

Thailand



GEOGRAPHY, CLIMATE AND POPULATION

Geography

Thailand covers an area of 513 120 km² and is located in the southeastern region of the continent of Asia (Table 1). Its immediate neighbours are Myanmar to the north and the northwest, Lao People's Democratic Republic to the northeast, Cambodia to the east and Malaysia to the south. The water bodies that skirt Thailand are the Mekong river in the east that forms Thailand's natural boundary with Laos, the Gulf of Thailand to the southeast and the Indian Ocean and the Andaman Sea to the southwest.

Administratively, the country is divided into 76 *changwats* (provinces), 4 regions and the Bangkok Metropolitan area. The four regions correspond approximately to the physiographical regions of Thailand: the northern region is mountainous with forests; the northeast is dry and consists of a plateau that borders the Mekong river; the central region is an extensive plain subject to flooding; and the southern part is a peninsula.

About 26.79 million ha are considered as cultivable, which represents 52 percent of the country. In 2009, the cultivated area was an estimated 18.995 million ha. Of this total, 15.300 million were under annual crops (mainly paddy rice) and the remaining 3.695 million ha were under permanent crops.

Climate

The climate is mainly governed by the alternation between the southwest monsoon, which brings heavy rainfalls (May-October), and the northeast monsoon, which is comparatively dry and cool (October-February). The transitional period (March-April) is characterized by heavy thunderstorms.

The average annual rainfall is about 1 622 mm. It ranges from 1 100 mm in the central plain and the northeast of the country to 4 000 mm in the southern peninsula near the Andaman Sea.

Population

The total population was an around 68.7 million in 2009, of which 66 percent lived in rural areas, compared with 69 percent in 1999. During the period 1999-2009 the annual population growth rate was an estimated 0.97 percent. The population density is about 134 inhabitants/km².

In 2008, 98 percent of the population had access to improved water sources (99 and 98 percent in urban and rural areas respectively). Sanitation coverage accounted for 96 percent (95 and 96 percent in urban and rural areas respectively).

ECONOMY, AGRICULTURE AND FOOD SECURITY

In 2009, the total economically active population was 39.5 million, or slightly more than



Legend

International Boundary	River
Administrative Boundary	Canal
Capital, Town	Lake
Zone of Irrigation Development	Dam

0 500 1,000 2,000 3,000 km
 Albers Equal Area Projection, WGS 1984

THAILAND

FAO - AQUASTAT, 2011

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TABLE 1
Basic statistics and population

Physical areas			
Area of the country	2009	51 312 000	ha
Cultivated area (arable land and area under permanent crops)	2009	18 995 000	ha
• as % of the total area of the country	2009	37	%
• arable land (annual crops + temp fallow + temp meadows)	2009	15 300 000	ha
• area under permanent crops	2009	3 695 000	ha
Population			
Total population	2009	68 706 000	inhabitants
• of which rural	2009	66	%
Population density	2009	134	inhabitants/km ²
Economically active population	2009	39 513 000	inhabitants
• as % of total population	2009	58	%
• female	2009	46	%
• male	2009	54	%
Population economically active in agriculture	2009	19 494 000	inhabitants
• as % of total economically active population	2009	49	%
• female	2009	45	%
• male	2009	55	%
Economy and development			
Gross Domestic Product (GDP) (current US\$)	2009	263 772	million US\$/yr
• value added in agriculture (% of GDP)	2009	12	%
• GDP per capita	2009	3 839	US\$/yr
Human Development Index (highest = 1)	2010	0.654	
Access to improved drinking water sources			
Total population	2008	98	%
Urban population	2008	99	%
Rural population	2008	98	%

58 percent of the total population. The economically active population in agriculture was around 19.4 million (49 percent of total active population) of which women represented 45 percent. In 2009, Thailand's gross domestic product (GDP) was US\$263 772 million of which agriculture sector accounted for 12 percent (Table 1).

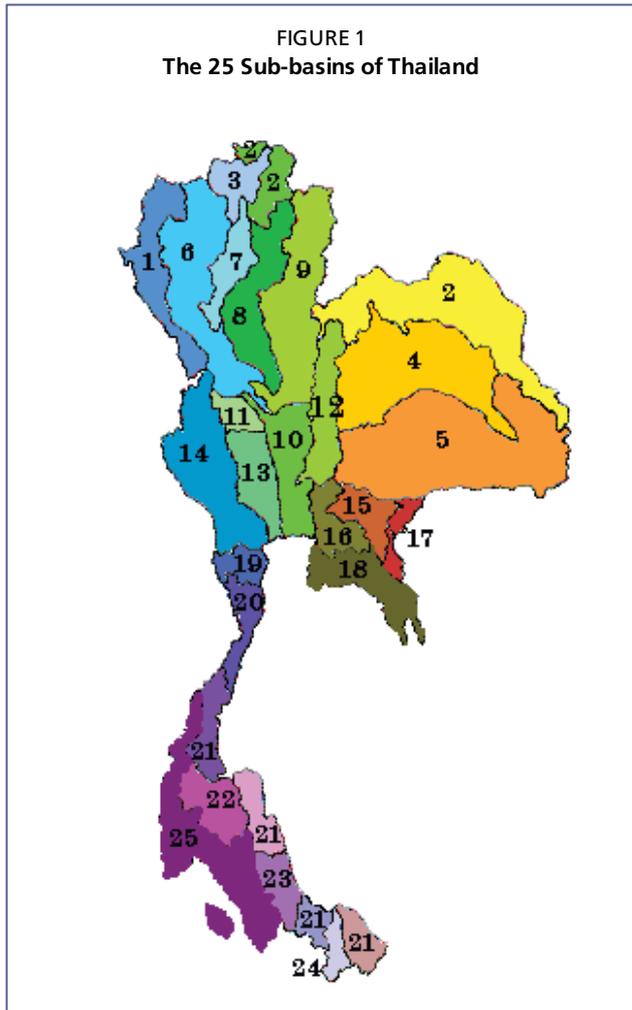
According to the Food and Agriculture Organization of the United Nations (FAO), Thailand's yearly hungry people reduce from 16.8 million (30 percent of total population) during 1990-92, to 13.8 million (23 percent) during 1995-1997, and 13.4 million (21 percent) during 2001-2003.

In 2003, food exports accounted for 24.6 million and food imports accounted for 8.4 million tonnes.

WATER RESOURCES AND USE

Water resources

Thailand can be divided into seven river basins, but in the literature it is generally divided into 25 subbasins. Figure 1 and Table 2 show the location and the characteristics of the 25 major river subbasins and indicate the total surface water resources, 213.35 km³/year. Aquifer recharge from rainfall is around 41.90 km³/year (about 5-6 percent of the total precipitation).



Approximately 30.70 km³/year are estimated to return to the river system (overlap). The total internal water resources of Thailand are therefore about 224.55 km³/year.

Thailand shares three major river systems with its neighbours: the Mekong river forms the border with Lao People's Democratic Republic in the north and east (about 18 percent of the total Mekong catchment area is located in Thailand), the Salween river is on the northwestern border with Myanmar, and the Kolok river is on the southern border with Malaysia. This last river, originating in Thailand and then bordering between Thailand and Malaysia, is very short with a total length of just over 100 km.

The Mekong river constitutes an additional external resource for Thailand, which has been estimated as half the discharge of the river, Thailand's contribution to this river has to be deducted over a long distance. The flow of the Mekong river at the point where it enters Lao People's Democratic Republic near Pakxé is about 280 km³/year. The contribution of Thailand to the Mekong river is an estimated 51.9 km³/year. This gives an accounted flow of the Mekong border river for Thailand of 114.05 km³/year. The Salween river on the border with Myanmar,

with an estimated flow of 200 km³/year, flows only over a relatively short distance on the border. It is therefore considered that there is not much contribution from Thailand over that short distance and the accounted flow is 200/2=100 km³/year.

By adding the internal and external resources together, the total renewable water resources are approximately 438.6 km³/year (Table 3).

Total exploitable water is an estimated 125.98 km³/year, consisting of 75.64 km³/year regular renewable surface water, 27.34 km³/year irregular renewable surface water and 23.00 km³/year regular renewable groundwater.

Total large dam capacity is an estimated 68.28 km³ in 2007, which is about 32 percent of the annual runoff. However, many dams have been over-designed, compared with the annual recharge obtainable. There are four categories of dams in Thailand:

- Large dams with hydropower component are built by the Electricity Generating Authority of Thailand (EGAT), the Royal Irrigation Department (RID) or the Department of Energy Development and Promotion and managed by the EGAT. Their total capacity is an estimated 62.87 km³. All these dams are multipurpose dams, and the irrigation component receives priority over the other components.
- Large dams without hydropower, and therefore mainly destined for irrigation, are operated by the RID. Their total capacity was an estimated 5.41 km³ in 2003.

TABLE 2
 Characteristics of the 25 major river sub-basins (Source: Hydrologist Assembly, 2006)

No	Basin (Sub Nation)	Catchment area (within the country)		Mean annual runoff (country's contribution)		Area equipped for irrigation	
		km ²	%	km ³	%	ha	%
1	Salawin	17 918	3.50	8.38	3.93	38 560	0.60
2	Mekong	57 424	11.23	30.77	14.42	400 960	6.25
3	Kok	7 895	1.54	4.18	1.96	77 600	1.21
4	Chi	49 476	9.68	11.24	5.27	461 280	7.19
5	Mun	69 700	13.63	19.50	9.14	501 280	7.81
6	Ping	33 896	6.63	8.73	4.09	597 760	9.32
7	Wang	10 792	2.11	1.62	0.76	92 640	1.44
8	Yom	23 616	4.62	3.66	1.71	404 320	6.30
9	Nan	34 331	6.71	12.01	5.63	421 760	6.57
10	Chao Phraya	20 125	3.94	1.73	0.81	1 161 440	18.11
11	Sakae Krang	5 192	1.02	1.12	0.53	106 400	1.66
12	Pasak	16 292	3.19	2.90	1.36	145 600	2.27
13	Tha Chin	13 681	2.68	1.36	0.64	613 440	9.56
14	Mae Klong	30 836	6.03	15.13	7.09	226 880	3.54
15	Prachin Buri	10 481	2.05	5.09	2.39	128 640	2.01
16	Bang Pakong	7 977	1.56	3.34	1.57	153 440	2.39
17	Tonle SAP	4 150	0.81	2.39	1.12	18 720	0.29
18	East Coast - Gulf	13 829	2.70	12.98	6.08	114 720	1.79
19	Phetchaburi	5 603	1.10	1.38	0.65	76 480	1.19
20	West Coast	6 744	1.32	1.34	0.63	76 000	1.18
21	Southeast Coast	26 353	5.15	22.26	10.43	320 640	5.00
22	Tapi	12 224	2.39	10.53	4.94	35 840	0.56
23	Songkhla dam	8 495	1.66	6.63	3.11	120 800	1.88
24	Pattani	3 858	0.75	2.67	1.25	43 520	0.68
25	Southwest Coast	20 473	4.00	22.40	10.50	76 160	1.19
Total		511 361	100.00	213.35	100.00	6 414 800	100.00

- Medium dams, similar to large dams with no hydropower, are also under RID. Reasons for not classifying these as large dams are:
 1. to avoid environmental assessment, and
 2. to shorten budget processing and construction times to cope with high priority areas.
- Small dams used to be under RID, but are now under local governments. Most of these small dams are for domestic and subsistence irrigation purposes.

There are five dams with a capacity of more than 5 km³: Srinagarind (17.75 km³), Bhumipol (13.46 km³), Sirikit (9.51 km³), Vajiralongkorn (8.86 km³) and Rat Cha Prapa (5.64 km³).

There are five main dams on the Mekong river basin in Thailand, the Sirindhorn (1 966 million m³), Chulabhorn (188 million m³), Ubol Ratana (2 264 million m³), Pak Mun (114 million m³) and Lam Ta Khong (310 million m³).

International water issues

In general, Thailand's international water issues stem from the country's thirst for water, hydroelectricity, and utilization of coastal areas. The main issues include:

- The Mekong river Treaty (1995): This is a treaty between Thailand, Lao People's

TABLE 3
Water: sources and use

Renewable freshwater resources			
Precipitation (long-term average)	-	1 622	mm/yr
	-	832 435	million m ³ /yr
Internal renewable water resources (long-term average)	-	224 559	million m ³ /yr
Total actual renewable water resources	-	438 609	million m ³ /yr
Dependency ratio	-	48.8	%
Total actual renewable water resources per inhabitant	2009	6 384	m ³ /yr
Total dam capacity	2007	68 281.1	million m ³
Water withdrawal			
Total water withdrawal	2007	57 302	million m ³ /yr
- irrigation + livestock	2007	51 786	million m ³ /yr
- municipalities	2007	2 739	million m ³ /yr
- industry	2007	2 777	million m ³ /yr
• per inhabitant	2007	845	m ³ /yr
Surface water and groundwater withdrawal	2007	57 302	million m ³ /yr
• as % of total actual renewable water resources	2007	13.1	%
Non-conventional sources of water			
Produced wastewater	2007	2 191	million m ³ /yr
Treated wastewater	2007	523	million m ³ /yr
Reused treated wastewater		-	million m ³ /yr
Desalinated water produced			million m ³ /yr
Reused agricultural drainage water			million m ³ /yr

Democratic Republic, Vietnam and Cambodia. The treaty specifies the method of cooperation and conflict resolution among the countries involved, but does not propose any sharing of water between the riparian countries.

- Myanmar: There are a number dams that are planned or under-construction both inside Myanmar and on the border that international non-governmental organizations (NGOs) question because of their possible environmental impact. No agreements have been signed on the Salween river.
- Lao People's Democratic Republic: Issues are similar to Myanmar but include existing dams that supply electricity to Thailand.
- Cambodia: Issues are similar to Myanmar but include natural resources in coastal areas.

Water use

In 2007, total water withdrawal was an estimated 57.3 km³, of which 90.4 percent was for agricultural, 4.8 percent for municipal and 4.8 percent for industry (Table 3 and Figure 2). In 1990, total water withdrawal was an estimated 33.1 km³, of which 91 percent was for agricultural purposes, 5 percent for municipal use and 4 percent for industrial use. Of the total withdrawal of 57.3 km³, 82.9 percent was surface water and 17.1 percent was groundwater (Figure 3).

Wastewater treatment is not common. Industrial wastewater is generally discharged into rivers and canals. About 2 191 million m³ of wastewater were produced in 2003. In 2007, some 523 million m³ of wastewater were treated. Numerous wastewater treatment projects are being developed in the Bangkok metropolitan area. There is no reuse of treated wastewater in Thailand.

IRRIGATION AND DRAINAGE DEVELOPMENT

Evolution of irrigation development

Irrigation from river diversion and reservoirs started in the north seven centuries ago. In modern times, canal construction for irrigation started at the beginning of the last century, in parallel with the creation of the RID. The aim was to maintain water in canals for irrigation and navigation, and to drain paddy fields during periods of flooding. Irrigation has traditionally been supplementary irrigation for the wet season. It is only recently that schemes have been designed for dry season irrigation.

The irrigation potential for the wet season can be roughly estimated as 12.2 million ha, considering both soil and water availability but excluding basin transfers (World Bank, 1985). New estimates consider that irrigation potential accounts for 9.5 million ha (Thai Hydrologist Assembly, 2007).

In 2007, the area equipped for wet season irrigation was an estimated 6 414 800 ha. In 2005, the regional distribution of irrigated area in the wet season was 54 percent in the central plain, 18 percent in the north, 14 percent in the northeast and 14 percent in the south. In 1995, the area equipped for wet season irrigation was an estimated 5 003 724 ha, of which 47 percent in the central plain, 24 percent in the north, 19 percent in the northeast and 10 percent in the south.

In 2007, the area actually irrigated was an estimated 5 089 914 ha, or 79 percent of the equipped area (Table 4).

Surface irrigation is the only technology used in the schemes. Sprinkler and localized irrigation are at an experimental stage only for fruit trees. Generally surface water is used, accounting for 90.9 percent of the total area equipped for irrigation (Figure 4).

Early systems were designed to operate at full capacity only in the wet season. The canal capacities and control regulators are inadequate for the increasing demand for dry season irrigation. Furthermore, irrigation water demand has to compete with demand from other sectors. This becomes a sensitive issue during the dry season. A certain flow of water must be maintained for navigation, to prevent saltwater intrusion, and to supply water for domestic and industrial purposes in the Bangkok area. In the dry season, water resources can no longer meet the increasing water demand from all sectors, and particularly from the irrigation subsector, which needs to withdraw more and more water because of the development of dry season irrigation. This water competition has led to poor agricultural performance in recent dry seasons.

Dry season irrigation is practiced on 60 percent of the equipped area, up from 18 percent in 1994.

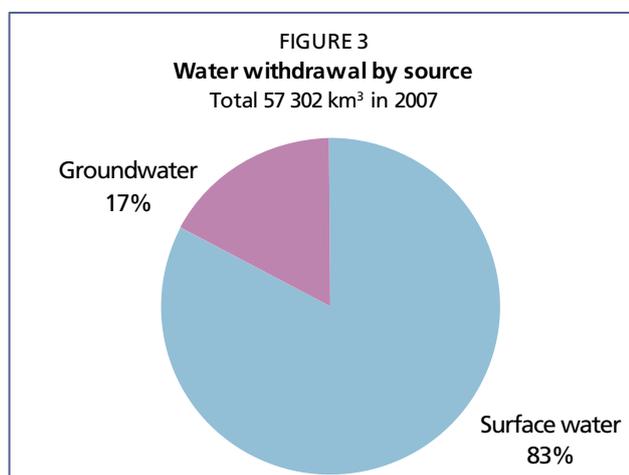
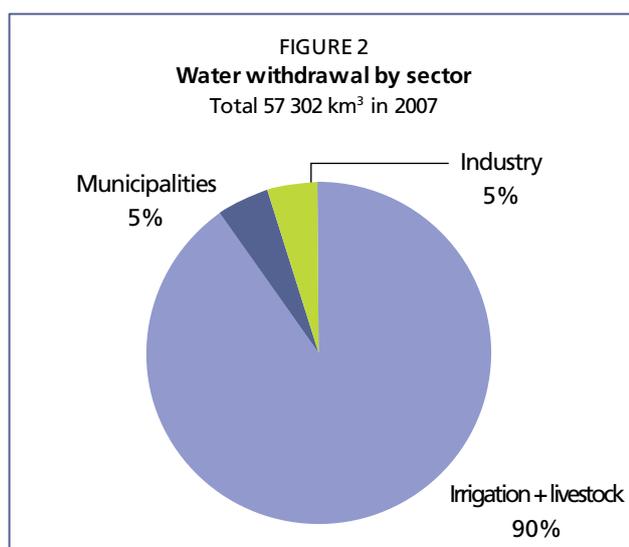


TABLE 4

Irrigation and drainage

Irrigation potential		12 245 000	ha
Irrigation			
1. Full control irrigation: equipped area	2007	6 414 800	ha
- surface irrigation	2007	6 414 800	ha
- sprinkler irrigation			ha
- localized irrigation			ha
• % of area irrigated from surface water	2007	909	%
• % of area irrigated from groundwater	2007	91	%
• % of area irrigated from mixed surface water and groundwater			%
• % of area irrigated from non-conventional sources of water			%
• area equipped for full control irrigation actually irrigated	2007	5 059 914	ha
- as % of full control area equipped	2007	79	%
2. Equipped lowlands (wetland, ivb, flood plains, mangroves)		-	ha
3. Spate irrigation		-	ha
Total area equipped for irrigation (1+2+3)	2007	6 414 800	ha
• as % of cultivated area	2007	34	%
• % of total area equipped for irrigation actually irrigated	2007	79	%
• average increase per year over the last 9 years	1995-2007	21	%
• power irrigated area as % of total area equipped	2007	72	%
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)	2007	6 414 800	ha
• as % of cultivated area	2007	34	%
Full control irrigation schemes:		Criteria:	
Small-scale schemes	< 1 year construction	2007	2 848 240 ha
Medium-scale schemes	> 1 year construction and < 12 800 ha	2007	898 880 ha
Large-scale schemes	> 12 800 ha	2007	2 667 680 ha
Total number of households in irrigation			-
Irrigated crops in full control irrigation schemes:			
Total irrigated grain production (wheat and barley)			- metric tons
• as % of total grain production			- %
Harvested crops:			
Total harvested irrigated cropped area		2007	7 387 072 ha
• Annual crops: total		2007	6 644 913 ha
- Rice (first season)		2007	2 327 158 ha
- Rice (second season)		2007	3 940 922 ha
- Sugarcane		2007	256 016 ha
- Vegetables		2007	83 421 ha
- Other annual crops		2007	37 396 ha
• Permanent crops: total		2007	742 159 ha
- Other permanent crops		2007	742 159 ha
Irrigated cropping intensity (on full control area actually irrigated)		2007	146 %
Drainage - Environment:			
Total drained area		-	- ha
- part of the area equipped for irrigation drained			- ha
- other drained area (non-irrigated)			- ha
• drained area as % of cultivated area			- %
Flood-protected areas			- ha
Area salinized by irrigation		1999	400 000 ha
Population affected by water-related diseases		1995	960 000 inhabitants

Small-scale projects are those that can be completed within one year and without land compensation. The schemes that cannot be completed within one year, or that need land compensation are considered medium-scale. Schemes are classed as large-scale if there is a storage capacity of more than 100 million m³ or if they can irrigate at least 80 000 *rais* (12 800 ha). Irrigated areas can be divided into the three categories(Figure 5):

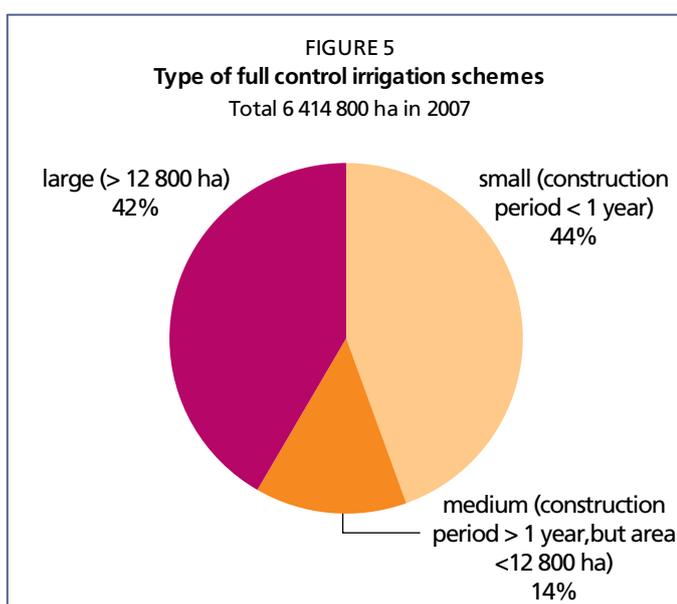
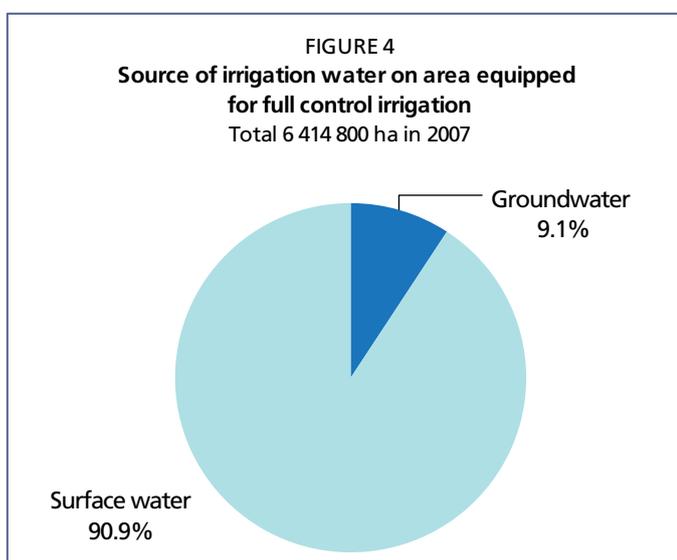
- There were 83 large-scale projects under the Royal Irrigation Department (RID) and operational by 2002 with a combined storage volume of 6 662 million m³. In 2007, the total command area was about 2.7 million ha. Water management in these projects is the responsibility of RID and water user groups.
- There were 607 medium-scale projects by 2002 with a combined storage volume of 3 191 million m³. In 2007, the total command area was 898 880 ha. Water management in these projects is also the responsibility of RID and water user groups.
- There were 10 606 small-scale projects by 2002 with a combined storage volume of 2 110 million m³. In 2007, the total benefit area was around 2.4 million ha. Water management in these projects is the responsibility of local governments and water user groups.

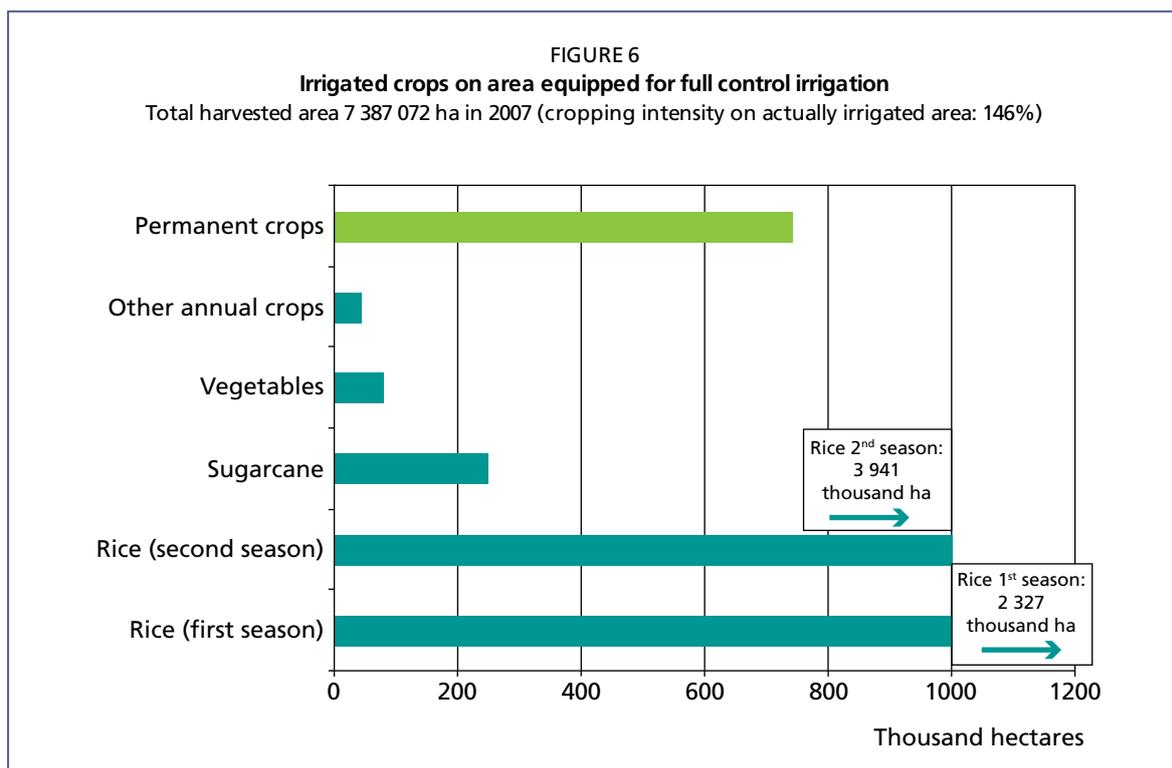
By 1999, there were 1 985 pumping projects. Essentially these are small-scale projects with electrical pumping from nearby waterways. In 2007, their combined command area was 460 000 ha, mainly in the northeast and north. Water management in these projects is the responsibility of RID and water user groups. Management responsibility is to be transferred to Local Governments.

Role of irrigation in agricultural production, economy and society

In 2007, total harvested irrigated cropped area was an estimated 7 387 072 ha. Rice accounts for 6 268 080 ha (2 327 158 ha first season rice and 3 940 922 ha second season rice), or 84.9 percent of the harvested irrigated cropped area, vegetables represent 83 421 ha (1.1 percent), sugarcane 256 016 ha (3.5 percent), other annual crops (tobacco, cotton, etc.) 37 396 ha (0.5 percent) and permanent crops 742 159 ha (10.1 percent) (Table 4 and Figure 6). There are also 233 033 ha of fish ponds, which are irrigated and not taken into account in the total, because they are not a crop.

Irrigation development costs US\$3 647/ha as follows: construction of head work US\$2 187/ha, conveyance system US\$860/ha, field system US\$600/ha and maintenance cost US\$33/ha per year.





Poverty is observed to be concentrated in non-irrigated areas (or rainfed areas).

WATER MANAGEMENT, POLICIES AND LEGISLATION RELATED TO WATER USE IN AGRICULTURE

Institutions

In total there are 31 ministerial departments under ten ministries, one independent agency and six national committees that are involved in water resources development. They are responsible for water policy, irrigation, domestic and/or industrial water supply, fisheries, flood alleviation, hydropower generation, navigation or water quality.

The National Water Resources Committee (NWRC), under the Office of the Prime Minister, is responsible for setting a policy to develop water resources throughout the country.

In general, the Ministry of Natural Resources and Environment (MONRE) is responsible for policy planning while the Ministry of Agriculture and Cooperatives (MOAC) is responsible for implementation.

The National Economic and Social Development Board is responsible for economic planning.

The Department of Groundwater Resources, under the MONRE, monitors groundwater resources, while surface water monitoring is mainly carried out by the Department of Water Resources, and the Royal Irrigation Department, which has its own network.

Many departments or agencies are involved in water supply for domestic or industrial purposes. The main one is the Metropolitan (or Provincial, outside Bangkok) Waterworks Authority. Wastewater treatment and water quality are mainly the responsibility of the Ministry of National Resource and Environment.

Large dams are operated either by RID or by the Electricity Generating Authority of Thailand (EGAT), while small dams have been developed by the Land Development Department or the Department of Water Resources.

The Harbour Department is in charge of protecting inland waterways, and of issuing licenses for navigation.

Irrigation is managed by the RID for public schemes, or by the Department of Water Resources. The RID is the supervising agency for private irrigation.

Water management

There are four levels of water user organization in the irrigation areas:

- Water User Group (WUG): These are the smallest groups, responsible for one tertiary irrigation canal. In 2004, there are 14 930 WUG with 358 846 farmer members.
- Integrated Water Users Group (IWUG): This is integration of many WUG to cover one level up of irrigation canals, the secondary canals. In 2004, there are 410 IWUG with 234 203 farmer members.
- Water Users Association (WUA): This is a legally recognized IWUG. In 2004, there are 40 WUA with 17 575 farmer members. IWUG is not profit oriented.
- Water Users Cooperative (WUC): This is the cooperative form of a WUA. In 2004, there are 83 WUC with 53 158 farmer members. WUC is business-oriented.

Participatory irrigation management (PIM) and cost sharing in water management are encouraged in all the RID irrigation areas but not widespread.

Policies and legislation

By 2025, Thailand is projected to have sufficient water of good quality for all users as a result of its efficient management, organization and a legal system that ensures the equitable and sustainable use of its water resources with due consideration to the quality of life and participation of all stakeholders.

Thailand's nine-point National Water Policy and Vision, as set forth by RID, details how this will be implemented:

- Accelerate promulgation of a Draft Water Act as the framework for national water management by reviewing the draft and implementing all necessary steps to make it effective, including reviewing existing laws and regulations.
- Create water management organizations both at national and river basin level with supportive legislation. The national organization is responsible for formulating national policies, monitoring and coordinating activities to fulfill the policies. The river basin organizations are responsible for preparing water management plans through a participatory approach.
- Emphasize suitable and equitable water allocation for all water use sectors and fulfill basic water requirements in agriculture and domestic uses, to be achieved by establishing efficient and sustainable individual river basin water use priorities under clear water allocation criteria, incorporating beneficiary cost-sharing based on the ability to pay and the level of services used.
- Formulate clear directions for raw water provision and development compatible with basin potentials and demand, ensuring suitable quality while conserving natural resources and maintaining the environment.
- Provide and develop raw water sources for farmers extensively and equitably in response

to water demand for sustainable agriculture and domestic uses, similar to deliveries of other basic governmental infrastructure services.

Most laws related to water management are outdated. All existing laws are focused on individual aspect of water management and none on a holistic view (IWRM). There is no law specifying water rights. Currently there is a draft Water Law that specifies water rights, river basin organizations and national apex body for water management. This draft passed the cabinet in June 2007, and is waiting for approval from the parliament. Earlier versions of this law have been at this stage before but failed to pass.

ENVIRONMENT AND HEALTH

In 2004, surface water quality classified as 'good', 'fair' and 'poor' accounted for 48 percent, 32 percent and 20 percent respectively. The classification carried out by analysing the quality of samples of water taken from natural waterways throughout the country. The overall situation has improved compared to 2003. Critical areas are: lower Chao Phraya in central Thailand and Lower Lam Takong in northeast Thailand. In the North, Northeast and South water quality is good (surface water quality) and improving, while the Central is good with mixed improvement, and the East is fair and stable.

In 1999, in the northeast, 10 percent of the irrigated land was affected by salt. The presence of the salt bearing nature of the soil parent material has been identified as the primary cause. Other activities, such as irrigation, could be classed as secondary causes for accelerating this condition locally. Many programmes have been launched to correctly manage cash crops and paddy on saline soils. Salinization is now reported to be affecting large areas in the coastal parts of the central plain.

Bangkok faces problems of both too much and too little water. Flooding occurs frequently in the wet season owing to low average elevation, high tides and inadequate drainage. The Metropolitan Waterworks Authority is unable to supply water to meet all domestic and industrial demand. As a result, in the outskirts of Bangkok, private and industrial abstraction of groundwater exceeds the safe yield of the aquifer. This accelerates the rate of land subsidence (5-10 cm/year), which in turn aggravates the problem of flooding. Indeed, subsidence has caused some parts of the drainage systems to be below the normal water level and has thus rendered them ineffective.

The minimal discharge to maintain a water level of 1.7 m for navigation (this means 300 m³/s released in the navigation channel from Nakhon Sawan to the Chao Phraya dam, and 80 m³/s downstream of the dam) cannot be maintained because large amounts of water are diverted from the river for dry season irrigation in the northern and central regions. This has reduced the volume of inland waterway transport fivefold between 1978 and 1990. The volumes of water released by the Bhumipol and Sirikit dams are increasingly important to prevent saltwater intrusion, even if they do not meet the navigation demand.

Leptospirosis seems to prevail in flood-prone and irrigation areas, but is under control. There are no clear impacts (positive or negative) of irrigation on health. This is probably the result of a the complicated interaction between socio-economic factors and land use changes. People whose paddy is in irrigation areas are better off economically than those in rainfed areas and hence can afford better health care. Changes in land use transform remote irrigation areas into suburban areas with reasonable road access. As noted above, poverty is less in irrigation areas than in rainfed areas.

During the period 1984-2007 Thailand has 317 513 cases of HIV, resulting in 87 643 deaths. Most HIV cases occur in the services and agriculture sectors in age ranges from 25 to 34 years.

In 1999, the main water-borne diseases were acute diarrhoea (affecting 1.48 percent of the population) dysentery (0.14 percent) and enteric fever (0.03 percent). Malaria, as a water-related disease, affected 0.12 percent of the population.

PROSPECTS FOR AGRICULTURAL WATER MANAGEMENT

Water management in agriculture is said to have to focus on improving water-use efficiency. Reasons for this are:

- the trend indicates that Thailand's water shortage is emerging;
- the agriculture sector consumes the largest proportion of water.

Improving agricultural water-use efficiency must be done through IWRM and must be river basin oriented. To do so, organization and institutional tools must be in place. Organization tools include river Basin Organizations, Apex body and line agencies. Institutional tools include laws, policy and strategies.

In tandem with improving agricultural water-use efficiency, the farmers should move from traditional agriculture to modern agriculture, making use of high technology such as precise water control.

MAIN SOURCES OF INFORMATION

Center for Agricultural Statistics, Ministry of Agriculture and Cooperatives. 2006. *Agricultural statistics of Thailand, crop year 2005/06*. Bangkok.

ESCAP (United Nations Economic and Social Commission for Asia and the Pacific). 1991. *Assessment of water resources and water demand by users sectors in Thailand*. New York.

FAO. 1999. Irrigation in Asia in figures. *FAO Water Report No. 18*. Rome.

Hydrologist Assembly. 2006. *Hydrologist Assembly, Eleventh Year Volume 10-2006*. Bangkok

National Economic and Social Development Board, Office of the Prime Minister. 2001. *The ninth national economic and social development plan 2002-2006*. Bangkok.

National Economic and Social Development Board, Office of the Prime Minister. 2006. *The tenth national economic and social development plan 2007-2011*. Bangkok.

National Statistical Office, Office of the Prime Minister. 2006. *Statistical yearbook of Thailand*. Bangkok.

Thai Hydrologist Assembly. 2007. *Journal of Hydrologist Assembly*.

World Bank. 1985. *Options and Investments priorities in irrigation development*, Washington, DC.