Population</strong></td>
<td></td>
</tr>
<tr>
<td>Total population</td>
<td>2009</td>
</tr>
<tr>
<td>- of which rural</td>
<td>2009</td>
</tr>
<tr>
<td>Population density</td>
<td>2009</td>
</tr>
<tr>
<td>Economically active population</td>
<td>2009</td>
</tr>
<tr>
<td>- as % of total population</td>
<td>2009</td>
</tr>
<tr>
<td>- female</td>
<td>2009</td>
</tr>
<tr>
<td>- male</td>
<td>2009</td>
</tr>
<tr>
<td>Population economically active in agriculture</td>
<td>2009</td>
</tr>
<tr>
<td>- as % of total economically active population</td>
<td>2009</td>
</tr>
<tr>
<td>- female</td>
<td>2009</td>
</tr>
<tr>
<td>- male</td>
<td>2009</td>
</tr>
<tr>
<td><strong>Economy and development</strong></td>
<td></td>
</tr>
<tr>
<td>Gross Domestic Product (GDP) (current US$)</td>
<td>2009</td>
</tr>
<tr>
<td>- value added in agriculture (% of GDP)</td>
<td>2009</td>
</tr>
<tr>
<td>- GDP per capita</td>
<td>2009</td>
</tr>
<tr>
<td>Human Development Index (highest = 1)</td>
<td>2010</td>
</tr>
<tr>
<td><strong>Access to improved drinking water sources</strong></td>
<td></td>
</tr>
<tr>
<td>Total population</td>
<td>2008</td>
</tr>
<tr>
<td>Urban population</td>
<td>2008</td>
</tr>
<tr>
<td>Rural population</td>
<td>2008</td>
</tr>
</tbody>
</table>
TABLE 2
Water: sources and use

<table>
<thead>
<tr>
<th>Renewable freshwater resources</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Precipitation (long-term average)</td>
<td>-</td>
<td>645 mm/yr</td>
</tr>
<tr>
<td>- Internal renewable water resources (long-term average)</td>
<td>-</td>
<td>6 189 000 million m³/yr</td>
</tr>
<tr>
<td>Total actual renewable water resources</td>
<td>-</td>
<td>2 812 400 million m³/yr</td>
</tr>
<tr>
<td>Dependency ratio</td>
<td>-</td>
<td>1 %</td>
</tr>
<tr>
<td>Total actual renewable water resources per inhabitant</td>
<td>2009</td>
<td>2 079 m³/yr</td>
</tr>
<tr>
<td>Total dam capacity</td>
<td>2005</td>
<td>562 379 million m³</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Water withdrawal</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total water withdrawal</td>
<td>2005</td>
<td>554 100 million m³/yr</td>
</tr>
<tr>
<td>- irrigation + livestock</td>
<td>2005</td>
<td>358 020 million m³/yr</td>
</tr>
<tr>
<td>- municipalities</td>
<td>2005</td>
<td>67 530 million m³/yr</td>
</tr>
<tr>
<td>- industry</td>
<td>2005</td>
<td>128 550 million m³/yr</td>
</tr>
<tr>
<td>• per inhabitant</td>
<td>2005</td>
<td>414 m³/yr</td>
</tr>
<tr>
<td>Surface water and groundwater withdrawal</td>
<td>2005</td>
<td>554 089 million m³/yr</td>
</tr>
<tr>
<td>• as % of total actual renewable water resources</td>
<td>2005</td>
<td>19.5 %</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Non-conventional sources of water</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Produced wastewater</td>
<td>2006</td>
<td>53 700 million m³/yr</td>
</tr>
<tr>
<td>Treated wastewater</td>
<td>2004</td>
<td>22 100 million m³/yr</td>
</tr>
<tr>
<td>Reused treated wastewater</td>
<td>1995</td>
<td>13 390 million m³/yr</td>
</tr>
<tr>
<td>Desalinated water produced</td>
<td>2008</td>
<td>10.95 million m³/yr</td>
</tr>
<tr>
<td>Reused agricultural drainage water</td>
<td>-</td>
<td>- million m³/yr</td>
</tr>
</tbody>
</table>

Population density was 131 inhabitants/km², varying from less than 10 inhabitants/km² in the west to 670 inhabitants/km² in the east and 2 042 inhabitants/km² in Shanghai. The annual demographic growth rate was an estimated 1.1 percent over the period 1989-1999, which decreased to 0.6 percent over the period 1999-2009.

In 2008, 89 percent of the population had access to improved drinking water sources (98 and 82 percent for urban and rural population respectively), while 58 and 52 percent of urban and rural population respectively had access to improved sanitation.

ECONOMY, AGRICULTURE AND FOOD SECURITY

In 2009 the gross domestic product (GDP) was US$4 985 461 million (Table 1). In 2009, agriculture accounted for around 10 percent of GDP; while in 1999 and 1989 it accounted for 16 percent and 25 percent respectively. The economically active population is about 818 million (2009) of which 54 percent is male and 46 percent female. The agriculture sector employed 503 million inhabitants, 61 percent of the economically active population, of which 52 percent were men and 48 percent women, while in 1998 and 1988, the agriculture sector employed 67 and 72 percent respectively of the economically active population.

China has about 21 percent of the world population, with about 6 percent of the world’s freshwater and 9 percent the world’s farmlands. Per capita freshwater availability was 2 079 m³ in 2009, compared to a global average of 6 225 m³ per capita. To feed the increasing population, China has to increase total agricultural products by almost 30 percent in 2030 (Yuanhua Li, 2006).

Irrigation makes a major contribution to food security, producing nearly 75 percent of the cereals and more than 90 percent of cotton, fruits, vegetables and other agricultural commodities...
on around half of the farmlands in China. Because of the development of irrigation, food production has kept pace with population growth in recent decades. In the future, as population increases, irrigation would have to play an even more important role in China to increase production, since farmland expansion becomes a limiting factor (Li, 2006).

Northern China, although it has only 20 percent of the nation's water resources, contains 65 percent of China's cultivated land and produces roughly half of its grain and nearly all of its wheat and maize. This region accounts for more than 45 percent of the nation's GDP (Wang et al., 2005).

Drought affects an average of 15.3 million ha of farmland every year, nearly 13 percent of the total farming area (Yao, 2009).

**WATER RESOURCES AND USE**

**Surface water resources**

The average annual river runoff generated within the country is 2,711.5 km³. Precipitation makes up 98 percent of total river runoff, the remaining 2 percent coming from melting glaciers.

China can be divided into nine main river basin groups (Table 3). In the north there are the Song-Liao or Heilong (Amur)-Songhua, the Huai, the Huang (Yellow), the Hai-Luan and the interior or endoreic river basin groups. The total average annual internal surface water resources (ISRWR) in these five river basin groups are an estimated 535.5 km³, which is almost 20 percent of the country's IRSWR. In the south there are the Chang (Yangtze), the Zhu (Pearl), the southwest and the southeast river basin groups. The total average annual ISRWR in these four river basin groups are an estimated 2,176.2 km³, which is just over 80 percent of the country's IRSWR.

**TABLE 3**

River basins in China (Compiled from: FAO, 1999, and World Bank, 2006)

<table>
<thead>
<tr>
<th>Major river basin</th>
<th>Internal renewable surface water resources (km³/year)</th>
<th>As % of total</th>
<th>Percentage of national population</th>
<th>Arable land</th>
<th>Surface water resources (m³/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Population</td>
<td>Arable land</td>
<td>per capita (2006)</td>
</tr>
<tr>
<td><strong>North</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Song-Liao a</td>
<td>192.2</td>
<td>7.1</td>
<td>9.6</td>
<td>20.2</td>
<td>1,510</td>
</tr>
<tr>
<td>Huai</td>
<td>96.1</td>
<td>3.5</td>
<td>16.2</td>
<td>15.2</td>
<td>450</td>
</tr>
<tr>
<td>Huang (Yellow)</td>
<td>74.4</td>
<td>2.7</td>
<td>8.5</td>
<td>12.9</td>
<td>660</td>
</tr>
<tr>
<td>Hai-Luan</td>
<td>42.2</td>
<td>1.6</td>
<td>10.0</td>
<td>11.3</td>
<td>320</td>
</tr>
<tr>
<td>Interior basins b</td>
<td>130.4</td>
<td>4.8</td>
<td>2.1</td>
<td>5.7</td>
<td>4,670</td>
</tr>
<tr>
<td><strong>Sub-total North</strong></td>
<td>535.3</td>
<td>19.7</td>
<td>46.4</td>
<td>65.3</td>
<td>870</td>
</tr>
<tr>
<td><strong>South</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chang (Yangtze) c</td>
<td>999.9</td>
<td>36.9</td>
<td>34.3</td>
<td>23.7</td>
<td>2,190</td>
</tr>
<tr>
<td>Zhu (Pearl)</td>
<td>333.8</td>
<td>12.3</td>
<td>12.1</td>
<td>6.7</td>
<td>2,080</td>
</tr>
<tr>
<td>Southwest d</td>
<td>583.3</td>
<td>21.5</td>
<td>1.6</td>
<td>1.8</td>
<td>27,440</td>
</tr>
<tr>
<td>Southeast e</td>
<td>259.2</td>
<td>9.6</td>
<td>5.6</td>
<td>2.5</td>
<td>3,480</td>
</tr>
<tr>
<td><strong>Sub-total South</strong></td>
<td>2176.2</td>
<td>80.3</td>
<td>53.6</td>
<td>34.7</td>
<td>3,060</td>
</tr>
<tr>
<td><strong>Total China</strong></td>
<td>2711.5</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>2,040</td>
</tr>
</tbody>
</table>

Notes (figures between brackets are surface water resources expressed in km³/year):

a Includes Heilong (Amur), Songhua, and Liao, Wusuli, Suifen, Tumen, Yalu (draining into the Yellow Sea)
b Includes Ertrix (10.0), Aksu, Emin, Ill
c Includes Min (58.6)
d Includes Yarlung Zangbo (165.4)
e Includes Nu (68.7), Lancang (73.6), Yuan (44.1)
In total, there are more than 50 000 rivers with a basin area of over 100 km², 1 500 rivers have a basin exceeding 1 000 km². Rivers can be classified into two categories: rivers discharging into seas (outflowing rivers), and inland rivers running into depressions in the interior (endoreic basins). The total drainage area of rivers flowing to the sea cover about 65 percent of the territory, most drains into the Pacific Ocean and small areas to the Indian Ocean and the Arctic Ocean. Endoreic river basins cover the remaining 35 percent of the country’s total area.

The volume of water flowing to nine neighbouring countries (Bhutan, India, Kazakhstan, Kyrgyzstan, Lao People’s Democratic Republic, Mongolia, Nepal, Pakistan, and Viet Nam) is an estimated almost 719 km³/year (Table 4). To the north, the Heilong river enters the Russian Federation before it empties into the Sea of Okhotsk, the Ertix river joins the Ob River in Kazakhstan, the Ili river discharges into Lake Balkhash in Kazakhstan, and the Suifen river flows through the Russian Federation to the sea at Vladivostok. To the south, the Yuan, Lixian, Panlong rivers are the upper reaches of the Red river in Viet Nam, the Lancang river becomes the Mekong river after it enters Lao People’s Democratic Republic, the Nu river becomes the Salween river after it enters Myanmar, the Yalung Zangbo river is called the Brahmaputra river after it enters India, and the Langqen Zangbo and Sengge Zangbo rivers of west Tibet and the Qipuqiapu river of Xinjiang are the upper reaches of the Indus river flowing through India and Pakistan into the Indian Ocean.

There are 12 main rivers that enter China from six neighbouring countries (India, Kazakhstan, Kyrgyzstan, Mongolia, Pakistan, and Viet Nam). The mean annual volume of water entering the country is just over 17 km³, of which 4.2 percent in the Heilong river basin from Mongolia, 52.9 percent in inland rivers, 42.2 percent in the Zhu river basin from Viet Nam, and 0.7 percent in rivers in the southwest (Table 5).

### Table 4
Rivers flowing to neighbouring countries

<table>
<thead>
<tr>
<th>Region</th>
<th>River</th>
<th>Destination</th>
<th>Average runoff flowing out of the country (km³/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heilong</td>
<td>Suifen and Amur</td>
<td>Russian Federation</td>
<td>119.040</td>
</tr>
<tr>
<td></td>
<td><strong>Sub-total</strong></td>
<td></td>
<td><strong>119.040</strong></td>
</tr>
<tr>
<td>Southeast</td>
<td>Nu</td>
<td>Myanmar</td>
<td>68.740</td>
</tr>
<tr>
<td></td>
<td>Lancang</td>
<td>Lao PDR* and Myanmar</td>
<td>73.630</td>
</tr>
<tr>
<td></td>
<td>Yuan</td>
<td>Viet Nam**</td>
<td>44.100</td>
</tr>
<tr>
<td></td>
<td>Rivers in west Yunan</td>
<td>Myanmar</td>
<td>31.290</td>
</tr>
<tr>
<td></td>
<td><strong>Sub-total</strong></td>
<td></td>
<td><strong>217.760</strong></td>
</tr>
<tr>
<td>Southwest</td>
<td>Yarlung Zangbo (to Brahmaputra)</td>
<td>India</td>
<td>165.400</td>
</tr>
<tr>
<td></td>
<td>Rivers in south and west Tibet (to Indus)</td>
<td>India</td>
<td>181.620</td>
</tr>
<tr>
<td></td>
<td>Other rivers</td>
<td>Nepal</td>
<td>12.000</td>
</tr>
<tr>
<td></td>
<td><strong>Sub-total</strong></td>
<td></td>
<td><strong>359.020</strong></td>
</tr>
<tr>
<td>Inland rivers</td>
<td>Emin</td>
<td>Kazakhstan</td>
<td>0.310</td>
</tr>
<tr>
<td></td>
<td>Ili</td>
<td>Kazakhstan</td>
<td>11.700</td>
</tr>
<tr>
<td></td>
<td>Rivers on west slope of Barluke mountain</td>
<td>Kyrgyzstan</td>
<td>0.558</td>
</tr>
<tr>
<td></td>
<td>Aksu</td>
<td>Kazakhstan</td>
<td>0.927</td>
</tr>
<tr>
<td></td>
<td>Ertix (attached)</td>
<td>Kazakhstan</td>
<td>9.530</td>
</tr>
<tr>
<td></td>
<td><strong>Sub-total</strong></td>
<td></td>
<td><strong>23.025</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td><strong>718.845</strong></td>
</tr>
</tbody>
</table>

* Lao PDR = Lao People’s Democratic Republic
** According to some Chinese data the outflow to Viet Nam would be 47.89 km³/year
There are also a number of border rivers (Table 6). The main course of the Heilong river and its upstream tributaries (the Ergun and Wusuli rivers) flow along the border between China and the Russian Federation. After receiving the flow of the Songhua river (10.9 km³/year), the Heilong river flows into the Russian Federation. The total flow of the Heilong and Songhua rivers (117 km³/year) is considered as flowing out of China, while the resources before flowing out have already been included in the IRSWR. The Tumen and Yalu rivers flow along the border between China and the Democratic People’s Republic of Korea. However, the corresponding flow is not considered as outflowing as these rivers do not leave Chinese territory. Half of the total flow of 20.3 km³/year of these rivers, 10.15 km³/year, is counted for each country.

Glaciers

The total area of glaciers in China is about 58 651 km² extending over six northwestern and southwestern provinces or autonomous regions (Gansu, Qingha, Xinjiang, Tibet, Sichuan and Yunnan). In total the country’s glacier storage is around 5 100 km³ in total. The amount of mean annual glacier melt water is about 56 km³.

**TABLE 5**

Rivers entering China from neighbouring countries

<table>
<thead>
<tr>
<th>Region</th>
<th>River</th>
<th>Coming from</th>
<th>Average runoff flowing out of the country (km³/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heilong</td>
<td>Herlen</td>
<td>Mongolia</td>
<td>0.578</td>
</tr>
<tr>
<td></td>
<td>Wursun</td>
<td>Mongolia</td>
<td>0.145</td>
</tr>
<tr>
<td></td>
<td>Sub-total</td>
<td></td>
<td>0.723</td>
</tr>
<tr>
<td>Southeast (Pearl)</td>
<td>Upper reaches of the Zhu (Pearl)</td>
<td>Viet Nam</td>
<td>7.250</td>
</tr>
<tr>
<td></td>
<td>Sub-total</td>
<td></td>
<td>7.250</td>
</tr>
<tr>
<td>Southwest</td>
<td>Ruxu Zangbo</td>
<td>India</td>
<td>0.117</td>
</tr>
<tr>
<td></td>
<td>Sub-total</td>
<td></td>
<td>0.117</td>
</tr>
<tr>
<td>Inland rivers</td>
<td>Kara Ertix</td>
<td>Mongolia</td>
<td>0.450</td>
</tr>
<tr>
<td></td>
<td>Haba</td>
<td>Kazakhstan</td>
<td>1.370</td>
</tr>
<tr>
<td></td>
<td>Bulgan</td>
<td>Mongolia</td>
<td>0.228</td>
</tr>
<tr>
<td></td>
<td>Tekes</td>
<td>Kazakhstan</td>
<td>0.957</td>
</tr>
<tr>
<td></td>
<td>Kunmalike</td>
<td>Kyrgyzstan</td>
<td>3.580</td>
</tr>
<tr>
<td></td>
<td>Guokeshar</td>
<td>Kyrgyzstan</td>
<td>1.220</td>
</tr>
<tr>
<td></td>
<td>Kizi</td>
<td>Kyrgyzstan</td>
<td>0.556</td>
</tr>
<tr>
<td></td>
<td>Keleqing</td>
<td>Pakistan</td>
<td>0.718</td>
</tr>
<tr>
<td></td>
<td>Sub-total</td>
<td></td>
<td>9.079</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>17.169</td>
</tr>
</tbody>
</table>

**TABLE 6**

Border rivers between China and neighbouring countries

<table>
<thead>
<tr>
<th>Region</th>
<th>River</th>
<th>Catchment area within China (km²)</th>
<th>Bordering country</th>
<th>River discharge along border (km³/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heilong</td>
<td>Heilong (incl. Erguma and Wusuli)</td>
<td>891 093</td>
<td>Russian Federation</td>
<td>106.1</td>
</tr>
<tr>
<td></td>
<td>Tumen</td>
<td>22 861</td>
<td>DPR Korea*</td>
<td>15.4</td>
</tr>
<tr>
<td>Liaohe</td>
<td>Yalu</td>
<td>32 466</td>
<td>DPR Korea*</td>
<td>4.9</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>946 420</td>
<td></td>
<td>126.4</td>
</tr>
</tbody>
</table>

* DPR Korea = Democratic People’s Republic of Korea
Groundwater resources
The average annual groundwater resources for the whole country are an estimated 828.8 km$^3$. That part which reaches the rivers as baseflow, or comes from river seepage, called 'overlap', is an estimated 727.9 km$^3$.

About 70 percent of the groundwater resources are in southern China and 30 percent in northern China. The aquifers vary greatly across northern China and are geologically complicated. Unlike the south, where villages in mountainous areas can tap groundwater resources, mountainous areas in northern China are often groundwater deficient. In the flat plains, especially in the areas near the coast and especially in the Hai river basin many of the aquifers are multilayered. These multilayered aquifers typically have two to five layers. The first and third layers are the most water resource rich. The first layer is an unconfined aquifer made up of large grained homogeneous sand and gravel. The other layers are confined aquifers. In some areas, especially in the eastern parts of the Hai river Basin, there is a naturally occurring saline layer. Created during a previous Ice Age, saline water is often found in the second layer, is confined and has a high enough salt content that it must be treated before being used for agriculture (Wang et al., 2005).

Total renewable water resources
The total internal renewable water resources (IRWR) of China are around 2 812.40 km$^3$/year and are summarised in Table 7. The total renewable water resources (TRWR), considering external flows, are equal to 2 839.72 km$^3$/year, giving a dependency ratio of about 1 percent.

Lakes and dams
There are about 2 300 natural lakes (excluding seasonal ones) with a total storage of 708.8 km$^3$, of which the freshwater portion is 31.9 percent (226.1 km$^3$). There are five major lake districts (Table 8).

At the end of 2005, the total number of artificial lakes or reservoirs was 85 108 with a total capacity of 562 km$^3$. Of these, 470 were classified as large reservoirs (> 100 million m$^3$) with a total capacity of 419.7 km$^3$, 2 934 were medium reservoirs (10 – 100 million m$^3$) with a

<table>
<thead>
<tr>
<th>Major river basin</th>
<th>Area (km$^2$)</th>
<th>Long-term annual average</th>
<th>Internal renewable water resources (IRWR) (km$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Precipitation (mm)</td>
<td>Precipitation (km$^3$)</td>
</tr>
<tr>
<td>North</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Songh-Liao</td>
<td>1 248 445</td>
<td>510</td>
<td>638</td>
</tr>
<tr>
<td>Huai</td>
<td>329 211</td>
<td>860</td>
<td>283</td>
</tr>
<tr>
<td>Huang (Yellow)</td>
<td>794 712</td>
<td>465</td>
<td>369</td>
</tr>
<tr>
<td>Hai-Luan</td>
<td>318 161</td>
<td>560</td>
<td>178</td>
</tr>
<tr>
<td>Other interior basins</td>
<td>3 394 443</td>
<td>155</td>
<td>532</td>
</tr>
<tr>
<td>Sub-total North</td>
<td>6 084 972</td>
<td>330</td>
<td>2 000</td>
</tr>
<tr>
<td>South</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chang (Yangtze)</td>
<td>1 808 500</td>
<td>1 070</td>
<td>1 936</td>
</tr>
<tr>
<td>Zhu (Pearl)</td>
<td>580 641</td>
<td>1 545</td>
<td>897</td>
</tr>
<tr>
<td>Southwest</td>
<td>871 406</td>
<td>1 070</td>
<td>934</td>
</tr>
<tr>
<td>Southeast</td>
<td>252 569</td>
<td>1 670</td>
<td>422</td>
</tr>
<tr>
<td>Sub-total South</td>
<td>3 513 116</td>
<td>1 190</td>
<td>4 189</td>
</tr>
<tr>
<td>Total China</td>
<td>9 598 088</td>
<td>645</td>
<td>6 189</td>
</tr>
</tbody>
</table>
TABLE 8  
Natural lake

<table>
<thead>
<tr>
<th>Lake district</th>
<th>Area (km$^2$)</th>
<th>Storage (km$^3$)</th>
<th>Freshwater storage (km$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qinghai-Tibet plateau</td>
<td>36 889</td>
<td>518.2</td>
<td>103.5</td>
</tr>
<tr>
<td>Eastern plains</td>
<td>21 641</td>
<td>71.1</td>
<td>71.1</td>
</tr>
<tr>
<td>Mongolia Xin plateau</td>
<td>9 411</td>
<td>69.7</td>
<td>2.4</td>
</tr>
<tr>
<td>Northeast plains and mountains</td>
<td>2 366</td>
<td>19.0</td>
<td>18.8</td>
</tr>
<tr>
<td>Yunnan-Guizhou plateau</td>
<td>1 108</td>
<td>28.9</td>
<td>28.8</td>
</tr>
<tr>
<td>Others</td>
<td>372</td>
<td>2.0</td>
<td>1.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>71 787</strong></td>
<td><strong>708.8</strong></td>
<td><strong>226.1</strong></td>
</tr>
</tbody>
</table>

The total capacity of 82.6 km$^3$, and 81 704 were small reservoirs (0.1 – 10 million m$^3$) with a total capacity of 60.2 km$^3$.

The Three Gorges Dam on the Chang (Yangtze) river, situated at Sandouping of Yichang City, Hubei Province, was completed in 2006 and is considered to be the largest hydropower project in the world. Besides hydropower, its main purpose is flood control and navigation improvement. The dam is nearly 200 m high and the water level in the reservoir is to be kept at 175 m above sea level during the dry winter months, and lowered to 145 m for the summer flood season. The dam is about 600 m long and the total storage capacity of the reservoir is 39.3 km$^3$.

Until the Three Gorges Dam project (TGP) got under way, the most ambitious project completed was the Gezhouba hydroelectric dam, which was the first structure to block the flow of the Chang river. The dam is located in the suburbs of Yichang, 38 km downstream the TGP. The construction of the dam started in 1970 and ended in 1988. The dam is 54 m high with a total storage capacity of 1.58 km$^3$.

The Geheyan Dam, designed in 1987 and completed in 1994, is the first large dam on the Qing river, a tributary of the Chang river, in Yichang, Hubei. There were many problems with the non-functioning of the ship lift until 1998. This dam has recently fallen foul of many planning permit disputes, and is set to be demolished in June 2011.

The Liujiaxia dam, with a total capacity of 5.7 km$^3$, is a hydroelectric dam on the upper Huang (Yellow) river, in Liujiaxia Town, Gansu Province. The dam is located just downstream from the fall of the Tao river into the Huang river and has the largest water body within Gansu. The primary purpose of the dam is to generate electricity and for flood control, irrigation, and ‘ice flood prevention’. When it became fully operational in 1974, it became the country’s largest hydroelectric power plant, and remained so until the 1980s.

There are four hydropower projects on the Lancang river, which are the Manwan dam (1 500 MW and 0.66 km$^3$ of capacity), the Dachaoshan dam (1 350 MW), the Jinghong dam (1 750 MW) and the Xiaowan dam (4 200 MW and 15 km$^3$). Four more dams are under construction or are being planned on the Lancang river with a total capacity of 7 000 MW.

Other important dams are the Ertan dam (5.8 km$^3$ of capacity) on the Yalong river (Yangtze Basin), the Shuibuya dam (4.6 km$^3$) on the Qing river (Yangtze basin), the Longtan dam (27.3 km$^3$) on the Hongshui river, the Longyangxia dam (24.7) on the Yellow river, the Laxiwa dam (1.08 km$^3$) on the Yellow river and the Xiaolangdi dam (12.8 km$^3$) on the Yellow river.

In 2010, other important dams were being constructed, such as the Jinping 1 dam.
In 2006, the total installed capacity of hydropower was 52.93 GW and the annual generation of hydropower was 163.6 billion kWh (MWR, 2007b).

**Non-conventional sources of water**

Total wastewater produced accounts for 53.7 km³ in 2006, of which only 56 percent (30.07 km³) had some form of treatment. However, this rate reflects the installed wastewater treatment capacity rather than the actual treatment, which is likely to be lower owing to the lack of sewage networks and funds for operation and maintenance in many cities (World Bank, 2009a). In 2004, actual treated wastewater was about 22.10 km³ (World Bank, 2006).

The research of engineering technology of seawater desalination in China began in 1958. There have been more than 20 seawater desalination projects to date, among which are Shandong Huangdao power plant, Hebei Huanghua power plant, the No. 7 Petroleum Factory of China Petroleum Dalian Petrochemical Corporation, Tianjin economic-technological development area, Shandong Yantai city and Hebei Wangtan power plant are relatively large-scale seawater desalination enterprises that are in, or will be put into, production (Ji et al., 2006). In 2008, the accumulative production capacity of these projects was around 30 000 m³/day, which would be around 10.95 million m³/year (World Bank, 2009a).

**Water scarcity**

Although China has the fifth largest amount of internal renewable water resources in the world, after Brazil, the Russian Federation, Canada and Indonesia, it is faced with a regional water crises. Total actual renewable water resources per capita account for 2 079 m³/year in 2009, while the world average is an estimated 6 225 m³/year, and is expected to decline to 1 890 m³/year as its population rises to a projected peak of 1.5 billion by around 2033. Moreover, there is much variation within the country, from less than 500 m³/year per inhabitant in the Huai and Hai-Luan river basins in the north, to over 25 000 m³/year per inhabitant in river basins in the southwest.

The precipitation pattern further intensifies the uneven distribution of water resources. With a strong monsoonal climate, China is subject to highly variable rainfall that contributes to frequent droughts and floods, which also occur simultaneously in different regions (Yunlong, 2009).

The water shortages are largely concentrated in the dry north, which has only one-fifth of China’s water. This area, which includes the Huang, Liao, Hai and Huai rivers, boasts two-thirds of China’s cropland (Table 3). Irrigation demands are high, rapid economic growth and urbanization are fuelling additional water consumption, and water use and demand management is inefficient. In contrast, the south is well supplied with water. It encompasses the vast Chang river and has four times the groundwater resources of the north. But it has its own problems, exemplified by summer devastating flooding by the Chang river. While the south faces flooding every year, the north, where most agricultural activities exist with very dense population, faces severe water shortages. Nearly half of the 640 cities in China face water shortages, and 100 of them face serious water scarcity (Burke, 2000).

Signs of water stress are not hard to find. Perhaps the starkest example is the Huang river. In 1972, for the first time in China’s history, it dried up before reaching the sea. Since 1985, it has run dry part of each year. During the droughts of 1997 it didn’t reach the sea for 228 days, depriving the last province before the sea, Shandong, which produces one-fifth of China’s maize and one-seventh of its wheat, of half its irrigation supply. However, since the beginning of the 2000s, after a river basin approach was adopted in the Huang river basin, the river has not dried up. Groundwater also faces severe pressure, over-extraction is a serious problem in a number of cities, including Nanjing, Taiyuan, Shijiazhuan, and Xi’an. Levels in Shanghai and Beijing are falling by 1 m/year. In coastal cities, such as Delian and Qingdao, saltwater intrusion compounds the problem (Burke, 2000).
Internal water transfer projects

The uneven distribution of China’s water resources between the water scarce north and water abundant south is forcing the Chinese Government to seek measures to ensure sufficient water availability for people living in northern regions. One such measure is the ‘South to North Water Transfer Project’. At the time of completion (2050), this three route project will channel 44.8 km$^3$ of water per year from the Chang river to drought-stricken northern China. The project is designed to divert 13.4 km$^3$/year from the Chang river system to Beijing and will supply many other cities along the route. Work began in 2000 and the first supplies reached Shandong and Beijing in 2007 and 2010 respectively. Total project expenses, which were initially projected at US$60 000 million, have been increasing.

The project faces a number of logistical challenges, including the need to clean up water bodies at intersections through which the canals will pass. The 1 154 km eastern route of the project largely follows the Grand Canal route from the Chang river through Jiangsu and Shandong provinces to Hebei and Tianjin, will divert 14.8 km$^3$ annually, it crosses through 53 river sections in China’s most heavily water-polluted area. Cleanup operations will account for 37 percent of the total investment. If completed on schedule, it will represent one of the most comprehensive water cleanup operations in the world.

Challenges include implementation and effectiveness of wastewater treatment plants, ensuring inter-provincial dialogue, and agreement on project components. The vast cost of the projects may mean that water pricing will be a problem for some consumers (between 3.2 and 4.8 Yuan/m$^3$ in many cities and as high as 7 Yuan/m$^3$ in Beijing). The central route of the project will divert 13 km$^3$/year, will submerge 370 km$^2$ of land and will require the relocation of 330 000 people in Henan and Hubei provinces. The western route will divert 17 km$^3$/year from the upper reaches of the Chang river to the Huang river (Chao, 2009).

The Shanxi Wanjiazhai Huang (Yellow) river diversion project is an all-encompassing project to alleviate the water shortages in three of China’s industrial areas: Taiyuan, Pingsuo and Datong. The project started in 1997 and in November 2001 the first major step was inaugurated when water from the Huang river ran to the Fenhe reservoir. The cost of the entire enterprise is about US$1 500 million, US$400 million of which came from the World Bank.

The diversion project, which brings water from the Huang river to Qingdao in Shandong province, is the largest water conservancy and city water supply project since the founding of the People’s Republic of China. Water diversion began in 1989 to guarantee supplies to Qingdao city, which has the most serious water shortages in northern China. It has received more than 1.1 km$^3$ of water so far. Greater Qingdao covers an area of 10 654 km$^2$ and has a population of 7.5 million, more than one-third of whom live in its urban areas. The shortfalls have been exacerbated over the past decade as its population and economy have grown (China Daily, 2007). A second phase of the project is to divert water from Huang river to Qingdao and will increase the volume of diverted water by 140 million m$^3$/year to 250 million m$^3$/year. (ACCA21, not dated).

International water issues

In 1994, an agreement was signed between China and Mongolia on the protection of transboundary water resources concerning Lake Buir, the Kherlen, Bulgan, Khalkh rivers, and 87 small lakes and rivers located near the border.

Water use

In 2005, total water withdrawal was an estimated 554.1 km$^3$ of which 65 percent (358.0 km$^3$) was for irrigation, 12 percent (67.5 km$^3$) for municipal use and 23 percent (128.6 km$^3$) for industry (Table 2 and Figure 1). In 1993, total water withdrawal was 525.5 km$^3$, of
which 77 percent (407.7 km³) was for irrigation, 5 percent (25.2 km³) for municipal use, and 18 percent (92.6 km³) for industrial use.

Agriculture is the main sector that withdraws water; although only 45 percent is actually consumed by crops, owing to the low efficiency of the irrigation systems. On the other hand, however, this figure is comparatively high considering the cropping structure. The relatively poor water productivity, US$3.6 per m³, is lower than the average of US$4.8 per m³ in middle income countries, and much lower than the US$35.8 per m³ in high-income countries (World Bank, 2009a). The United Nations predicts that China’s population will increase from 1.2 billion to 1.5 billion between 2000 and 2030. The rapidly urbanizing population is expected to push demand to new heights. The expanding industrial sector is also greedy for water (Burke, 2000). The recycling rate in the industrial sector is only 40 percent, compared to 75-85 percent in developed countries (World Bank, 2009a).

In 2005, primary surface water withdrawal represented 80 percent of total water withdrawal (Figure 2). In 1995, the reused treated wastewater volume was 13.4 km³. In 2008, desalinated water accounted for 10.95 million m³. In addition to water withdrawal by the three main sectors (agriculture, municipalities, industry), China reserved 9.28 km³ of surface water in 2005 for ecosystems.

In southern China, the main source of water is primary surface water, which represents over 90 percent of the water withdrawal. Northern China is the region that uses the majority of China’s primary groundwater. In the five northern provinces, Beijing, Tianjin, Hebei, Shanxia and Inner Mongolia, 65 percent of the water withdrawal was from groundwater in 2005. In the three northeastern provinces, Liaoning, Jilin and Heilongjiang groundwater withdrawal accounted for almost 45 percent of total water withdrawal. In the Hai river basin, groundwater accounted for 67 percent and was being withdrawn from the aquifer at a rate of 95.5 percent. To compensate for the deficit of surface water in meeting demand, northern China has increasingly relied on groundwater.

This intensive use of groundwater resources has resulted in the lowering of water tables and the rapid depletion of groundwater reservoirs. For example, the annual sustainable withdrawal of groundwater in the Hai river basin is an estimated 17.3 km³, while withdrawals are 26.1 km³, which indicates an annual over-extraction as high as 8.8 km³. As a result, deep groundwater tables have dropped by up to 90 m and shallow groundwater tables by up to 50 m. In Beijing, groundwater tables have dropped by 100–300 m (World Bank 2009a). In contrast, less than 30 percent of the known groundwater resources in southern China are being used (Wang et al., 2005).
IRRIGATION AND DRAINAGE DEVELOPMENT

Evolution of irrigation development

China has a long history of irrigation and drainage. The first canals to divert and wells to lift water for irrigation were constructed 4,000 years ago. Since the founding of the People’s Republic of China in 1949, irrigation has experienced a period of vigorous development. From 1958 to 1985, about 643.68 million Yuan have been spent on irrigation and drainage projects. The area equipped for irrigation increased from 16,000,000 ha in 1949 to 62,938,226 ha in 2006 of which 62,559,130 in Mainland China, 378,096 ha in Taiwan and 1,000 ha in Hong Kong (Table 9 and Table 10).

After 1949, irrigation using groundwater was developed rapidly to promote agricultural production. In north China, insufficient surface water resources have meant that since 1950 the Government has had to rely on groundwater for the development of irrigation projects. In 1985, an area of 11.1 million ha was irrigated using tubewells. In 2006, groundwater irrigation using around 4.8 million tubewells was an estimated 19 million ha, 31 percent of the total area equipped for irrigation was 63 million ha (Figure 3). In addition, 17 million ha is power irrigated using surface water. This means that 57 percent of the total area equipped for irrigation, or 36 million ha, used power irrigation (Table 9 and Table 11). In 1995, the power irrigation area was 29 million ha and the total installed capacity of water-lifting machines for irrigation and drainage was 68,240 MW.

China can be divided into three irrigation zones:

- The zone of perennial irrigation, where annual precipitation is less than 400 mm and irrigation is necessary for agriculture. It covers mainly the northwest regions and part of the middle reaches of the Huang river.
- The zone where annual precipitation ranges from 400 to 1,000 mm, strongly influenced by the monsoon, with a consequently uneven precipitation distribution. Irrigation here is necessary to secure production. This zone includes the Hangh Huai Hai plain and northeast China.
- The zone of supplementary irrigation, where annual precipitation exceeds 1,000 mm. Irrigation is still necessary for rice (especially to improve cropping intensity), and supplementary irrigation is sometimes required for upland crops. This zone covers the middle and lower reaches of the Chang, Zhu and Min rivers and part of southwest China.

The irrigation potential is roughly 70 million ha. The maximum possible area that could be equipped for irrigation by 2050 is about 66 million ha, of which 63 million ha for annual or food crops (Zhanyi Gao, 2009). China uses the expression effective irrigation to indicate the area of food (annual) crops, not to be confounded with the area actually irrigated.

In 1996, the total area equipped for irrigation, including farmland (area regularly ploughed for growing agricultural crops, also called the area under effective irrigation in China), forests, orchards and pastures, was 52.9 million ha.
### Irrigation and drainage

#### Irrigation potential

<table>
<thead>
<tr>
<th></th>
<th>-</th>
<th>70 000 000 ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Full control irrigation: equipped area
   - surface irrigation 2006 59 337 789 ha
   - sprinkler irrigation 2006 2 840 952 ha
   - localized irrigation 2006 759 485 ha
   - % of area irrigated from surface water 2006 69 %
   - % of area irrigated from groundwater 2006 31 %
   - % of area irrigated from mixed surface water and groundwater - %
   - % of area irrigated from mixed non-conventional sources of water - %
   - area equipped for full control irrigation actually irrigated 2006 54 218 976 ha
   - as % of full control area equipped 2006 86 %
   - % of area irrigated from surface water 2006 69 %
   - % of area irrigated from groundwater 2006 31 %
   - % of area irrigated from mixed surface water and groundwater - %
   - % of area irrigated from mixed non-conventional sources of water - %
   - area equipped for full control irrigation actually irrigated 2006 54 218 976 ha
   - as % of full control area equipped 2006 86 %

2. Equipped lowlands (wetland, ivb, flood plains, mangroves)
   - ha

3. Spate irrigation
   - ha

Total area equipped for irrigation (1+2+3) 2006 62 938 226 ha
   - as % of cultivated area 2006 48 %
   - % of total area equipped for irrigation actually irrigated 2006 86 %
   - average increase per year over the last 10 years 1996-2006 1.7 %
   - power irrigated area as % of total area equipped 2006 57 %

4. Non-equipped cultivated wetlands and inland valley bottoms
   - - ha

5. Non-equipped flood recession cropping area
   - - ha

Total water-managed area (1+2+3+4+5) 2006 62 938 226 ha
   - as % of cultivated area 2006 48 %

#### Full control irrigation schemes

<table>
<thead>
<tr>
<th>Criteria</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small-scale schemes</td>
<td>35 553 278 ha</td>
</tr>
<tr>
<td>Medium-scale schemes</td>
<td>12 684 402 ha</td>
</tr>
<tr>
<td>Large-scale schemes</td>
<td>14 700 546 ha</td>
</tr>
</tbody>
</table>

#### Irrigated crops in full control irrigation schemes

<table>
<thead>
<tr>
<th></th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total irrigated grain production</td>
<td>323 209 000 metric tons</td>
</tr>
<tr>
<td>as % of total grain production</td>
<td>73 %</td>
</tr>
</tbody>
</table>

#### Harvested crops**

<table>
<thead>
<tr>
<th></th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual crops: total</td>
<td>93 382 000 ha</td>
</tr>
<tr>
<td>Rice</td>
<td>88 541 000 ha</td>
</tr>
<tr>
<td>Wheat</td>
<td>31 347 000 ha</td>
</tr>
<tr>
<td>Maize</td>
<td>22 250 000 ha</td>
</tr>
<tr>
<td>Other cereals (millet, sorghum, barley)</td>
<td>9 500 000 ha</td>
</tr>
<tr>
<td>Vegetables</td>
<td>9 000 000 ha</td>
</tr>
<tr>
<td>Cotton</td>
<td>2 632 000 ha</td>
</tr>
<tr>
<td>Rape</td>
<td>6 000 000 ha</td>
</tr>
<tr>
<td>Soybean</td>
<td>2 600 000 ha</td>
</tr>
<tr>
<td>Groundnuts</td>
<td>1 900 000 ha</td>
</tr>
<tr>
<td>Roots (potatoes, sweet potatoes)</td>
<td>629 000 ha</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>472 000 ha</td>
</tr>
<tr>
<td>Other annual crops (tobacco, sunflower, sesame, pulses, beet)</td>
<td>1 396 000 ha</td>
</tr>
<tr>
<td>Permanent crops: total</td>
<td>4 841 000 ha</td>
</tr>
<tr>
<td>Fruits and citrus</td>
<td>3 645 000 ha</td>
</tr>
<tr>
<td>Other permanent crops</td>
<td>1 196 000 ha</td>
</tr>
</tbody>
</table>

#### Irrigated cropping intensity (on actually irrigated area) 2006 172 %

#### Drainage - Environment

<table>
<thead>
<tr>
<th></th>
<th>-</th>
<th>ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total drained area**</td>
<td>4 471 950 ha</td>
<td></td>
</tr>
<tr>
<td>as part of the area equipped for irrigation drained</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>as other drained area (non-irrigated)</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>drained area as % of cultivated area</td>
<td>- %</td>
<td></td>
</tr>
</tbody>
</table>

#### Flood-protected areas

| 2005 | 44 120 000 ha |

#### Area salinized by irrigation

| 1999 | 6 700 000 ha |

#### Population affected by water-related diseases

| - | inhabitants |

---

* of which 62 559 130 in Mainland China, 378 096 ha in Taiwan and 1 000 ha in Hong Kong

** Mainland China
<table>
<thead>
<tr>
<th>River basin</th>
<th>Total area equipped for irrigation</th>
<th>Annual crops (effective irrigation)*</th>
<th>Forests</th>
<th>Orchards</th>
<th>Pasture</th>
<th>Other</th>
<th>Actually irrigated total (part of 2)</th>
<th>Actually irrigated annual crops (part of 3)</th>
<th>Actually irrigated other (part of 4+5+6+7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Songhua</td>
<td>4 558 990</td>
<td>4 501 860</td>
<td>5 130</td>
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* In China, irrigation of annual (food) crops is called “effective irrigation”
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<th>Moveable machine 3</th>
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<td>12085940</td>
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The total area equipped for irrigation is an estimated 62.9 million ha (2006). The area equipped for irrigation represents just over half of the total cultivated area. The area actually irrigated in 2006 was 54.2 million ha, which accounts for 86 percent of the total area equipped for irrigation.

Surface irrigation, mainly for cereals, vegetables and cotton, is practised on 59.3 million ha (59.0 million ha in Mainland China), which was 94.3 percent of the total area equipped for irrigation in 2006 (Table 9, Table 12 and Figure 4). Sprinkler irrigation was introduced into China in the early 1950s. The first sprinkler irrigation project was constructed in Shanghai in 1954. Sprinkler and localized irrigation were considerably developed in the late 1970s. In 1976, the area of sprinkler irrigation was about 67 000 ha. It increased until 1980, but then large areas were abandoned owing to the poor quality of equipment and poor management. Then, in 2006, the area expanded to about 2.8 million ha, which is 4.5 percent of the total area equipped for irrigation. Localized irrigation was practiced on about 0.8 million ha or 1.2 percent.

China uses the following categories (1 ha = 15 mu):

- very large irrigation schemes: > 500 000 mu or > 33 333 ha
- large irrigation schemes: 300 000 – 500 000 mu or 20 000 – 33 333 ha
- medium irrigation schemes: 10 000 – 300 000 mu or 667 – 20 000 ha
- small irrigation schemes: < 10 000 mu or < 667 ha

The very large, large and medium irrigation schemes are generally administrated by special governmental organizations. The small ones are usually farmer-managed. Some small ponds, wells and pumping stations are owned by individuals. In 2006, very large schemes covered 10.6 million ha (10.5 million ha in Mainland China), large schemes 4.1 million ha (4.1 million ha in Mainland China), medium schemes 12.7 million ha (12.6 million ha in Mainland China) and small schemes 35.6 million ha (35.3 million ha in Mainland China) (Table 9, Table 13 and Figure 5).

**Role of irrigation in agricultural production, economy and society**

China makes a distinction between the area irrigated for annual or food crops, and the area under other crops, which include irrigated forests, orchards and pasture. In 2006, of the 62.6 million ha, which was the total area equipped for irrigation in Mainland China, 57.1 million ha were under annual or food crops, 1.6 million ha forests, 2.0 million ha orchards, 1.2 million ha pasture and 0.7 million ha other crops. This means that 91.2 percent of the area equipped for irrigation was covered by annual or food crops.

In Mainland China, of the total area, 62.6 million ha equipped for irrigation, 53.9 million ha or 86 percent was actually irrigated in 2006. Of the 57.1 million ha area equipped for irrigation for annual or food crops, 49.0 million ha was actually irrigated, which is also 86 percent.

In 2006, the total harvested irrigated crop area in Mainland China was about 93.4 million ha, meaning an irrigated cropping intensity of 1.72 (Table 9 and Figure 6). The most important harvested irrigated crop is rice, followed by wheat and maize. The importance of irrigated vegetables is increasing. In 2005, almost three-quarters of grain production was
TABLE 12
Irrigation technology by major river basin in Mainland China in ha (Source: MWR, 2007/2006/2005)

<table>
<thead>
<tr>
<th>River basin</th>
<th>Total irrigation</th>
<th>Sprinkler irrigation</th>
<th>Localized irrigation</th>
<th>Surface irrigation</th>
<th>Low pressure pipe</th>
<th>Canal lining</th>
<th>Other engineering options</th>
<th>Non-improved surface irrigation</th>
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<td>335 610</td>
<td>32 700</td>
<td>2 795 240</td>
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<td>195 500</td>
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<td>267 830</td>
<td>49 520</td>
<td>11 171 100</td>
<td>931 940</td>
<td>981 590</td>
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<td>9 257 570</td>
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<td>222 700</td>
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1. Data on sprinkler and irrigation localized technologies were only available for effective irrigation area. It was considered that for all the others surface irrigation was used.
2. It was considered that non-improved surface irrigation [10] is equal to surface irrigation [6] minus low pressure pipe [7] and canal lining irrigation [8] and other engineering options [9].
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<th>Effective large (20000-33 333 ha)</th>
<th>Effective medium (667-20 000 ha)</th>
<th>Small effective (&lt; 667 ha)</th>
<th>Total effective irrigation</th>
<th>Small other irrigation</th>
<th>Total area equipped for irrigation</th>
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<td>22 010 580</td>
<td>1 267 370</td>
<td>23 277 950</td>
</tr>
<tr>
<td>Total 2006</td>
<td>10 521 000</td>
<td>4 091 000</td>
<td>12 608 000</td>
<td>29 858 400</td>
<td>57 078 400</td>
<td>62 559 130</td>
<td></td>
</tr>
<tr>
<td>Total 2005</td>
<td>10 232 000</td>
<td>4 080 000</td>
<td>12 106 000</td>
<td>26 418 000</td>
<td>56 562 360</td>
<td>5 335 580</td>
<td>61 897 940</td>
</tr>
</tbody>
</table>

1. Very large: > 500 000 mu or 33 333 ha; Large: 300 000 - 500 000 mu or 20 000 - 33 333 ha; Medium: 10 000 - 300 000 mu or 667 - 20 000 ha; Small: < 10 000 mu or 667 ha.
2. This is equal to the area equipped for irrigation of pasture, forests, orchards and other. According to the Chinese, this is all small irrigation.
irrigated. According to a nationwide survey in the early 1980s, the average paddy rice yield of irrigated farmland was 7.3 tonnes/ha and the average yield of non-irrigated paddy rice was 2.1 tonnes/ha. In 1995, the International Rice Commission estimated an average yield of 6 tonnes/ha for irrigated paddy rice.

There is no available figure on total harvested irrigated crop area in Taiwan, where rice is the main crop. Other crops are also irrigated, such as sugarcane, vegetables, sweet potato, wheat, maize, sorghum, tobacco, rape seed, beans, melons, citrus, banana, pineapple, tea, cassava, peanuts and jute.

Status and evolution of drainage systems
In 1996, the area subject to waterlogging was 24.6 million ha, of which 20.3 million ha were controlled by drainage. In 1995, the power drained area was 4.2 million ha, while in 2006 it was an estimated 4.5 million ha (Table 11).

WATER MANAGEMENT, POLICIES AND LEGISLATION RELATED TO WATER USE IN AGRICULTURE
Institutions
The main institutions involved in water resources management are (World Bank, 2009a):

- the Ministry of Water Resources (MWR): integrated water resource management, water resource protection planning, water function zoning, monitoring water quantity and quality in rivers and lakes; issues water resource extraction permits, proposes water pricing policy;
- Ministry of Environmental Protection (MEP): water pollution laws, regulations/standards, supervision/enforcement, water environmental function zoning, water pollution mapping in key rivers and lakes, monitors water quality;
- Ministry of Housing and Urban and Rural Construction (MHURC): urban water supply, urban wastewater treatment;
- Ministry of Agriculture (MOA): on-farm water management and agricultural non-point pollution;
- Ministry of Land and Resources (ML&R): water as a resource, land-use planning;
- State Forest Administration: forests for conserving water sources;
- Ministry of Transportation: ship transportation water pollution control;
- National Development and Reform Commission: pollution levy policy, wastewater treatment pricing policy, water pricing policy, industrial policies that affect wastewater discharge and its treatment;
- Ministry of Finance: Pollution levy proceeds management, manages wastewater treatment charges and water resource fee policy, State Office of Comprehensive Agricultural Development;
- The State Council: Implementation regulation, administrative regulation and order, lead, and coordination;
- National People's Congress: legislation, law, and supervision;
- Local Water Resources Management Department, responsible for water administration at provincial level. Each province has a Water Resource Bureau responsible for planning,
survey, design, construction, operation and management of irrigation, drainage, flood control works, and rural hydro-electricity. Water resources bureaux at the prefecture and county levels are directly responsible for the construction and maintenance of main and secondary canals, associated irrigation and flood control structures, and medium-sized reservoirs. Townships and villages share responsibility for constructing and maintaining branch canals, ancillary works, and small reservoirs;

- River Basin Management Commissions (RBMC): subordinate organization of the MWR for its seven large river/lake basins (six river basin management commissions and the Lake Tai Basin Management Agency). Responsible for preparing basin-wide water allocation plans and providing technical direction and guidance to local governments within the basin.

**Water management**

The following developments have taken place over the past years:

*Water management:* China adopted the integrated water resources management (IWRM) approach, as shown in the amended new Water Law. Water productivity, water pollution protection, demand management, environmental concern are highlighted in policies and mainstreamed into planning and procedures, such as specific water allocation for environmental use. Attention is being given to zoning of water function bodies, formulation of macro water allocations and micro water quotas, basin level resources management to protect the Huang river from drying up, special water diversion projects for ecosystems, and establishment of water-saving societies.
*Water development:* This has shifted from expansion to improvement. There are limited new water resource development projects, and highest priority is given to improving water use efficiency, productivity and quality.

*Water environment:* China implemented the largest ecosystem improvement programme in its history, costing US$43 billion, on restoring water bodies from farmland, restoring forestry from cultivation, restoring grazing from farming. Large numbers of small high pollution plants along the rivers have been closed. Also, the largest drinking water improvement programme in China’s history has been implemented, where millions of people now gain access to safe drinking water. The programme has lasted 10 years, with an average annual investment of US$2 billion.

*Water system management:* China issued new management policy and rules, grouping water infrastructures and management agencies into three categories – public services, semi-public services and commercial services – and implemented different management and financing policies for different systems. Environmental services are recognized and covered by government funds.

*Irrigation development:* Over ten years, China has implemented large-scale irrigation improvement programmes to improve water-use efficiency and productivity, with an annual investment of around US$2 billion. In the past 10 years, nationwide agricultural water-use efficiency has increased by 10 percent and food production has increased, while the water withdrawal amount has been reduced. The government target is to produce enough food for the 2030 population, while keeping the total water allocation for agriculture within the current scope.

In recent years, water user associations (WUA) have become a very popular form of public participation in water management in rural China. In October 2005, MWR, the National Development Reform Commission (NDRC), and the Ministry of Civil Affairs jointly promulgated the “Guidance for facilitating establishment of farmer water users associations”, specifying principles and procedures for establishing such associations and their role and responsibilities in relation to governmental organizations and water supply enterprises. According to MWR, by mid 2007 water users’ participation in irrigation water management had taken place in 30 provinces/municipalities across China. More than 20 000 organizations of farmer water users, mostly as WUAs, have been established, involving more than 60 million farmers participating in water management on behalf of end-users of water (World Bank, 2009a).

**Policies and legislation**

China’s Water Law was enacted in 1988 and establishes principles, general guidelines, and technical standards for water resources management. In 2002, the Chinese government amended the Water Law to establish a legal foundation for integrated water resources management and demand management. The amended Water Law enshrines the principles that everybody should have access to safe water, and that water conservation and protection are a priority. It focuses on five areas of water resources management:

1. water allocation,
2. water rights and water withdrawal permits,
3. river basin management,
4. water-use efficiency and conservation, and
5. protecting water resources from pollution.

According to this law, all water resources, except those in ponds and reservoirs belonging to rural collectives, are owned by the state and the State Council exercises the right of ownership on behalf of the state. In reality, the State Council has delegated water ownership rights to local governments under the supervision of MWR.
The 1991 Water and Soil Conservation Law recognized the inter-relationship between water resources and soil (land) conditions. The primary purpose of this law is: prevention and control of soil erosion, protection and rational utilization of water and soil resources, mitigation of disasters from floods, droughts and sandstorms, and improvement of the ecological environment and development of production (Wang et al., 1999).

The 1997 Flood Control Law is the first law for the prevention and control of natural disasters, although there have been previous administrative regulations promulgated under the water and other laws, and thus filled a gap in the water legislation system. The importance of this law is to address the specific nature of causes and remediation measures to be taken to prevent and control floods. The law introduces the important mechanism of designating “planned reserve zones or areas” in which special rules may apply to the use and activities within the area. It further provides specific requirements for the operation of reservoirs and other hydraulic works, for multiple use considerations in river course realignments and lake embankments, and for preparing a flood impact assessment for any projects in flood-prone areas (Wang et al., 1999).

The first Law for Water Pollution Control came into force in 1984. This law soon became inadequate to meet the needs of economic development and environmental protection for several reasons: water pollution continued to increase, the targets of water pollution control changed greatly, and the legal measures for the control of point sources were unable to stop the decline of water quality (Wang et al., 1999). Thus, the Law was amended in 1996. Adopted in 2008, the newly amended version provides more detailed measures for the prevention and control of water pollution from various sources, makes clearer specifications for the responsibilities of different stakeholders, and strengthens the legal liabilities for water pollution (World Bank, 2009a).

**Finances**

In 1985, the Government issued a new rule requiring water charges to be collected according to the cost of water delivery. The water charge has, in principle, been calculated based on the cost of the water supply. The water charge for agriculture is usually lower than that for industry. It is calculated either according to the quantity of water supplied, the beneficial area, or a mixture of basic water charge plus a metered water charge. Where shortages occur, a rational water allocation system is practised and dissuasive charges are applied to extra volumes of water. On average, water charges for irrigation varied between 150 and 300 Yuan/ha (US$18 and 36/ha) in 1995. The average cost for sprinkler irrigation development was 6 000 Yuan/ha (US$720/ha), and that for localized irrigation 18 000 Yuan/ha (US$2 200/ha). Even so, repeated studies have shown that water and sewerage prices in China are still below the requirements for financial cost recovery and take little account of environmental and depletion costs (World Bank, 2009a).

In 2006, the planned total investment of fixed assets in the water sector was 93 270 million Yuan (US$11 680 million) of which 30 840 million Yuan from the Central Government, 44 150 million Yuan from the local governments, 1 160 million Yuan from foreign investments, 11 200 million Yuan from domestic loans, 2 890 million Yuan from enterprises and the private sector, and 3 030 million Yuan from other financial sources. In the total investment plans 93 270 million Yuan, 45 percent, was allocated to flood control, 38 percent to water resources projects (including 8 460 million Yuan invested in the South-to-North water transfer project), 5 percent for soil and water conservation and ecological projects, and 12 percent for hydropower and other special projects (MWR, 2007b).

Outside investments and technology are very important in order for China to cope with its environmental challenges. It is hard to calculate how much external funding China has received for water issues. The World Bank has been active in loans for tackling water shortages. This started as early as the mid 1980s with emphasis on irrigation facilities rehabilitation, modernization, promotion of water saving and water resources management, and water supply

ENVIRONMENT AND HEALTH

In China, serious pollution occurs widely in every river system and no single river is clean. More than half of the groundwater resources have been severely contaminated. According to FAO, 80 percent of the 50 000 km of major rivers in China are so degraded that they no longer support fish. Around urban areas 90 percent of rivers are seriously polluted, especially in the north where heavy industry is concentrated. Looking at their total river length, 69 percent of the Hai river, 73 percent of the Huai river and 71 percent of the Huang river are classified as polluted by Chinese standards (Burke, 2000).

In 2004, of all 745 monitored river sections, 28 percent were unsafe for any use and only 32 percent were safe for industrial and irrigation uses only. Of the 27 major monitored lakes and reservoirs, 48 percent were unsafe for any use, 23 percent were safe for industrial and irrigation uses only, and only 29 percent were safe for human consumption after treatment (World Bank, 2009a).

The extent of pollution aggravates water scarcity. Currently, approximately 25 km$^3$ of polluted water are held back from consumption, contributing to unmet demand and groundwater depletion. As much as 47 km$^3$ of water that does not meet quality standards are however supplied to households, industry, and agriculture, with the attendant costs related to damage. A further 24 km$^3$ of water beyond rechargeable quantities are extracted from the ground, which results in groundwater depletion (World Bank, 2009a).

There are a number of complex factors behind this pollution crisis. The fundamental one is that economic growth is the number one goal of the country. Also, there has been a long period of ignorance and neglect at all government levels and lack of effective policy mechanisms to address those issues. Much of the pollution results from inadequate treatment of municipal and industrial wastewater (Burke, 2000).

Total wastewater discharges have steadily risen to 53 700 million tonnes in 2006 of which only 56 percent had some form of treatment (this rate reflects the installed wastewater treatment capacity rather than the actual treatment, which is likely to be lower because of the lack of sewage networks and funds for operation and maintenance in many cities). Since 2000, domestic wastewater discharges have surpassed industrial discharges, and have become the most important source of pollution. It was not until 2007 that the rising trend of water pollution began to show a sign of reverse, as total emissions of chemical oxygen demand (COD) dropped by 3.14 percent over the 2006 level. However, the water pollution situation is still very serious. A major element is that only 56 percent of municipal sewage receives some form of treatment, versus 92 percent of industrial discharges (World Bank, 2009a). The most challenging drinking water pollutant is fecal coliform from sewage.

Rural areas have also witnessed an increase in pollution caused by the inappropriate use of chemical pesticides and fertilizers: several groundwater sites were examined in northern China where nitrate levels exceeded the limits allowed for drinking water. Further, farmers have traditionally used sewage to irrigate crops but now they are also using industrial wastewater laced with all sorts of toxic and persistent chemicals (Burke, 2000).

The World Bank estimates that the water crisis is already costing China about 2.3 percent of the GDP, of which 1.3 percent is attributable to the scarcity of water, and 1 percent to the
direct impacts of water pollution. These estimates do not include the cost of impacts for which estimates are unavailable, such as the ecological impacts associated with eutrophication and the drying up of lakes, wetlands, and rivers, and the amenity loss from the extensive pollution in most of China’s water bodies. Thus, total costs are undoubtedly higher.

The economic cost of disease and premature deaths associated with the excessive incidence of diarrhoea and cancer in rural China has been estimated, based on 2003 data, at 66 200 million Yuan, or 0.49 percent of the GDP (World Bank, 2009a). Above the Huang river, for example, abnormally high rates of mental retardation, stunting, and development diseases have been linked to naturally present arsenic and lead in water. In Shanxi province around the Huang river, high levels of lead and chromium were found in rice, and cadmium in cabbages (Burke, 2000).

In 2005, the area subject to waterlogging was 21.3 million ha. In northern China in particular, waterlogging, salinization and alkalinization have been the main constraints to agricultural production. In 2005, 6.03 million ha of saline-alkaline cultivated areas have been improved or reclaimed and the total cultivated area protected from floods is about 44.1 million ha (MWR, 2006). More than 100 million ha of China’s land has become salinized over the past several decades. The area salinized by irrigation was an estimated 6.7 million ha in 1999 (Mashali, 2005). The majority of the most serious problems have occurred in the northeast, the northwest and in some places on the north China plain. In recent years, the area affected by salinization has somewhat fallen. Ironically, it may be that the same forces diverting surface water away from agriculture and forcing producers to rely increasingly on groundwater may be the primary cause of such improvements (Wang et al., 2005).

The depletion of groundwater resources is contributing to the drying up of lakes and wetlands and an increase in groundwater salinity, which occurs when seawater intrudes or when declining groundwater resources are substituted by brackish water that often lies between the shallow and deep groundwater tables. In some locations, intrusion of brackish water has been monitored at a rate of 0.5 to 2 m per year for the past 20 years. Sea water intrusion has occurred in 72 locations along coastal provinces, covering an area of 142 km² (World Bank 2009a).

**PROSPECTS FOR AGRICULTURAL WATER MANAGEMENT**

The further development of irrigation in China faces a number of problems (Yuanhua Li, 2006):

- Water scarcity: The country level data hide massive regional differences in water scarcity behind the average figures. In 2030, the deficit at the national level would be around 13 km³, but the water shortage on the North China Plain would be as high as 25-46 km³.
- Shortage of funds for the rehabilitation and modernization of irrigation systems: Most of the irrigation systems were constructed in the 1950s and 1960s, and low design standards, aged structures and imperfect field works lead to low irrigation water-use efficiency, poor irrigation service, low irrigation reliability.
- Farm size: Farm size is small, and farmer’s income is quite low.
- Institutional frictions: These remain among various administrative levels concerning planning, financing, constructing, and maintaining irrigation facilities.

The strategies for coping with water scarcity in China are (Yuanhua Li, 2006):

**Strategy 1:** Research and development

- Research and implementation of water-saving irrigation (WSI). WSI refers to any measure leading to reducing irrigation water or increasing irrigation water productivity without distinct reduction in crop yields, as:
• reducing conveyance losses;
• capturing return flow;
• alternative wet and dry irrigation (AWDI) for paddy;
• non-full irrigation;
• improving irrigation water management; and
• increasing application efficiency, etc.

Strategy 2: Modernization of irrigation systems

- The large and medium-size schemes claim top priority for state investment, the improvement of which is extremely important both for water saving and food security.
- The ‘melons-on-the vine’ irrigation system in south China and ‘well-canal’ system in north China have been recommended to improve the reliability of irrigation water supply and irrigation water efficiency.

Strategy 3: Institutional development

- Improve irrigation water management to increase irrigation efficiency, water productivity and income of farmers.
- Maximize the effects of irrigation systems and find incentives for farmers to protect the irrigation facilities and improve irrigation water management on-farm level.
- High-level policy support to provide incentives for research and dissemination of new technologies.
- Funding policy – priority is given to those with wider adoption of WSI practices.

Strategy 4: Water transfer

- China needs more water savings from the irrigation sector because the total water supply is limited, hence, there is an urgent need to increase water and land productivity. The following indicators are included in the Report of the Eleventh Five-year Plan for national economic and social development by Premier Wen Jiabao on 5 March 2006 (Yuanhua Li, 2006):
  • total grain production must be increased to more than 500 million tonnes;
  • irrigation efficiency must be increased to 50 percent from around 45 percent; and
  • water productivity for industry must be increased by 30 percent.

Outside investment and technology are very important in order for China to cope with its environmental challenges (Burke, 2000).

The Water Resources Minister said in February 2009 that China will tighten water resources management and consider measures to reduce waste. This is to cope with worsening water shortages and that this water shortage has impelled China to consider overall economic and social development and the economical use of water resources to ensure sustainable economic and social development. China is planning to reduce water consumption per unit of GDP to 125 m^3 by 2020, a reduction of 60 percent from current use. At the end of 2008, water consumption averaged 229 m^3 per 10 000 Yuan worth of products, according to statistics provided by the Ministry of Water Resources (MWR). That figure was down 10 percent compared with the previous year. The Minister also expected to increase 79.5 km^3 of water resources by 2020 and secure water supplies for both urban and rural inhabitants. Finally, the Minister proposed reinforcement of laws and regulations on water allocation, consumption and preservation as a fundamental way to achieve this goal (Yao, 2009).

Note:

The expressions ‘He’ and ‘Jiang’ that are often added to the names of rivers, mean ‘river’ and ‘large river’. Therefore, in this English version of the country profile, these words have been removed from the
name of the river and replaced by the word ‘River’. As an example, Qingjiang has been changed to Qing river and Huaihe has been changed to Huai river.

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