TRANSNATIONAL INTEGRATED MANAGEMENT OF WATER RESOURCES IN AGRICULTURE FOR EUROPEAN WATER EMERGENCY CONTROL (EU.WATER)

**Priority Axis**: Protection and Improvement of the Environment
**Area of Intervention:** A.O.L. 1.2 Improve integrated water management and flood risk prevention
**Project Duration:** 36 months

# REGIONAL REPORT FOR THE COLLECTED INFORMATION: "REGION OF ISTRIA, CROATIA" (FINAL VERSION)

**WP3: Knowledge capitalization and sensitive area maps**

**Act 3.2:** Organization / rationalization of data concerning the available information, deliverables and guidelines about water management in agriculture (relevant normative frameworks & agronomic features included)

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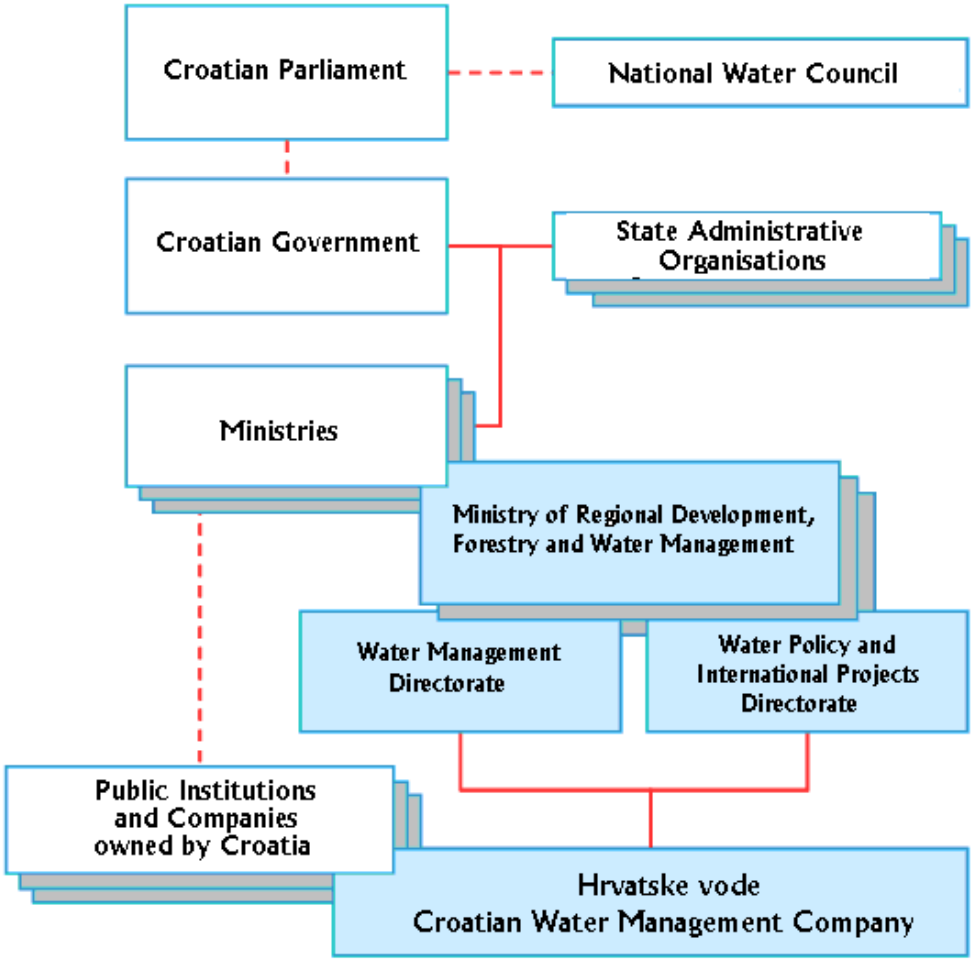
# 1. Water Resources Management in National-regional level (Croatia)

## 1.1 Institutional framework for water resources management

Water management works comprise a number of activities ranging from legislation activities to organisation of immediate management and monitoring of the water system status.
The authorized and responsible leaders of such activities are: Croatian Parliament, National Water Council, Croatian Government, Ministry of Regional Development, Forestry and Water Management, as well as other state administration organisations, local and regional self-government units and Hrvatske vode as the company in charge of water management.

The National Water Council (appointed by the Croatian Parliament) is a body established to harmonize various interests and to examine systematic issues related to the water management area at the highest level. The broadest administrative authority in water management belongs to the Ministry of Regional Development, Forestry and Water Management, within whose framework function the Water Management Directorate and the Water Policy and International Projects Directorate. The Ministry of Regional Development, Forestry and Water Management perform administrative and similar expert tasks, in particular:
(i) Water policy and strategic planning;
(ii) Monitoring of the status, implementation of administrative and inspection supervision;
(iii) Preparation of laws and regulations;
(iv) Provision of financial means to fund the activities in the field of water management;
(v) Decision-making in single important cases and adopting decisions of second instance in cases already decided upon by other bodies.

Apart from the Ministry of Regional Development, Forestry and Water Management as the primary leader of administrative affairs, some activities have been downscaled to the scope of other state administrative organisations such as: the Ministry of Environmental Protection, Physical Planning and Construction, the Ministry of Culture and the Ministry of Health and Social Care. Units of local and regional self-government are authorized and responsible for water issues within their territories.




**Picture 1:** Water management within the state organisation

**Source:** Water Management Strategy (2009-2038)

Hrvatske vode is the legal person in charge of water management. The company was established by the Water Act, which represents their deed of incorporation, for "permanent and unimpeded performance of public services and other activities of water management within the scope defined by the plans and in line with the financial means." These are in particular: preparation of groundwork as the basis of water policy creation, preparation of programmes, plans and other acts representing the basis for providing sufficient quantities of suitable water for various intended uses, protection of water from pollution, regulation of watercourses and other waters and protection from adverse effects of water, investment and other tasks applied to carry out these plans and programmes, implementation of measures ensuring rational use of water, protection of water and protection from flooding and other adverse effects of water. Hrvatske vode are operative on the whole territory of Croatia and cover all river basin districts and river basins. Apart from the central departments in Zagreb, the company is organised in five water management divisions further divided in water management subsidiaries for various river basin districts.


| Water management subsidiary for water catchment area | | |
|---|---|---|
| 1.1 | Bid-Bosut | ZV |
| 1.2 | Brodska Posavina | ZP |
| 1.3 | Orljava-Londža | ZO |
| 1.4 | Šumetlica-Crnac | ZC |
| 1.5 | Subocka-Strug | ZN |
| 1.6 | Ilova-Pakra | ZI |
| 1.7 | Česma-Glogovnica | ZČ |
| 1.8 | Zelina-Lonja | ZL |
| 1.9 | Lonja-Trebež | ZT |
| 1.10 | Banovina | ZB |
| 1.11 | Kupa | ZK |
| 1.12 | Krapina-Sutla | ZS |
| 2.1 | Vuka | OV |
| 2.2 | Baranja | OB |
| 2.3 | Karašica-Vučica | OK |
| 2.4 | Županijski kanal | OŽ |
| 2.5 | Bistra | OĐ |
| 2.6 | Plitvica-Bednja | OP |
| 2.7 | Međimurje | OM |
| 3.1 | Mirna-Dragonja | RM |
| 3.2 | Raša-Boljunčica | RB |
| 3.3 | Kvarnersko primorje i otoci | RK |
| 3.4 | Lika, Podvelebitsko primorje i otoci | RL |
| 3.5 | Gorski kotar | RG |
| 4.1 | Zrmanja-zadarsko primorje | SZ |
| 4.2 | Krka-šibensko primorje | SK |
| 4.3 | Cetina | SC |
| 4.4 | Srednje dalmatinsko primorje-otoci | SS |
| 4.5 | Vrljika | SV |
| 4.6 | Matica | SM |
| 4.7 | Neretva-Korčula | SN |
| 4.8 | Dubrovačko primorje | SD |

**Picture 2:** Territorial Organisation of Croatian Water Resources

**Source:** Water Management Strategy (2009-2038)

In accordance with the provisions of the Water Act, the territory of the Republic of Croatia is, for water management purposes, divided into 4 river basin districts, namely: the Sava river basin district, the Drava and Danube river basin district, the littoral and Istrian river basin district and the Dalmatian river basin district. The Decision on setting out a river basin district takes into consideration, apart from minor exception, watersheds of the Sava, Drava and Danube and the Adriatic Sea. Lower water management territorial units are the river basins. A river basin, as part of a river basin district, comprises one or more basins of smaller watercourses which, due to the interlacing of water policy, constructed water system and economic requirements, ensure single water management. The territory of Croatia is organised in 34 river basins managed by 32 water-management subsidiaries plus the Water Management Department for the river basin district of the City of Zagreb. Table 1 shows the vertical division of water protection competencies at national level.

**Table 1:** Vertical division of water protection competencies

| LEVEL | TASK/RESPONSIBILITIES DESCRIPTION |
|---|---|
| **Central state administration** | 1) construction of treatment plants with a population equivalent greater than 50,000, 2) implementation of measures of protection arising from international agreements and conventions, 3) implementation of recovery plans for cases of 2nd grade pollution; 4) resolving pollution issues by washing of the roads and soil of national importance |
| **Regional level** | 1) construction of treatment plants with a population equivalent between 10,000 and 50,000, 2) water protection measures from washing out of roads, soil, erosion and similar |
| **Local level** | 1) construction of treatment plants with a population equivalent not greater than 10,000, 2) implementation of recovery plans for cases of 1st grade pollution |

**Source:** "Environmental protection programme for the Istrian Region" (including the Environmental Status Report")

### 1.2. Reference laws

The **Constitution of the Republic of Croatia** specifies waters as common good of special interest together with the sea, air space, mineral wealth, land, forests and other goods and natural resources. The field of water is dealt with the **Water Act (OG 107/95, 150/05)**, which "governs the status of the water and water resources, manner and conditions for water management, organisation and performance of jobs and tasks dedicated to water management; basic requirements for performance of water management activities; competencies and duties of state administration entities and other state organisations, and other issues pertinent to water management." Funding of water management is governed by the **Water Management Funding Act (OG 107/95, 19/96, 150/05)**.

The above listed basic acts are elaborated through a large number of subordinate legislation (regulations, ordinances, decisions). Among them, the following are the most pertinent in the field of water protection: **Water Classification Regulation (OG 77/98); Hazardous Substances in Water Regulation (OG 78/98); Ordinance on limit values of indicators of hazardous and other substances in waste water (OG 40/99, 06/01, 14/01)**; **Regulation on defining areas of sanitary protection of water sources (OG 55/02)**; and **Decision on drainage in towns and municipalities (Art. 75 of the Water Act)**.

Apart from the fundamental acts, particular provisions relating to water can be found in laws and regulations governing other legal areas. Worth mentioning are: **Environmental Protection Act (OG 82/94, 128/99)**, some of whose provisions relate to water as an important element of environment, **Nature Protection Act (OG 70/05, 139/08)** dealing with protection of water and land ecosystems and biodiversity**, Protection from Natural Disasters Act (OG 73/97 and 174/04)**, concerning flooding, erosion disasters and accumulation of ice in watercourses, **Act on Inland Navigation (OG 19/98, 151/03 and 138/06))**, prescribing powers and duties with regard to opening and marking of inland waterways and their technical maintenance, **Utility Services Act (OG 36/95, 70/97, 128/99, 57/00, 129/99, 59/01, 26/03-consolidated text, 82/04 and 178/04)** containing provisions on utility activities regarding drinking water distribution system and waste water drainage and treatment system.

In the planning process domains of competence must be respected as set by the **Physical Planning and Building Act (OG 76/07, 38/09)**, **Forest Act (OG 140/2005)**, **Agricultural Land Act (OG 152/08, 153/09, 21/10)**, **Land Expropriation Act (OG 9/94, 35/94, 112/00, 114/01, 79/06)**, **Fresh-Water Fisheries Act (OG 106/01)**, **Energy Act (OG 68/01, 177/04, 76/07, 152/08)** and other.

The issue of mineral and geothermal waters which can be used as a source of mineral raw materials or whose accumulated heat can be used for energy purposes is governed by the **Mining Act (OG 27/91, 92/94, 35/95, 114/01, 190/03)**. The procedures of defining reserves of mineral raw material of this type are carried out in compliance with the regulations adopted by the Ministry of Economy, Work and Entrepreneurship.

**Planning documents**

Act on Amendments to the Water Act provides the adoption of the **Water Management Strategy** which is the fundamental planning document for water management at national level. The Strategy is adopted by the Croatian Parliament. Each river basin district must then adopt water district management plans which are the base for water management of river basin districts, must be in compliance with the Water Management Strategy and are adopted by the Croatian Government every 6 years. The Water Management Plan is the executive and planning document used as the basis for collecting income and settling expenditures necessary to accomplish activities and measures; it must be in compliance with the basin district management plans and is adopted by the Management Board of the Croatian water management company Hrvatske vode for a period of one year.

The priority and permanent task of water management, local self-government and utility companies is to put every effort into preparing projects, strengthening institutional capacities, carrying out organisational adjustments and preparing relevant applications to increase absorption capacities to the highest possible level as background for the future cohesion and structural funds and to take the advantage of the available grant money intended for the development of the water and utility services infrastructure in the country and thus accelerate the completion of development aims defined by the Strategy.

**International Framework**

Due to its position, Croatia has always been bound to cooperate in area of water management with the neighbouring countries and wider international surroundings. International cooperation is governed by international contracts, conventions and agreements stipulated in the area of water, which have been incorporated into the legal framework for water management in Croatia.


**Picture 3:** Regional hydrologic qualification of Croatia
**Source:** Water Management Strategy (2009-2038)

International conventions and agreements signed and ratified by the Republic of Croatia concerning the implementation of: integral management of river basin districts, planning of measures and construction of water structures in accordance with the international water legislation, are important to accomplish sustainable water management in Croatia.

The problems related to the protection and usage of water are mainly governed by the following documents:

• Convention on the protection and use of transboundary watercourses and international lakes (The Helsinki Convention, 1994) and the relative Protocol on *Water* and *Health*,

• Convention for the Protection of the Mediterranean Sea against Pollution (The Barcelona Convention, 1993) and the relative: Protocol for the protection of the Mediterranean Sea against pollution from land-based sources,

• Convention on cooperation for the protection and sustainable use of the river Danube (Convention for the protection of the Danube, 1996) and the relative Joint Action Plan 2000 - 2005,

• Framework Agreement on the Sava River Basin and the relative Navigation Regime Protocol.

As candidate country for the EU membership, the Republic of Croatia is liable to harmonise the national legislation with the EU acquis communautaire. An extremely important document, which sets out the operational framework in the area of water policy, is the Directive 2000/60/EC establishing a framework for Community action in the field of water policy (Water Framework Directive).

Apart from harmonisation with the Water Framework Directive, the national legislation is harmonised with other water directives:

1. Council Directive 91/271/EEC concerning municipal solid waste-water treatment - the Directive requires the collection and treatment of waste water within short terms (depending on the sensitivity of the area) in all agglomerations with a p.e. of more than 2000;
2. Council Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources (The Nitrates Directive) – requires designation of nitrate vulnerable zones affected by pollution caused by nitrates from agricultural sources and promotes good agricultural practice;
3. Directive 2006/11/EC on pollution caused by certain dangerous substances discharged into the aquatic environment – requires establishment of a list of dangerous substances whose discharge into natural recipients is prohibited or limited, and control measures.
4. Directive 2006/118/EC on the protection of groundwater against pollution and deterioration – establishes special measures Directive, measures to prevent and control groundwater pollution and is aimed towards protection from deterioration of all bodies of ground water.
5. Directive 75/440/EEC concerning the quality required of surface water intended for the abstraction of drinking water in the Member States – requires monitoring of the quality and division into categories of surface waters intended for human consumption and the relative methods of purification in order to ensure safety of drinking water. Directive 79/869/EEC concerning the methods of measurement and frequencies of sampling and analysis of surface water intended for the abstraction of drinking water – defines reference methods of measurement and frequencies of sampling and analysis for the prescribed quality indicators.
6. Directive 98/83/EC on the quality of water intended for human consumption (Drinking Water Directive) – sets limit and standard values of quality and control of water intended for human consumption (water supplied from a water distribution network, water used for food-production undertaking for the manufacture, processing, preservation or marketing).
7. Directive 2006/7/EC concerning the management of bathing water quality – sets quality and monitoring provisions regarding the water used for bathing and recreational activities.

8. Directive 2006/113/EC on the quality required of shellfish waters (Shellfish Water Directive) – prescribes designation of coastal and transitional waters needing protection or improvement in order to support shellfish life and growth, and values for the parameters and monitoring measures.

9. Directive 2006/44/EC on the quality of fresh waters needing protection or improvement in order to support fish life (Fish Water Directive) – prescribes designation of salmonid waters and cyprinid waters, and values for the parameters and monitoring measures.

10. Directive 2007/60/EC on the assessment and management of flood risks (Flood Directive) – prescribes the undertaking of a flood risk assessment and establish and implement flood risk management plans.

The water protection is also governed by a range of directives regarding the protection of nature and environment in general:

• Directive 79/409/EEC on the conservation of wild birds (Wild Birds Directive);

• Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (Habitat Directive);

• Directive 96/61/EC concerning integrated pollution prevention and control (IPPC Directive);

• Directive 86/278/EEC on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture (Sewage Sludge Directive);

• Directive 91/414/EEC concerning the placing of plant protection products on the market (Plant Protection Product Directive);

• Directive 98/8/EEC concerning the placing of biocidal products on the market (Biocides Directive);

• Directive 96/82/EC on the control of major-accident hazards involving dangerous substances (Seveso I Directive).

The so-called horizontal directives are also relevant in water management as these prescribe general rules to be followed in planning and implementation of all projects and programmes:

• Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment (EIA Directive);

• Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment (SEA Directive);

• Directive 2003/4/EC on public access to environmental information (Environmental Information Directive);

• DIRECTIVE 2003/35/EC providing for public participation in respect of the drawing up of certain plans and programmes relating to the environment (Public Participation Directive).

### 1.3. Pilot area knowledge (undertaken studies, field surveys)

The Istrian region represents a pilot area where the EU.WATER Project is to be implemented. The water supply from public systems in the Istrian region (comprising the water companies Vodovod Pula, Vodovod Labin, Istarski vodovod Buzet – VSI Butoniga) covers over 95% of the population of the region and can be graded as very satisfying, considering that the Croatian average is about 70%. The mean consumption of water per capita is somewhat above 100 l/day.

The non-compliances include the poor quality of the water caused by inattention, overage transport and distribution network before treatment and, sometimes, after treatment.


**Picture 4:** Water supply areas in the Istrian Region: Water Supply Line Buzet | Water Supply Line Labin | Water Supply Line Pula | Water Supply Line Pula – The City of Pula
**Source:** Public Health Agency of the Istrian Region, www.zzjziz.hr

The coverage of the region with organised waste water drainage system is between 45% and 65% (depending on the area), as in the rest of Croatia. There is a large discrepancy between water supply and waste water drainage system coverage. This fact is extremely adverse for the

environment as water supply without a proper drainage of waste water means a multiple increase of uncontrolled disposal of untreated waste water into the environment. The lack of an adequate waste water drainage and treatment system is even more pronounced considering that the karst aquifer in the Istrian Region is extremely sensitive to surface pollution and that 70% of the area of the region is under some sort of water protection regime.

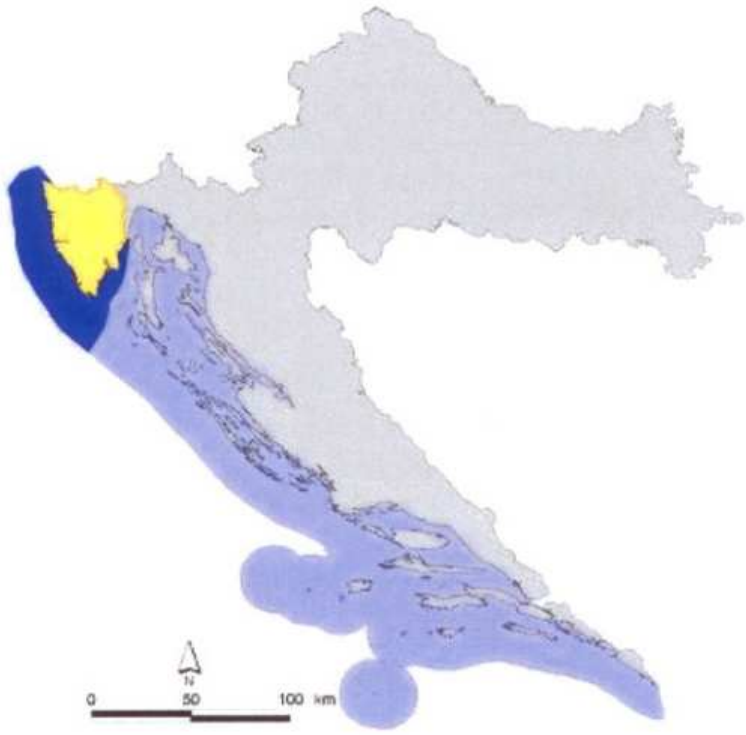
Pollution/contamination of surface and ground water is caused by the emission of non-treated urban solid waste water and by illegal emission of septic tanks into water courses in pits (faecal bacteria, organic pollution), but also by leaching of mineral fertilizers (nitrates, nitrites, Fe, Mn, Cu, P, K) used in agricultural production. Also, one of the problems is water coming from large urban centres, industrial water and water leaching from illegal waste disposal areas.

The existing studies and maps regarding the Region of Istria are related to: *geology, hydrogeology, soil texture, piezometry, rainfall, land use, water resources uses and water resources quality*. The principal realized studies concerning water resources are:

- "Feasibility study of the construction of the waste water drainage and treatment system in small settlements in water protection areas of the Region of Istria"
- "Public drainage and water protection systems in the Region of Istria"
- The "Adriatic Project" is a project dedicated to the protection from pollution of coastal water (sea)
- "Establishment of an integrated waste management system"
- "Water Management Strategy"
- "National Irrigation and Agricultural Land and Water Management Project"
- "Irrigation Plan for the Region of Istria"
- "Hydrogeology of Istria" / Artur Tomić, Zagreb, 1980“
- Ground connections and ground water movement speed in the area of central Istria" / Snježana Likić, Zagreb, 1993
- "Pedosphere of Istria" / A. Škorić et al., Zagreb, 1984
- "Climate of Croatia" / A. Filipčić, Zagreb, 1992

# 2. Region of Istria, Croatia

## 2.1. Location and topography of the study area




**Picture 5:** Location of the Region of Istria within Croatia
**Source:** "Regional operative programme of the Region of Istria (2006-2010)"

The Region of Istria is located in the northwesternmost part of the Republic of Croatia. In the north it borders with Slovenia, in the east and south with the Primorsko-Goranska County and in the west it shares the sea borderline with Italy. Geographically it occupies the largest (2,822 km2) part of Istria – the biggest (3,476 km2) peninsula in the Adriatic.

Within the structure of economy of the Region of Istria, according to the total income data in 2005, the key position is taken by the processing industry (33%) and trade (29%), followed by hospitality and catering industry (10%), construction industry (8.3%) and real estate activities and business services (6.4%).
The processing industry, providing 1/3 of the total income and the total employment, along the tourism sector, is the most important economic sector in the Region of Istria. The most significant and the most developed branches within the processing industry are: shipbuilding, production of construction material (lime, cement, bricks, stone), production of tobacco products, furniture, electrical machines and devices, parts used in automobile industry, glass, processing of metal, plastic, wood, textile and production of food.

The area, i.e. the spatial location of the Region of Istria, is possibly the most important, or at least a considerably important natural predisposition giving the region comparative development advantage: deeply indented into the European mainland thus giving the most of

Europe its "closest warm sea"; attractive coastal surrounding; easily reachable and predominantly "not ruined" by uncontrolled growth of anthropogenic pressure.

The Region of Istria has certain natural predispositions, human resources and tradition which make it a strongly attractive area both for living and for developing and implementing numerous activities: from agriculture, livestock farming, fishery, mariculture over shipbuilding and industrial production of non-metal products (cement, lime, brick, stone accessories etc.) to tourism.

Water resources can mostly be found in sensitive karst area and require a high level of protection.
In the widest sense, all ground and surface waters of the Region of Istria belong to the Adriatic basin. Even though the actual river and the relative spring areas are complex and conditioned by an intricate network of connections, the following standard drainage systems (basins) can be singled out in the Region of Istria: river basin of Dragonja, river basin of Mirna, river basin of Pazinčica, river basin of Raša and Boljunčica, basin of the west coast of Istria, basin of the southern Istria; basin of the Kvarner Gulf coastal springs.
The interpretation of the hydrogeology of Istria has introduced a new term – the central Istrian aquifer, which serves as retention recharging karts springs of the Mirna and Raša river basins and the western and southern Istrian basins.

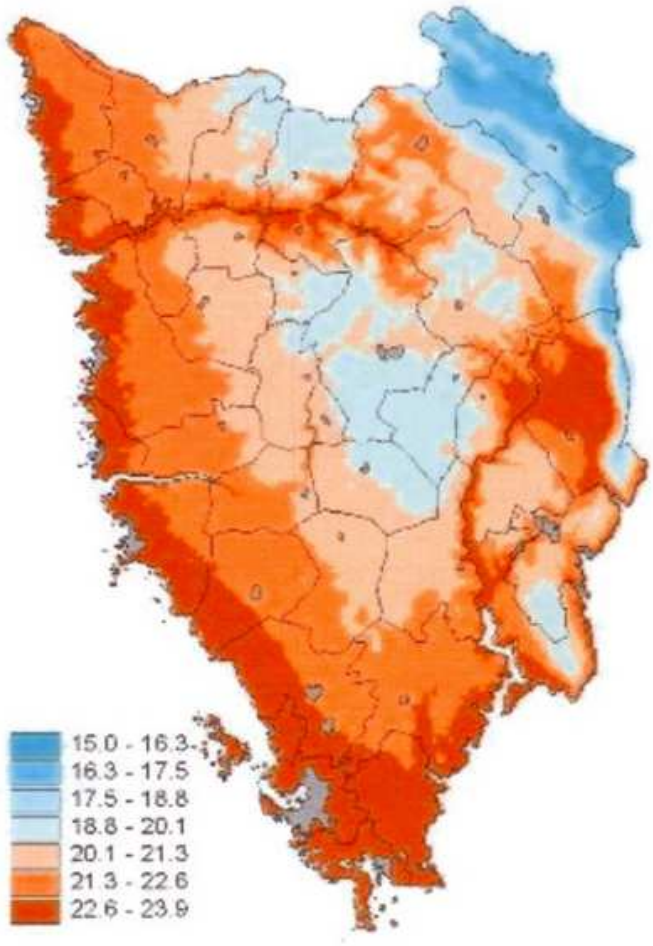
The Karst territory of the Region of Istria features a very rich underground with about 2,000 registered speleological landforms.

Basic ways of land usage in the Region of Istria: about 30% cultivated land, 23% grassland/pastures and about 43% forests.

Even though the soil types are not very suitable for agricultural production, pedologic/hydrologic/ climate natural givens create relatively suitable circumstances for the agricultural sector, especially for olive and vine growing and the growing of diverse vegetable cultures.


**Picture 6:** Location of the largest settlements in the local self-government unit of the Region of Istria
**Source:** Environmental Protection Plan for the Region of Istria (with Environmental Status Report)

## 2.2. Hydrometeorological data




**Picture 7:** Spatial distribution of mean monthly temperatures in July in the Region of Istria
**Source:** Environmental Protection Plan for the Region of Istria (with Environmental Status Report)

The climate in the Region of Istria is Mediterranean along the coast, shifting into sub-Mediterranean towards the centre of the peninsula, and due to the closeness of the mountains and the Alps, even to continental or submountain-continental climate. More precisely, the largest area of the Region is characterised by rather pleasant and favourable climate: warm and dry summers, mild and pleasant winters, large number of sunny days (2,800 per year), relatively low annual air temperature variations and the lowest sea temperature in March of about 10ºC and the highest in August of about 25ºC. The soil generally does not freeze.

The quantity of precipitation varies between 900 mm on the west coast to 1,200 mm on the east coast – the Kvarner coast reaching the maximum in the second half of autumn and the minimum during mid summer. Snow is a rare phenomenon, but incidental climate phenomena (hail and/or heavy storms) are relatively frequent (2 to 4 times a year), just like sudden lowering of temperature and frost during winter and early spring, when the Siberian

anticyclone has a great influence. In winter and springtime, about 15 days of fog were recorded along the western coast.

The dominant winds are, just as in other parts of the eastern Adriatic coast, bora (north-eastern wind, whose direction heavily depends on the configuration of the coast, as a rule blows vertically from the coastline), sirocco (south-eastern wind) and the northwestern wind. A trend of gradual strengthening of the bora and weakening of the sirocco and the north-western wind has been observed and is becoming more pronounced towards the northern Adriatic where, at its very end, lies Istria.

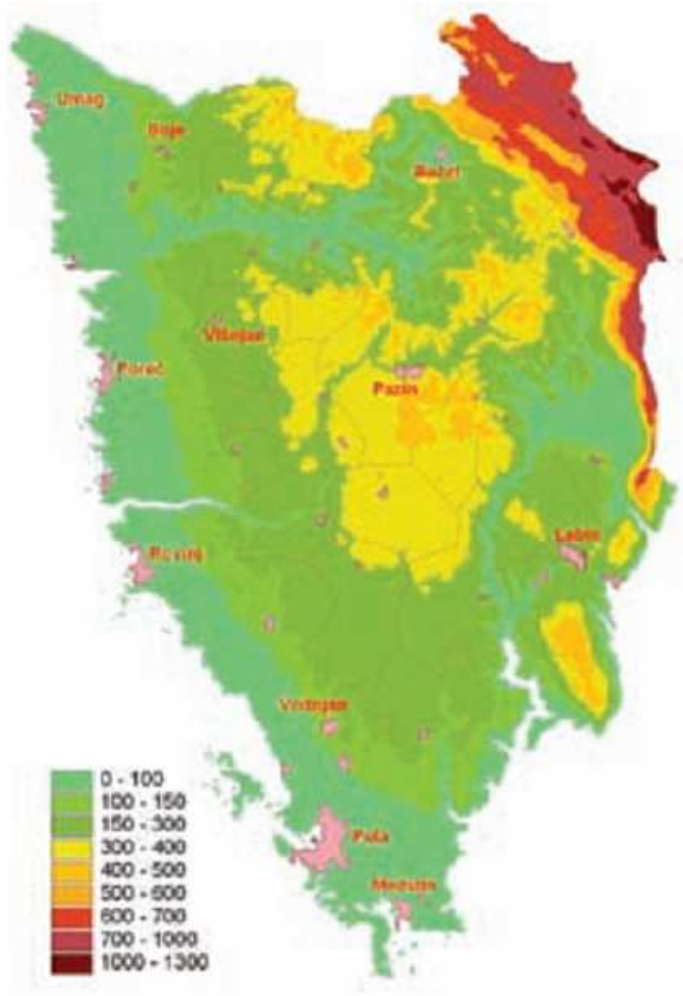
Table 2 gives data on mean monthly temperatures, precipitation quantities and drought index for three localities within the Region of Istria. It is evident that the south of Istria (Pula) is the warmest and driest area, the northern coastal area (Poreč) is slightly colder and less dry, while the central area (Pazin) is the coldest and least dry.

**Table 2:** Mean monthly temperatures, precipitation quantities and drought index in the period 1931-1960.

| Mjesec | PULA | | | POREČ | | | PAZIN | | |
|---|---|---|---|---|---|---|---|---|---|
| | Temp. [°C] | Ob. [mm] | IS | Temp. [°C] | Ob. [mm] | IS | Temp. [°C] | Ob. [mm] | IS |
| I | 5,3 | 55 | 43,1 | 4,5 | 56 | 46,3 | 2,5 | 78 | 74,8 |
| II | 5,8 | 59 | 44,8 | 4,9 | 62 | 49,9 | 3,3 | 80 | 72,1 |
| III | 8,5 | 52 | 33,7 | 7,6 | 54 | 36,8 | 6,2 | 75 | 55,5 |
| IV | 12,2 | 47 | 25,4 | 12,1 | 50 | 27,1 | 10,4 | 68 | 40,0 |
| V | 16,9 | 47 | 20,9 | 16,7 | 71 | 31,9 | 14,8 | 84 | 40,6 |
| VI | 21,0 | 46 | 17,8 | 20,3 | 69 | 27,3 | 18,0 | 85 | 36,4 |
| VII | 23,7 | 43 | 15,3 | 23,2 | 66 | 23,9 | 21,1 | 74 | 28,5 |
| VIII | 23,2 | 39 | 14,0 | 22 | 64 | 24,0 | 19,3 | 70 | 28,6 |
| IX | 19,7 | 69 | 27,8 | 19,4 | 84 | 34,2 | 16,8 | 96 | 43,0 |
| X | 14,8 | 86 | 41,6 | 14,3 | 114 | 56,3 | 11,8 | 128 | 70,5 |
| XI | 10,3 | 99 | 58,5 | 9,7 | 101 | 61,5 | 7,3 | 136 | 94,3 |
| XII | 7,3 | 68 | 47,1 | 6,4 | 78 | 57,0 | 4,1 | 98 | 83,4 |

**Source:** Environmental Protection Plan for the Region of Istria (with Environmental Status Report)

## 2.3. Soil properties




**Picture 8:** Relief map of the Region of Istria
**Source**: Environmental Protection Plan for the Region of Istria (with Environmental Status Report)

**Relief**
The relief of the territory of the Region of Istria is extremely diverse, with a range of heights from 0 to 1.300 masl and four main relief bodies. The above picture shows the relief map of the Region of Istria.

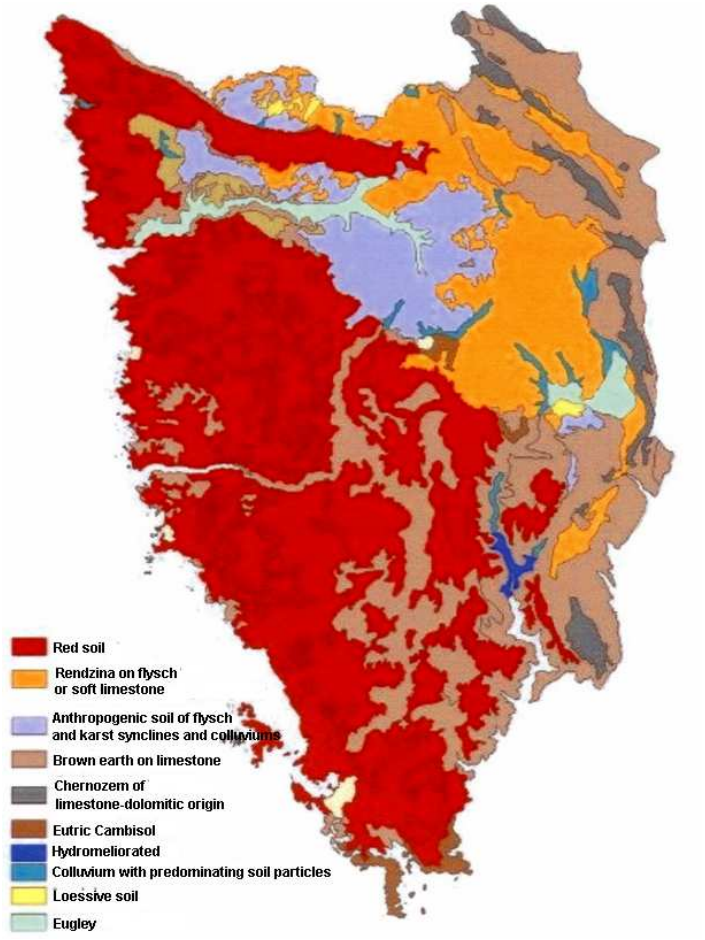
The lowest (and the largest) is the coastal area of the so-called Poreč and Pula plate or the plain of the southern and western Istria featuring large flat complexes and hills which get more and more pronounced towards the inland.
Next is the highland Istria characterized by a very developed relief formed by the past (Pleistocene and Holocene), but also contemporary processes of sheet, rill and gully erosion.

The highest territory comprises submountainous and mountainous massifs of Ćićarija and Učka in the northeasternmost part of the Region of Istria (the highest peak being Vojak, 1396 m, located in the Primorsko-Goranska County).
A noteworthy area is occupied by Istrian poljes and valleys. The main poljes are the Čepić and Krapan poljes, formed by land amelioration of the Čepić and Krapan lakes respectively. The valleys include the valleys of the rivers Mirna, Raša, Boljunčica and Pazinski potok. Table 3 shows the areas of various "height belts" in the Region of Istria.

**Table 3**: Areas of various "altitude belts" in the Region of Istria

| Altitude [masl] | up to 50 | 50 - 100 | 100 - 150 | 150 - 300 | 300 - 600 | 600 - 1000 | 1000 - 1300 |
|---|---|---|---|---|---|---|---|
| Surface area [km2] | 410 | 360 | 317 | 905 | 659 | 155 | 14 |
| % | 14.5 | 12.7 | 11.3 | 32.1 | 23.4 | 5.5 | 0.5 |

**Source:** Environmental Protection Plan for the Region of Istria (with Environmental Status Report)




**Picture 9:** Pedological map of the Region of Istria
**Source:** Environmental Protection Plan for the Region of Istria (with Environmental Status Report)

## Soil

Even this characteristic follows the division of Istria to Red, White and Grey Istria featuring: red soil; chernozem of limestone-dolomitic origin and brown earth; various soils on flysch (rendzina, colluvium, loessive soil) respectively. However, apart from these categories, the following classes can be singled out: hilly area around Labin with chernozem of limestone-dolomitic origin and brown earth on dolomite and limestone; eastern and central part of southern Istria featuring red soil; brown earth on limestone and areas of valleys and rivers with hydromorphic gleyic and alluvial-colluvial soils.
Table 4 gives information on the basic distribution of the Region of Istria in accordance with the abundance of various soil types.

**Table 4**: Distribution of the Region of Istria in accordance with the abundance of various soil types

| | |
|---|---|
| Western Istria on limestone bedrock – "Red Istria" | red soils typical, anthropogenic and loessive, mid thick to thick; brown earth on limestone (in the hilly area) |
| Eastern and central part of Istria | red soil, brown earth on limestone, dystric brown earth on limestone and dolomite |
| Hilly area around Labin | limestone-dolomitic chernozem, lithosols, brown soil on limestone and dolomite, regosols |
| Central hilly part of Istria – "Grey Istria" | differing soils on flysch: rendzina, sirozem on loose substrates, colluvium, vertic brown earth, regosols, pseudogleys and loessive soils |
| Mountain ranges of Učka and Ćićarija – "White Istria" | limestone and dolomite chernozem, rendzina, lithosol, brown earth on limestone and dolomite |
| Valleys and rivers of Istria | hydromorphic, limestone and eutric alluvial-colluvial gleysols, colluvial and alluvial soils, salt-affected soils |

**Source:** Environmental Protection Plan for the Region of Istria (with Environmental Status Report)

In accordance with site productivity, the soils of the Region of Istria can be divided into the following classes:
P1 – very valuable cultivated soil; P2 – valuable cultivated soil; P3 – other cultivated soils; PŠ – farming soils of poor arable fields and pastures or soils allocated as forests or forest land. Table 5 gives information on the basic division of the Region of Istria in accordance with the soil productivity in agriculture production criteria.

**Table 5:** Classification of the soils of the Region of Istria in accordance with soil productivity in agriculture production

| SOIL PRODUCTIVITY CLASS | DESCRIPTION OF PREDOMINANT USAGE | AREA |
|---|---|---|
| very valuable cultivated soil | areas under perennial cultures (vineyards, orchards, olive groves) and existing meliorated and irrigated farming areas | 11,315 ha |
| valuable cultivated soil | growing of cereals, industrial and vegetable cultures and fodder plants; as a rule comprises rural parts of settlements | 48,540 ha |
| other cultivated soils | less valuable detached cultivated areas | 14,123 ha |
| other farming and forest soils | extensive agricultural production (pasture, fire wood, and similar) | 34,490 ha |

**Source:** Environmental Protection Plan for the Region of Istria (with Environmental Status Report)

The highest productivity degree is possessed by alluvial and alluvial carbonate gleyic and moderate gleyic areas (in the above map shown in light green, blue and dark green colour), which, following the hydro and agromelioration, enter the P1 class of very valuable cultivated soils presenting high fertility for crop and vegetable production (with the possibility of irrigation).

Class P2 of valuable cultivated soils comprises areas of deep to medium deep red soils in the western part of Red Istria, north of the Limski kanal, and in the eastern edge parts. Rolling area north of Limski kanal, presenting small quantity of rock, is traditionally used for intensive grape and olive growing, even for vegetable growing where irrigation is provided. Somewhat less quality, but still valuable cultivated land can be found in the central flysch part of Istria, where the land is, depending on the inclination, traditionally used as arable fields, vineyards and orchards. High average gradient of the terrain makes the soils of the area susceptible to soil erosion and calls for measures of protection of soil and water.

The P3 class of other cultivated soils comprises areas of shallow to medium deep red soils that can be found in the central and southern part of the Istrian plate (Red Istria). In this area, numerous small patches of soil of higher productivity can be found in karst depressions as well as areas of limestone dolomite chernozina and brown earth on limestone and dolomite.

The region of the mountainous White Istria is least favourable for cultivation. With the exception of small cultivated spaces in karst depressions, the region falls into the PŠ class comprising pastures, degraded forests or some of the forest areas (Š1, Š2, Š3).

In accordance with the chemical content and in terms of suitability for agricultural production, it can generally be said that the soils of Istria are: poor in phosphorus, medium rich to rich in potassium, red soils and anthropogenic soils stand out for being poor in nitrogen supply. Reaction of the soil moves from acidic reaction with red soils containing no carbonates to alkaline reaction with flysch soils rich in carbonates.

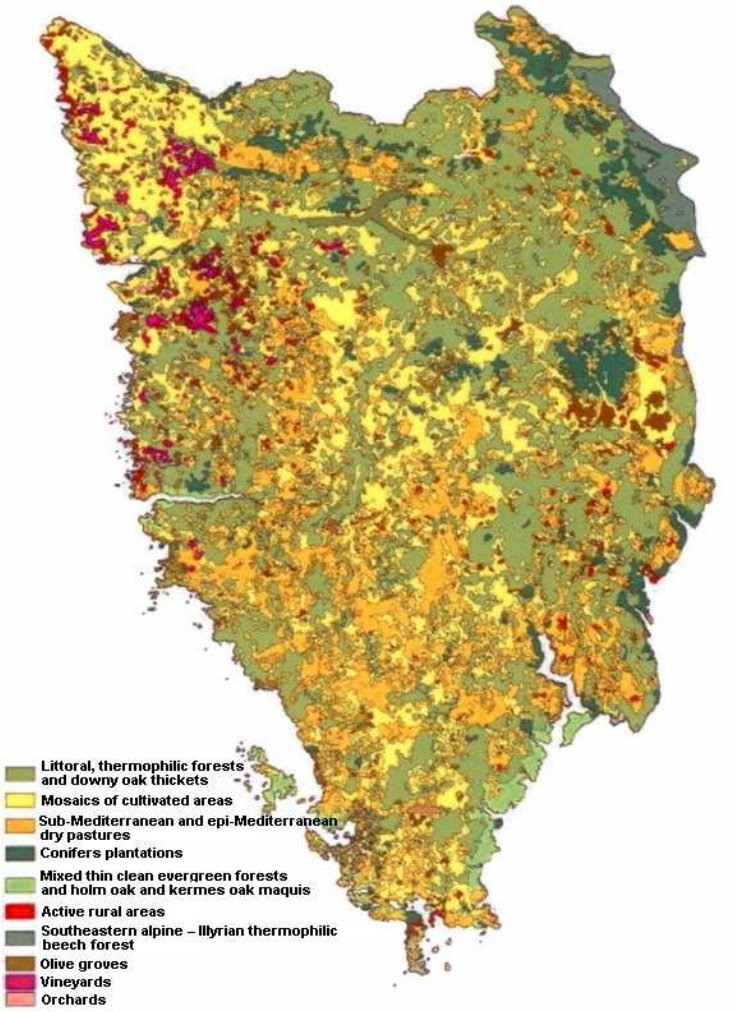
**Table 6**: Distribution of single types of soil in Istria.

| Soil type | Area | Percent. | Rocks | | Only Soil | | TOTAL |
|---|---|---|---|---|---|---|---|
| | (ha) | (%) | (ha) | (%) | (ha) | (%) | (%) |
| Lithosol | 4053,43 | 1,44 | 1850,13 | 45,64 | 2203,30 | 54,36 | 100,00 |
| Regosol | 15763,33 | 5,60 | 1476,76 | 9,37 | 14286,57 | 90,63 | 100,00 |
| Colluvium | 9598,74 | 3,41 | 51,39 | 0,54 | 9547,35 | 99,46 | 100,00 |
| Calcomelanosol | 16241,86 | 5,77 | 6944,45 | 42,76 | 9297,41 | 57,24 | 100,00 |
| Rendzina | 25671,71 | 9,12 | 3356,43 | 13,07 | 22315,28 | 86,93 | 100,00 |
| Vertisol | 872,61 | 0,31 | 0,00 | 0,00 | 872,61 | 100,00 | 100,00 |
| Eutric Cambisol | 4166,02 | 1,48 | 79,89 | 1,92 | 4086,13 | 98,08 | 100,00 |
| Dystric Cambisol | 3237,11 | 1,15 | 73,15 | 2,26 | 3163,96 | 97,74 | 100,00 |
| Calcocambisol | 68851,96 | 24,46 | 21390,49 | 31,07 | 47461,47 | 68,93 | 100,00 |
| Red Soil (Terrarossa) | 78338,11 | 27,83 | 11373,18 | 14,52 | 66964,93 | 85,48 | 100,00 |
| Luvisol | 3940,83 | 1,40 | 1064,07 | 27,00 | 2876,77 | 73,00 | 100,00 |
| Regosol | 39323,87 | 13,97 | 858,56 | 2,18 | 38465,31 | 97,82 | 100,00 |
| Deposol | 112,60 | 0,04 | 0,00 | 0,00 | 112,60 | 100,00 | 100,00 |
| Fluvisol | 225,19 | 0,08 | 0,00 | 0,00 | 225,19 | 100,00 | 100,00 |
| Pseudogley | 4419,36 | 1,57 | 188,18 | 4,26 | 4231,18 | 95,74 | 100,00 |
| Semigley | 281,49 | 0,10 | 0,00 | 0,00 | 281,49 | 100,00 | 100,00 |
| Eugley | 4194,17 | 1,49 | 0,00 | 0,00 | 4194,17 | 100,00 | 100,00 |
| Hidromeliorated | 2195,61 | 0,78 | 0,00 | 0,00 | 2195,61 | 100,00 | 100,00 |
| TOTAL | 281488,00 | 100,00 | 48706,68 | 0,00 | 232781,32 | 100,00 | 100,00 |

**Source:** Zoning Plan for the Region of Istria

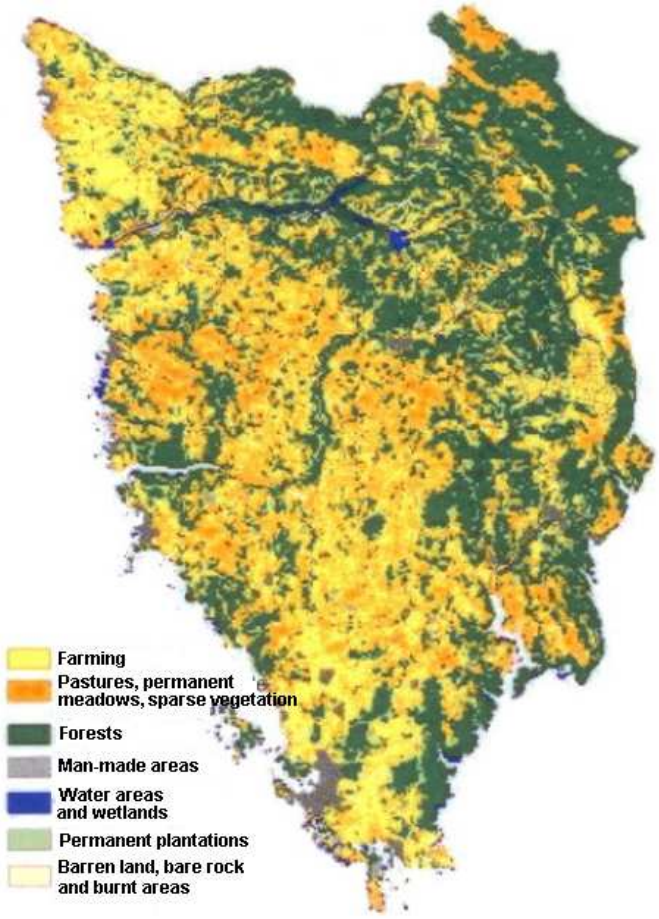
Table 6 shows soil types in Istria (total and per area) and the distribution (total and percentage) of rocks and types of the soil. The dominant types of soil in Istria, where the majority of farming production is carried out, are the red soil (terrarossa), brown earth on limestone and dolomite (calcocambisol), rendzina and anthropogenic soils (regosol).

## 2.4. Land uses and agricultural land




**Picture 10:** Spatial distribution of primary habitats on the territory of the Region of Istria
**Source:** Environmental Protection Plan for the Region of Istria (with Environmental Status Report)

Already at first sight one can notice a marked dispersal of habitat dominated by areas covered in forests, dry grassland and dispersed agricultural areas being a consequence of the traditional mixed production and tendency towards self-sufficiency. Due to this fact the current production has not been completely adapted to agricultural and environmental features of the region where it is implemented.




**Picture 11:** Soil cover / soil usage (important component of the landscape) on the territory of the Region of Istria
**Source:** Environmental Protection Plan for the Region of Istria (with Environmental Status Report)

Agricultural activities are among the most important activities in the Region of Istria despite the fact that its contribution to the total GDP of the Region of Istria is rather low (just above 5%, including forestry and hunting, and about 8% including fishery), it has a key role in rural development and sustainable management of rural regions which cover a considerable part of the Region of Istria. Table 7 gives information on the basic division of various types of agricultural areas in the Region of Istria according to ownership.

**Table 7:** Various types of agricultural areas in the Region of Istria according to ownership

| | Farming areas | Arable land and gardens | Orchards | Olive groves | Vineyards | Meadows | Pastures |
|---|---|---|---|---|---|---|---|
| Total [ha] | 167.136 | 62.523 | 919 | 1.421 | 5.831 | 16.045 | 80.397 |
| State land and private land [ha] | 46.365 | 15.349 | 23 | 267 | 381 | 1 | 30.344 |
| Family farms [ha] | 120.771 | 47.174 | 896 | 1.154 | 5.450 | 16.044 | 50.053 |
| Family farms [%] | 72 | 75 | 97 | 81 | 93 | 100 | 62 |

**Source:** Environmental Protection Plan for the Region of Istria (with Environmental Status Report)

Data show a rather large percentage of farming (59 %) and cultivated (31 %) areas within the total space of the Region of Istria. It must be emphasized that a considerable percentage of grazing land deriving from abandoned farming land is currently in the initial or advanced stage of wooded overgrowth.
The Region of Istria does not belong to the leading farming regions of Croatia with the exception of certain cultures (e.g. grape vine, olive trees and other woody plants) where tradition is long-standing both in their production and processing (renowned wines – malvasia, teran etc. and exceptionally high-quality olive oils) and poultry farming whose intensive production started in the 1970's and 1980's.
Crop production on family farms in the Region of Istria is characterised by the growing of traditional cultures: wheat, barley, maize and lucerne. These cultures cover 2/3 of the total arable area. Table 8 gives information on crop production in the Region of Istria per culture.

**Table 8:** Crop production per culture

| Red broj | Farming culture | Meas unit | Production p.a. | | | | |
|---|---|---|---|---|---|---|---|
| | | | 1986. | 1988. | 1990. | 1992. | 1994. |
| 1. | Wheat | t | 31.537 | 33.822 | 33.967 | 35.102 | 24.586 |
| 2. | Rye | t | 1.809 | 965 | 324 | 574 | 36 |
| 3. | Barley | t | 8.547 | 6.339 | 7.900 | 7.225 | 6.679 |
| 4. | Corn | t | 10.945 | 5.586 | 12.012 | 10.129 | 3.974 |
| 5. | Beans | t | 575 | 517 | 631 | 650 | 477 |
| 6. | Potato | t | 49.095 | 41.869 | 51.146 | 57.917 | 38.911 |
| 7. | Cabbage and kale | t | 9.183 | 7.446 | 8.284 | 8.300 | 7.839 |
| 8. | Onion | t | 6.594 | 4.721 | 5.819 | 7.225 | 6.634 |
| 9. | Tomato | t | 6.794 | 4.332 | 6.996 | 3.200 | 4.043 |
| 10. | Lucerne (alfalfa) | t | 29.575 | 27.998 | 29.643 | 21.800 | 21.679 |
| 11. | Peaches | t | 994 | 1.018 | 1.166 | 916 | 730 |
| 12. | Grape | t | 48.480 | 35.507 | 40.524 | 45.380 | 41.714 |
| 13. | Wine | hl | 339.395 | 248.549 | 283.670 | 317.660 | 292.000 |
| 14. | Olive fruit | t | 434 | 838 | 808 | 1.415 | 1.418 |
| 15. | Olive oil | hl | 801 | 1.363 | 1.208 | 2.122 | 1.702 |

**Source:** Environmental Protection Plan for the Region of Istria (with Environmental Status Report)

Even though Istria presents vast potentials for its development, animal farming is one of the most neglected agricultural sectors. This is especially true of hilly parts with thin earth cover, which does not offer possibilities for other forms of farming production, and animal husbandry becomes the key potential element of economy, retaining of population and sustainable usage of available natural resources offered by these rural spaces.

**Table 9:** Agriculture in the Region of Istria and its share in the agriculture of Croatia

| | | Croatia | Istria | Istria% Croatia | | | Croatia | Istria | Istria% Croatia |
|---|---|---|---|---|---|---|---|---|---|
| No. of household farms | | 448,532 | 13,534 | 3 | Poultry | Total | 15,989,365 | 968,062 | 6.1 |
| No. of companies | | 1,364 | 72 | 5.3 | | Household Farms | 10, 477, 514 | 352,249 | 3.4 |
| Used agric. land | Total | 1,077,403 | 24,643 | 2.3 | | Companies | 5,511,851 | 615,813 | 11.2 |
| | Household Farms | 860,195 | 22,040 | 2.6 | Olive trees | Total | 2,432,653 | 266,382 | 11.0 |
| | Companies | 217,208 | 2,603 | 1.2 | | Plantations | 1,724.32 | 676.42 | 39.2 |
| Cattle | Total | 488,646 | 7,516 | 1.5 | | Fruitful trees on plantations | 342,746 | 135,609 | 39.6 |
| | Household Farms | 398,037 | 6,433 | 1.6 | Grapes | - | - | - | 8.5 |
| | Companies | 90,609 | 1,083 | 1.2 | Hay | - | - | - | 11.5 |
| Pigs | Total | 1,924,672 | 11,990 | 0.6 | | | | | |
| | Household Farms | 1,726,895 | 11,915 | 0.7 | | | | | |
| | Companies | 197,777 | 75 | 0.0 | | | | | |

**Source:** Environmental Protection Plan for the Region of Istria (with Environmental Status Report)

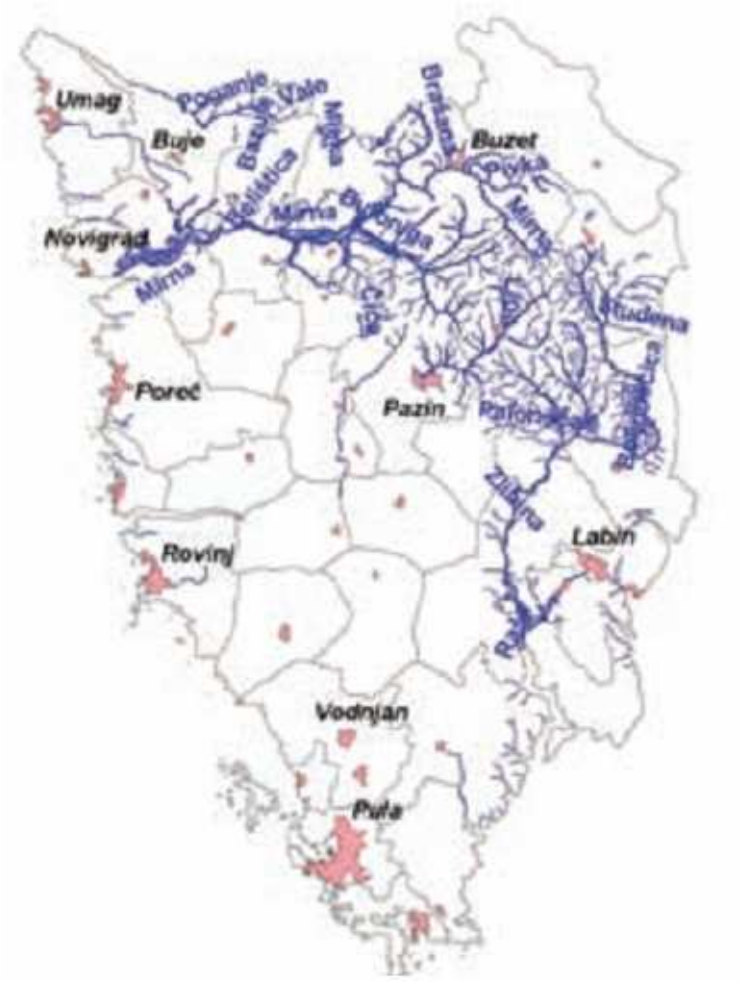
Table 9 gives information on agriculture in the Region of Istria and its share in the agriculture of Croatia.

The main factors limiting a more considerable agricultural production comprise:
- Scarce rainfall during vegetation periods (regular summer draughts), which is not compensated through a wider application of irrigation systems;
- Shallow layer of earth over about 40% of arable fields,
- Tiny and scattered land plots; average size of arable plots is 0.22 ha, which aggravates the application of modern technique and technology in production processes;
- Average size of land owned by family farms (agricultural land plots 6.5 ha with cultivated land of 3.8 ha) is smaller than the EU average of 22.2 ha of total land. However, when compared with certain countries (Italian average is 9.3) divergences are not large;
- Abandonment or decrease of production (animal husbandry) or low level of the use of technology (land, machinery);
- Large number of families make their living also outside the farm;
- Education of farmers in relation to implementation of modern technology in agriculture and fishery is not adequate.

In order to solve the above-listed problems, processes of farm concentration (increase of average size and decrease of their number) which will lead to the establishment of sustainable (economically, environmentally, socially and culturally justifiable) agricultural production in the Region of Istria.
The target of the existing strategy of agricultural development in the Region of Istria is the increase of the average size of farms from the current 6.5 ha to about 11.5 ha of cultivated land and increase of the percentage of farms with possessions of more than 10 ha of agricultural land from the current 12% to about 18%. Measures aimed to achieve this target are primarily linked to the policy of state land purchase and system of incentives for the establishment of new and rehabilitation of old perennial crop plantations, first of all olive

groves and vineyards. These activities have been an absolute priority receiving sizable investments as further extension of area will be limited following the accession to the EU.

## 2.5. Surface waters




**Picture 13:** Surface watercourses in the Region of Istria
**Source:** "Regional Operative Programme for the Region of Istria (2006-2010)"

**Hydrography**
Hydrographic features of watercourses in the Region of Istria:
Surface area of the water reservoir Butoniga: 2.51 km² (2,509,333 m²).
Surface area of the water retention reservoir Letaj: 68,596 m².
Surface area of the ponds near the Cerovlje field: 93,884 m².
Length of the canal of the Čepić field and Potpićan: 92.4 km (92,367 m).
Length of the canal of the Raša field: 26.6 km (26,560 m).
Length of the canal of the Krapanj field: 5.1 km (5,106 m).
Length of the Mirna river canal: 116.4 km (116,415 m).
Length of the Dragonja river basin: 190.5 km (190,501 m).

Length of the Mirna river basin: 1,670.4 km (1,670,370 m).
Length of the Raša river basin: 251 km (250,960 m).
Length of the Boljunčica river basin: 178.4 km (178,384 m).
Length of the Pazinčica river basin: 129.8 km (129,771 m).

**Hydrological Features of Surface Waters**

The most important surface watercourses on the territory of the Region of Istria are: Mirna, Raša, Boljunčica, Dragonja and the subterranean river Pazinčica. In water supply terms, an important role is played by the Butoniga and Boljunčica water reservoirs. The latter, due to heavy losses of its flood zone, is used only for one purpose – retention reservoir for the protection of the Čepić field from flooding.

The main Istrian watercourses provide water from about 1,100 $km^2$, i.e. from about 40% of the total surface are of Istrian river water basins. Considering that the average annual quantity of rainfall for the area of Istrian river water basins is 1,110 mm, with the acceptable average coefficient of infiltration of rainfall water of 0.6 applicable to karst regions, and the average drain coefficient of 0.4 applicable to flysch regions, following a rough approximation it can be estimated that approximately 500 M $m^3$ (on average approx. 16 m3s-1), and from the remaining karst areas twice more – about 1,000 M $m^3$ (on average approx. 32 m3s-1) water per year flow into the sea. The given values approximately match the sum of the flow at the mouths of these watercourses.

**Irrigation**

Agriculture – especially the growing of olive trees and the production of high quality olive oil, cultivation of grapes and production of first-rate wines, production of early vegetable cultures, but also livestock and poultry farming have a long-standing tradition on the territory of the Region of Istria. The existing resources (farming land), favourable climate, possibility of irrigation on one hand and the tourist sector as a potentially significant market for high-quality (traditional, recognizable, organic) products on the other, are the conditions which can certainly enable further successful development of agriculture and its complementary activities as important elements of sustainable development of the Region of Istria

On the basis of the macro-territorial approach, NAPNAV (National Irrigation and Farming Land and Water Management Project for Croatia), it has been estimated that in the Region of Istria there is the total of approx. 88,000 ha of farming land of various classes of fitness for irrigation (I- soil well fit, I- soil moderately fit, II- soil of limited fitness), and approx. 59,000 ha of land temporarily or permanently unfit for irrigation.

Current agrarian structure is not favourable for an intensive development of a modern and specialised agricultural production and represents the main obstacle to reaching production which would be competitive with the EU agriculture.

The backward techniques and technology and inadequate and underdeveloped basic infrastructure, including also the irrigation systems as one of the requirements for an intensive, modern and competitive farming production in the Region of Istria, can be highlighted as some of the main development challenges and needs of the farming sector in the Region of Istria. Only about 500 ha (1.5 % of the used areas) are being irrigated today, mostly from alternative resources (groundwater, water main).

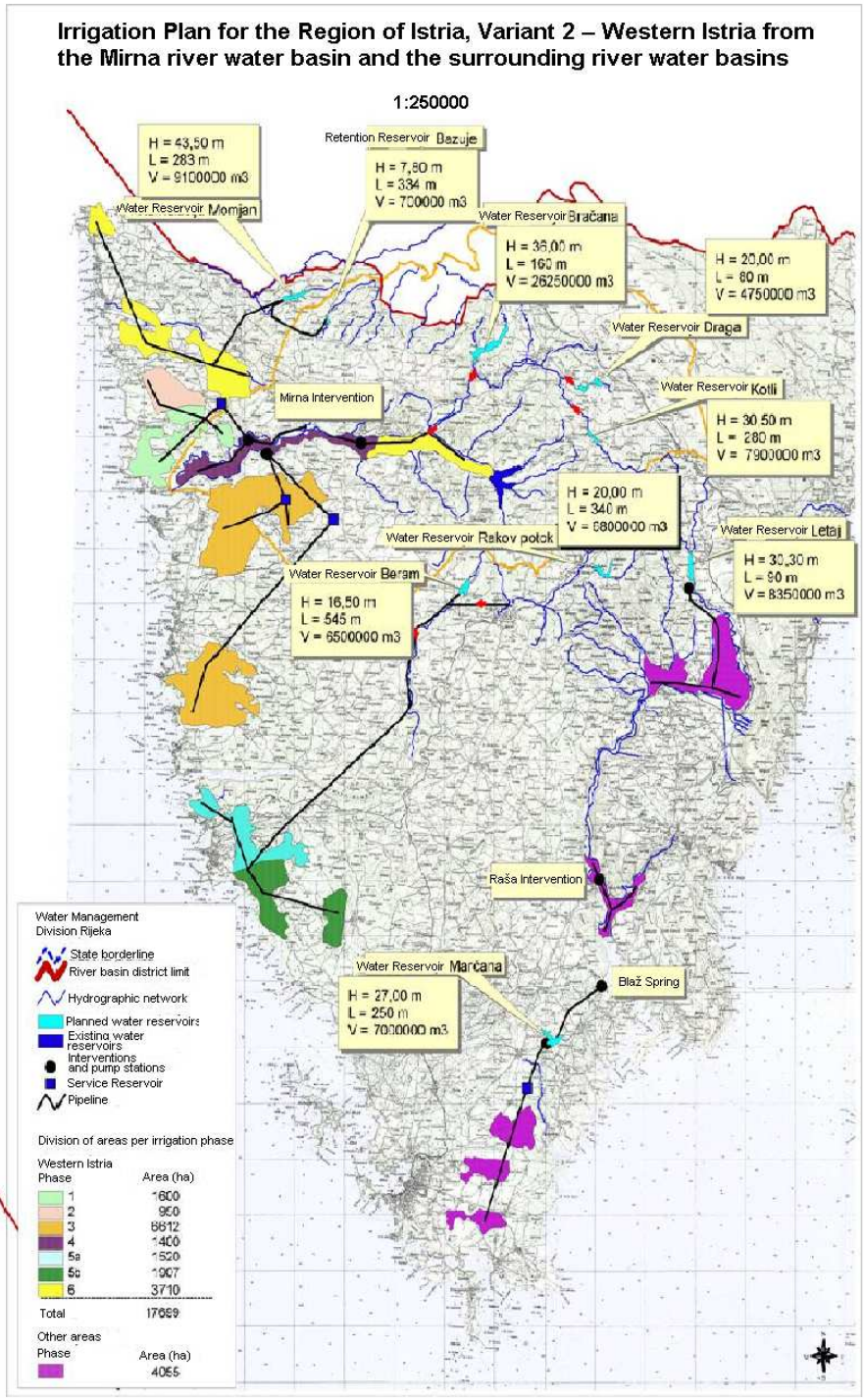
Farmers have expressed their interest to introduce irrigation over the total surface area of agricultural soil, which presents an increase from the planned 21,752 ha to the total figure of 56,183 ha.
Cultures which would be grown under the irrigation system would be the following: 18% vegetables, 26% woody plants, 22% vineyards, 34% crops.
Taking into consideration the required needs of single farming cultures, the assessed current annual requirements for water amount to 83.4 M $m^3$.

The Irrigation Plan for the Region of Istria is based on a phase approach to planning of the enlargement of the irrigation system in the Region of Istria. Generally, from the today's point of view, the development of the irrigation system can be divided into three phases.

The first phase of the irrigation system development should harvest 10-15M $m^3$/year from local ground and surface water resources (including additional/standby technical systems) in agricultural areas of western and southern Istria, which have already entered the Basic Irrigation Plan for the Region of Istria as the most attractive in terms of irrigation.

The second phase of the irrigation system development should harvest further 52M $m^3$/year of water from large surface accumulation reservoirs which have been proposed in Alternative I of main water transport routes of the Basic Irrigation Plan for the Region of Istria as the optimum set of reservoirs.

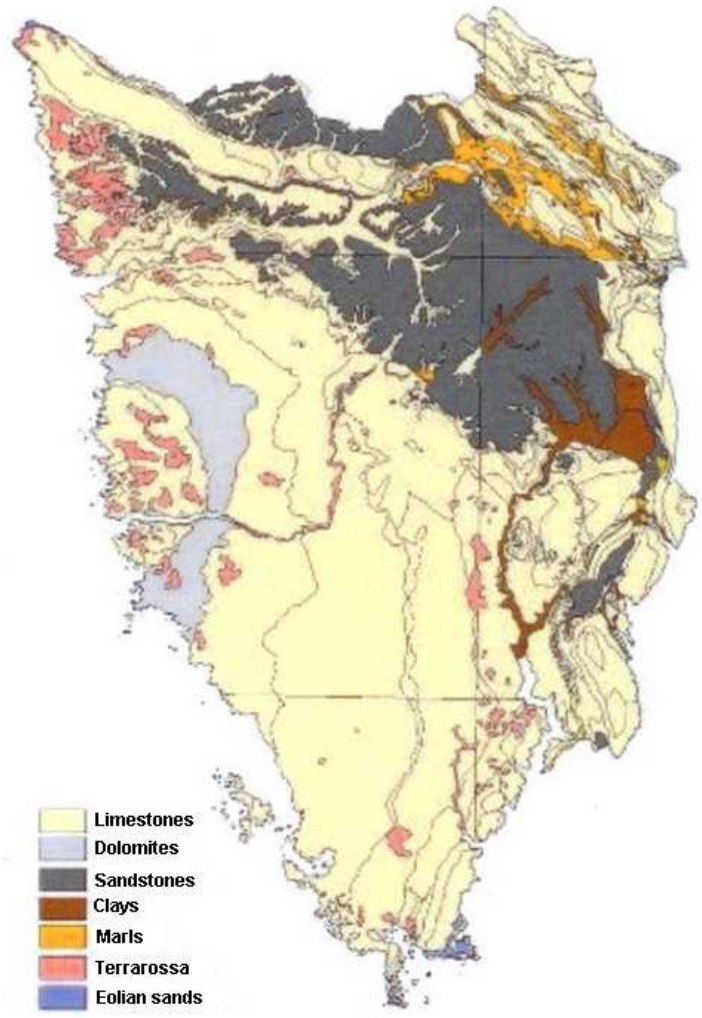
In the third (final) phase the water requirements (estimated to 28M $m^3$) for a long-term period shall be covered by the construction of additional large reservoirs, These will necessitate the preparation of relevant studies or, alternatively, will be selected from the range of reservoirs already analysed within the Basic Irrigation Plan for the Region of Istria.




**Picture 14:** Irrigation Plan for the Region of Istria, Variant 2 – Western Istria from the Mirna river water basin and the surrounding river water basins
**Source:** Irrigation Plan for the Region of Istria - Amendment

## 2.6. Hydrogeology and ground water quality

### *2.6.1. Hydrogeology and aquifer characteristics*




**Picture 15:** Geologic and Lithologic Map of the Region of Istria
**Source:** Environmental Protection Plan for the Region of Istria (with Environmental Status Report)

**General Hydrological Features**
On the basis of its hydrological features, Istria has been divided into three areas showing different conditions of formation and existence of surface and ground waters.

These are:
1. The area built from carbonate deposits (south of the flysch basin)
2. The area built from flysch deposits (flysch basin)
3. The area built from the replaced carbonate and flysch deposits – area of wet tectonics (north-east of the flysch basin).

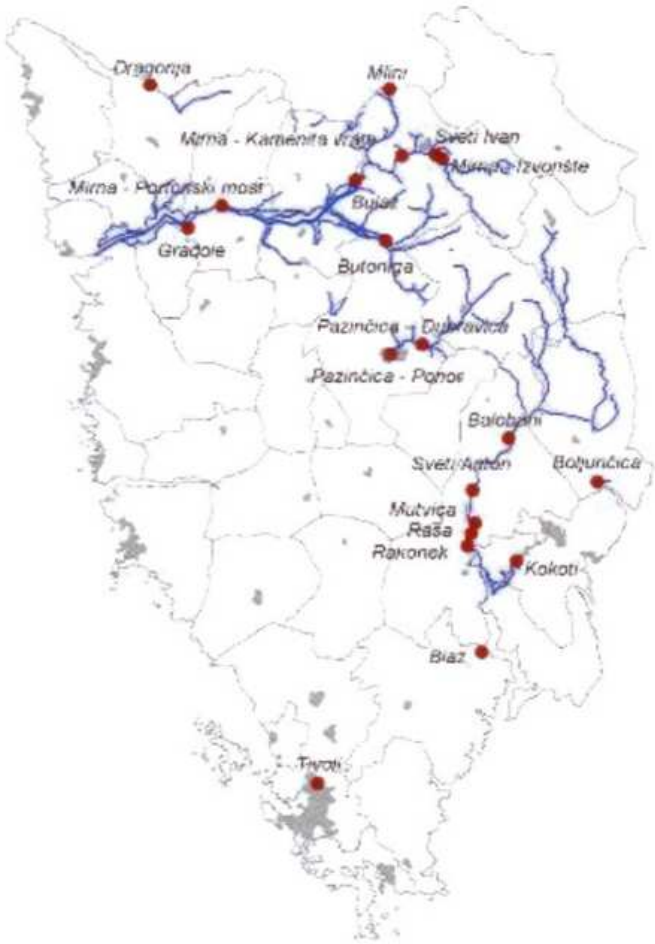
Carbonate area, covering almost ¾ of Istria south of the flysch basin is the typical karst aquifer of uniform characteristics. It comprises the territory south of the Mirna, from Vižinada to Pazin reaching the south end of the Čepić field and part of the Labin area (along the lower section of the Raša Channel). Carbonate rocks are of various ages, composition, appearance and structural relations. 90% of the carbonate deposits were formed during the Cretaceous and only a small part, between Poreč and Rovinj, belongs to Jurassic deposits. The extension of various lithostratigraphic members runs mostly N-S, reflected mostly in the direction of the groundwater flow.
Considering the abundance of the registered hydrogeological bodies and hydrochemical water characteristics, this area can be subdivided into the inland and the seaboard.
The basic feature of the inland is the lack of major hydrogeological phenomena on the surface, sinking of the water into the ground and its flowing through systems of crevices and channels towards the seashore or the valleys of the Mirna and the Raša.
The seaboard comprises the area along the valleys of the Mirna and the Raša where groundwater emerges on the surface and where the sea considerably affects the water.

The area formed from flysch deposits comprises the Trieste – Pazin basin extending from the Dragonja, along Motovun and Pazin towards the western boundary of the Čepić field and Plomin to reach Labin and Raša.
The Ćićarija mountain range borders this area in the north-east and the Učka range on the east.

Flysch deposits are characterized by the change of the lithological content, i.e. the exchange of rough and firm clastic sediments, i.e. exchange of sandstone and marl with sporadic appearance of breccias, conglomerates and marly limestones. The basic characteristic is the predominant surface drainage towards the western or eastern side of the peninsula, but also disappearance into the carbonate areas on the southern side of the flysch basin. Surface drainage takes place through torrent ditches until reaching the deposits of quaternary material in the lower located ditches and valleys of the main watercourses. Flysch deposits condition the formation of permanent and torrent watercourses of Istria: the Mirna, the Dragonja and the Raša. In the flysch area north of the Savudrija to Buzet tectonic thrust, a few stream valleys, the so called blind valleys, have formed in which surface streams end when meeting limestone. Water disappearing in caves reappears at the Bulaž spring. The spatial situation of the flysch deposits within the wider Buzet area make them function as a hydrogeological barrier obstructing the streaming of groundwater coming from the Ćićarija. Water flowing under the flysch and in the morphologically lowest part of the terrain penetrates the deposits and emerges as the Sv. Ivan (St. John's) Spring.

The area built after the replacement of carbonate and flysch deposits due to the thrust tectonics and lithologic changes shows complex features. It encompasses the mountain ranges of Ćićarija and Učka, with a range of thrusts and imbricate structure, karst area on the northeastern side of the Ćićarija, detached carbonate area on the northwestern part of the peninsula and the fault between the Labin-Raša basin and Koromačno with a number of recorded thrust structures. Tracing of groundwater streams coming from the Ćićarija (Dane, Lanišće) has shown a link with the springs located in the Kvarner Gulf (springs of Opatija) on one hand and springs located in central Istria (Sv. Ivan spring) on the other. On the Učka massif thrust elements have been recorded with appearance of permanent of temporary springs at occasional points. In the Labin-Raša basin groundwater emerges deep in the mines

and the penetration of fresh and sea water can be linked to very deep faults. The detached carbonate area between Buzet and the Savudrija Cape, the so called Buje Karst is surrounded by flysch sediments on its north and east side. Inside this wide thrust structure of cretaceous carbonate deposits, groundwater forms and emerges as a range of springs in the valley of the Dragonja and as coastal springs in the area of Savudrija. This means that groundwater partly flows parallel to the structures and partly gravitates towards the Dragonja River. The underground watershed between these waters has not been defined. At the contact of cretaceous limestone with flysch sediments and eocenic limestone, ponors (surface water inlets) appear.




**Picture 16:** Surface water measuring station network in the Region of Istria
**Source:** Environmental Protection Plan for the Region of Istria (with Environmental Status Report)

**Hydrological characteristics of groundwater**

Drainage systems of the Istrian peninsula, namely of the Region of Istria, are somewhat differently distributed compared to the above division into three characteristic areas. Thus, starting from the north, we distinguish:

1. Mirna river basin and part of the Dragonja river basin;

2. Raša river basin and
3. Southern Istria basin.

Underground streams flow over flysch deposits, while the lower sections of the streams are located in valleys deeply cut into the carbonate deposits. At the contact between flysch and carbonate deposits part of the water disappears into the ground and the other part flows over thick fine-grained clay quaternary deposits formed by sedimentation of river deposits whose creation can be linked back to the wearing of flysch deposits in the upper parts of river streams.

The Mirna river basin and part of the Dragonja river basin

The Mirna river basin covers the area of 912 km$^2$ situated in the central and western Istria and is the largest river basin in Istria. The limits of the river basin on the northeastern side towards the Ćićarija and the Karst are not clearly defined and tracing of the ponors in that area shows that groundwater flows away both towards the littoral springs of the Kvarner Gulf and towards the Mirna river basin, and partly probably towards the springs in the Trieste Gulf. The valley of the Mirna has a number of springs of various capacities on both river banks and on its confluents. The springs are of karstic ascending character. In this valley the mineral-thermal spring of St. Stephen (Istrian Spa) is located.

The water intake from the St. John Spring in Buzet is connected into the water-supply system of Istria. The water emerges on the surface from the limestone bed through flysch deposits. The minimum discharge rate of the spring is 200 l/s and maximum more than 2,000 l/s. The minimum/maximum discharge rate ratio varies between 1:10 and 1:15.

The middle tract of the Bračana watercourse, which flows into the Mirna downstream from Buzet, is intensified by a spring group (spring area) Črnica, better known as Mlini (after the nearby village). This spring area consists of three springs: Ara, Sopot and Sušec/Slapi/Mlini.

Upstream from the Istrian Spa, the river drains the water coming from the surface of the surrounding hillsides made from watertight flysch deposits so that a larger water supply into the river Mirna derives from the Bulaž spring where water emerges from the karst underground. It comes on the surface in the form of a lake 50 m in diameter. The discharge rate of this karst spring in natural conditions may vary from 60 l/s to a few thousand l/s. The recharge system enables pumping of 200 l/s even in arid summer months.

Until reaching the biggest karst spring in Istria – the Gradole spring, the Mirna and its confluents regain the characteristics of a surface drain. The spring is situated 9.5 km upstream from the mouth of the Mirna, and follows the edge of the valley flowing under steep cliffs. Water emerges from a karst crevice. The stream water is collected to be used by the Istrian regional water supply network. Its minimum discharge rate is 500 to 600 l/s, and the maximum rate can reach 15,000 l/s.

Thermal spring – Istrian Spa represents a specific phenomenon. It is located at the crossing between reversed and cross fault at the contact between carbonate anticline and flysch deposits, southwest of the Bulaž spring and distant about 500 m. For its temperature and mineralization of the thermal spring, according to the balneological classification, the water of the spa belongs to the group of mineral isotherms. The average temperature is 34.5qC, and mineralisation is 3.425 g/l. The H2S content is about 23 mg/l and radioactivity is Rn 49 nC/l. The dominant ions above 20 mval % are Na-Ca-Cl. Water shows oscillations of temperature, chemism and capacity due to mixing of cold and thermal water.

The Raša river basin

The valley of the Raša downstream from Podpićan is built from carbonate deposits of the upper Cretaceous. These deposits make a gentle anticline with its crest plunged between two parallel faults creating a tectonic graben. Inside this graben there is a row of vertical faults extending in the northwest – southeast direction. These have conditioned the directions of groundwater streams along the Raša anticline and across it with springs appearing to both the right and left side of the river banks. Springs are mostly overflow or rising, generally conditioned by the contact of carbonate deposits and fine clastic alluvial deposit brought by the Raša river.

The basin of the springs on the Raša right (west) bank

The basin of the springs on the Raša right bank was built from carbonate deposits of cretaceous age. On the right bank, north to south, the known springs are Jaškovica, Bolobani, Sušnica, Sv. Antun, Grdak, Rakonek, Česuni 1 and 2 and the Blaž spring, far away in the Raša Bay.

The hydrogelogical relations of the Jaškovica spring have been disrupted by mining activities, after which it dried out and reappeared inside the mine with the capacity of about 45 l/s.

The minimum overflow of the Bolobani spring is about 15 l/s, and at the maximum point its discharge rate is about 100 l/s.

The Sušnica spring, when the water is at a middle level, has the discharge rate of about 700 l/s, and when the level is heigh it can reach 7,000 l/s.

The Sv. Antun spring, when the water is at a low level, has the mean discharge rate of about 70 l/s, and when the level is high it can reach over 4,000 l/s.

The normal overflow of the Grdak spring gives a capacity of about 50 l/s. Maximum discharge rate of the spring is 3,200 l/s with the spring dry in summer.

The minimum discharge rate of the Bolobani spring is about 150 l/s, and at the maximum point its discharge rate exceeds 3,000 l/s. It is located on the west side of the Raša and currently it is the only spring on this side of the Raša where water is collected and used for the needs of the water supply system managed by "Vodovod" Pula.

The Blaž spring, when the water is at a high level, has the mean discharge rate of about 2,500 l/s, and when the level is low it varies between 50 and 100 l/s.

The springs are in direct contact with the sea (on the seashore) and when the water level is low, mixing of fresh and sea water occurs. Salinity is rather variable, varying between 250 and a few thousand mg/l.

The basin of the springs on the Raša left (east) bank

The basin of the springs on the Raša left bank consists of a number of interconnected springs.

The known springs are Mutvica, Šumber, Vapnara – the lime manufacturing plant, Krečana on the left bank, at the contact between river deposits and limestone, the springs Fonte Gajo I, Fonte Gajo II and Kokoti in the Krapanj valley, and within the area of Labin, Plomin and Čepić Field the springs Kulak, Plomin, Bubić precipice, Beka.

The Mutvica spring, when the water is at a low level has the mean discharge rate of about 40 l/s, and when the level is high it is about 630 l/s.

The spring near the lime manufacturing plant is located at the contact between quaternary landforms and a carbonate complex. It is used by the plant for its own needs. The discharge rate of the spring is 40 l/s. The lime manufacturing plant has placed a pump at the spring and is maintaining and using spring. The capacity of the pump is adequate to meet the needs of the lime manufacturer.

The capacity of the Fonte Gajo spring is from 70 l/s to 2970 l/s.
The discharge rate of the Kožljak spring is about 14.5 l/s.
The minimum capacity of the Plomin spring is about 3.8 l/s, and the maximum one is 8 l/s. Water from this spring is collected for the needs of the water supply system managed by "Plomin", but only 4 l/s are used.
The capacity of the Beka spring is about 15 l/s.
The Bubić precipice is situated not far from the Plomin Bay, within the ring of the Thermal Power Plant of Plomin. Its water is collected and used in the power plant for cooling. 30 l/s are used for the needs of the power plant, without raising the salinity of the water.

The Basin of Southern Istria

The basin of southern Istria covers the area of about 893 km2 of the southern and southwestern part of the Istrian Peninsula. It extends between the mouth of the Mirna river diagonally cutting the peninsula towards the mouth of the Raša river. This basin comprises also the Limski Channel and part of the valley of the Čipri watercourse, a periodic watercourse discharging into the Limski Channel.
The fundamental characteristic of this area is an open coastal area with numerous littoral springs in the low part of the river basin, between the mouth of the Mirna and the southernmost cape of the peninsula plus a part of the eastern, much steeper coast up to the mouth of the Raša where springs are linked to deeply cut in bays. There are no permanent surface watercourses and it has been confirmed with dye tests that the periodic stream towards Limski Channel belongs in part to the Mirna river basin and only in a smaller part to the basin of southern Istria where water streams exclusively underground.
Groundwater springs along a range of periodically abundant coastal springs or mixes underground with the sea in a dispersed way. Due to a rather low relief, access to groundwater or to natural pits or to water collecting tanks – wells is possible. This is today the main way of usage of groundwater in this region. Wells are mostly situated on the western side of the Istrian Peninsula (greater area of Savudrija-Buje-Novigrad, in the area of Poreč and in the greater area of Pula). The level of the water in these wells is 0.8 m to 49 m below surface. Table 9 gives the survey of the pump sites managed by the Pula's water supply management company "Vodovod".

**Table 9:** Survey of Pula water supply system pump sites

| SURVEY OF THE WATER SUPPLY SYSTEM PUMP SITES | | | | |
|---|---|---|---|---|
| **No. j** | **Well name** | **Disch. rate (l/s)** | **Geological conditions** | **Note** |
| 1 | Jadreški | 34,5 | Heavy-layered rudist limestone K2 | ACTIVE WELLS |
| 2 | Šišan | 26,5 | Heavy-layered rudist limestone K2 | |
| 3 | Valdragon 3 | 7,4 | Heavy-layered rudist limestone K2 | |
| 4 | Valdragon 4 | 10 | Heavy-layered rudist limestone K2 | |
| 5 | Valdragon 5 | 6 | Heavy-layered rudist limestone K2 | |
| 6 | Fojbon | 6 | Heavy-layered rudist limestone K2 | |
| 7 | Campanož | 21 | Heavy-layered rudist limestone K2 | |
| TOTAL | | 111,5 | | |
| 8 | Tivoli | 40 | Plate limestone $1K_1^6$ | INACTIVE WELLS |
| 9 | Škatari | 5,5 | Heavy-layered rudist limestone K2 | |
| 10 | Lokvere | 5 | Heavy-layered rudist limestone K2 | |
| 11 | Ševe | 10 | Heavy-layered rudist limestone K2 | |
| 12 | Rizzi | 11 | Heavy-layered rudist limestone K2 | |
| TOTAL | | 71,5 | | |
| 13 | Izvorište Karolina | 24 | Heavy-layered rudist limestone K2 | DISCONNECTED |

**Source:** "Zoning Plan for the Region of Istria"

Apart from the springs, twelve collection wells and a large number of private, dug or drilled, wells have been recorded. The latter ones are currently of unknown pumping regime and discharge rate.


**Picture 17:** Division of the Water Supply System in the Region of Istria: Water Supply Network Buzet Water Supply Network Labin | Water Supply Network Pula | Water Supply Network Pula – City of Pula
**Source:** Public Health Agency of the Istrian Region, www.zzjziz.hr

**Table 10:** Springs, wells, reservoirs used to supply water in the territory of the Region of Istria

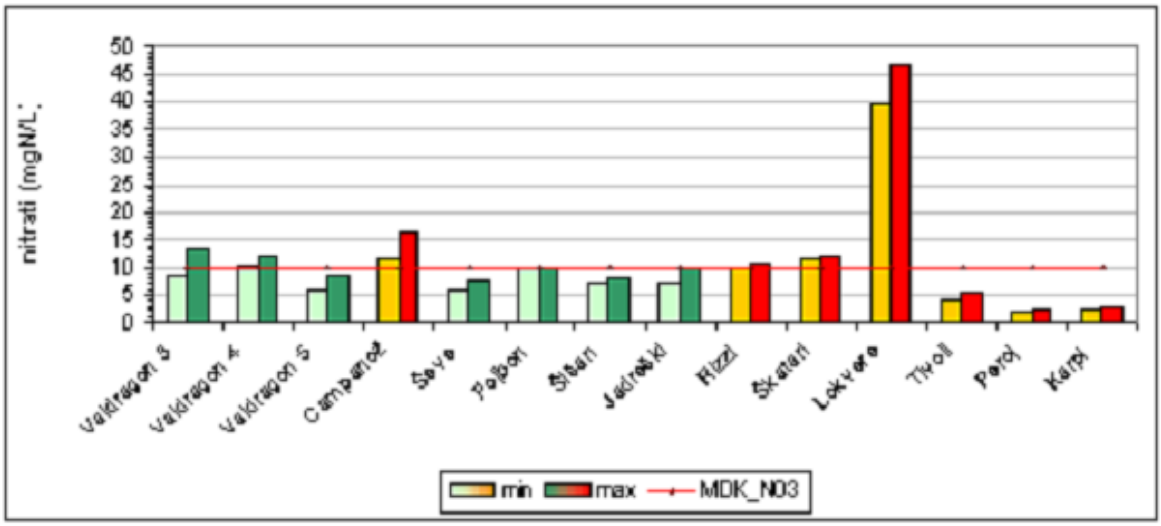
| Water Supply Network Buzet | | Water Supply Network Pula | | Water Supply Network Labin | |
|---|---|---|---|---|---|
| Spring Name | Capacity | Spring Name | Capacity | Spring Name | Capacity |
| Sv. Ivan | 208 l/s | Pulski bunari* | 100 l/s | Fonte Gaja – Kokoti | 180 l/s |
| Gradole | 1000 l/s | Rakonek | 250 l/s | Kožljak | 7 l/s |
| Bulaž | 132 l/s | Gradole | 160 l/s | Plomin | 4 l/s |
| Butoniga Reservoir – provides steady supply of the whole Region of Istria: Phase 1 – 1,000 l/s; final capacity 2,000 l/s. Currently used to supply Pula (in summer) and recharge Gradole spring via the Čiže ponor. | | | | | |

**Source:** Environmental Protection Plan for the Region of Istria (with Environmental Status Report")

### *2.6.2 Groundwater quality*

**Quality of groundwater used in water supply of the Region of Istria**

The majority of the available water quantity used to supply the Region of Istria with water is provided by groundwater: springs and wells. The quality of water is assessed in accordance with various criteria, depending on the specific purpose and usage.
The central and northern ends of the peninsula are characterized by springs of different level of discharge rate, while in the southern end the only water resources are the wells.
Waters can vary in their geochemical characteristics, starting from waters with a low quantity of minerals to be found in the areas of recharge of Ćićarija, via the moderately hard and hard waters between the Mirna river basin and the Raša water basin, to the very hard waters with an extremely high mineral content of the wells in the wider area of Pula and the southern tip of Istria.
All groundwaters are of hydrocarbonate type with various levels of mineralization. Springs near the Raša river mouth and the wells of the Pula area feature a higher content of sodium and chlorides.
Springs react to changes of water flow in a very karstic manner – showing events of great opacity. The appearance of great opacity leads to an increase of almost all pollution indicators: increase of the contents of nutrients – nitrogen compounds (in particular of the organically bound nitrogen and ammonium) and total phosphorus, total lipophilic substances and heavy metals bound to a suspended substance, in this case sludge. There is also a great increase of all indicators of bacteriological pollution of faecal origin. Such distribution of multiplied concentrations of certain indicators related to the inflow of rainfall water, of sudden changes of the flow and the total anthropogenic influence in areas of spring recharge, greatly affects the classification of water, but is, with the exception of bacteriological indicators and iron content and in spite of the oscillations, still acceptable in compliance with the drinking water criteria.
Compared to the springs, wells hardly ever become opaque and the bacteriological pollution is very low. The greatest problem with the wells in water supply is the high content of nitrates, which has already resulted in closing a range of wells from the water supply system (Peroj, Rizzi, Lokvere, Karpi, Campanož, Škatari and Tivoli). Almost all of them are situated in urbanized areas of towns or suburban settlements where the waste water drainage system is inadequate or non-existing.
Furthermore, extraction of groundwater at private drill-wells for individual and very intensive vegetable growing is substantial.




**Graph 1:** Contents of minimum and maximum values of nitrates at all wells
**Source:** "Javnozdravstveni glas", Bulletin of the Public Health Agency of the Region of Istria, Year: IV, Issue: 13 – 14, ISSN 1334-4145, January - June 2003.

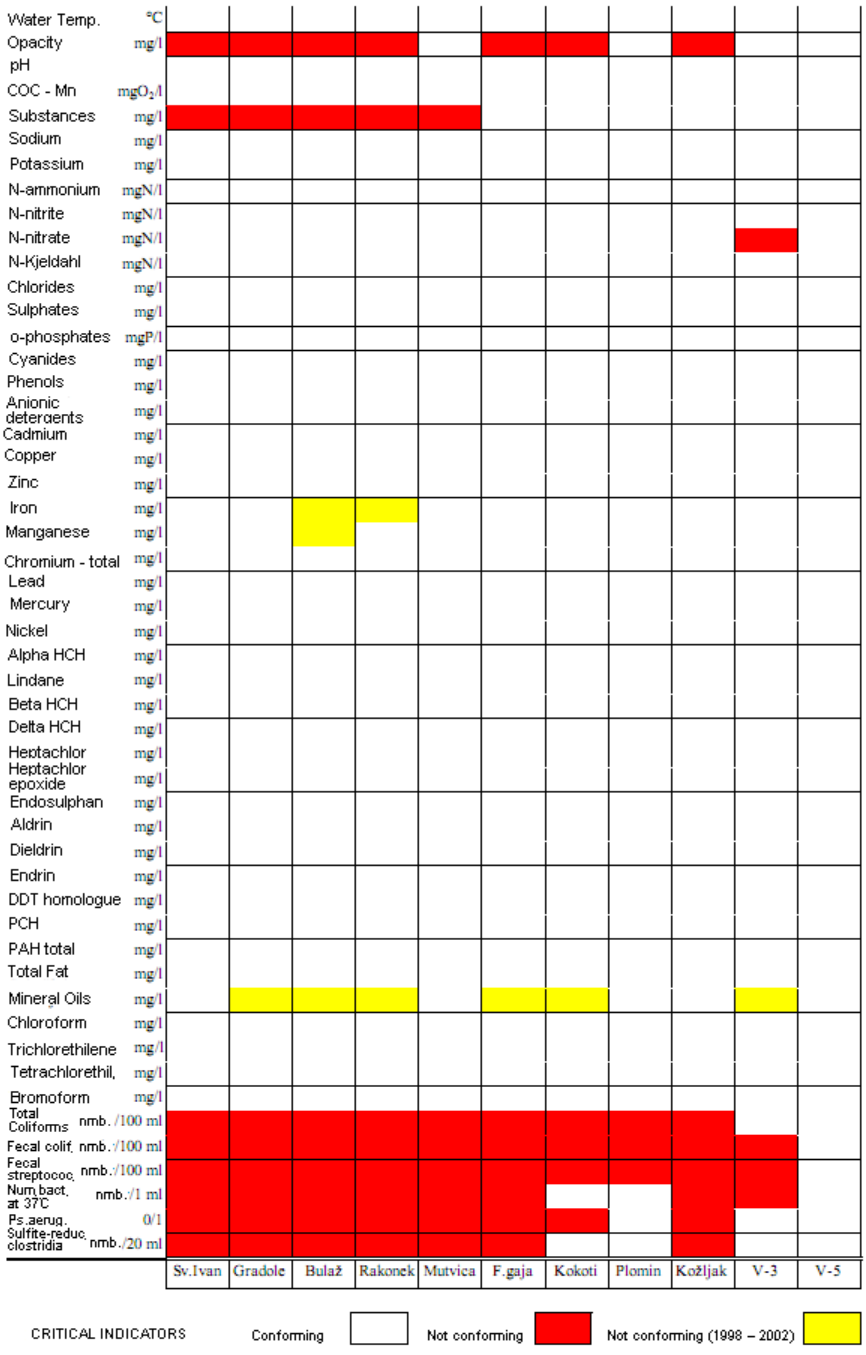



**Table 11:** Summary of the quality of the water springs
**Source:** "Javnozdravstveni glas", Bulletin of the Public Health Agency of the Region of Istria, Year: IV, Issue: 13 – 14, ISSN 1334-4145, January - June 2003.

Red colour (“non-conforming”) highlights indicators which exceed the MAQ (minimum allowable quantity) set by the 2002 Ordinance (notwithstanding the concentration and rate). The yellow colour highlights indicators which have exceeded to MAQ from time to time during the last five years of testing. Both colours point to those critical indicators which, taking into consideration the present treatment level, could affect the quality of the final product – drinking water.

From year to year almost the same final grade reappears in relation to allocation and usage conditions. Parallel to the said phenomena of opacity, i.e. suspended material and bacteriological pollution contained in groundwater, when the water is largely opaque, it contains chemical substances such as mineral oils, iron and manganese above the maximum allowable concentration. Mineral oils come in concentrations not exceeding 15mg/l; the contents of iron and manganese sometimes greatly exceed the MAQ values. None of the indicators of the tested toxic substances has exceeded the MAQ set by the Ordinance.

Current status of water treatment at wells, including sedimentation, filtration and disinfection, provides complying standard of drinking water. The level of treatment at wells is not adequate to guarantee the required standard, which has resulted in withdrawal of wells from the system and decrease of disposable quantity of groundwater for water supply. Chemical and toxic substances do not endanger safety of drinking water.

## 2.7. Pollution Sources

**Pollution of surface and ground waters**

Karst aquifers of the Region of Istria are exceptionally sensitive to external pollution due to: speed of flow with lower self-cleaning potential; dense networks of cracks drain a large river basin area; drained water does not undergo cleaning processes on the ground on its way into the ground because it reaches the underground through a crack or through the thin earth cover over a limestone bad.

Major pressures/sources of pollution on the territory of the Region of Istria include: municipal waste water, 2) untreated industrial waste water; 3) leachate water from landfills 4) untreated rainfall water which leach pollution from urban areas and roads; 5) agricultural (crop and animal production); 6) occasional exceptional pollutions (industrial, traffic accidents and similar).

Untreated municipal waste water is the largest and the most widespread source of pollution/contamination, particularly of groundwater.
The next important type of pressure from urban areas is rainfall waste water coming from surfaces where urbanisation has changed the regime of drainage and cleaning of rainfall water (roads, car parks, roofs).
Many companies either have not obtained the water permit or have not complied with it. This problem is even more emphasized in areas with no utility infrastructure for drainage and treatment of waste water. A large number of companies is located in water protection areas (even within the Class I area, e.g.: Buzet Concrete Batching Plant, Čiritež Quary and Cimos Foundry at Roč) causing a problem of cumulative influence of a large number of such smaller plants (garages, dyeing plant, poultry farms, slaughtering houses).
Inadequate official and illegal waste disposal sites i.e. their leachate and drainage water coming into contact with it, are a considerable source of water pollution in the Region of Istria. Wild disposal sites are particularly risky as they provide no control of disposed waste, may cause contamination by some kind of hazardous waste and are often located in natural depressions, which accelerates seepage of polluted water into ground.
Leaching from polluted areas, apart from the above mentioned disposal areas, comprises polluted soil after accidents, roads, urban areas. Research results show that from 1 ha of urban area 130 kg of suspended substances, 60 kg COD (chemical oxygen demand) and a noteworthy quantity of lead are massed up over 1 year.

Treating of surfaces within the intensive farming production represents a significant pressure on surface and ground water in the Region of Istria, especially when carried out in relatively strict water protection areas.

Severity of the problem is proportional to the intensity of farming production (synthetic fertilizers and pesticides). The volume of such farming area can be inferred from the 2003 Farming Census: 1) total area treated with plant protection products is 5,566 ha, 2,422 with herbicides and 2,438 with insecticides; 2) total area treated with fertilizers is 12,202 ha, 7,560 ha with mineral fertilizers and 4,642 ha with organic fertilizers. The consumption of mineral fertilizers in Istria is 86 kg/ha, which is more than in the counties of the littoral and mountainous parts of Croatia, but much less than in the north-western and north-eastern parts of Croatia. However, even such consumption of fertilizers represents a risk for the

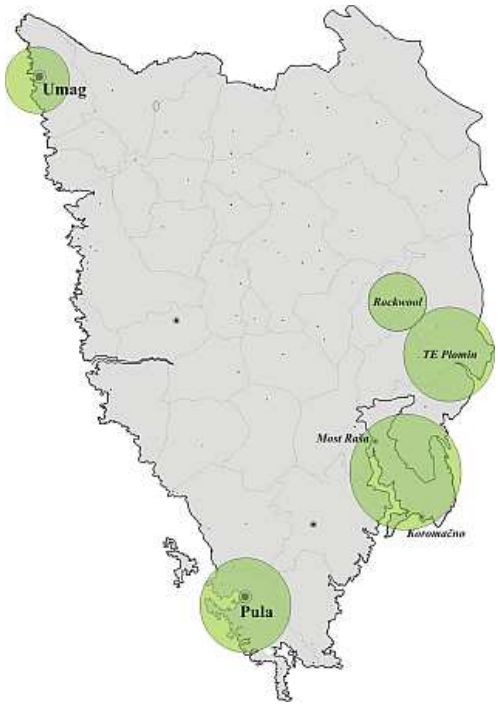
groundwater in the permeable part of the Istrian plate, for surface watercourses in the central flysch part and in the river valleys and poljes of Istria.

Torrents, i.e. soil erosion and washing out, may represent the most conspicuous item of the watercourse burden. About 30% of the territory of the Region of Istria is endangered by erosion, primarily in flysch areas. Especially endangered is the area surrounding the Butoniga Water Reservoir.
Cases of ecological incidents (e.g. spillage of large quantities of mazut into the Pazinčica cave and/or heating oil in Buzet and similar) had proven long-lasting negative consequences on water quality.

**Air Pollution**
In the vicinity and on the territory of the Region of Istria there are potentially large sources of emission into the air. Of the overseas influences, the most prominent are those in northern Italy – one of the economically most developed regions in the world, but also one of the regions where air is the most polluted. Acid rains originating in that area have an adverse effect on the plant cover and the soil also in the Region of Istria.
Of the sources of pollution in the Region of Istria the most notable and the largest single source of pollution is the Plomin thermal power plant. In accordance with the official reports (Ministry of Environmental Protection, Zoning and Construction, 2005) on emission of pollutants into the air on the territory of Croatia, this plant belongs to the most important single sources according to a number of criteria, such as: the largest single emitter of N02; the fourth largest single emitter of S02; the sixth largest single emitter of CO; considerable source of mercury.
The location has been inserted onto the list of a dozen of "black spots" (high risk and polluted locations) in Croatia. The rehabilitation of the disposal site of radioactive ash of the plant Plomin 1 certainly falls into the priority measures of environmental protection for the Region of Istria. Radioactivity is the consequence of the use of coal coming from the nearby coal mines, which have been closed down and the coal which is today imported is up to 20 times less radioactive.

Industrial pollution sources are primarily the cement factory, lime factory, rock wool factory (emission from large furnaces), but also chemical industry (solvents are the largest source of NMVOC - non-methane volatile organic compounds), industrial glass, etc. Quarries can be (and in a few locations in Istria actually are) considerable sources of dust for the nearby places.

Currently air quality is monitored at 14 measuring stations (5 of which automatic) located in the area of 7 local self-government units (Umag, Pula, Raša, Labin, Sv. Nedelja, Pićan, Kršan). The existing air quality monitoring network spatially covers the most important single sources of emission (cement factory, lime factory, thermal power plant) in the Region of Istria.




**Picture 18:** Area of Air Quality Control (locations of standard measuring points) on the territory of the Region of Istria: Umag | Plomin | Most Raša - Koromačno | Pula | Rockwool
**Source:** Public Health Agency of the Istrian Region, www.zzjziz.hr

**Waste Disposal**

Waste records are poor and unreliable, but a general assessment says that the Region of Istria generates 70,000 t of municipal solid waste, 200,000 of non-hazardous technological waste and 10,000 t of hazardous waste.

Collected municipal solid and partly technological waste is disposed with at one of the seven landfill whose status, "measured" in accordance with standard criteria applicable to modern sanitary landfills, is mostly very unsatisfactory.
Apart from official non-arranged landfills, in accordance with the census of 2001, there are about 300 illegal disposal sites covering approximately 30 to 40 ha and containing approximately 350,000 $m^3$ of mostly municipal solid waste. The comparison with the last-year's quantity of generated municipal solid waste (about 70,000 t) and the total area of official landfills (36.8 ha) highlights the severity of the problem, especially in the light of the fact that there is no control of illegal waste disposal sites and that these are usually situated in natural depressions which are often points where rainfall water seeps into the karst underground of the Region of Istria.

Currently the role of the industrial and energy sector within the waste management system of the Region of Istria is performed by the Plomin thermal power plant and large parts of the Koromačno cement factory. These two are the main users of the RDF (Refuse Derived Fuel)

and have become strategic partners within the waste management system of the Region of Istria through extension and adaptation of the existing technological processes.

Holcim Croatia cement factory at Koromačno has actively joined the Istrian waste management system by using, and thus disposing, vast quantities of hazardous and /or non-hazardous technological waste, including: i) waste mineral oils, tires, meat and bone meal, sludge from municipal liquid waste treatment plants and alternative fuels; i) FGD gypsum (product derived from flue gas desulfurization (FGD) process at electric power plants, fly ash from the thermal power plant as cement supplement; and slag collected from the plant's furnace grids and used as raw material additive.

The extremely rich karst underground containing numerous speleological bodies, caverns and caves of which only a few have been protected, is not exempt from pressures and adverse effects. Attractive bodies, abounding in underground life (bats, insects, snails, bivalves, crabs, mushrooms, olm, …), are mostly unexplored and suffering from permanent pollution (irresponsible citizens throw municipal solid waste, dead animal bodies and slaughter waste, empty sewage tanks, car bodies etc. into them). Of the 115,000 speleological bodies recorded in the world, Croatia has more than 8,500, 2,000 of which are located in Istria.

The general rating is that the current status of waste management is not satisfactory (in terms of harmonisation with the existing national and EU legislation and standards). However, trends are positive and by taking them into consideration it can be planned that the status should approximate the EU standards within the next 10 to 15 years.

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