MEDUSA

Managing the human environment system to provide and sustain ecosystem services for all the users safeguarding human wellbeing and the biodiversity developing strategies to adapt to future changes

Final Report

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Executive Summary

The Var catchment includes an array of land uses, economic activities, communities, and perspectives. Traditional land use has, in many cases, enhanced the diversity of ecosystem types and species in the region, but in more recent times, rising demands on the region's land and water has placed increasing pressure on the region's ecosystem services. Changes in socio-economic conditions, land-use and land-management practices, resource exploitation, increased traffic on transit routes and increased tourism threaten to strain resources and exacerbate tensions between user groups. The MEDUSA project is designed to provide information for current planning and policy decision making which will have far-reaching implications for how these stressors will be addressed and what the future of the region will look like.

Using the Millennium Assessment (MA) scenarios to guide our research, we developed localized scenarios that reflect the forces at work in the Var catchment. Ecosystem services were analyzed to see how they would increase or decrease under the four different scenarios. Ecosystem services will decrease notably in the two reactive scenarios, Global Orchestration and Order from Strength. In the proactive scenarios, ecosystems services increase, with the exception of water provision for TechnoGarden and fire prevention for Adapting Mosaic. Our analyses indicate that in the future increasing water scarcity will likely lead to conflict about water access and management. An additional potential source of conflict is the tension between those desiring a more open landscape and those desiring a more forested one. Agriculture also emerged as a key activity that will influence the future of the entire region. Key policy considerations arising from our analyses and adaptation strategies are summarized below.

- Water quality and supply as well as biodiversity will benefit from a transition to sustainable, water efficient, low chemical input agriculture combined with measures to protect strategic natural habitats.

- The promotion of a diverse habitat mosaic, including patches of natural vegetation within agricultural areas, can be achieved through supporting diversified sustainable agricultural practices at multiple spatial scales.

- The restoration and upgrading of existing infrastructure, especially housing, in lieu of new construction lowers needs for new infrastructure and preserves cultural heritage.

- Rural development and local economy can be supported by encouraging local production and markets with an emphasis on product quality and use of sustainable practices.

- A significant reduction in the use for water can be achieved through improving education and supporting new water saving technologies. The overall demand could be managed by developing policies to internalize the social costs of water use in water prices.

- Facilitating discussion among stakeholder around the issue of water use and water shortage can address the conflicts and optimize the use of scare water resources in the Var Catchment.

Introduction

Stretching from the southern Alps to the Mediterranean coast, the Var catchment includes a diversity of land uses, economic activities, communities, and perspectives. Seven thousand years of human habitation has shaped the landscape, and the landscape has, in turn, shaped the vibrant culture and traditions that characterize the region. This 3800 km^2 area encompasses scenic high alpine peaks, productive farming valleys and the busy urban center of Nice. With dramatic natural scenery and thriving urban and rural centers, this area attracts an influx of tourists who are an important economic engine and, at times, a strain on resources.

The well-being of people in the Var catchment depends on material welfare, health, good social relations, security, and freedom. All of these depend on the benefits people obtain from ecosystems, called ecosystem services. Traditional land use has, in many cases, enhanced the diversity of ecosystem types and species in the region, but in more recent times, rising demands on the region's land and water has placed increasing pressure on the region's ecosystem services. Changes in socio-economic conditions, land-use and land-management practices, resource exploitation, increased traffic on transit routes and increased tourism threaten to exacerbate tensions between user groups. Planning and policy decisions made today have far-reaching implications for what the future of the region will look like. Against this backdrop of change and challenges, the MEDUSA project seeks to present potential pathways to a sustainable future for the Var catchment.

The MEDUSA project

The MEDUSA project (**M**anaging the human **e**nvironment system to provi**d**e and sustain ecosystem services for all **u**sers **s**afeguarding huma**n** wellbeing and biodiversity – developing strategies to adapt to future changes) is designed to address the possible futures of this complex region in a series of plausible scenarios. Within the project, we identify critical ecosystem properties to sustain ecosystem services of the Var catchment. At the catchment scale we assess the vulnerability for the most important sectors and evaluate the resilience of the human-environment system, using ecological and socio-economic modeling and a set of plausible future scenarios. The project does not amass new data but uses existing studies and experiences to develop informed management strategies and policy considerations.

The different scenarios for the Var catchment are based on the Millennium Ecosystem Assessment (MA) scenarios. Water, agriculture, nature conservation, and urban-rural transitions are among the most important sectors in the catchment. Ecosystem services and their inter-relations within each sector are discussed in the following chapters. Dialogues with stakeholders (including local farmers, developers, nature advocates, water managers, and European Union representatives) inform the content of these analyses. In addition to analyses of the individual sectors, interactions among sectors are examined for potential synergies and conflicts. Important questions and issues are integrated across sectors into a cogent analysis of emerging issues. This assessment develops adaptation strategies to provide and sustain services for all users. Policy considerations resulting from this analysis are outlined in the Executive Summary.

The Var Catchment Region

The Var catchment is located in the department of Alps Maritimes in southeast France (Fig.1). The topography is complex with altitudes above 3000 meters and steep gradients between mountain tops and valleys. The climate is characterized as Mediterranean-montane with a dry season less than two months long and mean temperatures ranging from a maximum of 22ºC in the warmest month to less than 2ºC in the coldest month (Pinto Correia and Vos, 2002). Forested areas occupy more than a half (54%) of the land in the Var catchment. The remaining natural habitats, primarily natural grasslands, cover 17% of the catchment. Agriculture occupies 24% of the land, while urban areas comprise about 5% of the catchment (Corine Land Cover).

The department of Alps Maritimes has a population of around 1 million people and a mean population density of 250 people/ km^2 (INSEE). Nice is the main urban centre with a population of 350 000 people and a population density of 4700 people/ km^2 (INSEE). Both people and infrastructure are concentrated in the valleys, while the mountain areas have less human pressure. Nearly one third (29%) of the population is more than 60 years old, and people under the age of 15 comprise about 16% of the population (NUTS3). The annual GDP per capita in the department of Alps Maritimes is 24000 € (NUTS3). Tourism is one of the main economic sectors, and recent data indicates an increase of tourists in mountain areas, with around 100 million tourists visiting the Alps each year (EEA, 2006).

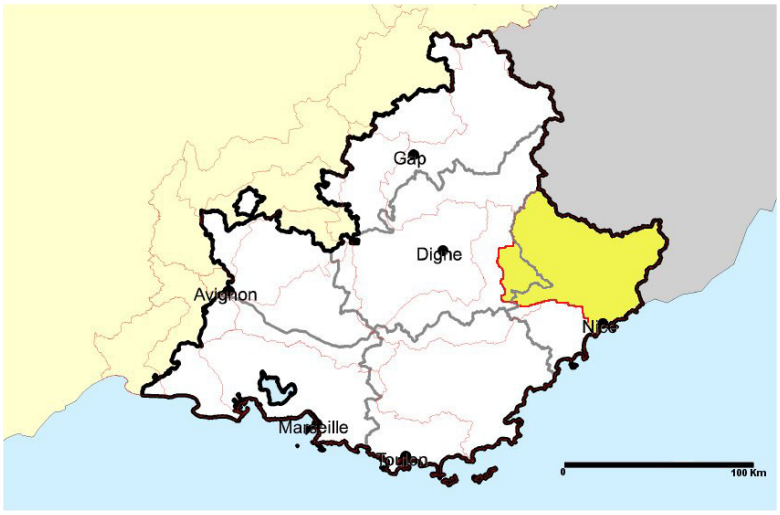


Figure 1 The Var catchment location.

The diversity of climate, topography, and other environmental conditions found in the region contributed to the development of agro-sylvo-pastoral systems which maximized the use of natural resources in the past and constitute important cultural landscapes today (Hubert 1991). After the start of the 20th century, a general exodus from rural to urban areas led to a strong decline of traditional activities as animal husbandry and agriculture. The reduction of grazing pressure and abandonment of the land allowed natural habitats, particularly forests, to expand (Hubert 1991). Biodiversity of the Var catchment region is rich. The variety of environmental conditions found along topographic and climatic gradients, coupled with geologic diversity, provide habitat to more than 2000 plants and to several charismatic animal species such as wolves, royal eagles, marmots and chamois (Le Mercantour).

Methods

The 32 members of the MEDUSA project divided into five working groups. Four groups focused on specific sectors relevant to the region: water, urban-rural transitions, nature conservation, and agriculture. The fifth group synthesized information across these sectors working in partnership with the delegates[1] of each sectoral group. This approach ensured a permanent communication between the synthesis and the four sectoral groups and also between the groups. For each sector, we identified key factors influencing ecological and social systems, referred to as drivers, and interviewed stakeholders to glean valuable information about current trends and desired futures for the region. Indicators, measurable attributes that indicate change, were also identified. For instance, for the Var catchment, tourism was identified as a driver, and the number of tourists visiting the catchment each year is an indicator for that driver. We developed a framework to visually describe the interactions among stakeholders, ecosystems, ecosystem services, and drivers.

These drivers were entered into scenarios to see how their indicators changed. Scenarios are plausible, simplified descriptions of how the future may develop. They are not predictions; rather, they represent possible futures for the Var catchment. For the MEDUSA project, global storylines developed by the Millennium Ecosystem Assessment (MA) were used as the foundation for building the regional scenarios for the Var catchment. As in the MA, four scenarios are defined by two axes: global vs. regional institutions and policies, and reactive vs. proactive environmental policies. While these regional scenarios represent four distinct pathways, combinations among these pathways are also possible. The scenarios describe what the Var catchment could look like in 2050. This date was also used by the MA and allows those interested in the Var catchment to compare the regional potential futures described in this report with the global potential futures described by the MA.

Each scenario is responding to different global and regional forces, and by entering the drivers for the Var catchment into each scenario, one can see how indicators may change. For instance, under the TechnoGarden scenario, tourism (the driver), and therefore the number of tourists visiting the catchment each year (the indicator), would increase, while under the Adapting Mosaic scenario, this same indicator would decrease. By seeing how indicators change under different scenarios, stakeholders and policymakers can plan for the type of future they would like to see.

The synthesis group worked to identify common themes and sources of conflicts among the sectors and the ecosystem services. From these scenarios and drivers, we developed storylines that paint a narrative picture of what the future may look like under each scenario. As with the scenarios, the storylines are not predictions, but they are descriptions of how the future may develop. Adaptation strategies to cope with future change were produced. Lastly, the MEDUSA team synthesized a list of policy considerations for safeguarding human wellbeing and biodiversity for the Var catchment.

[1] The synthesis group would like to acknowledge the work and valuable contributions of the four delegates: Patrick Zimmermann (Agriculture), Marleen Cobben (Nature Conservation), Luís Costa (Urban-Rural transitions) and Luca Marazzi (Water).

Results

Stakeholder Views and Visions

Members of the MEDUSA team interviewed stakeholders in the Var catchment for their views on the current situation and visions for the future. In synthesizing their responses, synergies as well as potential sources of conflict emerged. Most stakeholders do not consider a big change in lifestyles and expect solutions to be found to the maintenance of the ecosystem services that do not impact their actual lifestyle. In the same line, landscape and actual livelihoods are expected to be maintained. There was a general concern for biodiversity and natural dynamics. Stakeholders fear an increased hazard frequency (fires and floods). Several see the increase of protected areas and their connectedness and effectiveness as needed in the future. The local economy is perceived as dependent on the attractiveness of the area for tourism, and the continuous development of local markets, eco-tourism and high population are a result of this activity. The need for increasing the share of youngsters in the population and diversifying the agriculture was expressed. Concerning societal expectations, stakeholders have expressed the need for more and better cooperation between scientists and decision makers, between rural and urban livelihoods and actors, for example thanks to specific educational programs. A chart summarizing views by stakeholder group can be found in Appendix 1.

Framework

A conceptual framework providing a logical structure for the evaluation of the socio-ecological interactions at the Var catchment was designed for the MEDUSA Assessment in order to address stakeholders' information needs. In the conceptual framework, ecosystem services provide the linkage between the ecological system and the human society, including the stakeholders involved in the assessment. The main drivers that influence the production of ecosystem services in the region are also displayed. This conceptual framework enables the identification and analysis of the possible compromises between management options and ecosystem capacity to provide ecosystem services.

The diagram in Figure 2 represents the MEDUSA Assessment conceptual framework. Ecological systems produce ecosystems services (blue arrows) which benefit humans (users). The effect of stakeholders on the ecological system might affect the production of ecosystem services that are relevant to other stakeholders, leading to conflicts between stakeholders' views on management options. Conversely, stakeholders' impacts may also be synergistic, increasing the ecosystem benefits taken by the stakeholders. Ecosystem management options (red arrow) will be the final product of all the interactions between the social actors. The impact of the management options will change the ecosystem condition and determine its future capacity to produce ecosystem services (green arrow), thus constraining users' range of action.

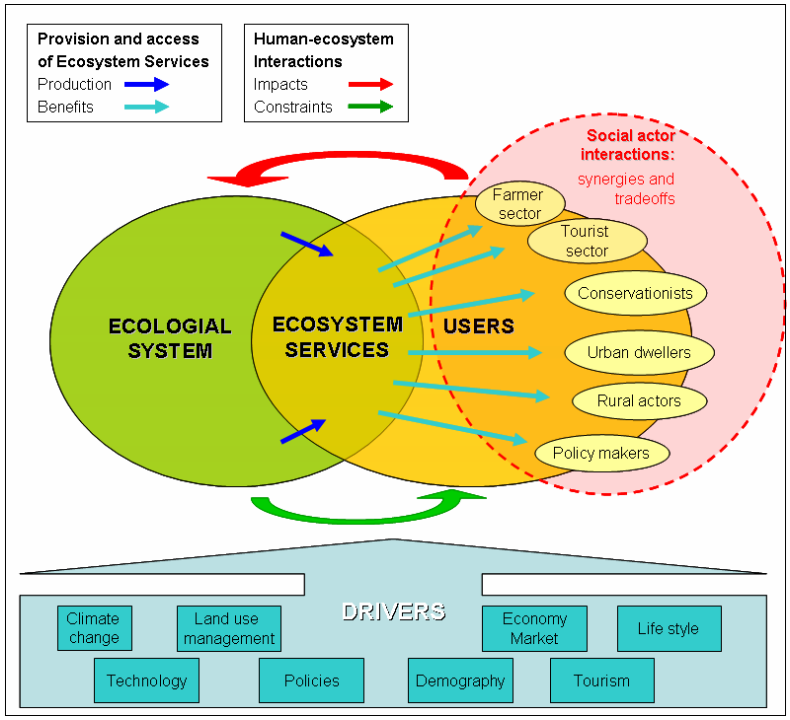


Figure 2 The MEDUSA Assessment Conceptual Framework: Dynamics between the ecological system, ecosystem services, users' needs and drivers of change in the Var catchment.

The drivers of change affect the ecological system and human actions, influencing human-ecosystem dynamics. Some drivers, such as land use change, have a more direct effect on ecological systems and others, such as policy, on human actions. Drivers can also affect both components, such as climate change. A table listing drivers, indicators, and how indicators are predicted to change under the different scenarios can be found in table 1.

[table 1 near here]

Discussion

Scenarios, Storylines and Possible Futures

Storylines provide a narrative view of the scenarios, allowing stakeholders, policy makers, and other readers to paint a more vivid image of what life might be like under the different scenarios. The storylines below represent information integrated across the four sectors.

Global orchestration

Increased globalization makes local markets less profitable, and the production of agricultural goods moves overseas. Traditional production of wine and cheese declines, and rural people move to cities in search of other employment opportunities. Cultural landscapes convert to forests as grazing pressure decreases, increasing the risk of fire. Despite more education opportunities, employment opportunities become scarcer. As a consequence, people have lower incomes,

though the gap between the rich and the poor becomes smaller. More tourists come to the Var catchment to enjoy scenic drives, relaxing in resorts, and other infrastructure-intensive activities. Investment in green technology is not prioritized, and consumption of freshwater, fossil fuels, and all forms of energy increases. Droughts become more frequent, further straining farmers, and water pollution becomes more problematic as consumption increases, especially in growing urban areas.

Technogarden

This is a globally connected world focused on the maximization of ecosystem services, through the use of technology. At the Var catchment the promotion of nations' interaction penalizes the preservation of local traditions and knowledge, and weakens local markets. The relative proportion of rural and urban areas does not suffer significant changes, but the economical input of rural areas to the GDP increases in relation to urban areas. There are no changes in the amount of agricultural land but there is an intensification of sustainable agriculture and crops diversification, based on large investments on green technologies. For example, the increase in water demand by the agricultural sector is solved through the use innovative technologies on water management. Climatic changes conduct to an expansion of open land, increasing the diversity of the landscape mosaic. The remaining natural areas become strictly protected to assure the provision of ecosystem services, and land owners are paid to manage these areas. Water quality is maintained as a result of forest conservation. Biodiversity increases due to conservation policies and the diversity of habitats found in the landscape mosaic. The use of non-renewable resources is heavily taxed, while there are subsidies for the production of renewable energies and related infrastructures. The existent agro-environmental measures draw some land owners back to rural areas. Ecotourism increases as a response to the investment in land conservation, contributing to the economic sustainability and revitalization of rural communities, with the restoration of former abandoned houses and the construction of some new infrastructures and buildings. At Nice the accommodation of tourists will be supplied by within the existing urban area without the need for new infrastructures.

Order from strength

In a regionalized and fragmented world, policies emphasizing security and protection have implications for environmental, social and economic indicators. Public goods and ecosystems problems do not receive much attention, so the condition of the environment declines. Policies to develop local markets (subsidies and quotas) and better conditions for economic growth lead to an increase in local products and income per capita. While the age structure will remain unchanged, the total population will gradually increase, as will the proportion of urban dwellers. The increase in the number of tourists and year-round residents leads to an increase in the consumption of water per capita, while its quality decreases as a consequence of the development of agricultural and urban areas. Losses in soil quality and biodiversity are produced by agriculture expansion. While the attitudes of people toward the environment will go down and the payment for environmental services remains the same, freshwater and energy consumption increases. The reactive approach to the environment limits the adoption of green-friendly technologies. As tourists visiting traditional vacation destinations increase, construction of high standard accommodation services will continue.

Adapting mosaic

We have a major impact of the regionalization of the economy and institutions: the reduction and regionalization of tourism. As international tourists form an important part of the tourists in the Var Catchment, we observe a net and important decrease in the number of tourists. As a result, there is a decrease in the tourism employment sector and unemployment around the Nice metropole goes up. The agricultural sector is not concerned directly as they continue to produce for the local market, therefore the share of land occupied by agriculture is maintained stable and consumption relies mainly on these local products and gather medicinal plants although climate change impacts their availability. Meat consumption may decrease. There is a strong investment in education in formal and informal ways, subsidizing knowledge creation through local experimentation and knowledge exchange between communities which leads to an increase in the co-management schemes among means to manage natural resources. Agricultural activities may demand more water but on parallel, there is also a strong awareness towards the good management of natural resources so life styles start to change and water and energy consumption per capita as well as the share of fossil fuels in the energy used decrease. Also, better use is made out of the forest stands for fire wood and the agricultural sector increases its share of sustainable farming. We observe a regionalization of the economy under this scenario so that more small businesses for the local transformation of agricultural and forest products takes place and the market is largely consisting of local products. A consequence is the movement of jobs from the urban to the rural area, particularly in the eco-tourism business. The population remains stable as a result of the balance between population increase in the rural area linked to rural development and shift to more labor intensive agriculture and the disappearance of the foreign retired rich immigrants. This reduces the overall emission of CO2 linked with commuting. Overall however, the income per capita is reduced because of the income forgone due to reduction of foreign money through tourism and people live a simple life. The disparity in income is also lower and solidarity within communities in cases of hazards is high. Investments in technology are localized and in favor of green technologies but they are limited by their local scale. The area under conservation remains stable and PES programs increase thus contributing to the effort towards achieving sustainability together with co-management strategies and sustainable agriculture with success. In addition, abandoned factories and houses in the area of nice provide habitats for urban wildlife. Habitats for wolves are concentrated in the higher mountains. Therefore, the temperature increase reaches only 3°C in 2050. However, the other signs of climate change still occur: the increase in extreme events and the decreased precipitation.

Ecosystem services of the Var catchment: conflicts and synergies

The following table gathers the most important ecosystem services in the Var catchment. Conflicts between ecosystem services may arise, such as the provision of habitats for both open-landscape species and closed landscape species. Conflicts appear both within sectors as described in our example or between sectors, for instance between agriculture and conservation of wolves. In a similar way, the provision of some ecosystem services may benefit other services such as is often the case between services provided by tourism and stakes of the rural-urban sectors. The main insight gained in the analysis is summarized as follows:

• Main conflicts arise around water constraint and the increasing demand in most sectors, and between the open-closure of the landscape.

• The agricultural sector has most synergies with other sectors, making it a key activity influencing the future of the region in the catchment.

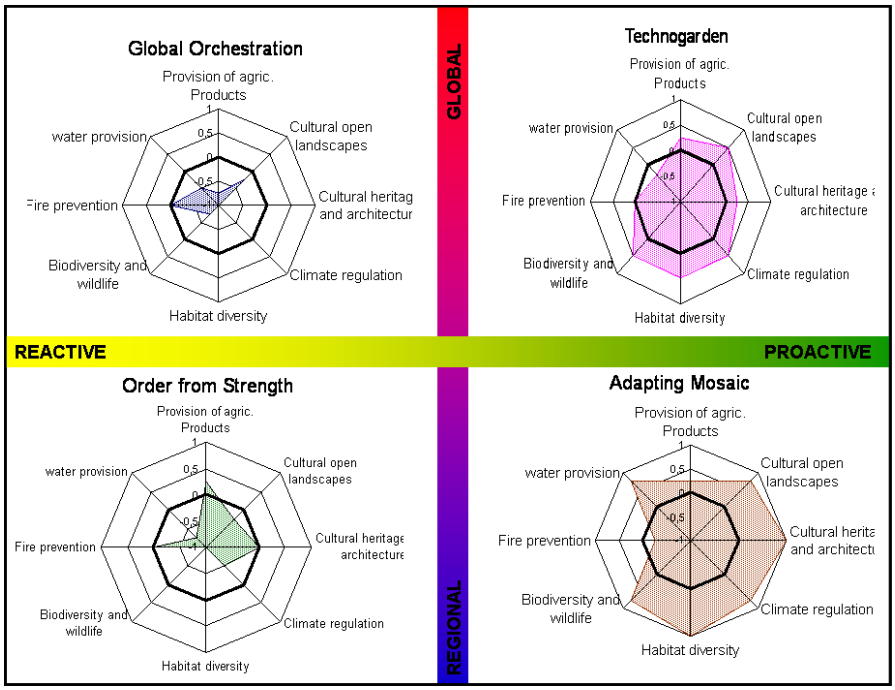
Table 2: Ecosystem services of the Var catchment: conflicts and synergies

Ecosytsem services		Possible conflicts between ES	Possible conflicts: sectors involved	Possible synergies between ES	Possible synergies: Sectors involved
Provisioning	Agricultural products (livestock, crops, medicinal plants)	Livestock vs. wolves population	Agriculture-conservation	Common stake between agriculture and tourism	Agriculture-tourism
Cultural	Landscape beauty/open landscapes	Open landscapes vs. Water purification	agriculture-water/conservation		
Cultural	Cultural heritage (support for traditional activities and culture (shepherds and villages))	Provision of accommodation vs. cultural traditional landscape; Development of tourism vs. traditional culture and agricultural practices	rural-urban intrasectoral	Agriculture and rural-urban sector and conservation benefit from each other thanks to eco-tourism	Agriculture+rural urban + conservation
Regulating	Climate regulation	Forest cover vs. open landscapes			
Regulating	Habitat mosaic/diversity	Aquatic habitats vs. provisioning of city and industry with water	water-agriculture/urban rural transition	Agricultural activity open the landscape and tourists consume local goods	Agriculture + rural urban

upporting	Biodiversity/wildlife	Terrestrial habitats for wolves vs. provision of water; Intrasectoral: habitat-specific BD	water-conservation	Agriculture-conservation: with eagles	Agriculture + conservation
Regulating	Fire prevention				
Provision	Water provision	Intersectoral: water provision for all sectors;	water		

Provision of Ecosystem Services

Fig. 3: Ecosystem services provision under each scenarios



Within each of the four scenarios, ecosystem services can be strengthened or weakened. The spider web diagram graphically displays how ecosystem services could be expected to respond in the different scenarios (Fig.3). A value of 0 indicates that there is no change in the ecosystem service; values greater than 0 indicate that the ecosystem service increases; and values less than 0 indicate that the ecosystem service will decrease in the scenario. These values were generated by asking sector working groups to assign a numerical value to how they expect ecosystem services to change for their sector and averaging the results. It is important to note that this is a qualitative understanding of change.
General trends in the diagram are immediately apparent. The largest reduction in ecosystem services occurs in the reactive scenarios: Global Orchestration and Order from Strength. The Adapting Mosaic and TechnoGarden scenarios show, with few exceptions, gains in ecosystem services. Adaption Mosaic shows the strongest increase, with only a slight decrease in the fire prevention ecosystem service. Water provision will decrease in all scenarios except Adapting Mosaic, and fire prevention remains stable or declines in all scenarios.

Ecosystem Services and the Social-Ecological System

Although the adaptive mosaic scenario seems to provide a frame for the best conservation of the ecosystem services, or even their increased provision, this achievement has very high transaction costs. In this paragraph, we adopt a wider view and consider the whole social-ecological system of the Var catchment. For this purpose, we use four critical ecosystem services identified in the previous paragraph (fire prevention, biodiversity, water provision and the cultural heritage of open landscapes) with four important indicators of the human system (income, decrease in the consumption of energy, tourism and agricultural production) in one spider diagram (Fig. 4).

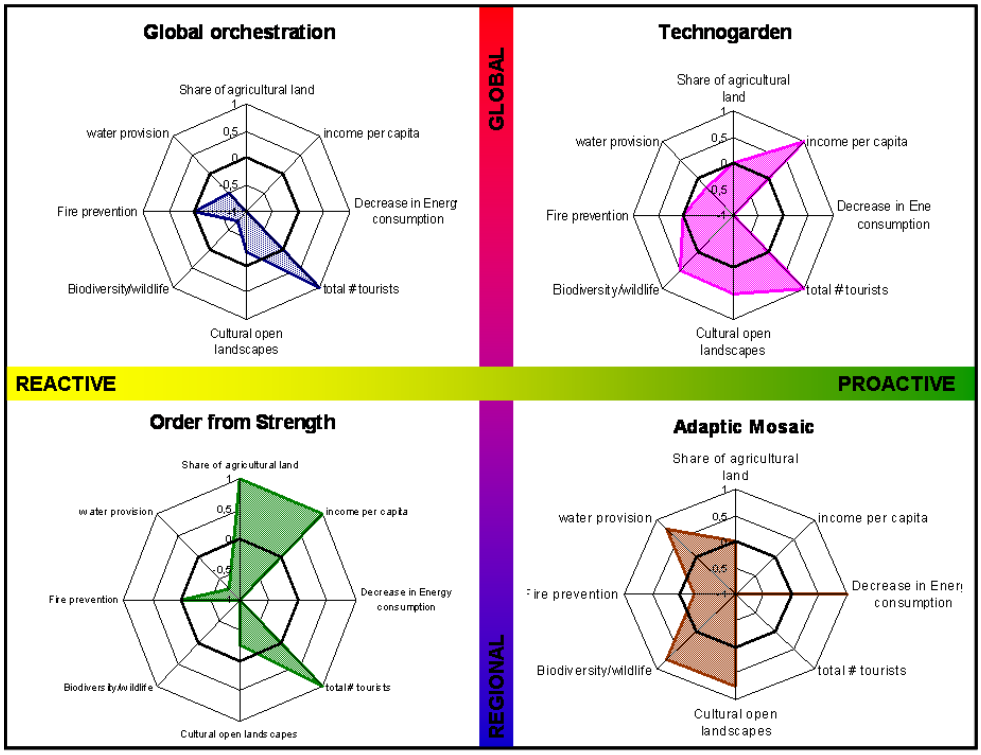


Fig. 4. Evolution of Social-ecological system under each scenario

On the left hand side are all ecological services available in the system. On the right hand side, you will find indicators of the social and economic sphere. The greater the values on the axes, the more benefits exist in the social-ecological system. This method reveals that although the Adaptive Mosaic scenario provides a frame for the improvement of the delivery of ecosystem services, these have great costs in terms of income per capita, linked to the reduction of tourism and other economic activities. The Global Orchestration scenario, which depicts an expansion of the current development trends in the world, shows a dark picture for the future with both livelihoods and ecosystem services provision reduced. In the Order from Strength scenario, only the economic side of the system is enhanced. Finally, the Technogarden appears as an interesting path as a balance between in the provision of ecological and socio-economic benefits is found.

Adaptation Strategies and Policy Considerations

The suggested adaptation strategies are designed to improve the resilience, or ability to withstand change and shocks, of the Var catchment. Table 3 lists all of the adaptation strategies by the ecosystem service to which they are related. We further distilled the adaptation strategies into key policy recommendations.

Policy Considerations

- Water quality and supply as well as biodiversity will benefit from a transition to sustainable, water efficient, low chemical input agriculture combined with measures to protect strategic natural habitats.
- The promotion of a diverse habitat mosaic, including patches of natural vegetation within agricultural areas, can be achieved through supporting diversified sustainable agricultural practices at multiple spatial scales.
- The restoration and upgrading of existing infrastructure, especially housing, in lieu of new construction lowers needs for new infrastructure and preserves cultural heritage.
- Rural development and local economy can be supported by encouraging local production and markets with an emphasis on product quality and use of sustainable practices.
- A significant reduction in the use for water can be achieved through improving education and supporting new water saving technologies. The overall demand could be managed by developing policies to internalize the social costs of water use in water prices.
- Facilitating discussion among stakeholder around the issue of water use and water shortage can address the conflicts and optimize the use of scare water resources in the Var catchment.

References

Corine Land Cover at http://www.eea.europa.eu/

EEA - European Environmental Agency (2006), Progress towards halting the loss of biodiversity by 2010. EEA Report, No 5/2006, EEA, Copenhagen.

Hubert, B. (1991), Changing land uses in Provance (France): Multiple use as a management tool. Option Méditerranéennes, Série Séminaires nº 15.

Le Mercantour, Parc National – Présentation (leaflet)

MEDUSA (2008) Annex I, Part B Description of Work.

INSEE – Institut National de la Statistique et de Études Économiques at http://www.insee.fr/

Pinto-Correia, T., e W. Vos (2002), Multifunctionality in Mediterranean landscapes: past and future in *Proceedings of the Frontis workshop on the future of European cultural landscapes*, Wageningen, NL pp. 135-164.

Table 1: Arrows show how indicators will change under each scenario.

DRIVERS	INDICATORS	GLOBAL ORCHESTATION	TECHNO GARDEN	ORDEN FROM STRENGTH	ADAPTING MOSAIC
CLIMATE CHANGE	*Temperature (C°)*	⇧	⇗	⇧	⇧
	Precipitation	⇩	⇩	⇩	⇩
	Extreme events	⇧	⇧	⇧	⇧
DEMOGRAPHICS	*Proportion urban/rural*	⇧	⇩	⇧	⇧
	Proportion of year-round residents	⇩	⇗	⇧	⇧
	Total population	⇧	⇗ =	⇧	=
	% population over 65	⇧	⇗	⇧	⇩
ECONOMY MARKET	*Income per capita*	⇩	⇧	⇧	⇩
	Income distribution	⇩	⇩	⇩	⇧
	Market share of local products	⇩	⇩ =	⇧	⇧
	Employment rate	⇩	⇘ =	⇩	⇩
	Share of rural employment	⇩	=	=	⇧
LAND USE AND MANAGEMENT	*% land in agriculture*	⇩	=	⇧	=
	% land in urban development	⇧	⇗	⇧	=
	% agriculture sustainable	⇩	⇧	=	⇧
LIFESTYLE	*Freshwater consumption per capita*	⇧	⇩	⇧	⇩
	Energy consumption per capita	⇧	⇧	⇧	⇩
	Attitude/values towards the environment	⇩	⇧	⇩	⇧
	% energy derived from fossil fuels	⇧	⇩	⇩	⇩
POLICY	*% land area under conservation*	⇩	⇧	=	=
	Investment in education	⇧	⇧	=	⇧
	Policy to promote local markets	⇩	⇩	⇧	⇧
	Payment for environmental services programs	⇩	⇧	=	⇧
	Subsidies	⇩	⇩	⇧	⇧
	Quotas	⇩	⇩	⇧	⇩
TECHNOLOGY	*Green vs. non-green technology*	⇩	⇧	⇩	⇧
TOURISM	*# tourists visiting area/year*	⇧	⇧	⇧	⇩
	% ecotourists	⇩	⇧	⇩	⇧

Table 3 – Potential adaptation measures for a sustainable use of ecosystem services and their relevance for the four Millennium Assessment scenarios (AM – Adapting Mosaic, GO – Global Orchestration, OFS – Order from Strength and TG – Technogarden).

Ecosystem services	Adaptation measures	Relevance for scenarios
Provision services		
Agricultural products	- maintain patches of natural vegetation inside the agricultural matrix to assure pollination services	- OFS
	- penalize the excessive use of fertilizers and pesticides	- GO, OFS
	- incentive the use of organic fertilizers	
	- improve irrigation strategies	- GO, OFS
	- enhance education programs for farmers	- AM, OFS
		- AM, GO
	- promote crop diversity	- AM, GO, OFS, TG
Water provision	- promote the rational use of water	- GO, OFS
	- develop new technologies for water management	- GO, OFS, TG
	- internalise the social costs of water use in water prices	- AM, GO, OFS
	- collect rain water and recycle water for alternative uses (grey water)	- AM, GO, OFS, TG
	- improve irrigation strategies	- AM, GO, OFS, TG
Regulating services		
Fire prevention	- select fire adapted species, in particular native ones, for the reforestation of burned areas	- AM, GO
	- promote habitat heterogeneity	- AM, OFS
Cultural services		
Landscape beauty	- promote landscape diversity	- AM
Cultural heritage	- restoring and upgrading traditional houses instead of constructing new ones	- AM, OFS
	- promote local products with an emphasis in products quality and use of sustainable practices	- AM, GO, OFS, TG
Supporting services		
Biodiversity	- promote habitat heterogeneity	- AM, OFS
	- promote ecosystem connectivity: species corridors between natural habitats in territorial planning, species passages in new dams to maintain river connectivity	- GO, OFS, TG

Appendix 1: Stakeholder interview results: assets, threats and visions for the future.

Stakeholders→	Water	Nat Cons	Developer	Farmer	Mr. EU
Current positive	- technical solutions exist - water reservoir for H2O in Nice, and power plant - tourism and population growing - supports grazing to reduce forest cover, anti-forests	- different ecozones, predators - ag creates open spaces - organic ag - fire good, natural - tourists bring money, well behaved - BioD is high - current cons areas - educational value of park	- maintaining Nature and ecosystems for her activity	- proud of tradition, community, landscape - open to tourism, nature conservation, other alternatives	- all directives are partly implemented (water, common ag practices, habitat, natura 2000)
Current negative	- ag uses too much water, pollutes - water infrastrux bad - water framework directive to restrictive - Nice can't take groundwater (salinity problems)	- overgrazing - not enough cons areas - fire risk - damaging "fancy" tourism - forest mngmt. policy not strong enough - not enough open land -lack of knowledge, research - actors not cooperating - climate change - water stress - migration - pesticides	- Infrastructures not enough for her activity - increasing pressures on Natural resources	- production is not sufficient for survival, people need alternative work - young people migrate to cities - H2O shortage, drought, fire - soil erosion - farms abandoned - ag land value decreasing, more money for selling	- Rural/urban: not enough lively communities - Ag: vulnerability due to lack of diversification - Water: under climate change, lack of water quality and quantity expected - Nature cons: limits connectivity of natura 2000 sites
Vision	- H2O demand will increase - ag will not increase - decrease flood risk - more reservoirs, more water plants - recycle H2O upstream and downstream - no desalination	- more protected areas - ecotourism - more monitoring, research - cooperation w/ stakeholders - kids visiting from Nice - ag still active - more strict rules, policies - marketing local products	- Increasing demand for housing - Keep high altitude protected areas	- keep landscape and lifestyle as is - get young people back - help from scientists and politicians - live w/o subsidies	- diversified ag - sustainable livelihoods - enough good H20 - aquatic and terrestrial habitats maintained - natura 2000 sites interconnected