



**Convention on Protection and Use of Transboundary Watercourses and
International Lakes**

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ECOSYSTEM ROLE IN CROATIAN WATER MANAGEMENT

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1. Natural characteristics

Land surface of the Republic of Croatia spreads over a total of 56,538 km², mostly belonging to the Danube river basin (62 %), with a minor part in the Adriatic river basins (38 %). There are approximately a total of 4,400,000 inhabitants residential to the area, of which 69 % live in the Danube river basin and 31 % in the Adriatic river basins. The watershed divide between the Danube river basin and the Adriatic river basins traverses the area of the Dinaric karst and is thus mostly «wandering», since its location depends on the saturation level of the karst underground.

The area of the Danube river basin in Croatia is located in the Pannonian plain and its hilly, mountainous boundary areas, whereas the Adriatic river basins cover the hilly, mountainous regions of Central Croatia, the coastal zone and the islands. The geological composition of Croatian territory greatly varies. The Danube river basin is dominated by thick deposits of pond and quaternary alluvial deposits, wherein aquifers of intergranular porosity, characterized by high permeability and significant accumulated groundwater quantities, are formed. The Adriatic river basins mostly belong to the Dinaric karst, whose backbone is formed by the Dinaric carbonate platform which includes the tallest Croatian mountains and karst fields located in between. The basic characteristics of karst river basins are spacious water-producing zones in mountainous areas, with very abundant precipitation and complex source conditions at the contacts with karstified impermeable clastic rocks.

Average precipitation in Croatia equals approximately 1,000 mm, with values ranging from 650 mm in eastern Slavonia to 3,800 mm in the area of Gorski Kotar. The density of hydrographical network in the Pannonian plain ranges up to 3.2 km/km², which is much greater than in karst areas. Croatian major rivers, with catchment areas larger than 10,000 km², are the Danube, Sava, Drava, Kupa, Una and Mura Rivers in the Danube river basin, and the Neretva River in the Adriatic river basins.

Vegetation cover of the national territory is exceptionally developed, dominated by forests (45 %), fields and gardens (25 %), followed by meadows, pastures and rare vegetation (17 %). Bare rocky ground covers only about 6 %, whereas other surfaces encompass only about 7 % of the national territory.

Based on its biogeographical location, Croatia is situated along the dividing line between three large ecoregions - the ecoregion of the Hungarian Lowland, the ecoregion of the Dinaric Western Balkans and the ecoregion of the Mediterranean Sea. Thanks to its position and relatively well preserved ecosystems and habitats, Croatia has very high biodiversity, which manifests itself in the richness and diversity of flora and fauna, particularly in the legally protected nature areas (8 national parks, 10 nature parks and numerous reserves and other protected areas), which encompass about 10 % of the national territory and are often directly related to water and water ecosystems. Biodiversity in Croatia, regardless of a rather dynamic socio-economic development in the last century or so, is also high in other parts of the national territory.

2. Water management

Water is a public resource which, because of its natural properties, cannot be anybody's property and thus pursuant to the Constitution of the Republic of Croatia enjoys special protection of the Republic of Croatia. Water management consists of a group of activities, decisions and measures meant for the purpose of maintenance, improvement and establishing of the integrity of the water regime in a given area, which is achieved in particular by providing the required quantities of water of adequate quality for various purposes, by protection of water against pollution, regulation of watercourses and other water bodies, and by protection from adverse effects of water.

The legal foundations of water management in Croatia are defined by the Water Act, the Water Management Financing Act and their bylaws, with individual provisions related to water found also in several other laws which regulate other legal areas.

The territory of the Republic of Croatia is, for water management purposes, divided into 4 water basins and 34 catchment areas. The water basin comprises one or more catchment areas of major river watercourses, or parts thereof, constituting a natural hydrographical entity, whereas the catchment area comprises, within a water basin, one or more catchments of minor watercourses for which integrated water

management is provided, with respect to interconnected problems, existing water system and economic conditions.

The planning basis for water management in Croatia is the Water Management Master Plan of Croatia and the water management plans and schemes of the catchment areas.

The Water Management Master Plan of Croatia is a long-term planning document which is systematically harmonized with changes occurring in the water system and socio-economic development, and is also mutually harmonized with the National Physical Planning Strategy, Environmental Protection Strategy, the state-level forest management planning documents and the planning documents of inland navigation system development.

Water management in the Republic of Croatia is under the competence of the Ministry of Agriculture, Forestry and Water Management as a state administration body and Croatian Water as a state agency. Due to the geographical and hydrographical characteristics of Croatian national territory, international cooperation is one of the key factors in water management in Croatia. So far, Croatia has concluded bilateral agreements on cooperation in the field of water management with the neighbouring countries of Hungary, Slovenia and Bosnia-Herzegovina, whereas the signature of such agreement with Serbia and Montenegro is under preparation. At the multilateral level, Croatia has signed the Convention on the Protection of the Danube River, the Framework Agreement on the Sava River Basin, the Barcelona Convention for the Protection of the Mediterranean Sea against Pollution and the Helsinki Convention on the Protection and Use of Transboundary Watercourses and International Lakes.

Due to their role in the hydrological cycle, ecosystems have a great significance in water management. Water management, combined with preservation of ecological functions at the level of species, habitat, ecosystem and landscape is, therefore, specially emphasized in the Strategy of Biological and Landscape Diversity of the Republic of Croatia as one of the goals of the sustainable development of the country.

3. Ecosystem role in water management

3.1. Forest ecosystems

Forests are the most preserved landscape component in Croatia. According to their share in the national territory (approximately 45 %), Croatia belongs to more wooded countries in Europe, with over 90 % of Croatian forests having their natural structure. The diversity of Croatian territory enabled the growth of numerous species of deciduous and coniferous trees, which form different types of forests, from willow forests in Kopacki rit on the Danube river banks, juniper forests on the mountaintops of Mt. Risnjak and Mt. Velebit to holm oak forests on the island of Mljet. Integrated approach to forest management, which dominates Croatian forestry, is incorporated into all significant regulations on forest management, i.e. the Forest Act and the Regulation on Forest Planning. A part of Croatian forests is specially protected under the Forest Act and the Nature Protection Act. Responsible for forest management in Croatia are the Ministry of Agriculture, Forestry and Water Management as a state administration body and Croatian Forests as a public company for the management of forests and forest lands in the Republic of Croatia.

The interaction between forest and water is multiple and inseparable; therefore, each permanent change in one system necessarily causes changes to the other. Due to a high level of interdependency between forests and water, wetland forests are the most sensitive ecosystems and also the ecosystems most abundant in organisms. The wetland forests along Croatian rivers are relatively well preserved and characterized by their natural state, both according to the composition of species and their structure.

Forests have a favourable influence on the mitigation of hydrological extremes in watercourses, i.e. mitigation of surface runoff rate and a potential to retain large water quantities on the surface, their infiltration and groundwater recharge as well.

Forests in riverbank zones protect ecosystems of watercourses and other landscape by creating a connection between them. They are a crucial part of these ecosystems, since they serve as sources and/or storages of nutrients necessary for their functioning. At the same time, riverbank forests also protect watercourses from riverbank erosion.

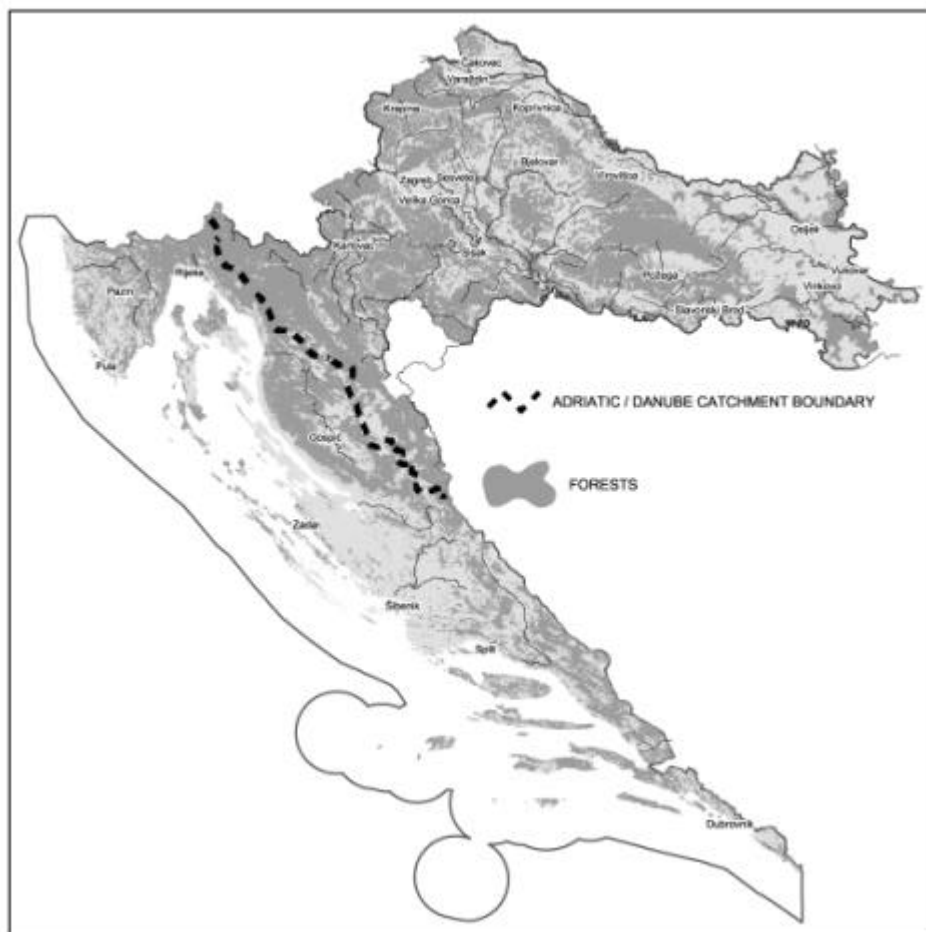


Fig. 1: Spatial distribution of forests in Croatia

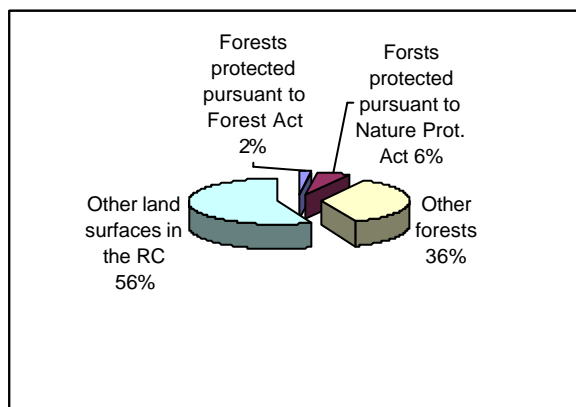


Fig. 2: Share of protected forests in Croatia pursuant to the Nature Protection Act and the Forest Act

Forests play a great part in the protection of soil from erosion processes which cause major damages. On one hand, they flush out fertile soils on sloped, unprotected agricultural surfaces in mountainous areas of the river basins, and thus directly reduce agricultural production; on the other hand, they reduce the soils' retention potentials to store stormwater, which expedites the occurrence of torrential flows. In their mountainous stretches, torrential flows create, move and transport great quantities of sediment, which is then deposited in riverbeds in lowland river basin stretches as well as in the retention and storage areas, thus reducing their volumes. Backfilling of riverbeds with torrential deposits makes them insufficiently permeable for normal discharge, which causes floods. The occurrences of erosions in river basins directly influence not only the silting up of watercourses and stillwater, but also the muddying of spring water, which has a negative impact on water supply.

Water, and, to a lesser extent, eolian erosion endanger large parts of Croatia, with the intensity of erosion processes in individual areas depending on the relief, geological characteristics, climate characteristics, vegetation cover and manner of land use. Intensive water erosion processes, with numerous extremely destructive torrents, are particularly present in karst areas with flysch bedrock (hilly, mountainous

parts of central Croatia, the coastal zone and the islands), while in the northern parts of Croatia, although less visible, they are very damaging as well.

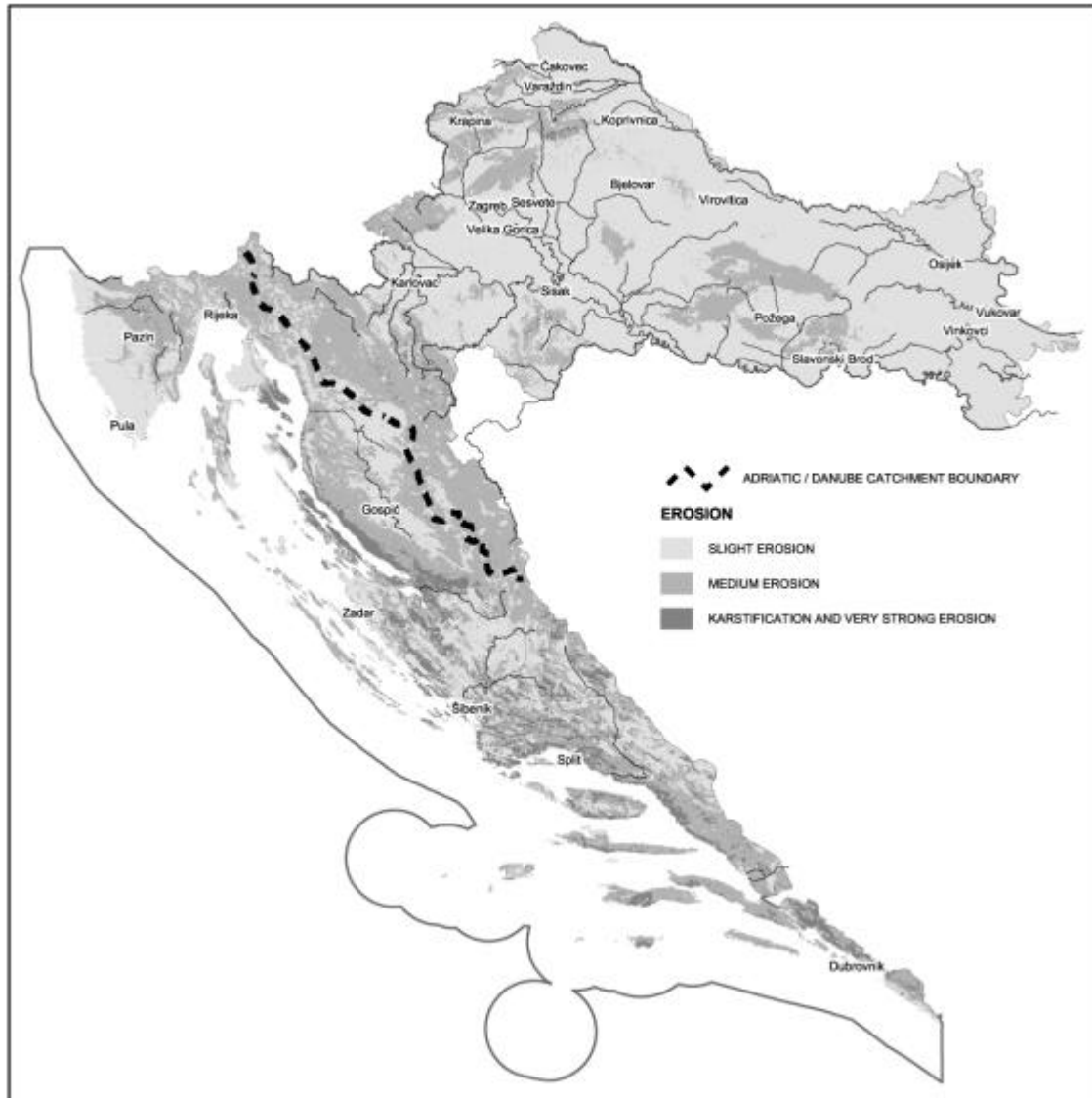


Fig. 3: Erosion status in Croatia

Regulation of torrential river basins by application of a combined approach, by which, on one hand, natural retention capacities of land and vegetation are maintained or improved, and on the other, technical measures with impact on the reduction of peak flows of flood waves and the protection of lowland of torrential flows are carried out, has a long tradition in Croatia. A historical example of the application of this approach in Croatia was the protection of the town of Senj on the Adriatic coast from torrential floods at the end of the 19th century based on the construction of sills in the torrential riverbeds and the afforestation of the basin. In the last hundred years or so, similar approach has been used to regulate numerous torrential watercourses across Croatia, particularly in the Adriatic river basins.

A close cooperation between forest and water management in Croatia has a long tradition, which recently opened up possibilities for establishing even more efficient cooperation by means of placing both activities under the competence of the Ministry of Agriculture, Forestry and Water Management. Forest management, for instance, excludes certain forests from regular maintenance in order to protect the sources of drinking water (management units of Karin, Orlovica, Oton Rimljaca, etc.) or to protect and preserve riverbank ecosystems (Lonjsko polje, etc.). In many cases, water management ensures a favourable water regime for forest growth by applying appropriate technical measures (regulation of the Bosut river basin, etc.).

3.2. Wetland ecosystems

Wetland ecosystems (swamps and frequently flooded areas) have extremely high level of biodiversity, and are found in all Croatia. The major sites in the Danube river basin are located in the areas of the Drava river mouth into the Danube, the Central Sava and Kupa areas, in the area of Spacva forests and in the areas of karst fields around the watershed divide with the Adriatic river basins. In the Adriatic river basins, the largest natural wetlands are located in the Neretva River delta and in the karst fields.

Wetland ecosystems have a great role in sustainable water management, and their particular values are: improved groundwater recharge, reduction of peak flows of flood waves in downstream river stretches, nutrient retention and a potential for development of water-related tourism.

The major part of wetland ecosystems in Croatia is adequately protected pursuant to the Nature Protection Act, with four such sites placed on the list of world natural heritage according to the Ramsar Convention. In the Danube river basin, the Ramsar sites are: Kopacki rit (3) at the Drava river mouth into the Danube, the fishpond of Crna Mlaka (2) and Lonjsko polje in the Sava river basin (1), whereas in the area of the Adriatic river basins a part of the Neretva delta is a Ramsar site (4) (Fig. 4). Institutions responsible for the management of protected areas in the Republic of Croatia are the Ministry of Culture as a state administration body and public institutions for the management of individual protected areas.

Integrated management of protected areas, which includes different aspects, is achieved by the development and implementation of spatial plans for special interest areas, regulation on internal order in protected areas as well as management plans for protected areas. Such documents harmonize often conflicting interests of different water and land users in these areas.

The significance of natural floodplains of the Pannonian Central Danube, Central Sava and Kupa areas for the reduction of peak flows of flood waves in the Danube, Sava and Kupa is clearly visible from charts, which illustrate the changes in average maximum annual discharges at water gauge stations of the said rivers depending on the increase of catchment areas (hydrological data and information from the archives of the Meteorological and Hydrological Service of the Republic of Croatia and Croatian Water). Without these areas, downstream lowlands along the said rivers would be almost impossible to protect from floods in a rational manner.

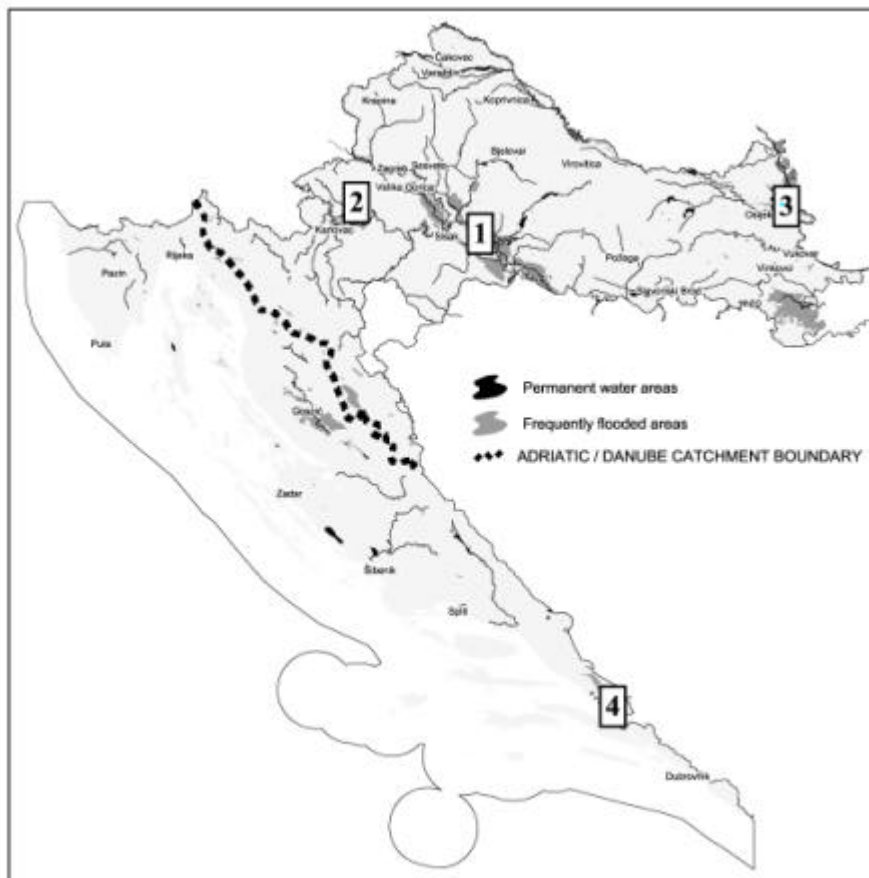


Fig. 4: Frequently flooded areas and the Ramsar sites in Croatia



Fig. 5: The Central Sava flood protection system

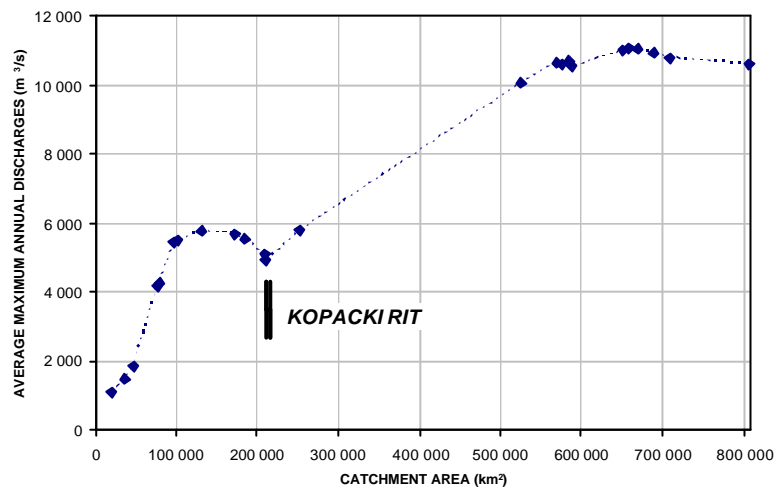


Fig. 6: Average maximum annual discharges of the Danube in relation to catchment areas

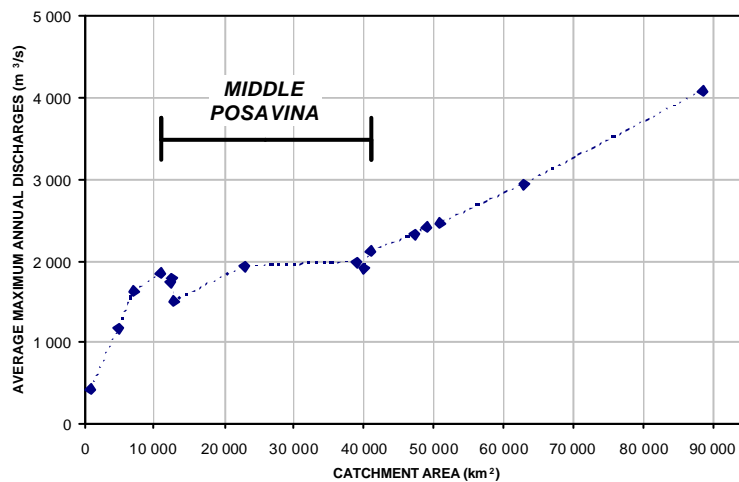


Fig. 7: Average maximum annual discharges of the Sava in relation to catchment areas

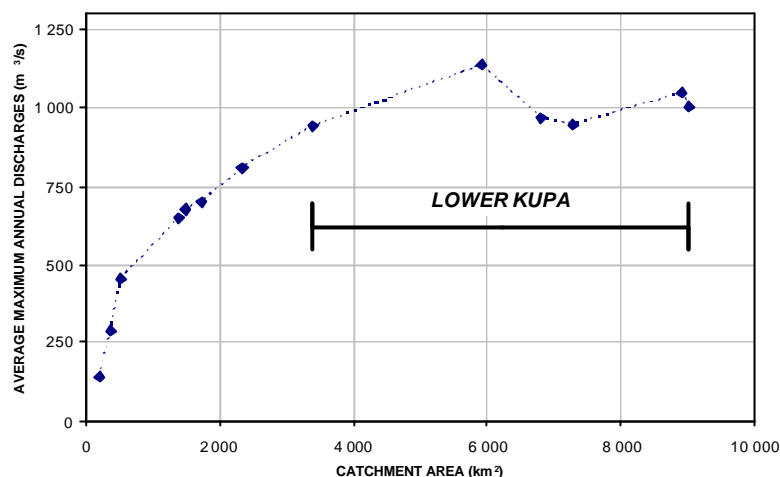


Fig. 8: Average maximum annual discharges of the Kupa in relation to catchment areas

3.3. Other protected areas

Preservation and improvement of relevant water ecosystems and water related ecosystems is a condition for the provision of adequate water quality for water uses such as water supply, bathing, recreation as well as fish and shellfish farming and for the purpose of protecting human health. Biodiversity contributes to the preservation of high water quality in these areas, and is simultaneously its indicator.

There are many examples of interdependency of biodiversity and high water quality all across Croatia. In the Danube river basin some fishponds particularly stand out due to their biodiversity, where numerous endangered bird species find a safe haven, and whose existence in itself is an indicator of high water quality. In the area of the Adriatic river basins one can single out as a special example the preserved ecosystem of the freshwater Vransko Lake on the island of Cres, whose waters are used for water supply of the islands of Cres and Lošinj.

The ecosystem protection in these areas is mostly regulated by the existing legislation related to water and nature protection.

4. CONCLUSION

Ecosystem role in Croatian water management is significant and mostly regulated by the existing national legislation. By becoming a candidate country for the EU membership, Croatia has made a commitment to gradually harmonize its national legislation with the relevant EU legislation. In the field of water management, the national legislation has to be harmonized with the requirements of the EU Water Framework Directive and related directives, and water management plans based on individual river basins should be developed and implemented, which will give a new dimension to the ecosystem role in water management.

5. LINKS

1. Ministry of Agriculture, Forestry and Water Management of the Republic of Croatia (<http://www.mps.hr> or <http://www.duv.hr>)
2. Ministry of Culture of the Republic of Croatia (<http://www.min-kulture.hr>)
3. Croatian Water (<http://www.voda.hr>)
4. Croatian Forests (<http://www.hrsume.hr>)
5. Meteorological and Hydrological Service of the Republic of Croatia (<http://meteo.hr>)
6. Public Institution Lonjsko Polje Nature Park (<http://www.pp-lonjsko-polje.hr>)
7. Public Institution Kopački rit Nature Park (<http://www.kopacki-rit.com>)