

ITALY

1. GENERAL INFORMATION

Italy, with a surface area of 301,341 km², is situated in Southern Europe at a central location in the Mediterranean basin with a high latitudinal extension, and linked to central Europe through the Alps mountains and also to the Sicily isle lying in front of the African coast.

The Country is bordered by France in North West, by Switzerland and Austria in North and by Slovenia in North East.

The country comprises four main land regions with a wide physiographical variation as follows:

- at the North the Alps mountains chain, extending from the west to east (including the highest peak in Europe: Monte Bianco);
- at the South of the Alps the lowland of the large basin of the Po river and its 141 tributary streams of first and second order;
- the peninsula, 800 km long, including the central Apennine mountains running from North to South and the coastline (7,500 km long) bordering the Adriatic sea in the East, Ionio sea in the South-East and Tyrrhenian sea in the West;
- the two wide isles Sicily and Sardinia located respectively at the South and the West of the peninsula.

The Alps are acting as a protection barrier against the cold wind blowing from the North, giving rise to a climatic pattern different from that of Central Europe.

More than 50% of the coastline are highly rocky and cliffed, very susceptible to processes of geomorphological instability mainly due to the exposition to strong seastorms and southern winds.

Extending southward from 47.50 N and 36.40 N latitude between the Alps and Mediterranean sea, Italy is characterised by extremely variable climatic conditions, ranging from Southern semi-arid type to humid conditions in the Alpine and Apennine ridges.

Rome is Italy's capital and the largest city situated in the central part of the country.

The official language is the Italian.

The population of the Country is 57,680,900 with a density of 190 inhabitants per km²; over the last few years population growth has been almost entirely the results of foreign immigration, whereas the size of the Italian population has been decreased.

Table 1. Italian population

Year	Males x 1,000	Females x 1,000	Total x 1,000	Average annual increase per 1,000
1951	23,259	24,257	47,516	7.4
1971	26,476	27,661	54,137	6.7
1991	27,558	29,220	56,778	0.4
2000	28,003	29,677	57,680	

The proportion of female population to the total population is 51.5% and that of the male gender is 48.5%, due mainly to a greater survival of women as compared to men. 83% of the Italian people are of the catholic faith.

In Italy the illiteracy is very low (2%), mainly due to the compulsory education for young people up to the age of 16 years. The population of primary school pupils is: 2,825,835; that of secondary schools is 1,907,024, with the figure for high schools being: 2,687,181. The total number of students at the Universities stand at about 1,061,690.

With the expansion of cultivated land coupled with the increasing population, many wild animal species have been disappearing in the past and some of them are now extinguished. However in some “protected areas” of the country (mainly in the Alps and Apennine areas) it is still possible to see ibex, chamois, roe-deer, deer, fallow-deer, mouflon, wild boar, lynx, fox, badger, weasel, marten, polecat, bear, beach-marten otter, marmot, squirrel, dormouse, hare, harvest mouse, mole, porcupine, bat, seal, tortoise, viper, frog, etc. The bird-fauna is very rich and the more frequent species are: sparrow, quail, nightingale, crow, woodpecker, thrush, flamingo, duck, heron, eagle, vulture, etc. The sea and lake fauna is plentiful and with an extraordinary variety of species.

The flora includes more than 5,000 species of vascular plants, the greatest part of which are of Mediterranean species such as: oak, ilex, chestnut, beech, maple, ashtree and lime. On the Alps mountains there is mainly coniferous forestry coverage; in the Mediterranean bush, mainly located along the coastline, are prevailing pine, cypress, palms, agave, indian fig, eucalyptus, acacia, araucaria, bamboo, cicadaceae, ficus elastica, etc. The main cultivated trees are olive, vine and many fruit varieties.

In 1998 the total workforce employed in Italy, expressed in standard work units, increased by 0.7% after remaining almost stationary during the previous years.

Table 2. Percentage of employed population according the sector

Sector	1971	1981	1991	1999
Agriculture	20.1 %	13.3 %	8.4 %	5.5 %
Industry	39.5 %	37.2 %	32.0 %	32.6 %
Services	40.4 %	49.5 %	59.6 %	61.9 %
Total	100.0 %	100.0 %	100.0 %	100.0 %

Over the last years the percentage of the population employed in agriculture has become ever less and less.

The urbanisation process is progressively absorbing land in Italy. There is a tendency for the total amount of unproductive land to be absorbed further by the spread of built-up areas and infrastructure. The area of agricultural land, on the other hand, has decreased by about 2.7 million hectares (-15.3%) since 1970 (almost 10% of national territory).

Moreover many anthropic factors such as deforestation, fires, careless agricultural activities along the slope, development of settlements and road network along the slope increase the soil erosion risk.

Urbanisation and conversion of agricultural land to housing and industrial settlement is a growing harmful process and affect, to a great extent, the most fertile lands along the coastal areas. Effects

of unplanned urbanisation are: the decreasing of ground water resources, the salinisation and pollution of phreatic and deep groundwater, the loss of fertile and irrigated farmland.

The population of town and coastal areas is increasing whereas the mountain and hill population is decreasing. Furthermore the mountain population is getting more and more older (20% of the people are older than 65 years).

The GNP was 350,220 billions of dollars. The ratio country deficit/GNP is decreasing by 2.7% and the inflation has decreased to 1.5%. The pro capita GDP is \$ 20,170.

Table 3. Value added at market prices base by sector

Sector	1996	1999
Agriculture	2.8 %	2.6 %
Industry	26.6 %	26.2 %
Structures	5.1 %	4.8 %
Services	65.5 %	66.5 %
Total	100.0 %	100.0 %

2. PYSIOGRAPHY

One of Italy's main geographical features is the prevalence of hilly and mountainous land.

Out of a total land surface area of about 30 million hectares, only 23% is lowland in the North, 18% in the South and 9% in Central Italy (Table 4).

As a whole, Italy is still geologically a relatively new land, nearly all its territory has emerged from the more recent orogenetic upheaval (the alpine upheaval), whose movements, although weaker, spread into the axis of the Central and Southern Apennines.

Table 4. The country surface according to the land elevation (ha 000)

	North	Centre	South	Italy
Mountain	5,532	1,576	3,503	10,611
Hill	2,273	3,724	6,548	12,545
Lowland	4,187	536	2,255	6,978
Total	11,992	5,836	12,306	30,134

The result of this tumultuous, though short, orogenetic evolution has been an extreme complex tectonic phenomenon and the formation of the widest variety of soils and shapes, which are not elsewhere so largely concentrated in such a limited stretch. Even though it is the source of the celebrated beauty of the landscape, its soils often present adversities in cultivation.

Italy's physical aspects are determined by the presence of the Alpine mountain range, the Apennine ridge and the elongated narrow shape of the Peninsula surrounded by the sea, nowhere farther than 250 km distant.

The sinuous course of the Apennines from west to east in the northern part, and then from northeast to southwest in the peninsular area causes important differences between the Tyrrhenian and the Adriatic slopes. The surface waters are thus obliged to flow torrentially with the consequential

uneven valley formation, limiting the flat areas along the shores to narrow coastal belts. Moreover, floods and the influence of sea currents have led to the formation of lakes and marshes (*tomboli, maremma*) in these narrow coastal zones. After centuries of fruitless efforts, these marshes have only recently been reclaimed and freed from malaria which had in the past adversely influenced settlement of rural populations (Venetian laguna, Tuscan maremma, Pontine plains, Ionic coast).

The distinctive features of the Alpine zone are due not only to its lithological character (crystalline rocks in the middle western and central area, calcareous rocks in the central and eastern zones), but are also due to the events that followed the levelling in the Tertiary period and the subsequent upheaval in the Quaternary period.

The Alps are the highest and most imposing mountain ranges along the coast of the Mediterranean depression and no other mountain system is known to be rich in the variety of mountain shapes.

The Alps appear as an enormous mass of mountain ranges with a protruding line of peaks leaning out towards the inner concavity causing the Italian slope to be steeper than the opposite one; the altitudes decline from west to east.

Different from the alpine zone, the Apennines have a very distinct individual characteristics.

The Northern Apennines are formed essentially by sandstone rocks in the higher parts and by clayey rocks in the middle and lower parts. As there are no glaciers (quaternary glaciation being of scanty importance), the mountain range lacks variety of altitudes and ruggedness owing also to the scanty incision of the valleys by superficial waters.

On the other hand, the Central Apennines are formed mainly by sandstone and limestone rocks. The highest peaks do not coincide with the watershed, but are situated on the western side; the highest peak, the Gran Sasso, lies within the limit of eternal snows. Owing to their lithological nature the appearance as a whole is more rugged, the development of the calcareous rocks causes a strong underground deep flow to feed abundant springs at the foot of the mountains.

The Southern Apennines are formed by isolated massifs of chalky, calcareous and tertiary rocks, interrupted by vales – some of which are of lacustrine origin. As regards the shape, they are not very different from those of the two other sections.

To the south of the Fortore, the sub-Apenninian range extends inland, continuing with the same characteristics but with more marked erosion and denudation in the Sannio and Lucania regions. Towards the Adriatic Sea, on the outside there is an anti-Apenninic zone formed by the Gargano, the Tavoliere of Puglia and the Salentine peninsula.

The Tyrrhenic slope differs from the others. The Ligurian Apennine is almost a continuation of the Ligurian Alps and falls into the sea with steep buttresses interspersed with little valleys. being a barrier to the cold north-east winds. A situation which determines the special climatic conditions of the Ligurian riviera.

There are four major river basins in Italy: Po, Tevere, Adige, Arno, etc. (Table 5).

Table 5. The main Italian rivers

Name of river	Length (km)	Drainage area (km ²)	Average annual discharge (m ³ /s)
Po	652	74,970	1,540
Tevere	405	17,169	230
Adige	410	12,200	250
Tanaro	276	8,324	130
Arno	241	8,247	146
Adda	313	7,979	210
Ticino	248	7,228	121
Oglio	280	6,649	120
Volturno	175	5,455	115
Garigliano	168	5,020	125
Reno	211	4,626	60
Dora Baltea	160	4,322	34
Simeto	120	4,169	40
Piave	220	4,100	90
Ombrone	161	3,480	40
Isonzo	136	3,460	20
Sele	63	3,223	43
Pescara	145	3,125	36

In the North East of the country, the rivers Adige, Brenta, Piave, Tagliamento and Isonzo from the Alps flow into the Adriatic sea. From the Central Apennines, the flows of the rivers Reno, Metauro, Tronto reach the Adriatic sea while those of the Arno, Tevere, Volturno, Garigliano, Sele discharge into the Tyrrhenian sea.

From Southern Apennines, the streams Pescara, Sangro, Biferno, Fortore and Ofanto are flow into the Adriatic sea while Bradano, Basento, Agri reach into the Ionic sea.

In the Sicily isle, the Alcantara river is reaches the Ionic sea while in the Sardinia isle the Flumendosa river flows from the northern region into the Tyrrhenian sea.

The main area of Po river basin is constituted by the Po river plain and its extension toward East (Veneto and Friuli lowland) and toward South East (lowland of Romagna) (Table 6).

Table 6. Main characteristics of the po river basin

Area of the basin (km ²)	74,970
Area of the plain (km ²)	29,000
Area of the delta (km ²)	380
Volume of major lakes (10 ⁶ m ³)	118
Surface of major lakes (km ²)	790
Volume of reservoirs (10 ⁶ m ³)	1,600
n. of lakes and reservoirs with area	108
n. of first and second order	141
Length of the river course (km)	652
Annual average precipitation (mm)	1,107
Mean annual flow rate m ³ /s)	1,540
Maximum flow rate (m ³ /s)	11,580
Minimum flow rate (m ³ /s)	275

The Po river basin extends over 23.6% of the entire Italian territory. More than 16 million inhabitants live within the basin, distributed among 3,188 municipalities.

The perimeter is completed by the coastlines of the Adriatic sea and by the boundary with the Apennines and Alpine highlands.

From the geological viewpoint, the whole area is characterised by river, glacial, delta and lagoon sediments of the Quaternary age with textures varying from coarse gravel sediments at the foot of the mountains to silts and clays in the lowland; porosity and permeability vary widely.

The exploited aquifers are prevalently one-layer at the foot of the mountains and multi-layer in the middle lowland. The transition between the two systems corresponds to the area of the springs, where present. The aquifers are confined in the lowland areas. The depth of the water table from the ground level varies from some tens of metres at the foot of the mountains to a few metres in the lower lowland.

The Po River Authority has full power on river basin planning, including the prevention of floods, water pollution and hydrogeological control. To pursue its objectives the Authority coordinates the activities of the seven regions included in the river basin Piemonte, Liguria, Lombardia, Veneto, Venezia Giulia, Friuli, Emilia.

Second in size in Italy, the Tiber river basin covers an area of 17,169 km² and spreads over five regions (Lazio, Umbria, Tuscany, Abruzzi and Marche). The basin's climate is typical of Central Italy, although it changes considerably from the coastal zones to the Apennine areas. For these reasons, although the average rainfall in the basin is just over 1,000 mm/year, there are areas with a rainfall of over 2,200 mm/year and others with less than 800 mm/year. The flow rate can vary considerably from season to season. The average value within the urban area of Rome is 230 m³/s and the actual range varies from a minimum of 60 m³/s to a maximum of 3,200 m³/s.

The lowland areas of the peninsula are very scanty mainly located along the coastline: Maremma, Agro Pontino and Campania plains in the Centre Tyrrhenian coast-line, Tavoliere pugliese in the South Adriatic coast-line and Metaponto in the Ionic coast-line.

The main lakes (Table 7) located in North Italy, are mainly formed by cluster shaped moraine systems due to erosion process of the glacier front. The lakes of the Centre arose from the volcanic craters.

Table 7. Major Italian lakes

Lake	Surface (km ²)	Max depth (m)	Volume (m ³ x 10 ⁶)
Garda (North)	370	346	50,400
Maggiore (North)	212	372	37,100
Como (North)	146	410	22,500
Trasimeno (Centre)	124	6	500
Bolsena (Centre)	114	151	9,200
Iseo (North)	62	251	7,600
Bracciano (Centre)	57	165	5,100

3. CLIMATE

The climate varies widely among the several Italian regions.

The climate of Italy is characterised by extremely variable conditions across more than 10 degrees of latitude between the Alps and Mediterranean Sea and ranging :

- from semi-arid Southern area (precipitation ranging over 450-600 mm/year and average temperature of 18°C),
- to sub-humid condition (500-800 mm/year and 15°C) in the Northern plain, and
- to humid condition (800-1530 mm/year and 13°C) on the Alps and Apennine mountains.

Such a wide range of climate results in differences in water resources availability. Southern areas of the peninsula, such as Apulia, as well as isles of Sicily, Sardinia and some regions in the Centre-North are sometimes subject to serious shortages of water supply for various uses and in particular for drinking purposes.

Other Southern coastline areas located in the Campanian-Lucanian areas normally with adequate amount of rainfall, which in conjunction with carbonate aquifers, provides sufficient water availability.

The region of Liguria and mountainous-hilly areas of the Northern Apennines are characterised by an abundance of water, as are some highlands in the north-east. In contrast, the Po Basin, with its high population density and pressing water demand, sometimes suffers from water shortages despite appearing at a first glance to be a water-rich area.

Italian climate is characterized by a spatial highly variable precipitation, concentrated over short periods of the year (mainly spring and autumn, by a large inter-annual variability and by frequent extreme events such as floods and droughts.

Rainfall regime greatly depends on the orography and latitude; more than 1000 mm/year well distributed over the year, are recorded in northern plain – and up to 3000 mm/year on the Alps – whereas less than 400 mm/year, mainly concentrated in autumn-winter, are recorded in Southern regions.

Actual sunshine hours are 7 in winter and up to 8-10 during the summer time. The reference evapotranspiration in summer is ranging from 5 mm/day (Northern area) to 8-10 mm/day in Southern regions.

Consequently, the drought period becomes longer from North to the South with values varying from 1 to 6 months and with deficit values in the peak month ranging from 150 to more than 230 mm.

In the Central regions irrigation is indispensable to obtain high yield whereas in the Southern regions the spring-summer crops cannot grow without irrigation.

The accumulated degree days (>0°C) are ranging from 2000 in Alps areas to more than 6000 in Southern and isles regions.

Due to the particular position of the peninsula, the Italian climate appears very responsive to the influences of both global changes and human action. Significant aspects of the global and regional changes are: increase of the sea level; reduction of glaciated areas; increase of climate variability;

increase of evaporation process; extension of the urban heat isles: growing frequency of very concentrated rainfall episodes.

All these conditions increase the risk of land degradation, salinization and deterioration of soil structure favouring frequent slope processes – from superficial erosion to mass movement – with heavy repercussion on flood phenomena in the valley and plain areas.

Overgrazing in the semi-arid areas of South Italy, the practice of burning residual of cereal crops, and land overexploitation practices without restoring organic matter lead to soil degradation and erosion and hence to the risk of desertification of about 27% of the agricultural land.

The large diffusion of marked geomorphologic and hydrologic hazards (earthquakes, volcanic activity in central and southern parts of the peninsula) is essentially tied to the geologic and geomorphologic complexity of the territory.

Moreover many anthropic factors such as deforestation, fires, careless agricultural activities along the slope, development of settlements and road networks along the slope increase the soil erosion risk.

All these factors causing spreading and increasing of geomorphologic unbalance give rise to alluvial phenomena with the possibility of flooding over large areas at the bottom and at the mouth of valley (the latter with an increase of solid materials transported by streams) in connection with particular intense meteorological events.

4. AGRICULTURE

Out of the total Italian surface area, almost two thirds (22 millions hectares) is farm land with 68 % of this (15 million hectares) used for agricultural purposes.

Italy is characterised by variations in land use across the areas considered with an evolution that has reflected, since ancient times, the natural distribution of water and which has in itself had a great impact on water resources. The main urban agglomerations in the central and northern parts of the country are located beside, or in the vicinity of rivers which supply a range of needs including agriculture, handicraft and sometimes transportation. The increase in the population and the need to protect riverside settlements has necessitated the construction of large hydraulic works for flood control, river training and diversion, and large reclamation schemes that still pose challenge to the natural regime of water.

In southern regions and in the larger islands the shortage of surface water has led to the compulsory development of concentrated dwelling areas with high population density.

These are located so as to gain the best possible advantage from local springs and rely on the supply of rainwater stored in domestic sumps.

Since the end of the Second World War Italy has undergone a substantial economic transformation involving the growth of the industrial sector to the detriment of agriculture and favouring a further increase in the size of large urban agglomerations. In particular the proportion of employment in the agricultural sector decreased from 45% of the total labour force in 1951 to 19% in 1971 while that of the industrial sector increased from 22% to 43%. At the same time there was a massive migration of approximately 15 million people to the industrialised towns of the north-west mainly from the southern regions and the islands.

This change has occurred in such a rapid and unplanned fashion that it has been impossible to ensure rational land use in accordance with the availability of natural resources, particularly water, and with the goals of harmonised social and economic improvement.

This has aggravated the conflict among the various users with the consequent deterioration of both land and water resources. The existing gap relating to climatic variations and uneven resource distribution has widened tremendously so that the condition of several areas has now become a serious concern for future generations. The active population of the countryside has declined while the urban agglomerations have become an unwelcome model of bad living conditions.

The climate anomalies that have recently occurred in Southern Europe and particularly in Italy have been the cause of great concern for various water-dependent activities, especially in areas where the natural availability of water has been widely acknowledged as supporting economic development. In the Northern plains of Piedmont and Lombardy, where irrigation has been performed for many centuries in the context of a highly sophisticated agriculture, the decrease in the average rainfall has caused serious problems for the farmers who are accustomed to withdrawing water from rivers and lakes and transporting it to their land via a dense network of artificial channels.

In the Southern regions rainfall shortages have exacerbated an endemic incapability of meeting some essential water demands including that of potable and domestic use, especially during the summer, when some large urban communities can no longer rely on the volumes of surface water stored in reservoirs or in replenished aquifers.

All these phenomena are relevant to land use since the uncontrolled urban development of recent years has increased water demand in restricted areas and in a comparatively short space of time. The difficulty of meeting such a demand from the available resources seems so far to have had very little effect on the actual trend of urban development and has resulted in the need to harness new resources resulting in an aggravation of the conflict among users.

Agriculture has suffered greatly from water shortages as several reservoirs, especially in southern regions, have remained partially empty for a long period of time. Such an unexpected event has aroused justified criticism of a planning activity that, based on the possibility of storing rainwater, had wrought deep changes in the cultivation patterns and favoured new settlements in areas where the natural conditions were not suitable for normal living conditions.

It is estimated that 2,470,600 farms exist in the country; 581,100 of them are managed by women. The average surface of a farm is 5,6 ha.

The number of farms and surface areas according to the land use and to the grown crops in the year 1990 are reported in Table 8.

The decreases in the number of farms were nearly always accompanied by corresponding decreases in used agricultural area (UAA), with the exception of farms managed directly by the farmer himself which, on the contrary, showed an increase of 1.8% in UAA.

In 1997, there were 2,302,264 families on Italian farms, numbering 5,804,657 members. People have been leaving the agricultural sector at a higher rate than in the past.

The prevailing concept in the Italian rural management is that the family farm is a business enterprise in which most of the labour and management are performed by members of the same family. With increasing technology the average size of farm operating unit has increased.

Table 8. Number of farms and surface areas according to the land use and grown crops (1990)

	No. of Farms		Surface Areas	
	n.	%	n.	%
Arable crops	2,008,200	66.5	8,129,732	35.8
• cereals	1,123,879	37.2	4,472,667	19.7
• potato	255,499	8.5	62,609	0.3
• sugar beet	69,622	2.3	257,901	1.1
• no food crops	170,010	5.6	574,459	2.5
• horticulture	387,525	12.8	317,354	1.4
• annual forage crops	510,411	16.9	1,828,764	8.1
Orchards	2,075,423	68.8	2,787,359	12.3
• vine and table grape	1,184,861	39.3	932,957	4.1
• olive tree	1,131,097	37.5	1,033,591	4.6
• citrus tree	173,018	5.7	172,179	0.8
• fruit trees	544,590	18.0	520,911	2.3
• chestnut	97,696	3.2	107,608	0.5
Grass and grazing land	672,057	22.3	4,128,808	18.2
Used agricultural area	2,957,527	98,6	15,045,899	66,3
Poplar wood	40,905	1,4	105,556	0,5
Wood land	776,922	25,7	5,509,982	24,3
No cultivated land	573,483	19,0	1,006,471	4,4
Other	2,029,803	67,3	1,034,447	4,6
Total	3,017,753	100,0	22,702,355	100,0

Table 9. Number of farms and surface areas according to the management and land holding pattern (1990)

	Farms		Surface	
	n.	%	ha	%
Management pattern				
Directly managed by farmers	2,893,145	95.7	15,961,093	70.3
Farms employing hired workers	118,020	3.9	6,603,522	29.1
Other	12,179	0.4	137,740	0.6
Total	3,023,344	100.0	22,702,355	100.0
Holding pattern				
Property only	2,660,024	88.1	16,666,285	73.4
Rent only	95,045	3.1	1,208,337	5.3
Partly property and partly rented	262,684	8.7	4,827,734	21.3
Total	3,017,753	100.0	22,702,355	100.0

In 1997, 96,5% of Italian farms were managed directly by the farmer; in 80% of these, the farmer managed his farm with the help of family labour only.

The size of families was directly proportional to the size of farms, reaching over 3 members at farms with more than 20 hectares of UAA. The 25% of families with one member only (the farmer) were mainly concentrated on farms with areas under 5 hectares of UAA or over 100 hectares.

In 1997 the tendency for Italian farms to be run by increasingly older farmers was consolidated further. This increase was only due to a rise in the percentage of farmers over 65 years of age. The growing proportion of elderly farmers concerned the regions in the Centre and particularly the two major islands. The ageing tendency was highest in the regions of Umbria, Marche, Molise and Sicily, whereas Lombardy, Trento and Tuscany showed a higher percentage of younger farmers than the national average.

In 1997, 428.7 million man working days were used for agriculture (an average of 185 per farm), of which 369.1 million man working days were contributed by family labour. In 1997, 45.3% of farms hired external services for a total of 3,957,234 man days of work. Specialisation in the arable sector prevailed in the North, while general cropping predominated in other parts of the country, especially the South and the two major islands. Specialist farms produced 82.9% of the total national SGM, using 78,7% of national UAA and 78.7% of the total volume of work.

The most common type of production, in terms of number of farms, was permanent cropping (vines, olive, trees, etc).

5. IRRIGATION, DRAINAGE AND FLOOD CONTROL

The water balance over the Italian national territory is represented in Table 10. The average precipitation depth is about one meter, corresponding to approximately 10^9 m³ of water received by the whole land in Italy. Rainfall is extremely variable in the Country, both spatially and temporally (Table 11).

The surface flow is about 155×10^9 m³ per year. Not all of this water is directly available since part of it belongs to bodies that are difficult to exploit. Potential water availability has been estimated as about 110×10^9 m³.

Table 10. Italian water balance

Flow	Average volume	
	10 ⁹ m ³	%
Surface flow	155	52.3
Subsurface flow to the sea	12	4.1
Losses	129	43.6
Total flow	296	100.0

Table 11. Water resource by geographic areas

Region	Precipitation		Surface water	
	(10 ⁹ m ³ /year)	%	(10 ⁹ m ³ /year)	%
North	121.0	40.8	81.8	52.8
Centre	65.6	22.2	30.1	19.4
South	72.3	24.4	32.1	20.7
Sicily	18.8	6.4	4.9	3.2
Sardinia	18.3	6.2	6.1	3.9
Italy	296.0	100.0	155.0	100.0

Considering the existent water storage systems in Italy (dams, reservoirs, etc.), the total exploitable water resources in Italy are estimated at approximately $40 \times 10^9 \text{ m}^3$ per year (Table 12).

Table 12. Available water

Available water	10 ⁹ m ³ /year
Potential	115
Exploitable	40
Mean annual	155

According to a recent study, it has been estimated that the total amount of groundwater available in Italy is about $40 \times 10^9 \text{ m}^3$ per year, where $30 \times 10^9 \text{ m}^3$ are relative to the large regional aquifers, and the remaining $10 \times 10^9 \text{ m}^3$ contribute to local aquifers balance. About 30% of the latter are related to spring outflow. The global national needs for water can be roughly estimated as $50 \times 10^9 \text{ m}^3$ per year. Most of this volume is devoted to agriculture ($30 \times 10^9 \text{ m}^3$), the remaining is used by industry ($14.2 \times 10^9 \text{ m}^3$) and as municipal water supply ($5.8 \times 10^9 \text{ m}^3$) (Table 13).

Table 13. Water demand in Italy

Water demand	Volume			
	10 ⁹ m ³ /year		%	
Agriculture	30.0		60.0	
Industry	14.2		28.4	
Civil use	5.8		11.6	
• domestic		3.95		68.0
• non domestic		0.52		9.0
• public		0.46		8.0
• industrial		0.87		15.0
Total	50.0	5.80	100.0	100.0

The main source of supplied water is surface water (Table 14).

Table 14. Sources of supplied water

Supplied water	Volume	
	10 ⁹ m ³ /year	%
Groundwater	12	24.0
- wells	9	18.0
- springs	3	6.0
Surface water	38	76.0
Total	50	100.0

The annual amount of water used by the municipal water supply systems in Italy is about 5.8×10^9 m³, for about 300 litres/person per day. The water for civil use is obtained by groundwater (50%), springs (40%) and surface water (10%).

The quantity of water used for agricultural purposes can be estimated at about 30×10^9 m³ per year, differing from North (78%), to the Center (5.5%) and to the South (16.5%). The main source of irrigation water is surface water from rivers (67%), followed by reservoirs (6%) and groundwater (27%). It can be estimated that 37.6% of the irrigation water is lost to evapotranspiration, while the remaining 63.5% is dispersed and generally contributes to the replenishment of groundwater. The mean annual volume of water used by industry is 14×10^9 m³, subdivided into 60% for the Northern area, 20% for Central area and 20% for Southern Italy. Power plants use water amounting to about 4×10^9 m³.

In this perspective, apart from overexploitation of the water resources, it should be considered that the Italian territory is subjected to drought problems, in particular the Southern regions. Recent drought events have stimulated scientific concerns to promote “ad hoc” investigations for studying the Italian situation. The following aspects have been specifically analysed :

- i changes in the hydrological cycle;
- ii limitation of current activities related to the water use, such as urban, agricultural and industrial supply;
- iii the need to estimate the decreased income for an impeded water related activity or the search for a surrogate activity.

More knowledge is still needed about several aspects, in particular, as far as changes in the hydrological cycle are concerned, some uncertainty persists as to whether the phenomenon can be considered a continuous trend toward drier periods or whether it is simply an alternation of dryer and wet years. The peculiarity of the 1988-1990 events was not the actual low rainfall over a single year (such years have occurred also in the past), but the fact that it was the sequence of three years with very little precipitation. The situation was evenly distributed over the whole national territory.

The analysis has been extended to the river behaviour and a substantial deficit was recorded for some main rivers, which over the three-year period examined, reached a total of the order of the annual surface runoff.

Drought has also affected groundwater in the Northern lowlands with aquifers, largely depleted by domestic use and by irrigation, displayed an unusual lowering of the water table, which lasted long after the period of scarcity was over. In the Central and Southern regions the yields of many springs have greatly decreased.

The recent droughts were perceived mainly as a change of climate. The climatic change has interfered substantially with various water dependent activities, which could not be performed correctly. In the Northern areas, the decrease in the average rainfall posed serious problems to the farmers. In the Southern regions the rain shortage accentuated a chronic incapability to meet domestic demands. Some large urban communities were no longer able to rely on the capability of their water supply systems.

The impossibility of filling some reservoirs during such events raised some criticism about the water management criteria adopted so far. According to such criteria, the construction of large reservoirs was deemed a reliable tool to store the meteorological water and conspicuous financial resources were invested for this end.

Any kind of intervention requires an assessment to be made of the damage, the true extent of which is always difficult to define. In any case the measures an Authority has to undertake vary according to the type of water utilisation. As regards irrigation, a survey confirmed that in 1989 only a few fields could be saved out of the thousand of hectares usually irrigated in several districts of Sicily and Sardinia. The priority given to potable water use allowed the demand to be met with no significant shortfall. An exception to this was some urban agglomerations in the South and in the larger islands, where the chronic scarcity was largely aggravated.

Hydroelectricity has been badly affected by drought. Generating plant equipped with reservoirs was not only unable to store the required amount of water, but also suffered a reduction of power as an effect of the lower head. In such conditions the pumped storage, characteristic of the most technologically advanced plants, was able to make only a very small contribution. Run-of-plants suffered from shortage of water and low river level, and likewise did the thermal plants, because of the unavailability of cooling water.

The impact of water shortage was very heavy on ecology and preservation of aquatic life, as water withdrawal from bodies was particularly intensive in the absence of other resources. Low flow in a river meant poor dilution of the discharged pollutants, and thus a risk of harming aquatic life. This kind of damage was very serious and persisted long after the emergency had passed.

As shown by the 1988-1990 event, a drought, with its associated shortage of water and severe effect on water resources management can deeply impact the economy of an entire region. As such events are likely to be repeated, the responsible Authority should work out rational management criteria to set up suitable conditions for coping with the effects of a foreseeable drought and reducing the damage to the water related activities. Such criteria would rely on both technical and economic measures and require a thorough inventory of all surface and underground water availability, as well as the available discharges. They also entail adopting technologies and management policies capable of making an appreciable impact on the whole economic system in which the water resources are located. In addition to technical and economic measures, the sensitivity of the people involved is of fundamental importance, particularly in reducing water consumption.

A shortage of available water leads, first of all, to increased conflict among the users, as the exploitation level of Italian resources is very high in all the regions also in view of the severe constraints imposed by the deteriorated quality. Potable water use comes first and claims the highest quality resources, but agriculture demands the largest quantities. Water for industrial uses are related to advanced economic development and their reduction can cause unfair social effects, such as unemployment and emigration. The use of water for hydropower, although non-consumptive, can be only partially implemented.

The peculiar climate and orographic conditions of the Country with prevailing slope areas in hilly and mountainous areas and lowlands subject to flood along with a high runoff discharging into the

sea ($155 \times 10^9 \text{ m}^3/\text{year}$) are requiring a strict water management policy and an unceasing flood control.

During the XX century many hydraulic works were carried out by the Government financing for the reclamation of marshy lowlands in northern Italy (Veneto), central area (Maremma Toscana), Agro Pontino and Sardinia isle (Arborea).

In Italy 2,711,000 hectares are irrigated in 1990 whereas 3,882,000 hectares are potentially irrigable (Table 15).

Table 15. Irrigable and irrigated surface areas (1990)

Region	Irrigable (ha)	Irrigated (ha)	Irrigated/Irrigable %
North	2,355,000	1,693,000	73
Centre	392,000	236,000	60
South and Isles	1,155,000	752,000	60
Italy	3,882,000	2,711,000	70

The irrigated farmland increased very poorly from 1982 to 1990 (Table 16).

Table 16. Irrigated farmland (1982-1990)

Irrigated crops	1982		1990		Variations	
	Farms n.	Irrigated surface ha	Farms n.	Irrigated surface ha	Farms %	Irrigated surface %
Durum wheat	-	-	18,566	69,489	-	-
Grain corn	200,002	559,804	179,057	507,170	- 10.5	- 9.4
Potato	-	-	90,925	34,710	-	-
Sugar beet	-	-	18,684	81,965	-	-
Sunflower	-	-	3,841	18,537	-	-
Soybean	-	-	40,250	201,083	-	-
Vegetable	264,015	217,607	233,873	233,587	- 15.2	7.3
Forage	143,290	650,280	96,202	439,376	- 32.9	- 32.4
Vineyards	136,439	159,177	113,119	162,391	- 17.0	2.0
Citrus fruit	122,180	146,734	137,212	153,815	12.3	4.8
Orchards	82,511	144,329	117,355	199,059	42.2	37.9
Other crops	282,859	643,261	384,574	609,999	36.0	- 5.2
Total	834,424	2,424,712	934,640	2,711,181	12.0	11.8

Water supply and irrigation methods used on irrigated farms are reported in Table 17.

Table 17. Number of irrigated farms according to the water supply type and irrigation scheme (1990)

Water supply	Farms (n.)
Water supply	
By self-asserting way, for direct derivation from:	655,946
• <i>from surface water</i>	194,557
• <i>lakes</i>	25,134
• <i>other</i>	456,401
Consortium	398,913
Other	65,629
Total	1,059,456
Irrigation methods	
• sprinklers	377,579
• flood	48,095
• gravity	583,183
• drip	113,577
• other	28,164

There are 500 storage reservoirs spread across the territory of Italy (Table 18).

Table 18. Number and water volume of reservoirs

Region	Reservoirs n.	Volume 10⁹ m³
Veneto	67	1,069
Liguria	19	28
Bacino del Po	196	2,140
Romagna e Marche	25	153
Toscana	26	100
Lazio e Umbria	18	435
Abruzzi e Molise	12	566
Campania	20	76
Calabria e Lucania	23	1,127
Puglia	8	396
Sicilia	33	710
Sardegna	51	1,399
Italy	498	8,199

In 1944 the ANBI (National Associations for reclamation, irrigation and rural development) was established. ANBI included Consortia for the reclamation, Consortia and agencies for the rural development and Consortia for water management.

The Government has been financing structural works for the reclamation of marsh and ponds, for reforestation, for the control of mountain streams, for strengthening slopes and dunes, for flood control and structures required for rural development. Land owners are obliged to belong to Consortia and are called in to bear the costs of the services provided by Consortia according to the received benefits. The association operates within the public utility system and is the type of enterprise that now predominates in the irrigation districts.

The Consortia collects sufficient funds to meet the annual charges for the operation and maintenance as required to deliver water to users and to maintain the systems in good operational shape.

The equipped surface served in 1998 with water delivered by Consortia is 2,730,601 hectares (Table 19).

Table 19. Equipped surface served by consortia

Region	Equipped surface ha
North	2,036,508
Centre	127,322
South and Isles	566,771
Italy	2,730,601

The works managed by Consortia are reported in Table 20 and 21.

Table 20. Work managed by consortia

	North	Centre	South	Italy
Area provided with flood control structures (ha)				
- by gravity:	2,204,512	745,333	1,089,374	4,039,219
- by pumping:	1,059,828	66,265	58,684	1,184,777
Total	3,264,340	811,598	1,148,058	5,223,996
Area equipped with irrigation system (ha)				
- by channels:	1,882,318	57,904	188,359	2,128,581
- by pipes:	154,190	69,418	378,412	602,020
Total	2,036,508	127,322	566,771	2,730,601
Canals (km)				
- drain canals:	25,099	8,345	22,099	57,543
- irrigation canals:	33,156	1,368	16,134	50,658
- dual-purpose canals:	33,227	462	140	33,829
- pipelines:	11,229	4,451	38,809	54,489
Total	102,711	14,626	79,182	196,519
Soil conservation devices:				
- river and sea flood control (km):	3,626	3,063	10,243	16,932
- dams for flood control (n.):	15,539	5,856	12,364	33,759
- pumping stations - n.:	474	80	77	631
- m ³ /s:	2,692	316	264	3,272
- kW	173,085	16,476	14,882	204,443
Irrigation works				
- storage reservoirs: - n.:	83	48	433	564
- m ³ x 10 ⁶	507	34	1,929	2,470
- traverse fluviali (n.):	488	38	137	663
Pumping plants				
- n.:	599	88	410	1,097
- m ³ /s:	856	51	1,529	2,435
- kW:	112,816	24,571	79,210	216,597
Wells:				
- n.:	361	24	173	558
- m ³ /s:	40	1	54	95
Other structures				
- roads (km):	4,075	2,763	9,015	15,853
- rural aqueducts: - n.:	245	181	261	687
- l/s:	672	479	984	2,135
- idropower: - n.:	108	1	3	112
- kW:	34,067	300	4,300	38,667

Table 21. Consortia main works

Regions	Area provided with flood control structures (ha)			Area provided with main drainage system only (ha)	Area equipped with irrigation system (ha)			Canals (km)			Flood control structures			
	natural drainage	mechanical drainage	total		for gravity	for pumping	total	drain	irrigation	dual purpose	river and sea flood walls (km)	dams for flood control (n.)	pumping stations	
													n.	m ³ /s
Piemonte	314,332	--	314,332	--	315,281	7,539	322,820	1,007	4,031	16,610	15	11	--	--
Lombardia	257,676	123,713	381,369	--	651,349	19,097	670,446	3,006	14,190	2,821	30	38	21	215.5
Trentino	12,757	6,037	18,794	5,229	4,915	8,650	13,565	321	423	163	37	52	21	40.6
Veneto	607,937	414,397	1,022,334	498,883	459,981	63,470	523,451	10,941	8,113	6,358	2,223	3,268	278	1,147.2
Friuli	55,755	22,590	78,345	--	63,512	34,392	97,904	1,330	2,628	32	254	122	29	151.1
Liguria	548	181	729	--	1,200	--	1,200	84	174	--	--	12	1	1.7
Emilia	955,507	492,910	1,448,417	1,041,295	386,080	21,042	407,122	8,410	3,597	7,216	1,068	12,036	124	1,136.3
Toscana	176,397	23,928	200,325	190,754	6,258	3,043	9,571	2,938	153	58	2,446	968	31	83.8
Umbria	49,626	--	49,626	37,830	1,450	10,346	11,796	158	--	83	--	140	--	--
Marche	9,750	--	9,750	--	7,280	15,650	22,930	141	492	35	5	473	--	--
Lazio	509,560	42,337	551,897	468,872	42,646	40,379	83,025	5,109	722	286	612	4,275	49	231.8
Abruzzo	60,116	1,934	62,050	6,090	17,050	38,910	55,960	808	2,216	60	3,086	622	4	13.6
Molise	16,940	2,650	19,590	--	3,938	17,658	21,596	297	299	--	--	251	5	10.0
Campania	144,975	16,780	161,755	96,667	53,945	11,143	65,088	4,074	2,907	--	4,678	1,510	16	11.5
Puglia	582,444	22,243	604,687	478,401	7,954	118,332	126,286	2,840	176	8	588	2,272	23	59.2
Basilicata	33,500	6,500	40,000	--	20,355	39,425	59,780	1,500	445	20	30	3,300	9	36.6
Calabria	9,112	--	9,112	--	10,520	10,023	20,543	437	2,361	12	434	2,306	--	--
Sicilia	82,706	2,000	84,706	--	53,122	61,769	114,891	11,952	2,862	30	1,054	2,011	5	1.0
Sardegna	159,581	6,577	166,158	63,351	21,475	81,152	102,627	2,190	4,868	1	37	92	15	32.5
Italy	4,039,219	1,184,777	5,223,996	2,887,552	2,128,581	602,020	2,730,601	57,544	50,658	33,829	16,932	33,659	631	3,272.3