

Nature Conservation in the Verdon Catchment

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Photo: Chris Andrews



The Verdon Catchment and its state concerning ecosystems and services

The Verdon Catchment is a strategic area for many species and provides ecosystem services to local population and tourists. The area has been designated as a Regional Natural Park with the objectives of conserving and enhancing natural and cultural heritage, develop new and experimental actions, increase public awareness on environmental issues and develop sustainably the territory.

The area is characterized by high species diversity typical for areas situated between the Mediterranean coast and the Alps. Some of the species found in this unique area are endemic. Many species benefit from special protection measures as for example *Parnassius appollo*, a butterfly protected by European regulation. The park holds one third of France's flora and it is habited by bats, chamois, bearded vulture and little bustard amongst others.

Tourism in the park is very concentrated at some sites. Nonetheless roads, hiking trails, camp-grounds and traffic are disturbing many species. Furthermore, concentrated tourism at the lakes leads to a higher concentration of nutrients which also has an effect about 2km downstream. Although there are some negative impacts from tourism it generates an important source of income for the local people living in the park. Agriculture is a further important source for income in the area. Governmental subsidy leads to increasing sheep herd sizes but lower number of sheep herds compared to the past. This has lead to erosion problems and to an increase in forest coverage decreasing abundance of many important species for the park, such as the vulture.

Various problems of the park are caused by water shortages. Beside droughts, which became more pressures in the past according to farmers in the area, unnatural variability in the water run-off is mainly caused by increasing variability in water volumes released by the dams in the river for energy generation of Electricité de France (EDF). Prior regulation, the Verdon had an erratic regime, with floods from autumn to spring and droughts in summer. Today only very little water is returned to the now largely inactive, shrunken channel because, after passage through upper hydroelectric power stations, it is used for irrigation and urban water supplies. Water returned to the system contains large suspended sediment loads decreasing water quality.

In this report we define ecosystem services as the benefits people obtain from ecosystems (Fritsch and Schröter, 2009). Ecosystem refers to natural and biological entities that interconnect to each other in steady state equilibrium. Biodiversity is the number, variety and variability of living organisms in an ecosystem, referring as the building blocks of ecosystem services.

There are several ecosystems based on land cover/use in Verdon Basin (6,953 km²), which are: Forests (58.6%), Agriculture (16.5%), Grassland (9.6%), Water bodies (1.4%), and Settlement (0.6%). Local residents enjoy the benefit from this wide range of ecosystems for goods production such as cheese, dairy products, truffles, aromatic and medicinal plants and other services such as clean water, fresh air, recreation and security from hazard. Significant number of tourists who visit the area had also get benefit through those services, especially aesthetic and health services.

The weighting of the importance of ecosystem services in the different landscapes, and the estimation of the vulnerability was mainly based on stakeholder meetings and interviews with locals at the field excursion in the Verdon region (Kreiner & Jolibert 2009). After discussing possibilities to find an efficient and timesaving way to weight the different ecosystem services focusing on the main habitat types the nature conservation workgroup decided to come up with a simple table. One of the main arguments for this solution was that we thought that it would also be a good tool to communicate the results to the stakeholders.

The following table shows the relative importance of each services provided by the different habitats or landscape types which range in altitude from 260 m to 3.051 m a.s.l. The importance is represented by (+) sign, where (+) indicates low, (++) moderate and (+++) high important. No sign indicates that the certain service is not applicable under such landscape. Among all the services, we identified that water flow, water quantity, and climate regulation are significantly provided by forests. Food provision and pollination are provided by agriculture, while grassland is providing similar services as agriculture. Recreation service is provided mainly by water bodies, and human shelter is provided by settlement

Table 1: Strength of connection between landscapes and ecosystem services ranging from less significant (+) to highly significant (+++)

Ecosystem Services	Landscapes/Habitats				
	Forest	Agriculture	Grassland	Water	Settlement
Erosion control	+++	+	++		
Water flow	+++	+	++		
Biodiversity/habitat	++	+	+++	++	
Food provision		+++	+++		
Recreation	++	++	++	+++	++
Climate regulation	+++		+	++	
Pollination	+	+++	+		
Sheep			+++		
Water quantity and quality	+++	+++	++	+++	+
Population (livelihood/culture)		+			+++

Vulnerability Assessment

The vulnerability of ecosystem services is analyzed by three main elements: exposure, sensitivity and adaptation capacity. We assessed the vulnerability of the ecosystems for the two drivers: Climate and Land use Change.

Climate Change Vulnerability Assessment:

The assessment had been carried out for 3 pressures to evaluate their impacts on the ecosystem services identified previously for each of the landscape type.

- Temperature increase: we found that climate regulation, water flow, food provision, habitat and water quality and quantity are most vulnerable services (Table2a).
- Precipitation decrease: in the forest, the climate regulation and pollination are vulnerable to the less precipitation. We found that all of the services provided by the other ecosystems are vulnerable to this pressure. For example, less precipitation will influence the irrigation activities in the agriculture system and it has negative influence on the water services (Drinking water, recreation) (Table2b).
- Extreme events increase: all the forest's services are vulnerable to this pressure, because of their high sensitivity and low adaptation capacity to the extreme events (Table2c).

Table 2: The vulnerability of ecosystem services to climate change provided by certain ecosystem types for: (a) temperature increase, (b) precipitation decrease and (c) increase of extreme events.

	Forests					Agriculture		Grassland		Water		Settlement	
	Climate Regulation	Erosion control	Water flow	Biodiversity/Habitat	Pollination	Food provision	Recreation	Sheep	Habitat	Recreation	Water quantity and quality	Population	Recreation
a. Temperature increase													
Exposure	+	+	+	+	-	+	-	+	+	-	+	+	-
Sensitivity	+	+	+	+	-	-	-	-	+	-	+	+	-
Adaptation	-	+	-	+	-	+	+	+	-	+	-	+	+
Vulnerability	++	+	++	+	-	++	-	+	++	-	++	+	-
b. Precipitation decrease													
Exposure	+	-	+	-	+	+	+	+	+	+	+	+	-
Sensitivity	+	-	+	+	+	+	+	+	+	+	+	+	-
Adaptation	-	-	-	+	-	-	-	-	-	-	-	-	+
Vulnerability	++	--	+	+	++	++	++	++	++	++	++	++	+
c. Extreme events increase													
Exposure	+	+	+	+	+	+	+	+	+	+	+	+	+
Sensitivity	+	+	+	+	+	+	+	+	+	+	+	+	+
Adaptation	-	-	-	-	-	+	+	+	+	-	+	+	+
Vulnerability	++	++	++	++	++	+	+	+	+	++	+	+	+

Climate regulation is the ecosystem service more vulnerable to climate change, and in overall, all the services provided by the forest. However, it is important to point out that almost all the services considered in this study are vulnerable to climate change.

Land use Change Vulnerability Assessment:

For this driver, we also identified three main pressures: intensification of agriculture, increase forest area and decrease of pasture grassland.

- Intensification of agriculture: this pressure influences mainly the forest's services which have high exposure and sensitivity and have low adaptation capacity. It does also impact on the services provided by water. As a consequence of the feedback between the services, settlement can be highly vulnerable. In other words, due to the vulnerability of the services provided by the forest and water, population and recreation (settlement services) can be also affected. For example, intensification of agriculture can increase the use of pollutants bringing a decrease of water quality and consequently, the services depending on these are vulnerable as is the case of settlement (Table 3a).
- Increase of forested area: it seems that this factor has not an impact on the most of the habitats, except the grass land habitat which is sensitive because there is less of food to the sheep (Table 3b)
- Decrease of pasture grassland: the climate regulation, biodiversity and the pollination are vulnerable to this pressure, and also, the services of grassland habitat are affected (Table 3c)

Table 3: The vulnerability of ecosystem services to land-use change provided by certain ecosystem types for: (a) agricultural intensification, (b) forest area increase and (c) decrease of pastoral grasslands

	Forests					Agriculture		Grassland		Water		Settlement	
	Climate Regulation	Erosion control	Water flow	Biodiversity/Habitat	Pollination	Food provision	Recreation	Sheep	Habitat	Recreation	Water quantity and quality	Population	Recreation
a. Agricultural intensification													
Exposure	+	+	+	+	-	-	-	-	-	+	+	-/+	-/+
Sensitivity	+	+	+	+	-	-	-	-	-	+	+	-/+	-/+
Adaptation	-	-	-	-	-	+	+	-	-	-	-	+	+
Vulnerability	++	++	++	++	-	-	-	-	-	++	++	-/+	-/+
b. Increase of forested area													
Exposure	+	+	+	+	+	+	+	+	+	+	+	+	-
Sensitivity	+	-	-	+	+	+	+	+	+	+	+	+	-
Adaptation	+	-	-	+	+	+	+	+	-	-	+	+	-
Vulnerability	-	-	-	-	-	+	+	+	++	++	+	+	-
c. Decrease of pastoral grassland													
Exposure	+	-	-	+	+	-	-	+	+	-	-	+	-
Sensitivity	+	-	-	+	+	-	-	+	+	-	-	+	+
Adaptation	-	+	+	-	-	-	-	-	-	-	-	+	-
Vulnerability	++	-	+	++	++	-	-	++	++	-	-	++	-

If we consider the three pressures at the same time, forest and grassland services' are the most vulnerable, creating feedbacks with services provided by other habitats.

Scenarios

Global Orchestration scenario

Under the Global Orchestration scenario agricultural activities are very concentrated in the Verdon catchment. Most of this area is farmed intensively due to the technological development. This leads to more monoculture and water and soil *eutrophication*. Since industry in the area is developed quite fast, impacts from industrial infrastructure can be also noticed in the regional natural park. The extension of touristic activities in the area also cause certain problems related to disturbance of wildlife and input of nutrients into the natural systems. Generally, the intensive use of the land leads to a higher pollution of soil and water as well as it increases habitat fragmentation. The higher nutrient input leads to a shift in floral species composition especially in grassland areas naturally poor in nutrients. Since the sheep herds are increasing in number but are less spread out in the area, the soil is more exposed to erosion at grazing sites while at other sites without sheep open landscape maintenance becomes very difficult. This increases also the likelihood of uncontrollable fire events. In this scenario the Verdon catchment is facing a climate change under a business as usual scenario leading to lower precipitation throughout the year, more extreme events and higher temperatures. This may cause a shift of the tree line resulting in a even wider spread of forested area. While forest in the upper altitudes is increasing, bark beetles are prospering in the lower altitudes. This leads to a huge number of dying trees increasing again erosion at lower altitudes. Increasing likelihood of extreme events, such as floods and droughts, are the reason why water regulation in the area will become one of the major issues for all sectors. Lower precipitation rates all over the year but more extreme events will result in an uncontrollable run-off of water through the river again increasing the likelihood of flood events. This might cause problems in water provision to the local people, to agriculture as well as for electricity generation. Overall the proportion of open landscapes associated with the most charismatic and vulnerable species will be reduced while the proportion of forested area is increasing. This will result in a general loss of genetic, species and ecosystem biodiversity.

Adapting Mosaic scenario

Under the Adapting Mosaic Scenario agriculture is extensified while economic development of the region stays at the current level. The shift towards organic agriculture results in a lower input of nutrients and lower pollution rates of soil and water. This is also accompanied by decreasing numbers of tourists and their impact on the ecosystems. The decreasing number of sheep per herd but the general increase of sheep herds results in a wider spread of sheep throughout the area. Therefore erosion becomes less in the area. Because of a wider spread of the sheep the landscape can be kept open without using heavy machines in the forest again decreasing erosion. Since the open landscape is of high importance for the provisioning of habitat to the grassland flora and fauna, which is characteristic for the region, we experience a general positive impact on biodiversity. Due to a moderate climate change scenario, precipitation decreases while temperature increases only on an intermediate level. Furthermore extreme events occur only rarely. Since temperature increase is only moderate and dead wood caused by storm events gets less abundant, bark beetles are not threatening the smaller patches of forest which will be kept under this scenario. The generally lower input of nutrients, moderate climate change and decrease in erosion result in a better water flow control and higher water quality. Water shortages

are still characteristic for that area but are not becoming more abundant.

Recommendations

To maintain important ecosystem services and the compositional biodiversity, which is characteristic for the Verdon catchment, we suggest the following recommendations:

- Subsidies, which are paid at the moment per sheep to the farmers, should be increased. But this financial support should only be paid up to a certain number of sheep per herd in order to keep the flock size at a sustainable level.
- Although we suggest increasing the open landscape within the area, we propose to maintain certain small patches of mixed forest. This will be beneficial for erosion control and water management. Moreover it will limit the threat of bark beetles. In order to maintain the soil quality and limit its compaction we suggest avoiding the use of heavy machines in the forest.
- Since water availability is limited in the Verdon catchment area we recommend avoiding intensified agriculture in the area. Rather we suggest adopting organic farming strategies with a limited use of fertilizers and pesticides. This will increase the regenerating ability of soil as well as water quality and flow control of the water body.
- To limit the negative impacts from tourism on the water bodies and on the catchment area we suggest the creation of buffer zones with limited access and restricted clearing.
- Generally we suggest the development of an integrated management plan for the region with participation of all sectors dependent on the ecosystem services provided by the park and its biodiversity.

Literature

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