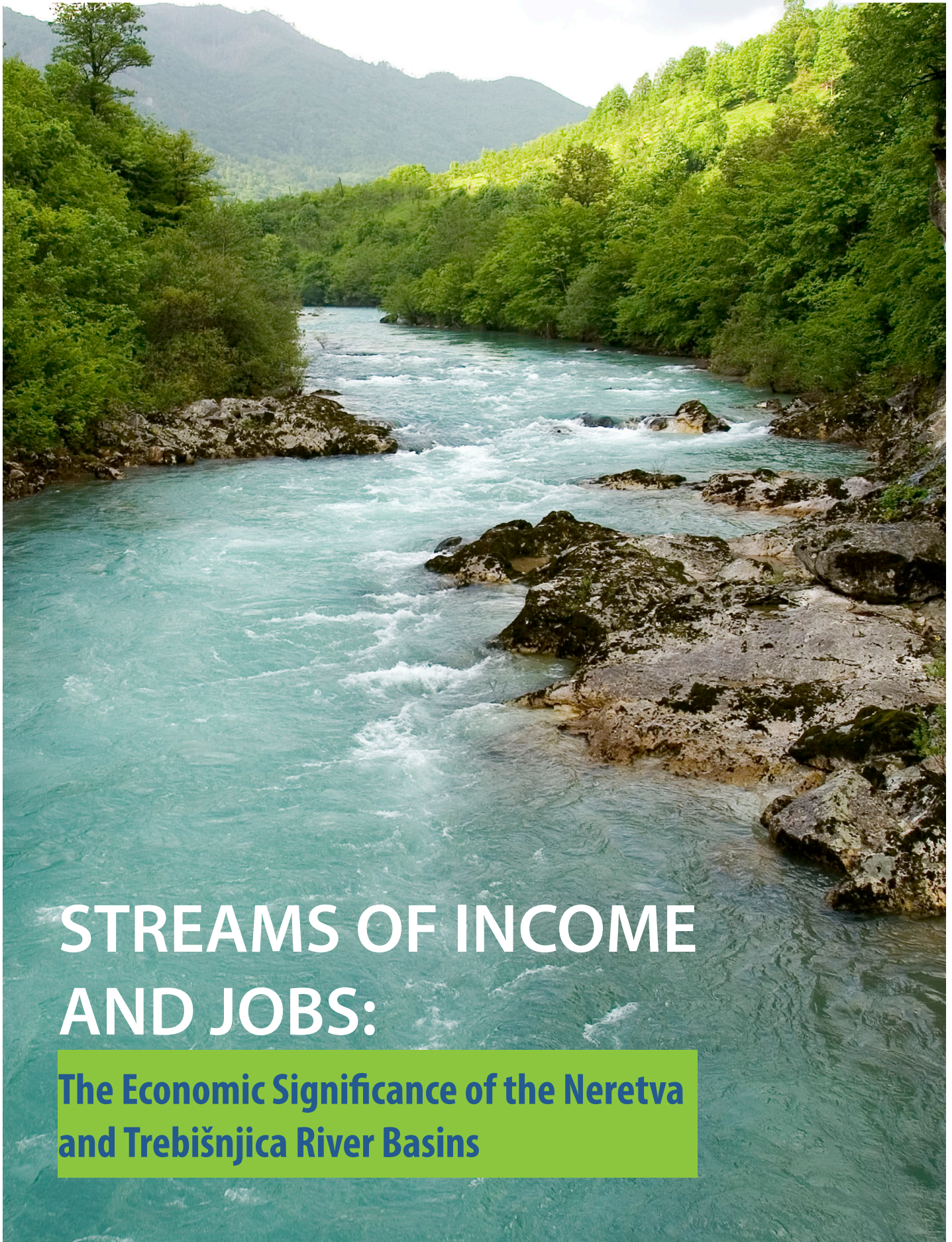




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# STREAMS OF INCOME AND JOBS:

**The Economic Significance of the Neretva  
and Trebišnjica River Basins**



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As at

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# EXECUTIVE SUMMARY

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This study provides economic evidence as to why it is critically important that the Neretva and Trebišnjica basins are managed in an integrated and transboundary way. Through this study the World Wide Fund for Nature (WWF) and the Open Regional Fund for South-East Europe – Biodiversity (ORF BD) “Ecosystem services and valuation in future course of action in South-East Europe Region (ESAV)” implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) and funded by German Federal Ministry for Economic Cooperation and Development (BMZ) set out to identify how many jobs and how much revenue is dependent on waters from the Neretva and Trebišnjica basins.

The study provides baseline information about the role of water in key sectors in the basins’ economies. It is a snapshot of ‘what’s at stake,’ as decision makers in Croatia, Bosnia and Herzegovina, and its two entities of Federation Bosnia and Herzegovina and Republika Srpska, and Montenegro weigh their options to manage shared water resources for sustainable development, environmental management and protection, and disaster risk reduction.



This information is critical. Decision makers across the region lack a comprehensive understanding of the value and interdependence of their shared water resources, and conversely, of the common costs that will result to all parties if the natural ecosystems that guarantee the quality and availability of these shared water resources are degraded or depleted. The natural water regime in the basins has already been permanently altered. Stretches of the Neretva and Trebišnjica are channelized for navigation and to fuel complex hydropower systems; and surrounding wetlands drained for agriculture.

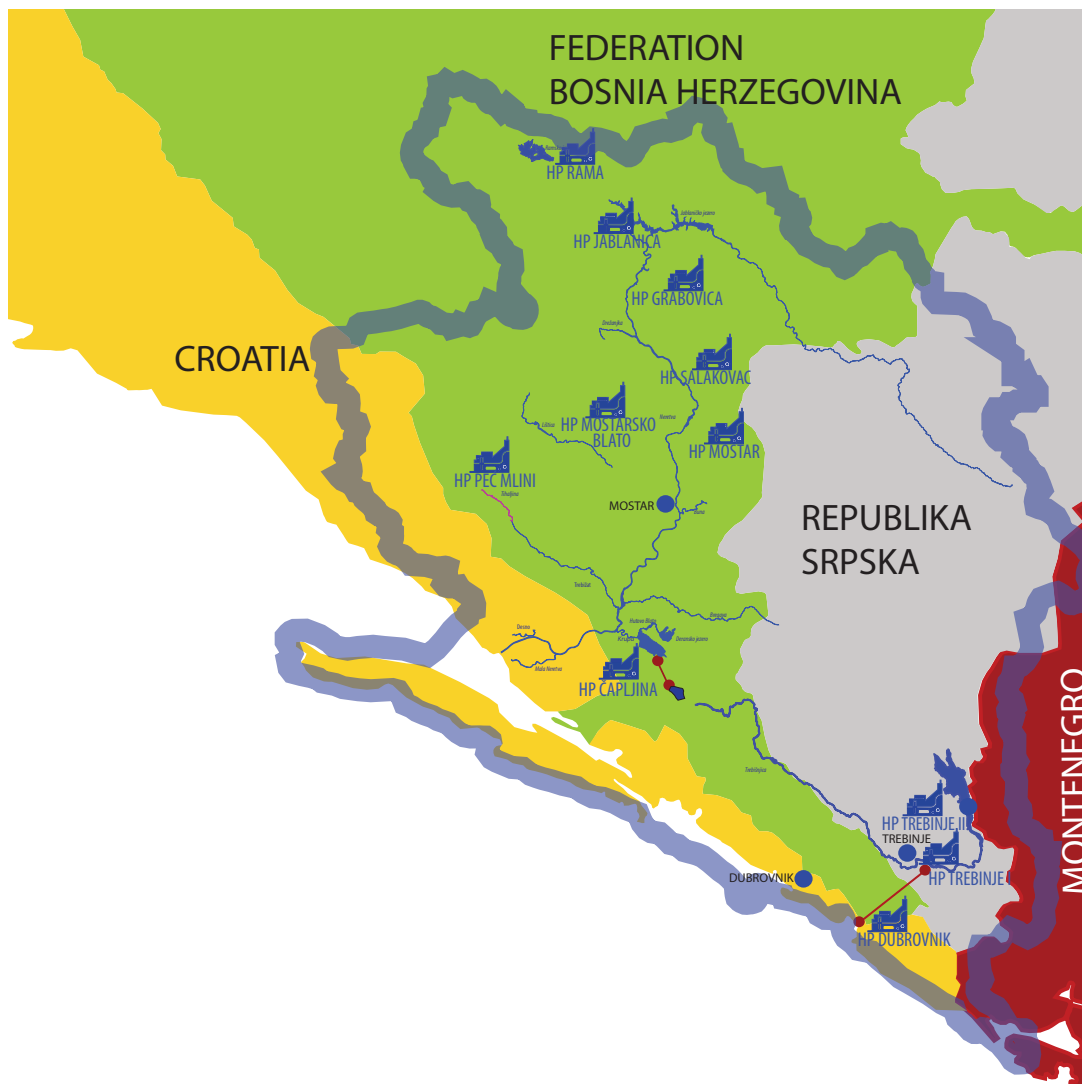
While the largest threat to the natural ecosystem of the basins has already been realized – the altered water regime – additional threats of increased salt-water intrusion and vulnerability to climate change are further impacting on already damaged ecosystems. This is reducing the quality and quantity of the benefits to people from the ecosystem services they provide. Continued degradation is disrupting agriculture in the basins and threatening the provision of municipal public water. Biodiversity and rare examples of Mediterranean wetlands are disappearing, along with community access to traditional activities.

While these threats are widely known, the four jurisdictions covered in this study are continuing to make separate water management decisions that can and do negatively affect both their own and each other's communities, economies, and the environment. Communicating baseline information about what is at stake economically and thus also socially is a crucial step to being able to model future scenarios for how water management decisions could impact on different economic sectors and municipalities across the region – let alone biodiversity and the environment.

This study examines three water-dependent sectors that are interlinked with each other: hydropower, agriculture, and public water supply in the municipalities in the Neretva and Trebišnjica basins in Croatia, the two entities in Bosnia and Herzegovina, and Montenegro. It also takes an in-depth look at three economic activities that are particularly important to the regional economy and are critically dependent on water: tangerine farming, wine production, and tourism in selected parts of the basins.

## Highlights – The Value of Water for Electricity

Hydropower provides a particularly high economic return in terms of revenue and jobs from Neretva and Trebišnjica basin waters. Some of the water that is managed through the network of dams and tunnels goes on to provide public water supplies or is used for irrigated agriculture, thereby generating even more value-added to the economy. As such, hydropower production decisions – how much water is released, to where, and at what times during the year – have a major impact on other sectors in the basins. This study shows the amount of cubic meters (m<sup>3</sup>) of water used annually to produce hydropower in the study area, and what this translates to in terms of revenue and jobs.



**The value of the Trebišnjica hydropower system:** Three jurisdictions are operating hydropower facilities in the Trebišnjica basin, sharing about 2.7 billion cubic meters (m<sup>3</sup>) of water per year and generating more than 2,000 gigawatt hours (GWh) of electricity in 2016. This is about 20 percent of the total electricity supply for Republika Srpska, 9 percent for Federation Bosnia and Herzegovina, and 4.3 percent for Croatia.

The combined total revenue attributable to this hydropower was €156 million in 2016. This equates to about 19 m<sup>3</sup> of water to generate every €1 of revenue. The GWh generated and revenue attributable to this production is summarized in Table 1 Summary of Trebišnjica hydropower system 2016.

**Table 1 Summary of Trebišnjica hydropower system 2016**

Country/Entity	No. Facilities	Installed capacity (MW)	GWh generated	% of Country/ Entity Total	Total attributable revenue (€)
Croatia	1 (shared)	208	730	4,30%	83.000.000
Republika Srpska	3 (1 shared)	296	1.188,95	20%	56.000.000
Federation B&H	1	440	145,25	9%	16.900.000
Total	4	944	2.064,20		155.900.000

**The value of the Neretva hydropower system:** Two electricity utilities in Federation Bosnia and Herzegovina are operating a total of seven hydropower facilities in the Neretva basin. The utility in Western Herzegovina, Elektroprivreda Hrvatske zajednice Herceg Bosne (HZHB) sources 68 percent of its electricity from four hydropower plants, while Elektroprivreda Bosnia i Herzegovina (BiH) sources 19 percent from its three facilities.

Overall in 2016 the total revenue attributable to the more than 2,400 GWh of hydropower production in the Neretva basin was about €219 million. In terms of m<sup>3</sup> of water required for €1 of revenue, the average across the Neretva basin is 35.5 m<sup>3</sup> for €1. See Table 2 Summary of Neretva hydropower system 2016 for details.

**Table 2 Summary of Neretva hydropower system 2016**

Federation Bosnia and Herzegovina	No. Facilities	Installed capacity (MW)	GWh generation	% of Public Utility Total	Total attributable revenue (€)
Elektroprivreda BiH	3	505	1.394,40	19%	90.287.620
Elektroprivreda HZHB	4	327	1.047,61	68%	128.284.720
Total	7	832	2.442,01		218.572.340

<sup>1</sup>Note, the average tariff across all categories of users is as follows: about €0.11 per kilowatt hour (KWh) in Croatia, about €0.07/KWh for Elektroprivreda BiH customers and €0.06/KWh for Elektroprivreda HZHB in Federation BiH, and €0.05/KWh in Republika Srpska.



**The value of employment in hydropower:** The research team collected employment data for the production of hydropower. Below is a summary of the number of people employed in the hydropower plants in the study area by jurisdiction, and in the case of Federation Bosnia and Herzegovina by utility as there are two. The table also includes the total 2016 GWh of hydropower generated. By looking at these two sets of figures it is possible to show a ratio of how many GWhs each ‘job’ generates. This ratio of GWhs per job in a hydropower facility is shown in the final column in Table 3 Jobs per GWhs of hydropower.

**Table 3 Jobs per GWhs of hydropower**

Location	Jobs in hydropower production	Amount Generated (GWH)	Ratio GWh per Job
Croatia	58	734	13 GWh to 1
Republika Srpska	695	1.190	2 GWh to 1
Elektroprivreda BiH (Federation B&H)	120	1.394,40	12 GWh to 1
Elektroprivreda HZHB (Federation B&H)	358	1.192,86	3 GWh to 1

**Analysis:** While Croatia, Republika Srpska, and Federation Bosnia and Herzegovina all benefit from hydropower in the Neretva and Trebišnjica basins, the jobs dependent on this production is relatively more important for Republika Srpska and the area in Federation Bosnia and Herzegovina serviced by Elektroprivreda HZHB (Herzegovina), than Croatia and the part of Federation Bosnia and Herzegovina serviced by Elektroprivreda BiH (Bosnia).

For example there are 947 total hydropower-related jobs in Republika Srpska, including production, distribution, and sales. This is 6 percent of all employment in that part of the study area. With an average household size of 3, a further 1,894 people are indirectly supported. The total of 2,841 people directly or indirectly supported by hydropower is 4 percent of the total population in that part of the study area. In Croatia in contrast the same analysis shows that the jobs related to its annual hydropower production in the study area are less than 2 percent of all employment, and that the total people supported by those jobs is less than 1 percent of the population in that part of the country.

As is shown in Table 3 Jobs per GWhs of hydropower, there are also significant differences in the ratios of facility-level employment to GWhs generated between the utility companies. HEP Group in Croatia and Elektroprivreda BiH have similar ratios: 13 GWh to each job and 12 GWh to each job, respectively. Elektroprivreda Republika Srpska and Elektroprivreda HZHB also have similar ratios: 2 GWh to 1 and 3 GWh to 1, respectively. These differences could reflect differing perspectives among decision-makers (i.e. preference for profit maximization and efficiency v. preference for higher employment). They also show that a significant disruption to the Trebišnjica or Neretva systems would adversely impact the economy of Republika Srpska and Herzegovina much more than Croatia or Bosnia.

The differing relative value of hydropower is also reflected in the ongoing negotiations between Croatia, Federation Bosnia and Herzegovina, Republika Srpska, and Montenegro over current electricity sharing arrangements and the possible expansion of the Trebišnjica

hydropower system. While these negotiations have been ongoing for decades now, the potential construction of new hydropower plants along the coast of Croatia and Boka Bay in Montenegro would mean that large quantities of water would no longer be available for irrigation of agriculture land in Republika Srpska, Federation Bosnia and Herzegovina and the Neretva Delta in Croatia. However, agriculture is an important sector and thus there would be economic consequences – a trade-off – between diverting more water to the coast for hydropower generation versus continuing to divert water for irrigated agriculture in-land.

## Highlights – The Value of Water for Agriculture

Agriculture is another primary sector<sup>2</sup> that relies on water from the Neretva and Trebišnjica basins and about 20 percent of the total study area, 343,241 hectares, is arable land. To understand the value of water in the Neretva and Trebišnjica basins in terms of revenue and jobs from irrigated agriculture, this study set out to determine the m<sup>3</sup> of water required annually for irrigation. As the amount of water used for irrigation in Federation Bosnia and Herzegovina was not recorded in any of the jurisdictions in the study area, this was calculated by applying average crop water requirements to the yield of 28 irrigated crops, and then comparing this to crop revenues. In Croatia, conflicting data about the hectares of agriculture land means that it was only possible to value tangerines (the major cash crop) in the Neretva Delta. Similarly, in Republika Srpska, data limitations meant that analysis was confined to calculating the value of irrigated water to the key sector of wine production. The key findings are below by jurisdiction.

### **The Value of Water for Irrigated Agriculture in the Study Area in Federation Bosnia and Herzegovina:**

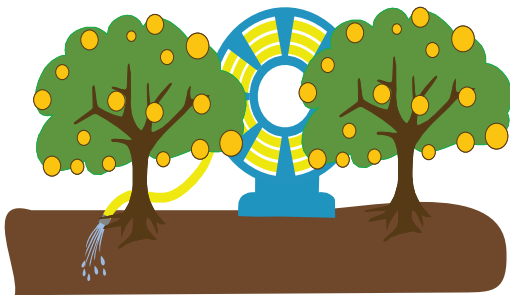
- About 23 percent of agricultural production in Herzegovina-Neretva Canton is irrigated and 26 percent in West Herzegovina Canton (around 16 percent of total agriculture land).
- In 2016, irrigated agriculture required 3,387,488 m<sup>3</sup> of water, and €23,074,801 in revenue is attributable to it
- 6.8 m<sup>3</sup> of irrigated water equates to €1 of agriculture revenue
- About 5 percent of the population (16,406 people) are supported by agriculture as either a primary or secondary source of income

<sup>2</sup> The national agriculture sector as a whole is about 4 percent of Croatia's GDP and about 8 percent of Bosnia and Herzegovina's GDP.

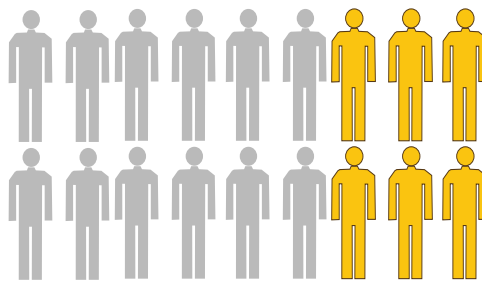
### The Value of Water for Tangerines in the Study Area in Croatia:

- In the Neretva Delta about 11,088 people, or 1/3rd of the population, are supported by agriculture as either a primary or secondary source of income
- Over the past five years average annual revenue from the sale of tangerines from Dubrovnik-Neretva County is about €15 million a year
- While the average is €15 million a year, over the past five years revenue from tangerines has fluctuated greatly, from €17 million in 2012 up to €23 million in 2014 and down to €8 million in 2016
- On average about 5.8 m<sup>3</sup> of water is equal to €1 of tangerine

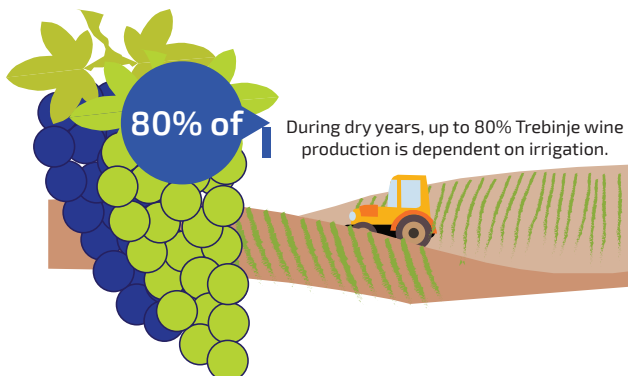
Average annual revenue from the sale of tangerines is about €15 million a year



In the Neretva Delta over 11,000 people, 1/3rd of the population, are supported by agriculture



**The Value of Water for Wine Production in the Study Area in Republika Srpska:** The study examined the four largest commercial vineyards in the Trebinje municipality, which together account for 40 percent of all wine production in the study area in Republika Srpska. In 2016 these vineyards produced about 560,000 liters of wine generating €4.6 million in revenue. During dry years up to 80 percent of commercial wine production near Trebinje is dependent on irrigation. In the dry year of 2015, €3.8 million in revenue from commercial vineyards is attributable to water from the Trebišnjica basin.



**Analysis:** As noted above, data limitations meant that it was only possible to value irrigated tangerine production in the Croatian part of the study area, and for wine production in Republika Srpska. It should however be emphasized that further data and analysis are required to assess the value of agricultural water use. This could be accomplished by applying the methods developed by the current study to value irrigated production in Federation Bosnia and Herzegovina to other parts of the basins.

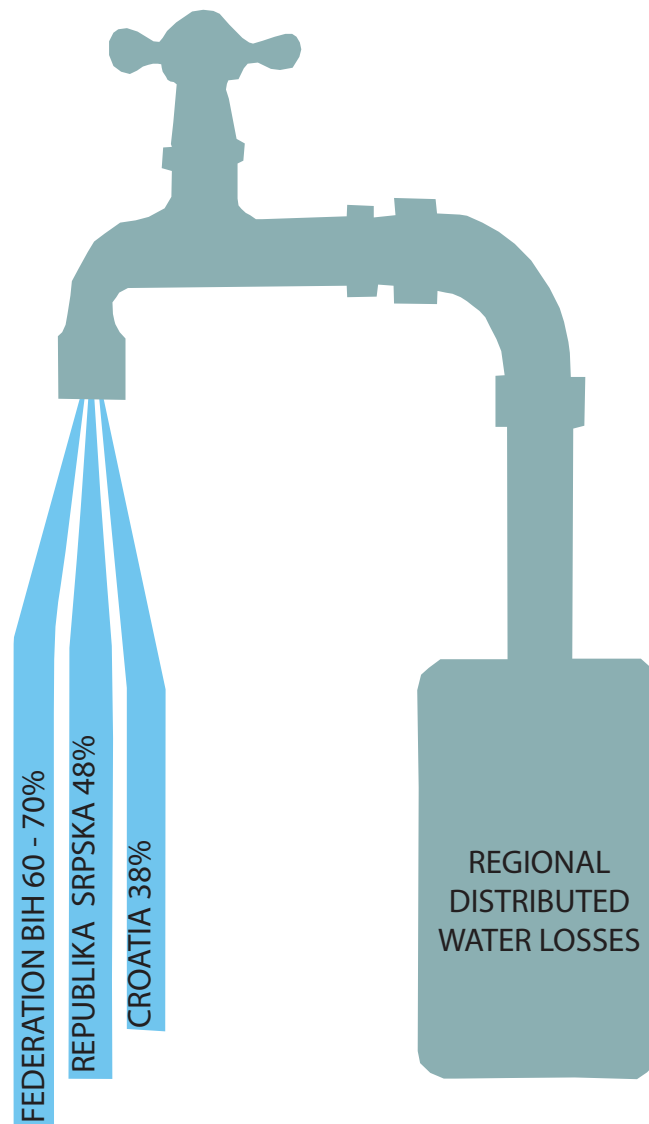
This analysis is important as without data on the amount of water needed for irrigation decision-makers do not have enough information to evaluate the potential impact on agriculture communities of reduced irrigated water supply. Such reductions are a very real possibility. Already salt-water intrusion is increasing into the Neretva Delta, degrading the quality of freshwater and agriculture land. Furthermore, if new hydropower infrastructure were to be built on the coasts, more freshwater would be diverted and released into the Adriatic Sea. Less would be available to divert to agriculture areas, particularly the Neretva Delta. As such, it is important for water managers and policy makers in the Neretva and Trebišnjica basins to understand just how much agriculture in their jurisdictions is dependent on irrigation.

## Highlights – The Value of Public Water Supplies

Municipal water supply is another demand on the finite water resources of the Neretva and Trebišnjica basins. Also as tourism in the study area expands, particularly in coastal areas of Croatia and Montenegro, there is an overall increasing demand for water. To show what is at stake for this sector the study investigated the amount of water from the Neretva and Trebišnjica basins currently being supplied into public water systems and distributed to end users. The key results are below:

- In Republika Srpska 1.1 m<sup>3</sup> of distributed water equates to €1, but losses are estimated as high as 48 percent in the system. If those losses are taken into account, about 2 m<sup>3</sup> of supplied water equals €1.
- In Federation Bosnia and Herzegovina 1.2 m<sup>3</sup> of distributed water equates to €1, but average losses of supplied water are between 60 to 70 percent. If those losses are taken into account, up to 4 m<sup>3</sup> of supplied water equals €1.
- In Herceg Novi in Montenegro 1.3 m<sup>3</sup> of distributed water equates to €1. No data on losses was found.
- The research team was unable to analyze this sector for the part of Croatia in the Trebišnjica and Neretva basins due to a lack of municipal-level data. Nation-wide data was available, showing overall losses of 38 percent.

**Analysis:** Overall the findings for revenue from distributed water for Republika Srpska, Federation Bosnia and Herzegovina, and Montenegro are largely consistent, between 1.1 to 1.3 m<sup>3</sup> per €1 in revenue. However the picture changes if losses are taken into account, with up to 4 m<sup>3</sup> per €1 in revenue in Federation Bosnia and Herzegovina. The high level of losses indicates weaknesses in the municipal water systems, infrastructure in need to repair and unrecorded/unpaid water users. As these water losses are not tracked, it is another indication that water managers and policy makers do not have a clear picture of how the basins' water resources are being used. But, as for agriculture, this information is fundamental to being able to make informed decisions. As a growing number of people are visiting the area, particularly the coasts of Croatia and Montenegro, having secure public water supply is increasingly important.

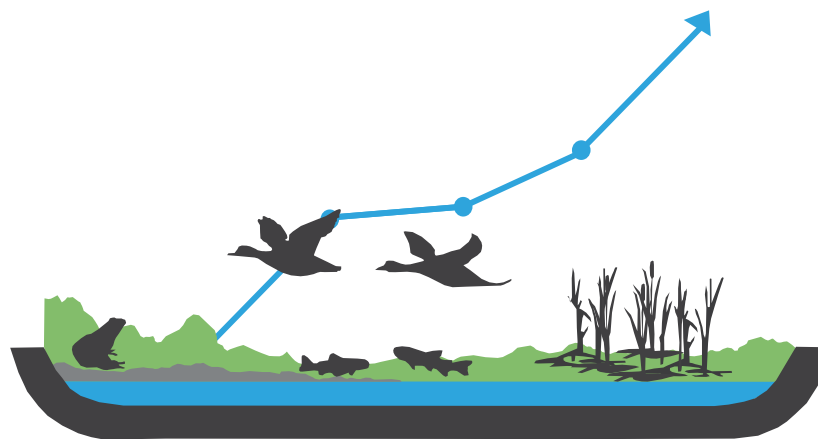


## Highlights – The Value of Water for Tourism

The beauty of the natural environment and the rich cultural traditions of the Neretva and Trebišnjica basins are attractive and tourism to the study area is growing, in particular to Croatia. In 2016 in Dubrovnik-Neretva County revenue from tourism was about €613 million – about half of that county’s GDP and 12.3 percent of Croatia’s total tourism revenue. The study focused on bird-watching tourism to the Neretva Delta, finding that that tourism to the area is increasing rapidly and is largely dependent on the freshwater ecosystems of the area. Key findings are:

- The number of tourists served by nine companies in the delta shows an average 224 percent increase in only 5 years; from 66,000 people in 2012 to 148,000 in 2016
- In 2016, 83 percent of visitors, 122,300 people, came to experience the unique water values of the area
- In 2016 the revenue attributable to this water-based tourism was €6.67 million and if current trends continue this number will increase.

### Tourism has increased by 224% in only five years



80% of visitors, over 120,000 people, come to the Neretva Delta because of its freshwater resources.  
In 2016 this tourism was worth €6.67 million

**Analysis:** Revenue from tourism is growing rapidly. In contrast, revenue from tangerines is in a steep decline – from €17 million, in 2012 to €8 million in 2016. While it is simplistic to suggest that the increase in tourism revenue could or would offset the drop in revenue from tangerines to the population, it does suggest 1) that tourism is an increasingly important economic activity for communities in the Neretva Delta, and 2) that more than 80 percent of this tourism is based on the wetlands and water ecosystems of the delta.

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## Conclusion:

The study found that the Neretva and Trebišnjica basins are of critical economic significance at local, national, and regional levels. It is in everybody's interests to ensure that these important shared water resources are managed in an integrated and transboundary way, for sustainable development, environmental management and protection, and disaster risk reduction. Just looking at a partial picture of the economics of water use in the four sectors investigated by the study – hydropower, public water supplies, tourism, and selected agriculture production – shows gross primary returns totaling almost €450 million a year, generating values of between €0.04 - €0.68 per cubic meter of water. Tens of thousands of jobs – and hundreds of thousands of livelihoods – depend directly on these water-based activities. Taking into account the substantial multipliers which link these sectors to additional jobs, earnings, and production in the rest of the economy would increase these values many times over.

The study has however also highlighted some major data gaps, which hinder understanding and awareness of the full economic value of water in the Neretva and Trebišnjica basins. Clear and comprehensive data is readily accessible about how water is being used for hydropower and its contribution to revenue and jobs. The electricity sector results of the study reinforce what is already commonly known, that hydropower is a significant source of revenue and jobs in the study area in Republika Srpska and Federation Bosnia and Herzegovina. In contrast however, data on the use of water for agriculture and municipal water supplies is not readily available and in many cases is contradictory. But these sectors are also significant users of water and the study shows that many communities are dependent on these water resources. For example, 1/3rd of the population of the Neretva Delta is supported by agriculture.

Without a clear picture on how much water from the Neretva and Trebišnjica basins is needed for these sectors, decision-makers in Croatia, Federation Bosnia and Herzegovina, Republika Srpska, and Montenegro are limited in being able to prioritize investments in improving water-related infrastructure. Moreover, they cannot fully evaluate the economic impacts of decisions to divert water away from agricultural areas for use in different parts of the Trebišnjica hydropower system. Water managers are also limited in their ability to make other decisions, such as which adaptation measures to implement for climate change or disaster risk reduction – let alone to ensure sufficient water resources to support the basins' ecosystems and biodiversity.

Underlying these challenges is the fact that the Neretva and Trebišnjica basins are transboundary. The policy choices made in one jurisdiction impact on communities in other countries. As the study shows, the importance of different water-reliant sectors is relative. Hydropower production has a higher value in terms of percentage of revenue and jobs in Republika Srpska than in Croatia, whereas agricultural communities in the Neretva Delta in Federation Bosnia and Herzegovina and Croatia see more benefits from irrigation. Coastal communities in Croatia and Herceg Novi in Montenegro are mostly concerned with secure public water supply. In order to balance these priorities and ensure that water-use trade-off

decisions are made in an inclusive way, policy makers should have access to comprehensive information on how water is being used and the benefits accruing to communities across the basins.

Towards this end, WWF and GIZ/ORF BD are working to establish a permanent and vibrant inter-governmental platform for dialogue between decision-makers about the management of the basins' shared water resources. Such structured discussion will result in better coordination, implementation, and strengthening of the existing Transboundary River Basin Management Framework and its constituent management plans, and other mutually agreed principles and action plans intended to guide the joint development of a transnational Neretva and Trebišnjica water management system. A joint system will allow for coordinated climate change adaptation, disaster risk reduction, electricity generation and secured livelihoods; all while minimizing further damage to critical ecosystems.



# BACKGROUND OF THE BASINS

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The Neretva and Trebišnjica basins are a contiguous system spanning approximately 17,500 square kilometers in the heart of Southeastern Europe's unique Dinaric karst region. This region includes flat valleys bounded by limestone ridges and rolling badlands above a network of deep open pits, underground caverns, and subterranean rivers. With its specific karst landscape, climate, soil, hydrology, biodiversity, and other natural characteristics the area is of international importance. It is also international in its management as three countries and four political entities share jurisdiction over the basins: Croatia, Montenegro, and Bosnia and Herzegovina with its two entities of Federation Bosnia and Herzegovina and Republika Srpska. Below is a short description of the basins.

**Neretva basin:** The Neretva river is one of the largest in the western Balkans flowing 225 kilometers from its source deep in Bosnia and Herzegovina and emptying into the Neretva delta and the Adriatic sea in Croatia. The river drops steadily in elevation from 370 km above sea level to 40 km, a drop that has been exploited for hydropower production. South of the city of Mostar, the river spreads into the Neretva delta and crosses into Croatia for an additional 22 km before emptying into the Adriatic sea. The Neretva carries large quantities of dissolved nutrients and organic substrates into the delta, which is characterized by fertile alluvial soil. As is typical of rivers in a karstic system, up to 40 percent of the tributaries of the Neretva flow underground.

**Trebišnjica basin:** The Trebišnjica basin also has more underground flows than surface waters, and the Trebišnjica used to be Europe's longest sinking river. However the construction of the Trebišnjica hydropower system resulted in a permanent change to the water regime of the area. Concrete channels now keep much of the Trebišnjica at the surface and its flows are regulated all year round. However, the basin still has a network of smaller underground rivers with long underground flows. The Trebišnjica basin is connected to the Neretva basin, with waters from the Trebišnjica basin draining into the Neretva delta from about sixty sources. Waters from the Trebišnjica basin also flow directly into the sea from numerous subterranean springs all along the coast of Dubrovnik-Neretva County in Croatia.

**The Neretva delta:** The delta is one of the largest and most valuable remnants of Mediterranean wetlands because of its biodiversity and variety of landscapes. The delta has large reed beds, wetlands, wet meadows, beaches, sand dunes, saltmarshes, lagoons, and karst formations. As such it is listed as a Wetland of International Importance under the Ramsar Convention to which both Croatia and Bosnia and Herzegovina are signatories, implying commitment for the responsible management and use of listed wetlands. The delta today has about 20,000 hectares of unique alluvial wetlands, of which 12,000 hectares are in Croatia, and about 8,000 hectares are in Bosnia and Herzegovina.

The delta is a crucial stop on bird migration routes between Europe and South Africa. Scientists have recorded 311 bird species in the delta, and among them 116 nesting birds including 35 species of water birds. The delta is also an important environment for fish. Among the hundreds of fish species recorded in the area, 35 are freshwater fish and 11 are endemic to the eastern part of the Adriatic.

The basins also provide significant cultural, historical, and aesthetic values. The Neretva and Trebišnjica basins, with their specific landscape, climate, soil, hydrology, biodiversity, and other natural characteristics, influenced the development of culture and lifestyles in the area. The region's karst formations are a natural bridge between east and west, north and south, and the border between different civilizations. This is particularly evident in the Neretva delta.

**Key threats to ecosystems and biodiversity:** The main threat that has already had a substantial impact on the ecosystems and biodiversity of the basins is the altered water regime. This is not a new development. In fact, people have been altering the basins' water flows and ecosystems since at least the late 17th century. Between the 17th-19th centuries these alterations focused on claiming land for agriculture in the delta through the construction of dykes, and later the channelization of the Neretva to aid navigation. As a result, where once the Neretva had twelve branches over an area of 10,500 km<sup>2</sup>, now there is one central channel surrounded by intensive agriculture, settlements, and reservoirs.

In the 20th century the complex Trebišnjica hydropower system and hydropower facilities in the Neretva basin were constructed. These systems were created without consideration of the impact they would have on the water regime of the Neretva and Trebišnjica basins, and in particular on the Neretva delta. Over the past fifty years the operation of these hydropower systems has degraded ecosystems across the basin. A prime example of this disruption is the wetland areas of Hutovo Blato.

**Hutovo Blato:** Hutovo Blato in Federation Bosnia and Herzegovina has been under various forms of protection since 1954 and in 2001 was listed under the Ramsar Convention. Thirty years ago it was a rare surviving example of Mediterranean wetlands with diverse and globally significant biodiversity with over 700 plant species, 235 bird species and 44 fish species. Due to the Trebišnjica hydropower system the amount of underground water emptying into Hutovo Blato was reduced, and now an artificial network of canals and hydropower installations drains into the site. Svitava Lake, which was once a part of the wetland, was converted to an artificial reservoir. Other sections have been reclaimed as agricultural land.

Due to these changes in the water regime there are now 30 to 40 percent fewer birds recorded in the area and fish populations declining. The final part of Hutovo Blato remaining in near natural condition, Derane Lake, is clogging with sedimentation and vegetation as 50 percent of the water that once flowed into the area is now diverted for electricity production. WWF is leading efforts to ensure minimum water flow to Hutovo Blato to save the remaining wetlands in near natural condition – as they still have considerable value. However, if wetland restoration work is not conducted and minimum flows established, WWF estimates that the remaining wetlands will disappear in the next 30 years.

Hutovo Blato remains an important link in the Adriatic flyway for migratory birds, providing crucial habitats for wintering and nesting species, and recreational fishing is an important traditional activity in the area. WWF's hydrological studies show that it is possible to restore parts of Hutovo Blato through a combination of additional water supplied from the Trebišnjica basin and manual removal of sediment and vegetation). Overall, this restoration work would protect only be about 10 percent of the historical natural wetlands of the Neretva delta.

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The wetland of Hutovo Blato is not the only casualty of the altered water regime, and other areas of the delta are increasingly affected by saltwater intrusion. The dams on the upper courses of rivers in the Neretva and Trebišnjica basins are preventing sediment from reaching the lower parts of the delta. As a result, the river bed in the main channel of the Neretva is sinking, allowing the saltwater to reach inland as far as Počitelj in Bosnia and Herzegovina – about 30 kilometers inland. This problem is exacerbated by uncontrolled pumping of groundwater for irrigation, which changes water pressure in the underground system and allows for saltwater intrusion. So far only partial suggestions have been offered to solve the problem of saltwater intrusion and protect remaining wetlands like Hutovo Blato. These suggestions usually only satisfy one set of stakeholders. A full solution to the salinization problem and to restore and protect remaining wetlands will involve stakeholders in all four jurisdictions and require consensus on a whole range of measures.

**Need for improved transboundary water management:** Water use decisions made in one country can and do adversely impact biodiversity, ecosystems, communities, and the economies of the other countries. To balance competing needs for water resources – all while considering the environment – policy makers in this transboundary area are faced with difficult and complex choices. All of the environmental threats and pressures outlined above have implications for the ‘natural infrastructure’ that underpins water availability and quality in the Neretva and Trebišnjica basins – and thus for local and regional economies. However no one government, acting alone, can maximize the social and economic benefits of their citizens. Optimal water management that protects nature and supports development must involve actors in all four political jurisdictions. It requires cooperation and trade-offs, based on consensus on a whole range of measures.

Towards this end, WWF and GIZ/ORF BD are working to establish a permanent and vibrant inter-governmental platform for dialogue between decision-makers about the management of the basins’ shared water resources. Such structured discussion will result in better coordination, implementation, and strengthening of the existing Transboundary River Basin Management Framework and its constituent management plans<sup>3</sup>, and other mutually agreed principles and action plans that are intended to guide the joint development of a transnational Neretva - Trebišnjica water management system. A joint system will allow for coordinated disaster risk reduction, electricity generation and secured livelihoods; all while minimizing damage to critical ecosystems.

WWF and GIZ/ORF BD undertook this study as part of the long-term process to improve transboundary water management in the area. This study makes the economic case for sustained and deepened collaboration by providing evidence of the fundamental role of shared water resources in the economy of the area, asking and answering the question: ‘What does water contribute to the economy of the Neretva and Trebišnjica basins?’



# METHODOLOGY

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Udruga Dinarica, WWF's exclusive implementing partner in Bosnia and Herzegovina, led the preparation of this study and data was collected and analyzed during a six-month period between August 2017 and January 2018. Udruga Dinarica, with technical assistance from GIZ/ORF BD, developed seven sets of questions for the following topics: overall context and land use, electricity, agriculture, public water supply, tangerines, wine, and tourism. Each set included questions, that if answered, would allow researchers to value the contribution of water from the Neretva and Trebišnjica basins in terms of revenue and jobs. Each set of questions investigated the economic inputs, linkages, and multipliers that were associated with different uses of water (i.e. hydropower, agriculture, public water supply) in each of the four jurisdictions.

To collect the data Udruga Dinarica formed a research team, led by its own staff, and comprised of data collectors and water experts in each of the four jurisdictions in the study<sup>4</sup>. The data collectors were instructed to use publicly available data to the extent possible to answer each question. Throughout this report publicly available data, such as published national level censuses, statistics, municipal strategies and reports, and strategic plans, is referred to as 'official data.' See the reference list at the end of this report for details.

In some cases there was not publicly available data and/or there were apparent inconsistencies between published data and general knowledge of water and/or land use in the area. In those situations the research team generated revised estimates based on the original research conducted for this study. All such 'unofficial' estimates are clearly described in the text. In other words, unless specified otherwise all data included in this study is based on publicly available data.

<sup>4</sup> Report author/lead data analysis was conducted by Hilary Drew Cottrill. Technical expertise and reviews by Zoran Mateljak and Lucy Emerton. Data collection, research, and/or translation support by: Dr. Nusret Dresković, Nebojša Jerković, Zdravko Mrkonja, Dragutin Sekulović, Petra Remeta, Zoran Šeremet, and Veronika Vlasić

<sup>5</sup> In particular Dr. Nusret Dresković of the University of Sarajevo.



# LAND USE

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To understand how water is currently being used in the study area the research team first prepared detailed maps using GIS data and produced tables with land-use information. This data is from the European Environmental Agency's Coordination of Information on the Environment (CORINE) programme and land-cover database and draws on data for Bosnia and Herzegovina first created in 2012 and updated in 2016. Land-use data was pulled for all land in the study area in Federation Bosnia and Herzegovina and Republika Srpska in Bosnia and Herzegovina, Croatia, and Montenegro. This data was organized by the CORINE categories for land-use and the research team prepared tables for each of the four jurisdictions in the study area. A summary of this information is presented in Table 4 Land-Use for total study area

**Table 4 Land-Use for total study area**

Land use	Total Study Area	
	Hectares	Percentage
Artificial surfaces	24.189	1,38%
Agricultural areas	343.241	19,60%
Forest and semi natural areas	1.357.580	77,50%
Wetlands	5.963	0,34%
Water bodies	20.682	1,18%
TOTAL	1.751.656	100%

Almost 78 percent of the entire study area is forest or semi natural area; karst open space with little vegetation. Agriculture areas are the second highest, at about 20 percent of the study area. Urban and industrial areas are less than 1.5 percent; and combined, wetlands, lakes, and rivers are less than 2 percent.

As the territory of these basins crosses boundaries, the following tables show the land use breakdowns for each of the four jurisdictions in the study area. The largest parts of the basins are in Federation Bosnia and Herzegovina, at 43.50 percent of the total study area. Republika Srpska has the second largest part of the basins with 26.24 percent, followed by Croatia with 17.8 percent and Montenegro with about 13 percent.

**Table 5 Land-Use Summary for Croatia**

Study Area in Croatia			
Land use	Hectares	By Percentage	Percent of Total Study Area
Artificial surfaces	8.430	2,80%	0,48%
Agricultural areas	64.943	21,58%	3,71%
Forest and semi natural areas	217.438	72,25%	12,41%
Wetlands	3.657	1,22%	0,21%
Water bodies	6.487	2,16%	0,37%
TOTAL	300.956	100%	17,18%

**Table 6 Land-Use Summary for Republika Srpska**

Study Area in Republika Srpska			
Land use	Hectares	By Percentage	Percent of Total Study Area
Artificial Surfaces	2.289	0,50%	0,13%
Agricultural areas	82.962	18,05%	4,74%
Forest and semi natural areas	371.608	80,84%	21,21%
Wetlands	49	0,01%	0,00%
Water bodies	2.798	0,61%	0,16%
TOTAL	459.706	100%	26,24%

**Table 7 Land-Use Summary for Federation Bosnia and Herzegovina**

Study Area in Federation Bosnia and Herzegovina			
Level 1	Hectares	By Percentage	Percent of Total Study Area
Artificial Surfaces	9.532	1,25%	0,54%
Agricultural areas	167.093	21,93%	9,54%
Forest and semi natural areas	573.360	75,25%	32,73%
Wetlands	2.257	0,30%	0,13%
Water bodies	9.696	1,27%	0,55%
TOTAL	761.938	100%	43,50%

**Table 8 Land-Use Summary for Montenegro**

Study Area in Montenegro			
Land use	Hectares	By Percentage	Percent of Total Study Area
Artificial surfaces	3.939	1,72%	0,22%
Agricultural areas	28.242	12,33%	1,61%
Forest and semi natural areas	195.175	85,21%	11,14%
Wetlands	0	0,00%	0,00%
Water bodies	1.701	0,74%	0,10%
TOTAL	229.055,92	100%	13,08%



# GENERAL CONTEXT

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In order to put the study area into context the research team collected demographic and economic data for each of the four jurisdictions as a whole, and as available for each of the municipalities within the study area in Croatia, Federation Bosnia and Herzegovina, Republika Srpska, and Montenegro.



Overall more than 575,000 people live in the Neretva and Trebišnjica basins. Table 9 Overview of demographic data provides a summary of the demographic and economic data for each jurisdiction in the total study area. This table is followed by additional detail about the municipalities for each jurisdiction.

**Table 9 Overview of demographic data**

Overview of Demographic Information	Dubrovnik-Neretva County, Croatia	Study area in Republika Srpska	Herzegovina-Neretva and West Herzegovina Cantons (FB&H)	Herceg Novi in Montenegro
% of Country/Entity Size (km <sup>2</sup> )	5%	19%	29%	2%
Population	122.568	66.710	355.061	30.729
% Population of Country/Entity	3%	5%	16%	5%
Number of People Employed	19.539	15.560	65,862	9.966
% Population Employed	16%	23%	19%	32%
Number of Enterprises	3.705	1.084	9,739	2.201
GDP as % of Country/Entity GDP	3%	6%	14%	N/A

**Croatia:** All 22 municipalities of the Dubrovnik-Neretva County<sup>6</sup> are within the Neretva or Trebišnjica basins. The majority of the Neretva delta is located in Dubrovnik-Neretva County and the majority of agriculture production in the county takes place in the Neretva delta. The Neretva delta has a total population of about 35,000 people. There are seven municipalities in the Croatian part of the Neretva delta: Pojezerje, Ploče, Kula Norinska, Metković, Opuzen, Slivno, and Zadržlje.

Of Split-Dalmatia County's 39 municipalities, 18 are all or partially in the Neretva basin and none are in the Trebišnjica basin<sup>7</sup>. As the parts of these municipalities in the Neretva basin have very low populations levels, limited commercial agriculture, and no hydropower facilities they were excluded from the detailed analysis of the Croatian part of the study area. They are however included in the maps and land-use tables.

<sup>6</sup> Dubrovnik-Neretva county's 22 municipalities are: Blato, Dubrovačko primorje, Janjina, Konavle, Kula Norinska, Lastovo, Lumbarda, Mljet, Orebić, Pojezerje, Slivno, Smokvica, Ston, Trpanj, Vela Luka, Zadržlje, Župa dubrovačka, Dubrovnik, Korčula, Metković, Opuzen, and Ploče.

<sup>7</sup> IOf that county's 39 municipalities the 18 that are all or partially in the Neretva Basin are: Cista Provo, Lovrec, Lokvičići, Proložac, Imotski, Šestanovac, Zadvarje, Brela, Podbablje, Zmijavci, Runovici, Zagvozd, Baška Voda, Makarska, Tučepi, Podgora, Vrgorac, and Gradac. As many of these municipalities have very low populations, limited commercial agriculture, and no hydropower facilities they were excluded from the detailed analysis of the Croatian part of the study area.



# Croatia Study Area

**Republika Srpska:** All or part of eight municipalities in Eastern Herzegovina in Republika Srpska – Kalinovik, Istočni Mostar, Nevesinje, Gacko, Bileća, Berkovići, Ljubinje, and Trebinje – are in the Trebišnjica basin. Of note, according to the Republika Srpska’s Institute of Statistics, the vast majority of the population in the study area lives in just four municipalities: Trebinje (28,244 or 42 percent), Nevesinje (12,196 or 18 percent), Bileća (10,349 or 16 percent), and Gacko (8,599 or 13 percent) with remaining 11 percent living in the other four municipalities<sup>8</sup>. This is significant as is described in more detail in the electricity section below, Gacko is the site of a thermal power plant and Bileća and Trebinje are located by major components of the Trebišnjica hydropower system.



<sup>8</sup> Noted that the population in all of these municipalities is declining, as is the overall population of Republika Srpska. The largest declines are being recorded in the rural municipalities, for example Istočni Mostar’s population is dropping at a rate of 2.5 percent per year. Even Trebinje, the economic and administrative center of Eastern Herzegovina, is losing population at a rate of 0.77 percent a year. Full data available at <http://www.rzs.rs.ba/>

**Federation Bosnia and Herzegovina:** There are a total of 16 municipalities in Federation Bosnia and Herzegovina that are all or partly in the Neretva and Trebišnjica basins. All of the nine municipalities of Herzegovina-Neretva Canton – Čapljina, Čitluk, Jablanica, Konjic, Mostar, Neum, Prozor-Rama, Ravno, and Stolac – are in the Neretva and Trebišnjica basins. Likewise, all four of the municipalities in West Herzegovina Canton – Grude, Ljubuški, Posušje, and Široki Brijeg are in the basins. Demographic/economic data for these cantons is included in the table above. There are three other municipalities that have slivers of territory in the basins, Kupres and Tomislavgrad in Herceg-Bosnian Canton, and Trnovo in Sarajevo Canton. There is no commercial agriculture, hydropower, or use of municipal water in these three municipalities that is reliant on the waters from the basins and the majority of their populations live outside the boundary of the basins. Thus they are excluded from the detailed analysis below. However, as parts of their territories are in the basins, these municipalities are included in the maps and land use tables.



The Study Area in Federation Bosnia and Herzegovina

Montenegro: Parts of two municipalities in Montenegro are in the Trebišnjica basin, Nikšić and Herceg Novi. Nikšić municipality has Montenegro's second largest population outside of the capital with 70,798 people, or about 11 percent of total population. However, the city of Nikšić itself – with 80 percent of the municipality's total population – is located outside the boundary of the Trebišnjica basin and does not use waters from the Trebišnjica basin for agriculture, hydropower, or public water supply. Therefore the table with economic and demographic information above includes only Herceg Novi. The maps and land use tables include both.



Montenegro  
Study Area

# THE VALUE OF WATER FOR ELECTRICITY

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Hydropower provides the highest overall economic return in terms of revenue and jobs from waters from the Neretva and Trebišnjica basins. Some of the water that is managed through the network of dams and tunnels goes on to provide public water supplies and is used for irrigated agriculture. As such decisions around hydropower production – how much water is released, to where, and at what times during the year – have a major impact on the entire basin systems. The research team set out to identify the amount of m<sup>3</sup> of water used annually to produce hydropower in the study area, and what that translated to in terms of revenue and jobs. Overall there was sufficient publicly available and credible data for this analysis



## Background of the Trebišnjica and Neretva hydropower systems

The Trebišnjica hydropower system in the Neretva and Trebišnjica basins is one of the most complex and largest in Europe. Its heart is in the study area in Republika Srpska and it currently is comprised of seven dams – including the mighty Grančarevo dam – six artificial reservoirs – including Bileća Lake – and over 70 kilometers of tunnels. Four hydropower plants are connected to the system including hydropower plant (HPP) Čapljina in Federation Bosnia and Herzegovina, two in Republika Srpska (HPP Trebinje I and HPP Trebinje II), and one in Croatia, HPP Dubrovnik.

The major water accumulation for this system was created in 1968, when all the jurisdictions were part of Yugoslavia, by the construction of the Grančarevo dam on the Trebišnjica river. This dam is 123 meters high and 439 meters wide and it created an artificial accumulation near Bileća in what is now Republika Srpska. Known as Bileća Lake, this hydropower reservoir is



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the largest in the Trebišnjica hydropower system and is 18 kilometers long with a surface area of about 33 square kilometers, depending on water levels. The lake is about 400 meters above sea level, and the volume of water in the lake is about 1.3 billion m<sup>3</sup>

The major water accumulation for this system was created in 1968, when all the jurisdictions were part of Yugoslavia, by the construction of the Grančarevo dam on the Trebišnjica river. This dam is 123 meters high and 439 meters wide and it created an artificial accumulation near Bileća in what is now Republika Srpska. Known as Bileća Lake, this hydropower reservoir is the largest in the Trebišnjica hydropower system and is 18 kilometers long with a surface area of about 33 square kilometers, depending on water levels. The lake is about 400 meters above sea level, and the volume of water in the lake is about 1.3 billion m<sup>3</sup>

HPP Dubrovnik is the largest facility and was built in the late 1960's with a total installed capacity of 216 megawatts (MW). Working about 20 hours a day it produces on average 1,500 GWh of electricity per year. This puts it on par with major thermal power plants in the area. HPP Dubrovnik is fed by a tunnel originating on the territory of Republika Srpska near Trebinje with flow speeds of about 90 m<sup>3</sup> per second (m<sup>3</sup>/sec) dropping about 300 meters in elevation across only 16 kilometers. After generating electricity, the majority of that water is then released directly into the Adriatic Sea. A portion of the remaining water, about 1 percent, is diverted through pipes to Herceg Novi for public water supply. This is described in detail later.

While a Croatian electricity utility owns and operates HPP Dubrovnik, it currently only has control over half of its total installed capacity with the electricity utility of Republika Srpska controlling the remaining half of installed capacity. This allocation reflects the fact that HPP Dubrovnik was built when what is now Croatia and Republika Srpska were both part of Yugoslavia – and that Republika Srpska controls the volume of water released into the tunnel system.

Lastly, there are a number of other facilities currently planned or partially constructed that would connect to and expand the Trebišnjica hydropower system. Two of the most significant for this report are HPP Boka (described in the Montenegro section below), and HPP Dubrovnik II. HPP Dubrovnik II has been on paper since the 1970's and would cost an estimated €200 million to construct. Electricity generated would again be split between Croatia and Republika Srpska. These facilities are discussed in the hydropower gap analysis section.

Overall, three jurisdictions are operating hydropower facilities in the Trebišnjica basin, sharing about 2.7 billion m<sup>3</sup> of water per year. The combined total revenue attributable to this hydropower was about €156 million in 2016 and about 19 m<sup>3</sup> of water are required to generate €1 revenue from the sale of electricity . The specifics for each of the jurisdictions in the study area are presented in full in the sections below. Table 1 Summary of Trebišnjica hydropower system 2016 above showed the high-level total in terms of GWh generated and the amount of revenue attributable to this production.

<sup>9</sup> This calculation is explained in full below in the section for Republika Srpska.

**The Neretva hydropower system** is located only in Federation Bosnia and Herzegovina. There are separate public utilities operating different facilities, but there are no transboundary/trans-entity considerations. There are seven hydropower plants using waters from the Neretva basin, excluding HPP Čapljina, which is part of the Trebišnjica system described above. Elektroprivreda BiH operates three, and Elektroprivreda HZHB operates four.

While the water in the Trebišnjica system is shared from one main source, Bileća Lake, the same is not the case for the Neretva basin facilities. Of the seven total facilities in the Neretva basin four are located directly on the main channel of the Neretva. The other three are on separate tributaries. The calculation for m<sup>3</sup> of water required for each facility – and for the facilities on the Neretva river as a group – is included in the sections below. In total about 7.8 billion m<sup>3</sup> of water is required per year from the Neretva basin, about 4.85 billion m<sup>3</sup> from the main channel of the Neretva and 2.9 billion m<sup>3</sup> from its tributaries.

Overall in 2016 the total revenue attributable to hydropower production in the Neretva basin was about €219 million. In terms of m<sup>3</sup> of water required for €1 of revenue, the average across the Neretva basin (excluding HPP Čapljina) is 35.5 m<sup>3</sup> for €1. Table 2 Summary of Neretva hydropower system 2016 above showed the high-level total in terms of GWh generated and the amount of revenue attributable to hydropower in the Neretva basin.

**Employment in hydropower:** As stated in the executive summary, for each jurisdiction the research team gathered and analyzed employment data related to the production of hydropower. Table 3 Jobs per GWhs of hydropower shows the results of this analysis including a summary of the number of people employed in the hydropower plants in the study area by jurisdiction, and in the case of Federation Bosnia and Herzegovina by utility as there are two.

The sections below include the details for each jurisdiction in the study area. Further discussion about jobs, public revenue, and social aspects of hydropower production follows in a gap analysis section.

The electricity sector is home to Croatia's 2nd largest enterprise, Hrvatska Elektroprivreda Grupa (HEP Group), which controls the hydropower plants in the study area. To evaluate the contribution of waters from the Trebišnjica basin to this sector the research team analyzed publicly available data from HEP Group. HEP Group is a vertically integrated public company comprised of 18 subsidiaries within Croatia and a further seven units in surrounding countries, including two in Bosnia and Herzegovina. These include:

- HEP ODS – the distribution system operator, which runs 100 percent of the distribution system in Croatia (i.e. no other distribution system operator exists in Croatia)
- HOPS – the transmission system operator, which runs 100 percent of the transmission grid in Croatia
- HEP Opskrba – a supplier of electricity
- HEP Proizvodnja – the owner and operator of power plants, including 26 hydropower plants and 8 thermal and partly nuclear power plants. HEP Proizvodnja produces about 75 percent of all electricity sold by HEP Group.
- As of 2016, HEP Group employed a total of 11,832 people

As HEP Group produces about 75 percent of all electricity distributed in Croatia, 100 percent of the transmission and distribution systems, and operates the only two hydropower plants in the study area in Croatia, information was not collected on Croatia's remaining small electricity companies. Below is a summary of HEP Group as a whole<sup>10</sup>, followed by calculations for value that water from the Trebišnjica basin is contributing in terms of HEP Group revenue and jobs.

**Overall picture:** The total installed capacity of HEP Group facilities in Croatia is 4,364 MW, of which about 48 percent (2,094 MW) is installed at 26 hydropower plants. In 2016, total electricity generated by HEP Group facilities was about 12,500 GWh and total distribution was 16,800 GWh. Total revenue in 2016 across the entire HEP Group was over €1.9 billion (net profit was about €275 million)<sup>11</sup>. While HEP Group does not publish tariff data by county, it is possible to estimate an average tariff across all categories of users countrywide by taking total revenue (1.9 billion) and dividing by total KWh distributed. This rough estimate is €0.11/KWh.

<sup>10</sup> Per HEP Group's 2016 annual report available in English online at: [http://www.hep.hr/UserDocsImages//dokumenti/Godisnje\\_izvjesce\\_EN//2016Annual.pdf](http://www.hep.hr/UserDocsImages//dokumenti/Godisnje_izvjesce_EN//2016Annual.pdf)

<sup>11</sup> PHEP Group does not have publicly available data for revenue by municipality. However, information on the number and type of connections and distribution by municipality is available. In the 22 municipalities in Dubrovnik-Neretva County there are about 53,043 connections (46,451 household connections and 6,592 commercial/public connections). Total distribution in the Dubrovnik-Neretva County in 2016 was about 419 GWh; 186 GWh for household users and 233 GWh for commercial/public users. This is about 2.5 percent of HEP Group's total distribution for Croatia, and is consistent with the fact that Dubrovnik-Neretva County has only 2.6 percent of Croatia's overall population.

**Hydropower in the study area:** There are two HPPs in the Dubrovnik-Neretva County in the Trebišnjica basin in Croatia, HPP Dubrovnik and the small HPP Zavrelje which has an installed capacity of 2 MW and requires about 5,685 m<sup>3</sup> of water to generate 1 MWh. As described above HEP Group controls half of HPP Dubrovnik's installed capacity of 108 MW. Only this Croatian portion controlled by HEP Group is included in the calculations in this section. The electricity/revenue calculations for the 108 MW controlled by Elektroprivreda Republika Srpska is discussed in the electricity section for Republika Srpska below.

In total the HPPs in the study area in Croatia have 110 MW of installed capacity (2 at HPP Zavrelje and 108 at HPP Dubrovnik). In 2016, HPP Zavrelje generated 4.3 GWh and HPP Dubrovnik about 730 GWh. This combined production of 734.3 GWh was about 5.8 percent of HEP Group's total electricity production and 4.3 percent of HEP Group's total electricity distribution. Using the percentage of total distribution to approximate the amount of revenue attributable to Trebišnjica waters, it is possible to estimate the contribution of the value of these waters to HEP Group's total revenues. Hydropower from the Trebišnjica basin is 4.3 percent of HEP Group's total distribution (734.3 GWh/16,800 GWh) and total revenue in 2016 was €1.9 billion. Assuming an equivalent 4.3 percent of revenue, the value that Trebišnjica waters are contributing was more than €83 million in 2016.

**Contribution towards jobs:** HEP Group's 2016 annual report listed its total employment at 11,832 people. The research team collected data for September 2017 in Croatia finding estimates of 1,933 employed in production – including a total of 58 employed at HPP Zavrelje and HPP Dubrovnik – 7,440 in distribution, and 215 in sales. The total estimated HEP Group employment in Croatia for 2017 used in this report is this unofficial total of 9,589. To calculate the number of jobs that are attributable to hydropower production in Dubrovnik-Neretva County the research team added the 58 jobs in production in HPP Dubrovnik and HPP Zavrelje, plus about 320 jobs in distribution (4.3 percent of all distribution jobs), and about 9 jobs in sale (4.3 percent of all sales jobs). The amount of HEP Group employment related to HPP in the study area in Croatia is about 387 jobs.

Furthermore, in Dubrovnik-Neretva County there are about 2.9 people per household, and it is reasonable to assume that only one person per household is employed in the electricity sector. Therefore, each of the 387 people employed in jobs related to HPP are supporting an additional 774 people, for a total of about 1,161 people supported.

## Republika Srpska

The heart of the Trebišnjica hydropower system is in Republika Srpska and the electricity sector is widely thought to be a cornerstone of the economy in this area. The research team investigated just how much the Trebišnjica hydropower system is contributing to the electricity production, revenue, and employment of Republika Srpska as a whole, and the study area in Eastern Herzegovina.

**Overall Picture:** In 2016 total electricity generation across all facilities in Republika Srpska was 5,823 GWh, about 4,016 GWh was distributed, and total demand was 3,784 GWh (about 94 percent of total distribution). The total annual revenue from electricity distribution in 2016 for Republika Srpska was about €280 million with an average tariff across all categories of users of €0.05/KWh (roughly half as much as HEP Group's €0.11 /KWh)<sup>12</sup>. Also of note, this was about 4 percent of total GDP for Republika Srpska.

The public company Elektroprivreda Republika Srpska, similar to HEP Group, is the primary electricity utility for Republika Srpska. Elektroprivreda Republika Srpska is comprised of five electricity production subsidiaries and five distribution subsidiaries. In the study area the main production entities are Zavisno preduzece Hidroelektrane na Trebišnjica (HET), and Preduzeće Rudnik i Termoelektrane (RiTE) Gacko. The electricity distribution entity for the study area is Elektrohercegovina Trebinje.

**Electricity production in the study area:** There are 13 power plants in the study area including three hydropower plants associated with HET: HPP Trebinje I, HPP Trebinje II, and HPP Dubrovnik. RiTE operates the one thermal power plant, in Gacko municipality. There is one small HPP at Berkovići, and 8 small solar installations. The total installed capacity of these facilities is 596 MW generating about 2,700 GWh per year. Of this production, about 44 percent is from hydropower, with a total installed capacity of 298 MW with generation in 2016 of 1,198 GWh. This breakdown is shown in Table 10 Hydropower plants in the study area in Republika Srpska. RiTE Gacko, with its installed capacity of 300 MW and 2016 generation of 1,512 GWh contributed about 55 percent of total generation in the study area – the solar made up the remaining (less than 2 percent).

**Table 10 Hydropower plants in the study area in Republika Srpska**

Facility Name	Installed MW Capacity	2016 GWh Generated
HPP Trebinje I*	180	479,4
HPP Trebinje II*	8	12,5
HPP Dubrovnik*	108	697,1
HPP Berkovići (MHE DO)	2	9,3
Total	298	1.198,30

\*Operated by HET

<sup>12</sup> In the study area in Republika Srpska there are 29,319 electricity connections, of which 27,332 are households. In 2016 revenue, not including outstanding invoices, collected from users in the study area from the sale of electricity was €15 million – about 5 percent of Elektroprivreda Republika Srpska's total revenue. This is consistent with the percentage of the population living in the area.

Of Republika Srpska's total electricity generation of 5,823 GWh in 2016, 20 percent (1,198 GWh) came from hydropower on rivers in the Trebišnjica basin<sup>13</sup>. Using the percentage of total generation to approximate the amount of revenue attributable to Trebišnjica waters, it is possible to estimate their value as a proportion of Elektroprivreda Republika Srpska's total revenues of €280 million. Hydropower from the Trebišnjica basin is 20 percent of total generation in Republika Srpska. Assuming an equivalent 20 percent revenue, the value that Trebišnjica waters are contributing in revenue was more than €56 million in 2016.

The volume of water required to generate electricity in Trebinje I, below the Grančarevo dam, fluctuates depending on the water levels of Bileća Lake. On average it is 5,610 m<sup>3</sup> for 1 MWh. In 2016 to generate 479 GWh at Trebinje I about 2.7 billion m<sup>3</sup> of water was required. The majority of this water is then diverted down to HPP Dubrovnik with the remaining water sent to HPP Trebinje II and on to HPP Čapljina in Federation Bosnia and Herzegovina as is described in detail further below.

As the water for all four of these facilities is supplied through Grančarevo dam in total about 2.7 billion m<sup>3</sup> is required per year. Controlling just for HET generation, the figure is 1.6 billion m<sup>3</sup> – as HEP Group's production at HPP Dubrovnik requires 1.1 billion m<sup>3</sup>. Again however, these waters are shared across the Trebišnjica hydropower system, including HPP Čapljina in Federation Bosnia and Herzegovina, which is fed by a channel downstream from HPP Trebinje II and uses the 'same' waters.<sup>14</sup>

**Employment:** Entity-wide, Elektroprivreda Republika Srpska employs over 13,400 people, including over 9,000 in production and over 4,400 in distribution and sales. Of that total about 22 percent, almost 3,000 people, are employed in the study area in Eastern Herzegovina. HET employs 695 people, and RiTE Gacko employs 1,725 people. Elektrohercegovina Trebinje employs a further 371 people for distribution and 199 are employed in sales.

It is possible to estimate how many of these jobs are related to hydropower, based on the fact that hydropower is about 44 percent of total generation in the study area. This calculation is all of HET's total employment of 695, plus 44 percent of employment for distribution and sales (252). The amount of employment related to hydropower in the study area in Republika Srpska is about 947 jobs. To put this into perspective, overall in the study area in 2016 there were about 15,560 jobs, meaning that hydropower-related jobs are about 6 percent of all employment.

These employment figures demonstrate that the electricity sector is a considerable source of jobs for the study area in Republika Srpska. These numbers are also significant as the unemployment rate among the working age population in Republika Srpska as a whole is 35.5 percent<sup>15</sup>. Using that entity-wide rate it is possible to estimate the amount of the working age population that is unemployed in the study area, about 8,400 people. If the 947 hydropower-related jobs didn't exist in Republika Srpska unemployment would increase by over 10 percent (947/8,400).

<sup>13</sup> A further 26 percent (1,501 GWh) was generated by RiTE Gacko in the study area. Together, electricity generation in the study area is 46 percent of the total for Republika Srpska. To put this in perspective, the study area has a population of 66,710, which is only 6 percent of the total population of Republika Srpska. Put another way, about 6 percent of the population of Republika Srpska lives in the area in which 46 percent of its energy is generated.

<sup>14</sup> Note, this calculation does not account for HPP Berkovići, which uses water from the Bregava River, which is part of the Trebišnjica basin and also a tributary of the Neretva. However this facility is less than 1 percent of total hydropower generation in the study area in Republika Srpska.

<sup>15</sup> According to the Republika Srpska statistics bureau, Republički zavod za statistiku, in Republika Srpska as a whole the working age population is 381,560. Of that total 245,975 are employed, and 135,585 are unemployed. <http://www.rzs.rs.ba/>

Also, it is reasonable to assume that there is only one person employed in the electricity sector per household. With an average household size of 3 people, the hydropower specific 947 jobs support an additional 1,894 people for a total of direct and indirect people supported by hydropower jobs in the study area in Republika Srpska being approximately of 2,841.

When comparing the ratio of jobs in hydropower plants - only production jobs, not including distribution or sales jobs – to GWhs generated, employment in the study area in Republika Srpska is much higher relative to Croatia. (See Table 3 Jobs per GWhs of hydropower). Around about 6 times as many people are employed in hydropower plants in the Trebišnjica basin in Republika Srpska to generate 1 GWh of hydropower than at hydropower plants in the Trebišnjica basin in Croatia to generate 1 GWh. Possible reasons for this are discussed in the Gap Analysis section below.

## Federation Bosnia and Herzegovina

Communities in Federation Bosnia and Herzegovina are also benefiting from the Trebišnjica hydropower system, through HPP Čapljina, and a further seven facilities in the Neretva basin. There are two separate public electricity utilities in Federation Bosnia and Herzegovina, one headquartered in Sarajevo in Bosnia – Elektroprivreda BiH, and one headquartered in Mostar in Herzegovina – Elektroprivreda HZHB. Elektroprivreda BiH operates three hydropower plants on the Neretva, and Elektroprivreda HZHB operates four hydropower plants in the Neretva river as well as HPP Čapljina, which is part of the overall Trebišnjica hydropower system. The calculations for this section consider each public utility individually, based on data in their published annual reports for 2016. The total is shown in Table 2 Summary of Neretva hydropower system 2016 above.

**Elektroprivreda BiH Generation and Revenue:** This public utility is comprised of 8 subsidiaries related to electricity and a further 12 mines/other companies. Related to electricity generation and distribution there are two thermal power plants outside of the study area and one group, Podružnica Hidroelektrane na Neretvi, Jablanica, that operates the three HPPs on the Neretva. It also includes five electricity distribution arms. Overall, the utility company controls a total installed capacity of 1,670 MW, and in 2016 generated about 7,245 GWh. Of this total, about 19 percent came from the three HPPs on the Neretva. The breakdowns by facility for 2016 are shown in Table 11 Elektroprivreda BiH on the Neretva.

**Table 11 Elektroprivreda BiH on the Neretva**

Facility Name	Installed Capacity (MW)	GWh Generated 2016	Average m3 water required for 1 KWh	m3 of Water required
HPP Jablanica	180	697,5	4,04	2.817.900.000
HPP Grabovica	115	387,5	12,53	4.855.375.000
HPP Salakovac	210	309,4	10,14	3.137.316.000
Total	505	1.394,40	n/a	n/a

In terms of revenue, about €475,198,000<sup>16</sup> of Elektroprivreda BiH's 2016 revenue was related to the sale of electricity and the average tariff per KWh across all categories of users was about €0.07/KWh. Hydropower from the Neretva basin is 19 percent of Elektroprivreda BiH's total generation. Assuming an equivalent 19 percent revenue, the value that Neretva waters are contributing in revenue was more than €90 million in 2016.

In terms of m3 of water required per year HPP Grabovica requires the most water and is in the middle of the three facilities on the Neretva. Therefore the research team is assuming that about 4.9 billion m3 of water is required to generate the total 1,394.4 GWhs produced in 2016. On average it takes about 54 m3 of water from the main channel of Neretva for Elektroprivreda BiH facilities to generate €1 of hydropower.

**Elektroprivreda BiH Jobs:** Elektroprivreda BiH employs 4,652 people, including 120 at Podružnica Hidroelektrane na Neretvi, Jablanica. Given time constraints the research team was not able to separate of the total jobs the number related to electricity production (versus jobs in mining and/or non-energy related holdings) and the research team did not calculate the total number of jobs including distribution and sales dependent on this hydropower. However, as 120 people work at Podružnica Hidroelektrane na Neretvi, Jablanica it is possible to calculate the amount of GWh produced by each 'job.' In 2016, the three HPPs on the Neretva produced 1,394.4 GWh, giving a ratio of 1 job to about every 12 GWh. This ratio is similar to HEP Group's in Croatia, which was 1 job to about 13 GWh.

**Elektroprivreda HZHB Generation and Revenue:** This public utility is also comprised of various production and distribution arms and operates hydropower plants in both the Neretva basin and the Vrbas basin, and HPP Čapljina which uses water from the Trebišnjica system. Overall, Elektroprivreda HZHB controls a total installed capacity of 860 MW and in 2016 generated 3,168 GWh. Of this total, about 68 percent came from HPPs in the Neretva basin, and 9 percent from HPP Čapljina using Trebišnjica waters – for a total of 77 percent of Elektroprivreda HZHB's total generation. The breakdowns by total and HPP facility for 2016 are shown in the table below. Note, HPP Mostar is the only facility on the Neretva itself and is downstream of the three operated by Elektroprivreda BiH. The breakdowns by facility for 2016 are shown in Table 12 Elektroprivreda HZHB in Neretva basin.

**Table 12 Elektroprivreda HZHB in Neretva basin**

Facility Name	River	Installed Capacity (MW)	GWh Generated	Average m <sup>3</sup> water required for 1 KWh	m <sup>3</sup> of Water required
HPP Mostar	Neretva	72	232,01	20	4.640.200.000
HPP Rama	Rama	160	687,23	3,3	2.267.859.000
HPP Peć-Mlini	Tihaljina	30	45,33	3,6	163.188.000
HPP Mostarsko Blato	Lištica	65	83,04	2,4	199.296.000
HPP Čapljina	Trebišnjica	440	145,25	1,9	280.332.500
Total		767	1.192,86	n/a	n/a

<sup>16</sup> This is about 70 percent of Elektroprivreda BiH's total 2016 revenue of about €683,632,000.



In 2016, Elektroprivreda HZHB had about €188,654,000 in revenue from the sale of electricity. The average tariff across all categories of users was about €0.06/KWh. Hydropower from the Neretva and Trebišnjica basins is 77 percent of total generation for Elektroprivreda HZHB. Assuming an equivalent 77 percent revenue, the value that Neretva and Trebišnjica waters are contributing in revenue was more than €146 million in 2016. This can be broken down further as follows:

- Taking only the hydropower plants in the Neretva basin, which generate 68 percent of Elektroprivreda HZHB's total electricity, the value in is €128 million in 2016.
- Looking just at HPP Čapljina using Trebišnjica waters, which generates 9 percent of Elektroprivreda HZHB's total electricity, the value in revenue was about €16.9 million in 2016.

For Elektroprivreda HZHB, the m3 of water required to generate €1 of hydropower varies as each HPP uses waters from a different source. The table below shows the calculation by facility.

**Table 13 Water requirements for Elektroprivreda HZHB facilities**

Elektroprivreda HZHB	GWh Generated	% Total HZHB Generation	Attributable € revenue (% x total HZHB)	M <sup>3</sup> water required	M <sup>3</sup> per €
HPP Mostar	232,01	15%	28.414.632	4.640.200.000	163,3
HPP Rama	687,23	45%	84.166.145	2.267.859.000	26,95
HPP Peć-Mlini	45,33	3%	5.551.637	163.188.000	29,39
HPP Mostarsko Blato	83,04	5%	10.170.040	199.296.000	19,6
HPP Čapljina	145,25	9%	17.788.997	280.332.500	15,76
Total	1.192,86	77%	146.091.451	n/a	n/a

Elektroprivreda HZHB Jobs: Elektroprivreda HZHB employs 1,840 people, including 358 at the five hydropower facilities in the Neretva and Trebišnjica basins. As for Elektroprivreda BiH, there was not sufficient time to breakdown the total jobs further. Therefore the research team did not calculate the total number of jobs, including distribution and sales, dependent on hydropower production in the basins. However, it is possible to calculate the amount of GWh produced for each of the 358 facility-level jobs. In 2016 the five HPPs in the Neretva and Trebišnjica basins produced 1,192.86 GWh, giving a ratio of 1 job to about every 3.3 GWh. This ratio is similar to Elektroprivreda Republika Srpska's ratio of 1 job to every 2 GWh.

<sup>17</sup> THPP Čapljina has an upper and a lower reservoir and water used to generate electricity can be pumped from the lower reservoir back up into the upper reservoir. Meaning that a lower amount of water than the 280,332,500 calculated above is required annually as the 'same' water can be 'reused' to generate electricity more than once.

## Montenegro

Montenegro is not generating hydropower from the waters of the Trebišnjica basin. However, part of the Trebišnjica hydropower system is on the territory of Montenegro and the current situation of zero economic benefit from the waters of the Trebišnjica basin is a point of significant international tension between Montenegro and Republika Srpska.

About 15 percent of Bileća Lake (4.88 square kilometers) is in what is now Montenegro, in the municipality of Nikšić and the flooding of Nikšić territory resulted in the forced relocation of about 60 Montenegrin households. Furthermore, the Assembly of the Socialist Republic of Montenegro of Yugoslavia never formally consented to the construction of the Grančarevo dam in the 1960's that created the lake. To date there has been no compensation payments made to the municipality of Nikšić, or Montenegro as a whole, for the flooding of its territory. Meanwhile, Republika Srpska and Croatia are benefiting from the part of Bileća Lake on Montenegrin territory by generating electricity through the Trebišnjica hydropower system. The position of the Government of Montenegro is that it has the right to compensation from Republika Srpska/Bosnia and Herzegovina – as the Grančarevo dam that created the lake is in Republika Srpska – through electricity and/or revenue sharing, and fees. Also, the Nikšić municipality is asking for 4 million Euros in compensation from Republika Srpska for use of its natural resources. However, any arrangement on electricity or revenue sharing between Republika Srpska and Montenegro could also have implications on similar arrangements with Croatia. This complicated web of disputes and negotiations is summarized in the below case study.

At the same time that Montenegro has been pushing for compensation from Republika Srpska, it has also been pursuing a plan to partner with that same entity to construct another hydropower plant. The idea is for HPP Boka to be built in Montenegro and connected via tunnel to infrastructure in Republika Srpska downstream of the Grančarevo dam – essentially right next to the existing tunnel to HPP Dubrovnik. Preliminary design work for HPP Boka has already been conducted calling for the construction of a more than 30 kilometer-long tunnel. It is estimated that construction for a facility able to generate 1,300 GWh per year would take at least five years and cost about €250 million. The Government of Montenegro is also considering a further investment of €45 million Euros to siphon additional water to use for Kotor municipality's public water supply.

The Government of Montenegro is offering Republika Srpska better electricity share terms than what they are currently getting from HEP Group at the Dubrovnik facility of 50/50. HPP Boka would also compete for water resources currently sent to HPP Dubrovnik, and the potential HPP Dubrovnik II (described in the Gap Analysis below). However, the Energy Development Strategy of Montenegro to 2025 does not foresee construction of HPP Boka before 2030. The Strategy also stipulates that prior to the start of construction of HPP Boka, Bosnia and Herzegovina (including both Federation Bosnia and Herzegovina and Republika Srpska), Montenegro, and Croatia<sup>18</sup> would need to negotiate and sign an agreement on the use of the Trebišnjica basin water resources for hydropower.

<sup>18</sup> While Montenegro and Croatia have already signed a bilateral transnational water management agreement in 2007, Croatia also has a 'stake' in HPP Boka as once constructed Republika Srpska would have the option to reduce/divert water that would have otherwise gone to HPP Dubrovnik.

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Overall, for the past 50 years what is now Republika Srpska in Bosnia and Herzegovina and Montenegro have been locked in dispute over whether Republika Srpska must share electricity/revenue from the Trebišnjica hydropower system with Montenegro. To date no compensation payments or electricity/revenue sharing arrangements have been made. While Trebišnjica waters from Montenegro are contributing to hydropower production in Croatia, Republika Srpska, and Federation Bosnia and Herzegovina – those same waters are now contributing €0 to Montenegro's economy.

## Case study – Calculating electricity or revenue sharing in the Trebišnjica basin

How an electricity or revenue sharing deal between Montenegro and Republika Srpska would be calculated is debatable. One option described to the research team by sources in Montenegro is that it could be calculated as at least proportional to the amount of the lake that is on Montenegrin territory, which is approximately 15 percent. If an electricity or revenue sharing deal was made on the basis of the territory of the lake in Montenegro it could be about 180 GWh of electricity or 8.4 million Euros per year – as Republika Srpska is generating about 1,190 GWh per year with waters from Bileća Lake and revenues from this production was about 56 million Euros in 2016.

In Republika Srpska individuals interviewed for this study shared an alternative position. Stating that if any revenue/electricity sharing deal was to be made it should be calculated on the share of the initial investment costs and ongoing costs to maintain the system. Not on the surface area of Bileća Lake in Montenegro. Under this method of calculation Montenegro would not be eligible for electricity or revenue share.

Croatia also has stake in the outcome of these negotiations, as they could set a precedent in the region. In fact, there are a number of ongoing court cases over electricity sharing between Croatia and Republika Srpska. Stakeholders in Republika Srpska are contending that instead of the current status quo of 50/50 sharing of electricity from HPP Dubrovnik, HEP Group and Elektroprivreda Republika Srpska should split all the electricity produced by HPP Trebinje I, HPP Trebinje II, and HPP Dubrovnik on the basis of 78 percent to Republika Srpska and 22 percent to Croatia. This would reflect the share of investment costs and costs to maintain the system. In Croatia on the other hand, stakeholders contend that the electricity produced at the Gacko thermal power plant should also be included in the calculations, as the initial investment for that facility came from the Yugoslav Republic of Croatia. The tables below use 2016 GWhs to illustrate what these various alternatives could mean.

**Table 14 Status quo electricity sharing Croatia and Republika Srpska**

Status Quo	GWh Generated	GWh Republika Srpska	GWh Croatia
HPP Trebinje I	479,4	479,4	0
HPP Trebinje II	13	12,5	0
HPP Dubrovnik	1.427	697	730
Thermo plant Gacko	1.512	1.512	0
Total	3.431	2.701	730

**Table 15 Scenario of 78% / 22% split of hydropower**

78% / 22% split of hydropower	GWh Generated	GWh Republika Srpska	GWh Croatia
HPP Trebinje I	479,4	374	105
HPP Trebinje II	13	10	3
HPP Dubrovnik	1.427	1.113	314
Thermo plant Gacko	1.512	1.512	0
Total	3.431	3.009	422

**Table 16 Scenario of 78% / 22% all electricity**

78% / 22% split of all electricity	GWh Generated	GWh Republika Srpska	GWh Croatia
HPP Trebinje I	479,4	374	105
HPP Trebinje II	13	10	3
HPP Dubrovnik	1.427	1.113	314
Thermo plant Gacko	1.512	1.179	333
Total	3.431	2.676	755

There is no consensus on these issues. For Montenegro and Republika Srpska it has been unresolved since the late 1960's and discussions are still on-going. Likewise Croatia and Republika Srpska have been locked in debate since the end of the Yugoslav war in the 1990's. These discussions are important to note in this study because they are a significant cause of transboundary tension. These disputes are reduce the ability of the jurisdictions effectively collaborate in transboundary water basin management.

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## Gap Analysis – Water for Electricity

**Employment:** There are significant differences in the ratios of facility-level employment to GWhs generated between the utility companies in the study jurisdictions. HEP Group in Croatia and Elektroprivreda BiH in Federation Bosnia and Herzegovina have similar ratios: 13 GWh to each job and 12 GWh to each job, respectively. Elektroprivreda Republika Srpska and Elektroprivreda HZHB also have similar ratios: 2 GWh to 1 and 3 GWh to 1, respectively. Comparing the two sets it is striking that in different parts of the Trebišnjica system up to six times as many people are employed to produce the same unit of electricity.

Further analysis is needed to take into consideration different operating environments. However, this initial finding does suggest a disproportionately high rate of employment in the study area in Republika Srpska and Herzegovina in Federation Bosnia and Herzegovina; compared to Croatia and the utility company headquartered in Bosnia. During the data collection phase the research team heard anecdotally from sources in the area that this 'extra' employment within Republika Srpska and Elektroprivreda HZHB in Herzegovina is attributed to political patronage networks.

It could also indicate a higher 'social' value attached to electricity. For example, in Republika Srpska the average tariff across all categories of users is €0.05/KWh and about 947 people are employed in jobs related to hydropower with a total of about 2,841 people supported by those jobs. In contrast, Croatia has a higher average tariff of about €0.11/KWh and employs significantly fewer people in hydropower related jobs, only 387, supporting about 1,161 people. These differences could reflect differing perspectives among decision makers (i.e. preference for profit maximization and efficiency v. preference for higher employment and cheaper electricity). These perspectives have different social implications that could be interesting for future research. For example, a significant disruption to the Trebišnjica system would adversely impact Republika Srpska much more than Croatia.

**Public revenue:** Along these same lines, the research team set out to track down the amount of taxes (including resource use fees and payments for environmental remediation) paid by the public utility companies to the various municipalities, cantons/counties, and entity/national governments. The intent was to analyze how much of government funding is supported by hydropower, and how those funds are spent (i.e. construction of sports facilities, funding of hospitals, other social programs, environment management/protection). However comprehensive data was not publically available, and with the time and resources available for this study the team was not able to fully conduct this analysis.

For example, in Federation Bosnia and Herzegovina the Law on Waters clearly stipulates that hydropower producers must pay a water use fee of about €0.50 per GWh produced. These fees are paid to the canton in which the electricity is produced, and then allocated as follows: 45 percent to the canton's general budget, 40 percent to the relevant water management agency, and 15 percent to the Federal Fund for Environmental Protection. Taking the total GWhs of hydropower produced in Federation Bosnia and Herzegovina in the Neretva and Trebišnjica basins in 2016 (about 2,587 GWh) the water use fee amount was about €1,319,370.

For context, in 2016 the budget for Herzegovina-Neretva Canton was about €97.4 million meaning that water use fees for hydropower production in that canton was only about 1 percent. In addition, the electricity utilities also pay fees/taxes to municipalities. For example Elektroprivreda HZHB operates HPP Čapljina and pays Čapljina Municipality each year. The amounts of these fees are not regulated through entity laws. Overall, complete information on the level of taxes paid in each jurisdiction by municipality and canton/county is not readily available.

Gathering information at the municipal, county/cantonal, and entity/country level of taxes/fees is an important area for follow-on research. It would add to the picture of the social and community benefits from the hydropower generated in the study area. In short, hydropower is not just income for the public utilities and jobs – it also funds government operations and social and environmental programs in Croatia, Federation Bosnia and Herzegovina and Republika Srpska.

**Future scenarios:** This study presents a baseline of the current situation. However there are a number of additions planned to the Trebišnjica hydropower system that are beyond the scope of this analysis, including HPP Dubrovnik, HPP Boka, and the expansion of the system within Republika Srpska through the upper horizons project. At the moment negotiations for HPP Dubrovnik II and HPP Boka are stalled for political, agricultural, and environmental reasons involving all four jurisdictions of this study. If constructed, the facilities discussed in this report (HPP Dubrovnik II and HPP Boka) could jeopardize irrigated agriculture in parts of Republika Srpska, Federation Bosnia and Herzegovina, and Croatia – as well as hydropower production at HPP Čapljina in Federation Bosnia and Herzegovina.

Water that would have gone to other parts of the basins instead would be funneled down to coastal areas and released into the Adriatic. Scenario modeling is required to fully understand the potential disruptions to the other economic sectors that are currently ‘using’ the water that in the future could be diverted. But as is described in the next section – The Value of Water for Agriculture – to model future scenarios it is first necessary to understand exactly how much water is being used for agriculture.

# THE VALUE OF WATER FOR AGRICULTURE

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Agriculture is the other primary sector that relies on water from the Neretva and Trebišnjica basins. As is shown in the land use tables above, the research team found that about 20 percent – 343,241 hectares – of the study area is agriculture land. The research team investigated the agriculture sector in each jurisdiction and by the municipalities in the study area with the intention of estimating the m<sup>3</sup> of water required for irrigation annually, and to demonstrate the value of that water in terms of revenue and jobs. As is described in detail in the sections below however, lack of publicly available data made this a challenging task. A comprehensive assessment of this sector was not possible given available data, resources, and time. The key findings for this section are presented in the Executive Summary.

For the study area in Federation Bosnia and Herzegovina, which is presented first, the research team reviewed more than 60 publicly available plans, strategies, and reports on the agriculture sector (listed in the references section below) and did not find sufficient data on irrigation to run any analysis. Similar reviews of public information in Croatia and Republika Srpska uncovered similar gaps. After not finding sufficient data the research team prioritized time and resources to conduct original research to estimate the use of irrigation in the study area in Federation Bosnia and Herzegovina. There was not sufficient time to re-create this analysis for all jurisdictions and this is a necessary avenue for future research.

Below are the results of the original research for Federation Bosnia and Herzegovina, followed by an explanation of the findings for Croatia and Republika Srpska, including a valuation of water for tangerines and wine. This is followed by a gap analysis for agriculture

## Federation Bosnia and Herzegovina

The research team collected publically available data on annual production, unit price<sup>19</sup>, and annual revenues for as many crop types as possible at both the entity-level and for the nine municipalities in Herzegovina-Neretva Canton and the four municipalities in West Herzegovina Canton<sup>20</sup>. As is shown in the tables below, the research team was able to collect a complete set of this information for 28 crops<sup>21</sup>.

Next the research team compiled CORINE data on land cover and publicly available data to determine, by each of the 28 crop categories, the following: hectares of land under cultivation, hectares of irrigated land, and percentage of irrigated land. Note, in the case of orchards the number of trees was used instead of hectares. The research team then estimated the total m<sup>3</sup> of irrigated water required to produce the annual volume (by ton) of each crop category. To make these calculations a member of the research team, Dr. Dresković of the University of Sarajevo, adapted information on water requirements by crop type in Herzegovina from the Faculty of Agronomy and Food Technology of the University of Mostar to the methodology of CROPWAT .

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<sup>19</sup> Average prices for entire Federation of Bosnia and Herzegovina from that entity's Statistics Bureau, Federacija Bosne i Hercegovine Federalni zavod za statistiku <http://fzs.ba/>

<sup>20</sup> The municipalities included in the analysis are those that are entirely within the Neretva and Trebišnjica basins. As previously noted, there are three other municipalities in Federation Bosnia and Herzegovina that have part of their territory in the Neretva and Trebišnjica basins; two in Herceg-Bosnian Canton and one in Sarajevo Canton. However these three were excluded from the analysis as the majority of commercial and irrigated agriculture production in these municipalities draws on waters outside the Neretva and Trebišnjica basins.

<sup>21</sup> The research team also investigated livestock and eggs/dairy, but were not able to gather sufficient price information and irrigation requirements to include these in the analysis.

<sup>22</sup> TPotrebe poljoprivrednih kultura za vodom – Agronomski i prehrambeno-tehnoloski fakultet Sveucilista u Mostaru, Biskupa Cule bb Published in: Osnove uređenja zemljišta program navodnjavanja i programa okrupnjavanja posjeda u Federaciji Bosne i Hercegovina

<sup>23</sup> Smith, Martin. CROPWAT: A Computer Program for Irrigation Planning and Management. Issue 46 of FAO irrigation and drainage paper, Food and Agriculture Organization, 1992



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Below is a summary of the results for 2016. Overall, the two cantons in the study area contribute about 25 percent of the total revenue from agriculture production in Federation Bosnia and Herzegovina (€119,984,797 / €471,967,240); with Herzegovina-Neretva Canton alone providing 22 percent. Key findings include:

- About 23 percent of agricultural production in Herzegovina-Neretva Canton is irrigated and 26 percent in West Herzegovina Canton (around 16 percent of total agriculture land).
- Total revenue from irrigated production (tons) of the major crops in these two cantons is about 5 percent of Federation Bosnia and Herzegovina's agriculture revenue (€23,074,801 / €471,967,240).
- In 2016 irrigated agriculture in the study area in Federation Bosnia and Herzegovina required 3,387,488 m<sup>3</sup> of water, and €23,074,801 in revenue is attributable to it.
- Put another way, about 6.8 m<sup>3</sup> of irrigated water equates to €1 of agriculture revenue in the study area in Federation Bosnia and Herzegovina

The tables below, Table 17 Agriculture in Herzegovina-Neretva Canton 2016 and Table 18 Agriculture in West Herzegovina Canton 2016, show the results by major crop categories for Herzegovina-Neretva Canton and West Herzegovina Canton. The crops are ranked from highest to lowest in terms of the percent of production that is irrigated. The tables also include the percent of total production in Federation of Bosnia and Herzegovina by crop type – for example, over 80 percent of all grapes grown in Federation of Bosnia and Herzegovina are grown in Herzegovina-Neretva Canton. The tables also show the m<sup>3</sup>s of water required for €1 in revenue for each crop. This number varies significantly from crop to crop, and the 6.8 cited above is the overall average.

Table 17 Agriculture in Herzegovina-Neretva Canton 2016

Herzegovina - Neretva Canton									
Crop Type	Annual Production (tons)	% FB&H total	Tons, Irrigated	% Irrigated	Estimate m <sup>3</sup> water	Average Price €/ton	Total Revenue	Share Revenue (€) from Irrigation	€/ m <sup>3</sup>
Cherries	1.581	25%	525	33%	92.540	586	1.818.150	307.732	3,33
Sour Cherries	362	13%	120	33%	24.033	612	434.400	73.525	3,06
Apricots	427	66%	142	33%	10.049	1.020	854.000	144.544	14,38
Grapes	26.790	81%	8.892	33%	387.401	887	46.614.600	7.889.786	20,37
Watermelon	6.120	45%	1.919	31%	100.601	408	4.896.000	782.870	7,78
Potato	28.541	13%	7.458	26%	885.467	189	10.560.170	1.407.142	1,59
Carrots	448	5%	117	26%	22.036	449	394.240	52.532	2,38
Cabbage	8.570	22%	2.239	26%	104.259	224	3.770.800	502.459	4,82
Tomato	11.091	45%	2.898	26%	176.813	510	11.091.000	1.477.875	8,36
Green Pepper	6.423	43%	1.678	26%	128.873	694	8.735.280	1.163.975	9,03
Cucumber	1.695	5%	443	26%	41.860	535	1.779.750	237.152	5,67
Beans	224	4%	59	26%	12.124	2.101	922.880	122.974	10,14
Yellow Onion	5.161	16%	1.304	25%	126.818	260	2.632.110	339.038	2,67
Garlic	521	9%	132	25%	28.917	760	776.290	99.993	3,46
Peas	112	23%	23	21%	11.105	433	95.200	10.148	0,91
Apples	8.832	27%	0	0%	0	362	3.197.754	0	0
Pears	660	7%	0	0%	0	688	454.365	0	0
Plums	2.609	6%	0	0%	0	571	1.490.115	0	0
Peaches	6.075	91%	0	0%	0	637	3.872.433	0	0
Walnuts	210	13%	0	0%	0	739	155.280	0	0
Wheat	799	1%	0	0%	0	167	262.032	0	0
Rye	45	0,54%	0	0%	0	185	16.356	0	0
Barley	746	3%	0	0%	0	159	232.431	0	0
Oats	54	0,58%	0	0%	0	255	27.000	0	0
Corn	308	0%	0	0%	0	152	92.003	0	0
Tobacco	60	12%	0	0%	0	3.004	353.400	0	0
Clover	562	1%	0	0%	0	51	56.200	0	0
Alfalfa	432	1%	0	0%	0	112	95.040	0	0
<b>Total</b>	<b>119.458</b>		<b>27.948</b>	<b>23%</b>	<b>2.152.897</b>		<b>105.679.278</b>	<b>14.611.745</b>	<b>6,79</b>

**Table 18 Agriculture in West Herzegovina Canton 2016**

West Herzegovina Canton									
Crop Type	Annual Production (tons)	% FB&H total	Tons, Irrigated	% Irrigated	Estimate m <sup>3</sup> water	Average Price €/ton	Total Revenue	Share of Revenue (€) from Irrigation	€/ m <sup>3</sup>
Cherries	337	0,02%	210	62%	45.853	1.150	197.631	241.982	5,28
Sour Cherries	60	0,01%	37	62%	11.432	1.200	36.716	44.956	3,93
Apricots	51	0,01%	32	62%	4.033	2.000	52.015	63.688	15,79
Grapes	5.872	0,01%	3.666	62%	327.373	1.740	5.210.302	6.379.565	19,49
Watermelon	3.116	0,06%	983	32%	51.509	408	1.271.055	400.840	7,78
Potato	9.036	0,09%	2.375	26%	474.713	189	1.704.926	448.055	0,94
Carrots	293	0,07%	77	26%	14.507	449	131.592	34.582	2,38
Cabbage	2.264	0,06%	595	26%	60.339	224	507.992	133.500	2,21
Tomato	1.942	0,02%	510	26%	81.906	510	990.323	260.257	3,18
Green Pepper	348	0,00%	91	26%	36.424	694	241.349	63.427	1,74
Cucumber	1.390	0,08%	365	26%	34.532	535	744.422	195.634	5,67
Beans	88	0,01%	23	26%	5.046	2.101	184.887	48.588	9,63
Yellow Onion	1.137	0,04%	289	25%	63.773	260	295.705	75.121	1,18
Garlic	364	0,05%	92	25%	20.323	760	276.631	70.275	3,46
Peas	28	0,03%	6	21%	2.829	433	12.299	2.586	0,91
Apples	300	0,01%	0	0%	0	362	108.619	0	0
Pears	60	0,01%	0	0%	0	688	41.306	0	0
Plums	281	0,02%	0	0%	0	571	160.491	0	0
Peaches	201	0,01%	0	0%	0	637	128.125	0	0
Walnuts	108	0,07%	0	0%	0	739	79.858	0	0
Wheat	2.228	1%	0	0%	0	167	372.606	0	0
Rye	5	0,03%	0	0%	0	185	927	0	0
Barley	1.593	1%	0	0%	0	159	253.104	0	0
Oats	5	0,02%	0	0%	0	255	1.275	0	0
Corn	1.903	2%	0	0%	0	152	289.879	0	0
Tobacco	254	0,07%	0	0%	0	3.004	761.414	0	0
Clover	935	2%	0	0%	0	51	47.680	0	0
Alfalfa	1.804	2%	0	0%	0	112	202.389	0	0
<b>Total</b>	<b>36.003</b>		<b>9.353</b>	<b>26%</b>	<b>1.234.591</b>		<b>14.305.519</b>	<b>8.463.056</b>	<b>6,85</b>

**Water Use Fees for Irrigation:** The research team shared these results with the water management agency, Agencija za vodno područje Jadranskog mora, responsible for the parts of the Cetina, Krka, Neretva, and Trebišnjica basins in Federation Bosnia and Herzegovina. The agency subsequently shared that since 2014 the government of the entity of Federation Bosnia and Herzegovina has been considering charging farmers a water-use fee for irrigation at a rate of €0.001/m<sup>3</sup>.

To evaluate this policy option, the agency conducted its own research to calculate irrigated hectares in its jurisdiction (including parts of four basins).<sup>24</sup> This calculation was done using a different methodology from the one for this study, with the agency assuming that each hectare of irrigated land requires about 5,000 m<sup>3</sup> of water, irrespective of what is being grown. Using this approximation, the agency estimated that per year 6,250,000 m<sup>3</sup> of irrigated water is used for approximately 1,250 ha of irrigated land. According to CORINE data, the agency's jurisdiction, including parts of the Cetina, Krka, Neretva, and Trebišnjica basins has 306,016 total hectares of agriculture land. Of this agriculture land, 138,923 hectares, or 45.4 percent, is in Cetina and Krka basins and 167,093 hectares, or 54.6 percent, is in the Neretva and Trebišnjica basins). Overall, the agency's separate estimate of m<sup>3</sup> of water used for irrigation is largely consistent with the original research in this study. Of the agency's total, taking just 54.6 percent for the part in the Neretva and Trebišnjica basins is 3,412,500 m<sup>3</sup>, slightly higher compared to the estimate from this study of 3,387,488 m<sup>3</sup> per year.

Once the agency determined their estimate for the m<sup>3</sup> of water used annually for irrigation, it estimated that at a rate of €0.001/m<sup>3</sup> the water-use fees for their entire jurisdiction would be €6,376 per year. Currently the agency is still in discussions with the entity government as to whether or not the proposed rate should be increased to reflect the costs that would be incurred to monitor and collect such water-use fees. Controlling just for the study area in Federation Bosnia and Herzegovina, should the water-use fee stay at €0.001/m<sup>3</sup> the potential tax revenue would be €3,387 (0.001 x 3,387,488). To date however, no water-use fees have been collected from farmers in the area.

**Agriculture Jobs:** The data on agriculture jobs indicates that while many people are involved in agriculture in the Herzegovina-Neretva Canton and West Herzegovina Canton, it is not their primary occupation. According to the Federation Bosnia and Herzegovina Statistics Bureau<sup>25</sup>, in 2016 there were 5,863 registered family farms with 13,685 people. This is about 2.3 people per family farm, which is lower than the average of 3 people per household in the area. In addition there were a further 846 registered businesses related to agriculture, with 907 people indicating full time employment in the agriculture sector. It is reasonable to assume that each of the people with jobs (907) support the rest of their households, meaning an additional 1,814 people are supported by those jobs.

Including people with family farms (13,685), and the total of people with agriculture jobs and their households (907+1,814), the total population with all or part of their income from agriculture in the two cantons is 16,406. The total population of those two cantons is 313,384 people, meaning that only about 5 percent of the population is directly or indirectly supported by agriculture. Controlling for irrigation, which is about 23 percent of agriculture production, the number would be that much lower. This a vastly different employment picture than in the Neretva delta in Croatia where one in three households are directly or indirectly supported by agriculture, as is shown below.

<sup>24</sup> See page 105 of the draft Adriatic water management plan (Federacija BiH, 2016)

<sup>25</sup> Federacija Bosne i Hercegovine Federalni zavod za statistiku <http://fzs.ba/>

The Neretva delta in Dubrovnik-Neretva County is the most intensively cultivated area in both the Neretva and Trebišnjica basins and agriculture is widely thought to provide income for a significant percentage of the population of the delta. The research team therefore set out to demonstrate how much revenue and jobs are dependent on irrigated agricultural production in the municipalities in Dubrovnik-Neretva County.

However, the research team was not able to access enough publicly available data to conclusively demonstrate the overall value of irrigated water. Nor was there sufficient time and resources available to conduct a similar analysis as was prepared for Federation Bosnia and Herzegovina above. Below is a summary of steps taken and collected data. This section also includes a case study on the estimated value of tangerine production in the Croatian part of the Neretva delta, and a case study on wine in the Dubrovnik-Neretva County.

Area under cultivation: The last publicly available full agriculture census in Croatia was conducted fifteen years ago in 2003. This data no longer corresponds to the situation in the area. Instead of relying on old data, the research team requested information from 2012 – 2016 from Croatia's statistics bureau, Državni zavod za statistiku (DZS), about the production of wine, olives, and citrus fruit by municipality in Dubrovnik-Neretva County. This formal request went unanswered. Next the research team partnered with the local rural development organization Lokalna Akcijska Groupa Neretva and jointly contacted the Official Production of Statistics of Agriculture, Forestry, and Fisheries of DZS. The team also collected data from municipal level studies and strategic plans.<sup>26</sup> Overall the team was able to gather a limited amount of data about hectares of cultivated land that is more recent than the 2003 DZS data. This is data shown in Table 19 Official statistics for agriculture in Dubrovnik-Neretva County.

<sup>24</sup> These sources included: DZS, Statistički ljetopis; Agro klub 2010; Strategija razvoja Općine Blato 2015. -2020; DZS, Popis poljoprivrede 2003; Izvješće o stanju u prostoru Općine Dubrovačko primorje 2015; Izvješće o stanju u prostoru Općine Trpanj za Razdoblje od 2010 do 2013; Izvješće o stanju u prostoru Općine Vela Luka 2012; Strateški plan Općine Ston 2017. -2019; Izvješće o stanju u prostoru Općine Orebić, 2015; Vodič za investitore u DNŽ; ARKOD 2015; Brojno stanje domaćih životinja, HPA 2015; Izvješće o stanju u prostoru Općine Konavle 2012

**Table 19 Official statistics for agriculture in Dubrovnik-Neretva County**

Municipality	Area under cultivation (ha)	Year of available data
Blato	850	2015
Dubrovačko primorje	1.083	2015
Janjina	149,28	2003
Konavle	842,25	2012
Kula Norinska	136,57	2003
Lastovo	57,46	2003
Lumbarda	86,14	2003
Mljet	198,87	2003
Orebić	2.298,71	2015
Pojezerje	173,8	2003
Slivno	382,85	2003
Smokvica	255,98	2003
Ston	1.558,33	2003
Trpanj	491,51	2014
Vela Luka	363,37	2012
Zažablje	38,16	2003
Župa dubrovačka	169,65	2003
Dubrovnik	3.438,30	2016
Korčula	289,61	2003
Metković	336	2003
Opuzen	1.251,15	2015
Ploče	521,64	2003
Total	14.972,63	

These figures are based on official records of land use and show about 15,000 hectares of agriculture land in the 22 municipalities in Dubrovnik-Neretva County. However, this is less than half of the area that is widely known to be used for agriculture. According to cultivation surveys and additional research undertaken for this study, as of 2017 the unofficial estimate is 32,727.75 hectares of agriculture land in Dubrovnik-Neretva County. This finding is largely consistent with the share of agriculture hectares of Dubrovnik-Neretva County (about half of the total for the study area in Croatia) found in the CORINE data adapted for this study presented above in Table 5 Land-Use Summary for Croatia.

Looking just at the seven municipalities in the Neretva delta in Dubrovnik-Neretva County, the unofficial estimate of land under cultivation is 4,502.82 ha. However, the official statistics show only about 60 percent of that amount, as shown in Table 20 Official statistics for agriculture in the Neretva delta in Croatia.

**Table 20 Official statistics for agriculture in the Neretva delta in Croatia**

Neretva Delta Municipalities	Area under cultivation (ha)	Year of available data
Kula Norinska	136,57	2003
Pojezerje	173,8	2003
Slivno	382,85	2003
Zažablje	38,16	2003
Metković	336	2003
Opuzen	1.251,15	2015
Ploče	521,64	2003
Total	2.840,17	

Put another way, official statistics for agriculture in Dubrovnik-Neretva County account for less than half of the total estimated land under cultivation, and only 60 percent of estimated cultivated land in the Neretva Delta itself.

These results are not surprising for anyone following the agriculture sector in Croatia. In fact, the Association of Family Farms “Život” filed a formal complaint in 2017 with the Croatian Agency for Payments in Agriculture, Fisheries, and Rural Development (Agencija za plaćanja u poljoprivredi, ribarstvu i ruralnom razvoju) after conducting their own study and finding that (i) nation-wide over 850,000 hectares of state-owned and (ii) currently cultivated agriculture land – about 40 percent of all of Croatia’s arable land – is not being counted in that agency’s ARKOD database of land use<sup>27</sup>. According to DZS, in 2013 the total amount of land in Croatia being used for agriculture was 1,301,985 ha<sup>28</sup> – with Život’s estimate being that the real figure is closer to 2,152,000 ha. The reasons behind these discrepancies are beyond the scope of this report to determine, but are likely related to non-registered non-taxed economic activity and land ownership issues.

These discrepancies in one of the fundamental data points for valuation, hectares of crops under cultivation, make credible valuation estimates for agriculture in Croatia challenging. Furthermore, these discrepancies continue into the official versus unofficial estimates of hectares of irrigated agriculture land. For example, according to statistics published by the European Commission, in 2013 irrigated agriculture in Croatia amounted to 13,430 ha<sup>29</sup>, or about 1 percent of ‘official’ agriculture land, or a little more than half of one percent of the ‘unofficial’ agriculture land in Croatia. Just using the Neretva Delta, which is an irrigated system, a quick comparison of hectares shows that the official data for irrigation are likely underestimating the true amount.

<sup>27</sup> A description in Croatian of this complaint was published by tportal.hr here, last accessed on 19.01.2018.

<sup>28</sup> See page 29 of the Croatian Ministry of Agriculture’s report on the state of agriculture in Croatia for 2013 (Godišnje izvješće o stanju poljoprivrede u 2013. godini). Published in Zagreb in 2014 and available here in Croatian. Last accessed on 19.01.2018.

<sup>29</sup> Agriculture statistics and indicators, Facts and Figures on EU Agriculture and the CAP. Here. Last accessed on 19.01.2018.

According to both official statistics (2,840 ha/1,301,985 ha) and unofficial estimates (4,503 ha/2,152,000 ha), agriculture land in the Neretva Delta is 0.2 percent of Croatia's total agriculture land. Agriculture in the Neretva Delta is irrigated, meaning that this area alone would be over 22 percent of all irrigated land in Croatia (33 percent if using unofficial estimates). However, there are many other areas of irrigated land in Croatia, particularly in Slavonia. This indicates that the reported statistics for irrigated hectares are much less than reality. In any case, Croatia does not have a system for directly charging for irrigated water. In some cases water for irrigation is factored into the overall price for renting land. In others, farmers simply use water free of charge.

**Agriculture Jobs:** Similar to the discrepancies in hectare data, there is also conflicting data about the number of jobs and people supported in the agriculture sector in the Dubrovnik-Neretva County. According to DZS, as of 2011 there were 41,636 households in the Dubrovnik-Neretva County, with an average size of three members. About 9,367 households (or almost 25 percent) are involved in agriculture in some way, with 7,711 households (or almost 20 percent) registered as a family agriculture business (*obiteljsko poljoprivredno gospodarstvo*). The percentages increase when controlling just for the municipalities within the Neretva Delta. The seven municipalities in the Neretva Delta have about 11,155 households, of which 3,696 are registered as family agriculture businesses – or 1/3rd of all households in the Neretva Delta. The delta also has half of the total family agriculture businesses in the Dubrovnik-Neretva County.

While the family agriculture business data shows that a significant number of households, particularly in the Neretva Delta, are engaged in agriculture, data on jobs shows otherwise. The 2011 census had only 2,355 people in the Dubrovnik-Neretva County stating they are involved in agriculture, hunting, fishing, and/or forestry (compared to the household data indicating that over 9,000 households are engaged in agriculture). According to the Croatian Chamber of Economy – Dubrovnik (*Hrvatska gospodarska komora – Dubrovnik*) the number of agriculture jobs is even lower. As of 2015 only 2 percent of people employed in Dubrovnik-Neretva County were registered as having jobs in the agriculture, fisheries and forestry sector (of 19,539 jobs in total, only 391 in agriculture, fisheries, and forestry). This could be a reflection of a widespread view that agriculture is perceived less as a job and more as a tradition/culture in area.

Regardless of which statistic is more 'accurate,' in general the data shows that agriculture production is mainly a source of supplementary income or household use – not a primary job for most people. This is consistent with the findings in neighboring Federation Bosnia and Herzegovina.

However, this research does demonstrate that agriculture production in the Neretva Delta involves about 1/3rd of all households in that area. As the average household size in that area is 3 people then 1/3rd of the population is supported by agriculture in the Neretva Delta as either a primary or secondary source of income.

**Croatia case studies:** The team conducted a valuation of tangerines based on public data in Dubrovnik-Neretva County. Tangerines were chosen as they form a significant part of agriculture production in the area and require irrigation. Plus, sufficient data exists to conduct a credible valuation, as tangerines are a cash crop. The team also investigated the wine sector, as vineyards are another substantial source of agriculture revenue in the Dubrovnik-Neretva County and rely on irrigation during dry years.



## Case study – Water for Tangerines

There are 289 registered producers of tangerines in the Neretva Delta, and, conservatively, tangerine fields are about 50 percent of all agriculture production in the Neretva Delta. According to official statistics this would be about 1,420 ha (2,840\*0.5); according to unofficial estimates this would be about 2,250 ha (4,502.82\*0.5).

Table 21 Tangerine production and revenue 2012 - 2016 presents official statistics from DZS for tons of tangerines produced and hectares of production in Dubrovnik-Neretva County by year. It also includes the recorded € price per ton of tangerines sold by producers (wholesale/local retail), and estimated average annual revenue.<sup>30</sup> Note, this calculation is considerably lower than other unofficial estimates heard anecdotally by the research team of up to €40 million per year, with an average retail price of €800 per ton. It should therefore be treated as a conservative, minimum estimate (in all likelihood, the 'true' value of water for tangerines is higher than the figures stated below).

**Table 21 Tangerine production and revenue 2012 - 2016**

Year	Tons Sold	Tons per Hectare	No. Hectares	Average Price per Ton	Average annual revenue
2016	52.050	24,8	2.100	€ 160	€ 8.328.000
2015	35.722	16,6	2.150	€ 350	€ 12.502.700
2014	64.378	29,9	2.150	€ 360	€ 23.176.080
2013	40.024	19	2.104	€ 360	€ 14.408.640
2012	50.786	29,5	1.720	€ 340	€ 17.267.240

Put another way, over the past five years average annual revenue from the sale of Neretva Delta tangerines is about €15 million a year. However, according to tangerine experts in the Neretva Delta interviewed for this study, it costs about €6,750 to produce one hectare of tangerines, with an average annual production cost of €13.8 million. This indicates that over the past two years tangerine production has not been profitable. Furthermore, prior to 2013 when Croatia joined the European Union, the country had provided a subsidy for tangerine production of about €94 per ton. This subsidy was removed as a condition of joining the European Union and anecdotal evidence suggests that fewer farmers in the Neretva Delta are planning to continue growing tangerines. Adding to this pressure is the fact that Croatia recently lost access to its largest export market for Neretva Delta tangerines – Russia – as that country is now under European Union sanctions.

The research team also estimated the amount of water required to irrigate the tangerine fields in the delta. WWF's prior research into the Neretva Delta indicates that 5 m<sup>3</sup>/sec of water are required for all irrigated agriculture. Assuming that tangerines are about 50 percent of agriculture in the delta, which is a conservative estimate, tangerine production requires 78,840,000 m<sup>3</sup> of water from the Neretva basin annually. Table 22 Euros per cubic meters of water for tangerines shows annual revenue, m<sup>3</sup> of water required, and the m<sup>3</sup> of water required per € revenue. On average about 5.8 m<sup>3</sup> of water equates to €1 of tangerines.

<sup>30</sup> There are a total of 11 distribution companies in the Dubrovnik-Neretva County that handle tangerines, and for each, tangerines are less than 50 percent of what they distribute. Currently there are not significant quantities sold of value-added goods made from tangerines in Dubrovnik-Neretva County. There are no local large producers of jam or juice, and locally made products from tangerines (jams/juices) are mostly sold in small quantities at local fairs and stands. At the national level however, Neretva Delta tangerines are used by the juice manufacturer Vindija and the brewing company Karlovačka pivovara.

**Table 22 Euros per cubic meters of water for tangerines**

Year	Average annual revenue	m <sup>3</sup> water per year	m <sup>3</sup> /€
2016	€ 8.328.000	78.840.000	9,47
2015	€ 12.502.700	78.840.000	6,31
2014	€ 23.176.080	78.840.000	3,4
2013	€ 14.408.640	78.840.000	5,47
2012	€ 17.267.240	78.840.000	4,57
Average	€ 15.136.532	78.840.000	5,84

## Case study – Wine in Dubrovnik-Neretva County

The research team investigated vineyards in the Dubrovnik-Neretva County in an attempt to value the contribution Neretva and Trebišnjica waters to that sector. Ultimately a valuation was not possible as again the team was unable to rely on publicly available information for hectares of production and hectares of irrigation. However, the investigation did uncover additional evidence to support the assertion that the official agriculture statistics are significantly underestimating actual cultivation and production.

According to published statistics in Dubrovnik-Neretva County there are 161 registered wineries, 3,257 vineyards, 373 different types of wine, and 185 distribution and/or storage companies related to wine. According to ARKOD data in 2011 there were 2,128 hectares of vineyards in Dubrovnik-Neretva County, with 6,200,900 liters of wine produced. Of this production roughly half takes place on the Pelješac peninsula and only around 5 percent in the Neretva Delta (31,500 liters in 2016).

However, not all of the vineyards in the Neretva Delta<sup>31</sup> are captured in the official statistics. According to DSZ, and consistent with the 2012 Dubrovnik-Neretva Strategy for the Development of Vineyards and Wineries (Strategija Razvoja Vinarstva i Vinogradarstva), there are only six wineries in the Neretva Delta. This is not accurate. For example, Eco-vineyard in Slivno municipality has about 100 hectares of vineyards and is not included in official statistics. Furthermore Eco-vineyard Slivno uses municipal water from Slivno for irrigation. This is discussed more in the gap analysis section for agriculture.

The research team also encountered problems determining irrigated hectares when assessing the contribution of Trebišnjica waters to agriculture in Republika Srpska. In the study area water for irrigation is currently free of charge<sup>32</sup> – other than the cost of the electricity for the pumps – and it is likely that the actual amount of irrigated agriculture land is higher than is accounted for in the official statistics. This ambiguity in the data made making a credible evaluation of the whole sector not feasible in the time available. However, the research team was able to gather credible data on commercial wine production in Trebinje and conducted a valuation of that subsector of agriculture production. Below is a summary of the findings and the wine case study.

Summary of findings: According to official data, there are 1,252,311 ha of agriculture land in all of Republika Srpska, or about 51 percent of that entity's total area. This land is further divided between arable land (593,540 ha) and family gardens (614,264 ha) – which together are 96 percent of total agricultural land. The remaining 4 percent is pastures, meadows, and orchards. Of the total, about 11 percent is irrigated and about 77 percent of those existing irrigation systems are reported as being in good working order.

For the study area in Eastern Herzegovina, land use data shows that about 18 percent is agriculture land (82,962.25 ha). However, official data indicates that only about 7 percent of land in this part of Republika Srpska is reportedly in use for agriculture. According to research conducted for this study, an even smaller area is possible to irrigate. Notably this includes the areas of Trebinjsko polje (963 ha) and Popovo polje (1,750 ha). However, official data again shows an even smaller irrigated area. For example only about 100 ha in Trebinjsko polje and about 100 ha Popovo polje are recorded as being irrigated.

As for Croatia, the unofficial estimates calculated by the research team for hectares under cultivation and hectares of irrigated land are significantly more than shown by official sources. More original research is required before a credible valuation can be made of the contribution of Trebišnjica waters to the agriculture sector in Republika Srpska in terms of revenue and jobs.

## Case study – Wine in Eastern Herzegovina

Per the land use data collected for this study, in the study area in Republika Srpska there are about 332.71 hectares of vineyards. The majority of commercial wine production in the area takes place in or near Trebinje municipality. There are four main commercial vineyards – Podrumi manastira Tvrdoš, Đordan Vinarije, Podrum Anđelić, and Podrumi Vukoje 1982 – that have about 128 hectares of vines near Trebinje. This is about 40 percent of all vineyards hectares in the study area in Republika Srpska. The research team gathered data from 2012 – 2016, with 2016 data summarized in the table below.

<sup>32</sup> During meetings held with government officials in Republika Srpska to discuss this study the research team learned of plans to introduce mandatory payments for irrigation. However, to date no such new laws/regulations have been passed.

**Table 23 Trebinje commercial wine production 2016**

Winery	Location	Jobs	Production Liters	Wholesale 0.7L Bottles	Retail 0.7L Bottles	Average unit price € per 0.7L	Estimated 2016 Revenue €
Tvrdoš	Petrovo Polje	8	200.000	270.000	15.000	5,6	1.596.000
Đordan	Petrovo Polje, mesari	3	130.000	0	200.000	6	1.200.000
Anđelić	Petrovo Polje, Zasad Gomiljani	5	100.000	114.000	28.500	5,1	726.750
Vukoje	Zasad polje, carski vinogradi Ušće	8	130.000	130.000	5.000	8,1	1.093.500
Total		24	560.000	514.000	248.500		€ 4.616.250

During dry years these commercial vineyards rely on irrigation, Nevertheless, the research team determined that over the last five-year period, 2012 and 2015 were dry years. Relying on expert estimates from specialists in the Trebinje area, the research team approximated the percentage of hectares that are irrigated per winery during dry years. This same percentage was then used to estimate the amount of revenue attributable to irrigation for 2015. Table 24 Trebinje irrigated wine production 2015 shows the result of this analysis. Overall, about 80 percent of total revenue for Trebinje's major commercial wineries in 2015, €3.8 million, is attributable to water from the Trebišnjica basin.

**Table 24 Trebinje irrigated wine production 2015**

Winery	Hectares	Estimate of Hectares Irrigated	Percent Irrigated	Estimated 2015 Revenue	Estimated 2015 Revenue Dependent on Irrigation
Tvrdoš	48	48	100%	€ 1.596.000	€ 1.596.000
Đordan	20	10	50%	€ 1.200.000	€ 600.000
Anđelić	30	19,5	65%	€ 726.750	€ 472.388
Vukoje	30	30	100%	€ 1.093.500	€ 1.093.500
Total	128	107,5	84%	€ 4.616.250	€ 3.761.888

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The team was not able to calculate how many m<sup>3</sup> of water is required to generate €1 of revenue, as the amount of water used for irrigation is not publicly available. This can possibly be attributed to the fact that people are not currently charged for their use of water for irrigation.

Also of note, the data collected from 2012 to 2016 only includes the four major commercial wineries in Trebinje. Expert estimates (not official data) suggests that small wineries and unregistered farms are producing upwards of 450,000 liters per year and selling that privately and unlabeled for between €2 and €2.5 per liter. This level of unregistered production is almost equal to the output of the major commercial vineyards and could be valued between €900,000 – 1,125,000 annually

## Montenegro

A small part of Nikšić municipality is in the Trebišnjica basin with the rest in the Drina basin. The research team investigated agriculture production in the entire municipality and found that the vast majority of commercial (non-household) agriculture takes place in the Drina basin, with irrigation primarily coming from the Piva River.<sup>33</sup> In Herceg Novi there is not significant commercial agriculture. As such, there is not notable contribution to the commercial agriculture sector of Montenegro from the waters of the Trebišnjica basin.

## Gap Analysis – Water for Agriculture

**Water for irrigation:** Given the significant discrepancies and gaps in data it was not possible to conduct a valuation of the contribution of Neretva and Trebišnjica waters to the agriculture sector as a whole for Dubrovnik-Neretva County and Republika Srpska. For Federation Bosnia and Herzegovina the team created a new model and conducted original research to estimate irrigated water required. This methodology was then used to conduct a detailed look by crop-type at the revenue dependent on irrigation in the study area in Federation Bosnia and Herzegovina.

To test these results the research team compared its findings to a broader high-level estimate made by the Agencija za vodno područje jadranskog mora. This agency estimated an annual amount of irrigated water required per hectare (not by crop-type) and the amount of irrigated hectares. Overall, the agency's separate estimate is largely consistent with the original research in this study – the agency's result for the study area was about 3,412,500 m<sup>3</sup> per year compared to the original research showing 3,387,488 m<sup>3</sup> per year. This reinforces the usefulness of the methodology developed for this study; which provides a higher level of detail by crop-type and allows for revenue calculations. As such the type of analysis conducted for the study area in Federation Bosnia and Herzegovina could be replicated in the other parts of the basins in Croatia and Republika Srpska.

<sup>33</sup> In Nikšić there are approximately 13,884 farmers, defined as people with family agricultural holdings. This is about 20 percent of Nikšić's total population of 70,789. Key crop types are cereals, vegetables, and orchards. Irrigation data was available from 2010, with 9.5 hectares of cereals reportedly irrigated, 13.9 hectares of vegetables, and 25.1 hectares of orchards. Reported total water use for irrigation in 2010 was 39,286.76 m<sup>3</sup>. However, as stated above, the water for this irrigation came from Piva River in Drina basin, not the Trebišnjica basin.

Further work is necessary to credibly determine how water from the Neretva and Trebišnjica basins is supporting agriculture, both in terms of quantity used for irrigation, and value in revenue and jobs. This information is crucial for water managers to be able to accurately understand how diversion of water away from agriculture – for example, to hydropower production in HPP Dubrovnik II or HPP Boka, which would drain directly into the Adriatic – would impact on the economy.

For example, the estimated 5.8 m<sup>3</sup>/sec of water for irrigation that supports agriculture in the Neretva Delta is dependent to some degree on the Trebišnjica hydropower system. The water that is used to generate electricity at HPP Čapljina in Federation Bosnia and Herzegovina is Trebišnjica waters channeled across Popovo polje. This water is then released into the Krupa river, which empties into the Neretva Delta. Should HPP Dubrovnik II or HPP Boka be constructed, it is estimated that less water would be released to HPP Čapljina – resulting in less water for irrigation down stream in the Neretva Delta and jeopardizing agriculture production in both Federation Bosnia and Herzegovina and Croatia.

In conclusion, there is not a clear picture of what is at stake for agriculture in the basins in Croatia, Republika Srpska, and Federation Bosnia and Herzegovina. With information on water use for irrigation, decision-makers do not have enough data to comprehensively evaluate the potential impact of new hydropower infrastructure on agriculture-dependent communities in the basins.

**Municipal water for irrigation:** The research team heard anecdotal reports when preparing this study that a ‘significant’ amount of water that is supplied through municipal water systems is used for agriculture and is recorded as losses (and unpaid). As is described in the section below – Water for Public Use – there are significant losses reported in the official data for public water across the study area. Understanding the link between these municipal losses and irrigation is another aspect for future work.

**Environmental impacts of irrigation:** While it is beyond the scope of this study to fully explain, the use of water for irrigation is already negatively impacting the environment in the basins. Separate WWF research has shown that in particular that the pumping of groundwater for use in irrigation, particularly in the Neretva Delta, is changing water pressure allowing for saltwater intrusion into the subterranean system. This increased saltwater intrusion is simultaneously degrading remaining freshwater ecosystems, and negatively impacting the quality of crops.

**Growth potential for hydropower versus agriculture:** Another area for additional analysis that is not covered in this study is the challenge of comparing the economic potential of agriculture and hydropower. Just considering the baselines presented in this report it would appear that water for agriculture has a ‘higher’ economic benefit and thus should be prioritized, for example to increase the supply of water to the Neretva Delta instead of diverting water to HPP Dubrovnik which is then released into the Adriatic. Compare the average of 6.8 m<sup>3</sup> of water required for €1 for the agriculture sector in Federation Bosnia and Herzegovina, and the 5.8 m<sup>3</sup> of water for €1 in tangerines – to the 19 m<sup>3</sup> of water required for €1 hydropower in the Trebišnjica system.

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However, it would be facile to conclude that prioritizing investments in agriculture would be better than investing in hydropower that would divert water that otherwise would have been available for agriculture. That would ignore the very real limitations for additional investment in agriculture to expand output (land, crop yields, market demand). In fact, the hydropower sector, while facing significant challenges in terms of international political negotiations and investments, could expand much more exponentially than agriculture. Further analysis and modeling is therefore required prior to being able to make an accurate or useful comparison between the potential value of water for hydropower versus agriculture; given the very real trade-offs between the two.





# THE VALUE OF PUBLIC WATER SUPPLIES

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Municipal water supply is another demand on the finite water resources of the Neretva and Trebišnjica basins. It also has an economic component as the public utilities charge for water use and employ people in local communities. Also as tourism to the study area expands, particularly in coastal areas of Croatia and Montenegro, there is an overall increasing demand for water. To show what is at stake for this sector, the research team investigated the amount of water currently being distributed in the study area and calculated its value in terms of revenue. Overall the research team was able to credibly value the contribution of Neretva and Trebišnjica waters for Republika Srpska, Federation Bosnia and Herzegovina, and Montenegro; showing similar results as follows:

- In Republika Srpska 1.1 m<sup>3</sup> of distributed water equates to €1
- In Federation Bosnia and Herzegovina 1.2 m<sup>3</sup> of distributed water equates to €1
- In Herceg Novi in Montenegro 1.3 m<sup>3</sup> of distributed water equates to €1

The research team was unable to conduct similar analysis for Croatia; steps taken for that jurisdiction are presented separately along with a final gap analysis for public water.

## Republika Srpska

The research team collected data over a five-year period (2012 – 2016) to estimate the value of Trebišnjica waters in terms of municipal water supply. The total distribution of water in all of Republika Srpska in 2016 was about 70,577,000 m<sup>3</sup>; but the estimated total amount of water supplied into the system entity-wide is 4 m<sup>3</sup>/sec or 126,144,000 m<sup>3</sup>. This estimate indicates losses of about 44 percent and is based on expert interviews conducted for this study. Further research by municipality is necessary to verify this estimate. Anecdotally, the research team heard that losses in the study area itself is even higher – up to 48 percent. In the study area each municipality operates their own water utilities, sourcing about 97 percent of distributed water from within the Trebišnjica basin<sup>34</sup>. These utilities employ in total about 234 people. Of those jobs about half, 120, are at the Trebinje municipal water facility.

The data for 2016 by municipality is presented in detail in Table 25 Republika Srpska study area public water supply 2016.<sup>35</sup> Overall in 2016 municipalities in the Trebišnjica basin produced 3,052,500 m<sup>3</sup> of water and distributed 3,151,954 m<sup>3</sup>; not quite meeting demand of 3,269,200 m<sup>3</sup>. Note, the collected data does not indicate the significant losses that are estimated above for the entire system. Additional field research is required to verify the data.

**Table 25 Republika Srpska study area public water supply 2016**

Location	Average annual production m <sup>3</sup>	Amount of water sold			Demand m <sup>3</sup>
		Household m <sup>3</sup>	Industrial/ Public m <sup>3</sup>	Total m <sup>3</sup>	
Trebinje	1.032.577	1.618.942	298.656	1.917.598	1.917.600
Nevesinje	1.200.000	336.000	84.000	420.000	420.000
Bileća	548.164	484.478	63.686	548.164	386.000
Kalinovik	60	35	19,21	54,21	66800
Berkovići	65.719	50.238	10.061	60.299	67200
Gacko	510	310	65	375	289.800
Istočni Mostar	-	-	-	-	8.400
Ljubinje	205.470	144.050	61.414	205.464	113.400
Total	3.052.500	2.634.053	517.901	3.151.954	3.269.200

<sup>34</sup> Giving just three examples, Trebinje's water utility sources from the Vrelo oko spring which yields about 500 liters per second, and from the waters of the Krš, Hrupjela, and Hum. The Trebišnjica River provides Bileća with another 500 liters per second, and Gacko's water utility yields 35 liters per second from Vratilo.

<sup>35</sup> While not shown in the table, of reported demand/distribution of public water in the study area, an estimated 5 percent is related to tourism. The rest is household, commercial/industrial, and public consumption. Overall for the study area in Republika Srpska there are about 15,565 household connections and 1,317 public and commercial/industrial connections.

The total reported consumption/sale of water of 3,151,954 m<sup>3</sup> was about 5 percent of total municipal water consumption in all of Republika Srpska (70,577,000 m<sup>3</sup>). This is consistent with the percentage of the population of the entity that lives in the study area. The largest municipality in the study area, Trebinje, had the highest distribution at 1,917,600 m<sup>3</sup>. This was 60 percent of the total in the study area, and demand in Trebinje is expected to increase to 2,218,000 m<sup>3</sup> in the coming years.

The total revenue from public water in 2016 in all of Republika Srpska was about €51.5 million. Of that total, a conservative estimate of €2.75 million was revenue from the study jurisdiction as shown in the table below.

**Table 26 Republika Srpska public water tariff and revenue 2016**

Location	Average tariff			Annual Revenue			
	Household	Public	Industrial	Household	Public	Industrial	Total
	€/m <sup>3</sup>	€/m <sup>3</sup>	€/m <sup>3</sup>	€	€	€	€
Trebinje	0,37	0,84	1,13	-	-	-	1.674.501
Nevesinje	0,46	0,92	0,92	127.963	15.171	60.685	203.820
Bileća	0,43	-	1,56	207.615	-	96.860	304.475
Kalinovik	1,02	-	1,02	18.936	-	19601	38.537
Berkovići	0,82	-	0,51	28.053	-	5.824	33.876
Gacko	0,66	-	1,35	252.447	-	104.056	356.503
Istočni Mostar	-	-	-	-	-	-	-
Ljubinje	0,66	-	1,35	98.473	-	40.730	139.203
Total							2.750.916

This is a conservative estimate as the research team was not able to collect data from Istočni Mostar and also received two conflicting sets of revenue data from Gacko and Bileća municipalities. The table above reflects the lower of those two amounts. The higher figures gives a total of about €3.2 million. Either way the revenue estimate would be between 5 and 6 percent of Republika Srpska's total revenue from public water. This again is largely consistent with the population size of the study area.

As waters from the Trebišnjica basin are 97 percent of municipal water supply in the study area in Republika Srpska, the estimated value of Trebišnjica waters is about €2.7 million in public water revenue per year. Put another way about 1.1 m<sup>3</sup> of public water from Trebišnjica in the study area equates to €1 in revenue. However if the estimated total amount of water supplied into the system, including the conservative estimated losses of 44 percent, are taken into account then about 2.1 m<sup>3</sup> of supplied water equals €1.

## Federation Bosnia and Herzegovina

For this part of the study area the research team benefited from detailed data included in the Strategy for the Development of Federation Bosnia and Herzegovina Public Water Supply (Strategy). This Strategy contained data on the average consumption of a person in liters per day for household use by municipality, and the number of people connected to the public water system per municipality. Overall only about 60 percent of the total population of the study area is linked into a municipal water system (the total population is 355,061 with about 188,000 municipal water users).

**Amount of water supplied and distributed:** According to the Strategy, the amount of water from the Neretva basin supplied annually into municipal water systems is 40,626,187 m<sup>3</sup>/year. However, much less is eventually distributed. The amount distributed for household use is 8,091,876 m<sup>3</sup>/year and the amount distributed to businesses/industry is about 4,018,044 m<sup>3</sup>/year. The total average annual distribution is 12,109,920 m<sup>3</sup>/year. These figures show losses of about 70 percent of all water supplied into the system (12,109,920 / 40,626,187).

As with the findings for irrigated water, the research team shared the above with the Agencija za vodno podrucje Jadranskog mora responsible for water management in the study area in Federation Bosnia and Herzegovina. According to their own calculations the amount of losses is less – at 60 percent. They also explained that it is difficult to know exactly as there are discrepancies between the data reported by the municipal water utilities to the agency to calculate the mandatory water-use fees, and the aggregated cantonal-level totals in the entity statistics data. The differences could be contributed to under-reporting to the agency to reduce water-use fees. The agency is already working at the entity level to try to address this issue and is supporting a draft strategy for water management. If approved by the entity government this strategy calls for new investments to repair municipal water supply systems.

**Value of water distributed:** The research team also determined the average tariff for household use in the study area, about €0.68 per m<sup>3</sup>, and for all other categories of users, about €1.13 per m<sup>3</sup>. With this information the research team was able to extrapolate an estimate of total m<sup>3</sup> of water distributed by municipality for 2016; 12,159,570 m<sup>3</sup>. This estimate is very close to the summary data presented in the Strategy of an average amount of 12,109,920 m<sup>3</sup>. Table 27 Federation B&H study area public water supply 2016 shows distribution by municipality, followed by Table 28 Federation B&H study area public water tariff and revenue 2016.

**Table 27 Federation B&H study area public water supply 2016**

Municipality	Number of People Connected to Municipal Water		Average m <sup>3</sup> /day per household	Estimated Household Use m <sup>3</sup>	Estimated Other Use m <sup>3</sup>	Total Estimated Use m <sup>3</sup>
Konjic	15.089		0,13	715.973,10	357.986,50	1.073.959,60
Prozor	8.568		0,13	406.551,60	203.275,80	609.827,40
Jablanica	6.067		0,13	287.879,20	143.939,60	431.818,70
Mostar	66.594		0,13	3.038.351,30	1.519.175,60	4.557.526,90
Široki Brijeg	15.911		0,1	580.751,50	290.375,80	871.127,30
Posušje	11.262		0,11	452.169,30	226.084,70	678.254,00
Čitluk	10.884		0,11	436.992,60	218.496,30	655.488,90
Ljubuški	15.801		0,1	576.736,50	288.368,30	865.104,80
Grude	9.810		0,11	375.968,30	187.984,10	563.952,40
Čapljina	15.594		0,12	683.017,20	341.508,60	1.024.525,80
Stolac	7.979		0,12	349.480,20	174.740,10	524.220,30
Neum	3.024		0,13	143.488,80	71.744,40	215.233,20
Ravno	1.470		0,11	59.020,50	29.510,30	88.530,80
Total	188.053			8.106.380	4.053.190	12.159.570

**Table 28 Federation B&H study area public water tariff and revenue 2016**

Municipality	Average Tariff		Estimated Revenue from Households €	Estimated Revenue from Other €	Total Estimated Revenue €
	Household €	Other €			
Konjic	0,68	1,13	486.861,70	404.524,80	891.386,40
Prozor	0,68	1,13	276.455,10	229.701,70	506.156,70
Jablanica	0,68	1,13	195.757,80	162.651,70	358.409,50
Mostar	0,68	1,13	2.066.078,90	1.716.668,50	3.782.747,30
Široki Brijeg	0,68	1,13	394.911,00	328.124,60	723.035,60
Posušje	0,68	1,13	307.475,10	255.475,70	562.950,80
Čitluk	0,68	1,13	297.155,00	246.900,80	544.055,80
Ljubuški	0,68	1,13	392.180,80	325.856,10	718.036,90
Grude	0,68	1,13	255.658,40	212.422,10	468.080,50
Čapljina	0,68	1,13	464.451,70	385.904,70	850.356,40
Stolac	0,68	1,13	237.646,50	197.456,30	435.102,80
Neum	0,68	1,13	97.572,40	81.071,20	178.643,60
Ravno	0,68	1,13	40.133,90	33.346,60	73.480,50
Total			5.512.338	4.580.105	10.092.443

Overall, the analysis for 2016 is that about 12,159,570 m<sup>3</sup> of water from the Neretva basin was distributed generating €10,092,443 in revenue. In other words, in Federation Bosnia and Herzegovina 1.2 m<sup>3</sup> of water equates to €1 in revenue from public water sales. However if the estimated total amount of water supplied into the system, including the estimated 70 percent losses, are taken into account then about 4 m<sup>3</sup> of supplied water equals €1.

## Montenegro

The team also researched the value of public water from the Trebišnjica basin in the two municipalities in the study area in Montenegro, Nikšić and Herceg Novi. Nikšić is the largest municipality in Montenegro by area and 80 percent of that municipality's population lives in the town Nikšić. Nikšić town itself is located in the Drina basin and the research team determined that the sources of public water is also coming from the Drina river basin. Therefore the research team concluded that waters from the Trebišnjica basin are not contributing in a significant way to public water supply in Nikšić municipality.

In contrast, waters from the Trebišnjica basin make up 100 percent of the public water supply for Herceg Novi municipality. Upwards of 90 percent of this water is pumped across the border from Croatia through tunnels from HPP Dubrovnik through the Konvale - East water supply system. The remaining 10 percent is groundwater from the spring 'Opačica' in Zelenika. The Herceg Novi municipality operates one public water utility, Vodovod i kanalizacija Herceg Novi, that employed 142 people in 2016. Overall water distribution in Herceg Novi is aligned with its relative population size – about 5 percent of Montenegro's total population consuming about 6 percent of the country's total public water. The research team collected public information on Herceg Novi's water supply over a five-year period from 2012 to 2016, summarized in the table below.

**Table 29 Herceg Novi public water supply, tariff, and revenue**

Year	m <sup>3</sup> water distributed			Average tariff €/m <sup>3</sup>		Total € revenue			m <sup>3</sup> /€
	Household	Other	Total	Household	Other	Household	Other	Total	
2016	2.072.660	582.677	2.655.337	1,05	2,16	2.159.082	1.219.542	3.378.624	1,27
2015	1.994.798	694.911	2.689.709	1,05	2,16	2.186.792	1.269.753	3.456.545	1,29
2014	2.036.459	630.398	2.666.857	1,05	2,16	2.025.997	1.641.335	3.667.332	1,38
2013	2.114.904	652.858	2.767.762	1,05	2,16	2.094.228	1.273.236	3.367.463	1,22
2012	2.161.000	668.696	2.829.696	1,05	2,16	2.155.987	1.359.076	3.515.063	1,24

Based on data summarized in the tables above, the estimated value of the public water supply from Trebišnjica basin in Montenegro in 2016 was €3.4 million. Put another way, about 1.3 m<sup>3</sup> of Trebišnjica waters in the study area in Montenegro equates to €1 in revenue from the sale of public water. Note, no information on losses was provided.

Lastly, it is important to emphasize that 90 percent of Herceg Novi's public water supply is dependent on water that passes through HPP Dubrovnik in the Trebišnjica hydropower system. As discussed in detail in the electricity section above, about 2.4 billion m<sup>3</sup> of water per year flows through HPP Dubrovnik. The water that is then diverted to Herceg Novi is less than 1 percent of that water. The remaining 99 percent of water from HPP Dubrovnik is released into the Adriatic Sea.

The research team was unable to value the contribution of Neretva and Trebišnjica basins' water to the public water sector in Croatia. The team gathered information at the national level on water supply and distribution, but only found limited information at the municipal level in the Dubrovnik-Neretva County. Data on distribution and revenue by municipality, or even county, is not publically available.<sup>36</sup>

The research team was told anecdotally that losses in the system in the study area – due to poorly maintained infrastructure and/or unregistered users accessing the system – are upwards of 50 percent. Analysis of available aggregate data, from DŽS, does show substantial losses at the national level. According to the DŽS Department of Environmental Statistics, in 2015, 508,541,000 m<sup>3</sup> of water was supplied into the public water system. Of that total, only 314,906,600 m<sup>3</sup> reached end users. 193,635,000 m<sup>3</sup> – or 38 percent – was recorded as lost. While this official data is lower than the anecdotal 50 percent estimate, it does indicate that substantial losses in municipal systems in the Dubrovnik-Neretva County are likely. Below is a summary of the research conducted into the water supply system for the Dubrovnik-Neretva County.

**Available Information:** The Neretva and Trebišnjica basins are the source of public water for all the municipalities in the Dubrovnik-Neretva County, including the islands of Korčula, Mljet, and Lastovo.. The research team identified 11 water supply systems that provide water to the 22 municipalities in the county, and the amount of water distributed is currently enough to meet reported demand. Table 30 Snapshot of public water systems in Dubrovnik-Neretva County summaries main points about these systems. There was no data publicly available on totals m<sup>3</sup> water supplied or distributed.

**Table 30 Snapshot of public water systems in Dubrovnik-Neretva County**

Name of the water supply system	Main Source	Type of Data/Note	m <sup>3</sup> /sec
Dubrovnik	Ombla	Minimum yield	3
Konvale - West	Duboka ljuta	Minimum yield	0,3
Konvale - East	Ljuta	System capacity	0,07
Župa dubrovačka	Duboka ljuta	Pumping capacity	0,13
Zaton-Orasac-Elafiti	Palata	Minimum yield	0,06
Slano	Nereze	Estimated system capacity	0,01
Ston	Studenac	System capacity	0,01
Neretvansko-peljesko-korculansko-lastovo	Prud	Minimum yield	2,77
Ploče	Klokun	Pumping capacity	0,1
Neum - Dubrovačko primorje	Mosevici	System is in B&H; connected via tunnel	-
Butina	Butina	System is in Split-Dalmatia County	-
Estimated total m <sup>3</sup> /sec			6,46

<sup>36</sup>For example, Metković municipality has information about public water supply on its webpage including source of the water and size of the distribution system, but it does not include data on how many m<sup>3</sup> of water are distributed annually. <http://www.vodovod-metkovic.hr/vodoopskrba/> Last accessed on 24.1.2018

## Gap Analysis – Public Water

Overall the research shows there are significant losses in the municipal supply systems in most of the study area. Additional research is required to understand the reason and extent of these estimated and recorded losses. For Croatia in particular additional research is needed to determine how much water from the Neretva and Trebišnjica basins is being supplied and distributed. The sources of the springs/underground systems that supply this public water are connected with larger water bodies in Federation Bosnia and Herzegovina or Republika Srpska. As such, the amount of water available for public use in this system is dependent to a degree on water management decisions made across the border.

Also, tourism to the coastal areas of Croatia in the study area is at a high level, as described in the tourism section below. While the current water supply system is able to meet demand, some in Croatia are estimating that if tourism continues to increase, demand will soon outstrip supply. Without a clear picture of how municipal water is being used (or lost), water managers in Croatia are missing critical information to adapt infrastructure to ensure they can meet growing demand.



# THE VALUE OF WATER FOR TOURISM

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The beauty of the natural environment and the rich cultural traditions of the Neretva and Trebišnjica basins are attractive and tourism to the study area is growing. Businesses in the region are improving infrastructure and developing new tourist attractions. Governments are also paying close attention, with Montenegro, Croatia, and Bosnia and Herzegovina all including tourism as part of their strategic development strategies. Given the perceived importance of tourism for local economies of the area, the research team investigated the current status of tourism that is wholly dependent on the waters of the Neretva and Trebišnjica basins: i.e. rafting, kayaking, caving, and bird-watching. The intent of this analysis was to set a baseline for 'water-based' tourism and to investigate its relative importance to overall tourism and the economy of local municipalities. It is however important to note that, in addition to direct water-based activities, the entire tourism sector depends indirectly on water quality and supply through its consumptive demand for water (e.g. human use, washing, industries, businesses, etc.), irrigated food crops (e.g. fruits, vegetables, grains) as well as hydropower. These indirect dependencies are reflected in the sections above on the value of water for hydropower, agriculture, and public supplies.

## Croatia

While there is some rafting and bird-watching tourism in Federation Bosnia and Herzegovina and Republika Srpska, the research team focused on Croatia given the prominence of tourism to Croatia's economy. According to the World Travel and Tourism Council's Travel and Tourism Economic Impact 2017 report for Croatia, nationwide the direct contribution from tourism in 2016 was about €4.98 billion, or 10.7 percent of GDP. Direct jobs in the tourism sector were 138,000 jobs, or about 10 percent of all employment. This is higher than the European Union average of 5 percent of GDP and about 5 percent of all jobs. In 2016 in Dubrovnik-Neretva County revenue from tourism was about €613 million – about half of that county's GDP and 12.3 percent of the country's total tourism revenue. According to the Ministry of Tourism of the Republic of Croatia, in 2016 there were 16.3 million tourist visits, with 91.3 million overnight stays, meaning the average number of nights per visit is about 5.6.

Of that total Dubrovnik-Neretva County recorded 8.73 million overnights, or about 10 percent. These numbers are significant compared to the county's overall population. As of the 2011 census there were about 122,568 people living in the county, and in 2016 there were 85,985 beds officially registered for tourist use. Unofficial estimates anecdotally told to the research team put the actual number of tourist beds to be about 30 percent higher. Put another way, the number of registered tourism beds in the Dubrovnik-Neretva County is about 70 percent of the total population, climbing to 90 percent if unofficial estimates are accurate.

The research team attempted to value the contribution of freshwater resources to tourism to the study area in Croatia. The research team focused on the municipalities in the Neretva Delta, as the majority of other tourism destinations in Dubrovnik-Neretva County are associated with coastal tourism and Dubrovnik. Overall the research team identified 9 companies with tourism offers that feature water in the Neretva Delta, mainly bird watching in wetland areas<sup>37</sup>. Table 31 Water-based tourism offers in the Neretva Delta shows the results of this research.

**Table 31 Water-based tourism offers in the Neretva Delta**

Name	Municipality	Water body	Type of offer	Estimate % dependent on water-based tourism
Vila Neretva	Opuzen	Jezero Kuti	Wetland photo safari	100%
Excursion OPG Crnčević	Zažablje	Jezero Kuti	Wetland photo safari	100%
Sedam Jezera	Ploče	Bačinska jezera	Lake photo safari	100%
Kite boarding klub	Ploče	Ušće Neretve	Kite boarding	100%
Restaurant LOPOČ	Kula Norinska	Rijeka Norin	Wetland photo safari	80%
Restaurant Buđoni	Kula Norinska	Rijeka Norin	Wetland photo safari	40%
Konoba Vrilo	Metković	Rijeka Norin	Wetland photo safari	30%
Restaurant Đuđa & Mate	Metković	Rijeka Norin	Wetland photo safari	30%
Excursion restaurant "Adria"	Zažablje	Jezero Kuti	Wetland photo safari	30%

<sup>37</sup>In addition to bird watching there are a number of annual events that attract visitors and center on the water resources of the delta. For example, every year in August there is a ceremony called "the traditional marathon of lađas" which includes boats older than 100 years old. This boat race starts in the town of Metković and finishes in Ploče, with a total length of 22,500 meters. In recent years over 50,000 spectators watched 600 participants take place in the race. Groups in Ploče also organize a smaller 'race of Neretva trupas' each year. Other local and international events/exhibits that feature the water of the Neretva Delta include the Metković Folklore Festival "Moonlight Shines Down on the Neretva" which celebrates the cultural heritage of the area, and the annual celebration of tangerines, Mandarin Days.

The research team also collected data on estimated number of tourists served per year over a five-year period, showing in all cases these businesses are growing.

**Table 32 Growth in tourism visits to Neretva Delta 2012 - 2016**

Name	Estimated number of tourists					Growth rate 2012 - 2016
	2016	2015	2014	2013	2012	
Vila Neretva	60.000	50.000	40.000	30.000	30.000	200%
Excursion OPG Crnčević	7.000	5.000	3.000	3.000	2.000	350%
“Sedam Jezera”	10.000	8.000	6.000	5.000	4.000	250%
Kiteboarding klub	5.000	5.000	3.000	2.000	2.000	250%
Restorant LOPOČ	40.000	35.000	30.000	20.000	20.000	200%
Restorant Buđoni	5.000	5.000	3.000	2.000	1.000	500%
Konoba Vrilo	5.000	4.000	3.000	3.000	2.000	250%
Restaurant Đuđa & Mate	10.000	9.000	8.000	5.000	3.000	333%
Excursion restaurant “Adria”	6.000	5.000	4.000	2.000	2.000	300%
Total	148.000	126.000	100.000	72.000	66.000	224%

Currently municipal and county level data for tourism does not include revenue by tourism operator. However, for these nine businesses identified above, the wetland and lake areas of the Neretva Delta are a crucial part of their business. Therefore, to value the revenue and jobs that are attributable to this water-based tourism, the research team used the World Travel and Tourism Council data on total direct revenue to approximate revenue per tourist visit. Specifically, there were 16.3 million visits lasting approximately 5.6 nights in 2016 generating €4.98 billion in revenue. Taking an overall average, each visit equates to about €305 in revenue, or about €54.55 per night. To apply these national averages to the Neretva Delta, the research team assumed that visitors were only spending a portion of their time in Croatia in the Delta, about 1 night. Table 33 Water-based tourism visits to Neretva Delta shows that there were about 122,300 water-based tourists in 2016. Assuming that each tourist equates to €54.55 in revenue, the revenue attributable to tourism based on the water resources of the Neretva Delta was about €6.67 million in 2016.

**Table 33 Water-based tourism visits to Neretva Delta**

Name	Estimated number of tourists in 2016	Estimate % water-based tourism	Water-based tourists
Vila Neretva	60.000	100%	60.000
Excursion OPG Crnčević	7.000	100%	7.000
“Sedam Jezera”	10.000	100%	10.000
Kite boarding klub	5.000	100%	5.000
Restaurant LOPOČ	40.000	80%	32.000
Restaurant Buđoni	5.000	40%	2.000
Konoba Vrilo	5.000	30%	1.500
Restaurant Đuđa & Mate	10.000	30%	3.000
Excursion restaurant “Adria”	6.000	30%	1.800
Total	148.000	83%	122.300

**Summary:** The tourism findings for the Neretva Delta are significant, indicating that tourism to the area is increasing rapidly and that the revenue attributable to water-based tourism is comparable to current revenue for tangerines – the major cash crop in the area. The collected data on the number of tourists served by the nine companies in the delta shows an average 224 percent increase in only 5 years; from 66,000 in 2012 to 148,000 in 2016. Furthermore about 83 percent of this tourism was to experience the unique water values of the area. In 2016 the revenue attributable to this water-based tourism was €6.67 million, and if current trends continue will continue to increase. In contrast, as shown in Table 22 Tangerine production and revenue 2012 - 2016, revenue from tangerines is in a steep decline – from €17,267,240 in 2012 to €8,328,000 in 2016. While it is simplistic to suggest that the increase in tourism revenue could or would offset the drop in revenue from tangerines to the population, it does suggest 1) that tourism is an increasingly important economic activity for communities in the Neretva Delta, 2) that more than 80 percent of this tourism is based on the wetlands and water ecosystems of the delta.

# CONCLUSION

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The study found that the Neretva and Trebišnjica basins are of critical economic significance at local, national, and regional levels. It is in everybody's interests to ensure that these important shared water resources are managed in an integrated and transboundary way, for sustainable development, environmental management and protection, and disaster risk reduction. Just looking at a partial picture of the economics of water use in the four sectors are investigated by the study – hydropower, public water supplies, tourism, and selected agriculture production – shows gross primary returns totaling almost €450 million a year, generating values of between €0.04-6.8 m<sup>3</sup> of water. Tens of thousands of jobs – and hundreds of thousands of livelihoods – depend directly on these water-based activities. Taking into account the substantial multipliers which link these sectors to additional jobs, earnings, and production in the rest of the economy would increase these values many times over.

The study has however also highlighted some major data gaps, which hinder understanding and awareness of the full economic value of water in the Neretva and Trebišnjica basins. Clear and comprehensive data about how water is being used for hydropower, and its contribution to revenue and jobs, is readily accessible. The electricity sector results of the study reinforce what is already commonly known, that hydropower is a significant source of revenue and jobs in the study area in Republika Srpska and Federation Bosnia and Herzegovina. In contrast however, data on the use of water for agriculture and municipal water supplies is not readily available and in many cases is contradictory. But these sectors are also significant users of water and the study shows that many communities are dependent on these water resources. For example, 1/3rd of the population of the Neretva Delta is supported by agriculture.

Without a clear picture on how much water from the Neretva and Trebišnjica basins is needed for these sectors, decision-makers in Croatia, Federation Bosnia and Herzegovina, Republika Srpska, and Montenegro are limited in being able to prioritize investments in improving water-related infrastructure. Moreover, they cannot fully evaluate the economic impacts of decisions to divert water away from agricultural areas for use in different parts of the Trebišnjica hydropower system. Water managers are also limited in their ability to make other decisions, such as adaptation measures for climate change or disaster risk reduction – let alone ensure sufficient water resources to support the basins' ecosystems and biodiversity.

Underlying these challenges is the fact that the Neretva and Trebišnjica basins are transboundary. The policy choices made in one jurisdiction impact on communities in other countries. As the study shows, the importance of different water-reliant sectors is relative. Hydropower production has a higher value in terms of percentage of revenue and jobs in Republika Srpska than in Croatia, whereas agricultural communities in the Neretva Delta in

Federation Bosnia and Herzegovina and Croatia see more benefits from irrigation. Coastal communities in Croatia and Herceg Novi in Montenegro are mostly concerned with secure public water supply. In order to balance these priorities and ensure that water-use trade-off decisions are made in an inclusive way, policy makers should have access to comprehensive information on how water is being used and the benefits accruing to communities across the basins.

Towards this end, WWF and GIZ/ORF BD are working to establish a permanent and vibrant inter-governmental platform for dialogue between decision-makers about the management of the basins' shared water resources. Such structured discussion will result in better coordination, implementation, and strengthening of the existing Transboundary River Basin Management Framework and its constituent management plans, and other mutually agreed principles and action plans intended to guide the joint development of a transnational Neretva - Trebišnjica water management system. A joint system will allow for coordinated climate change adaptation, disaster risk reduction, electricity generation and secured livelihoods; all while minimizing damage to critical ecosystems.

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