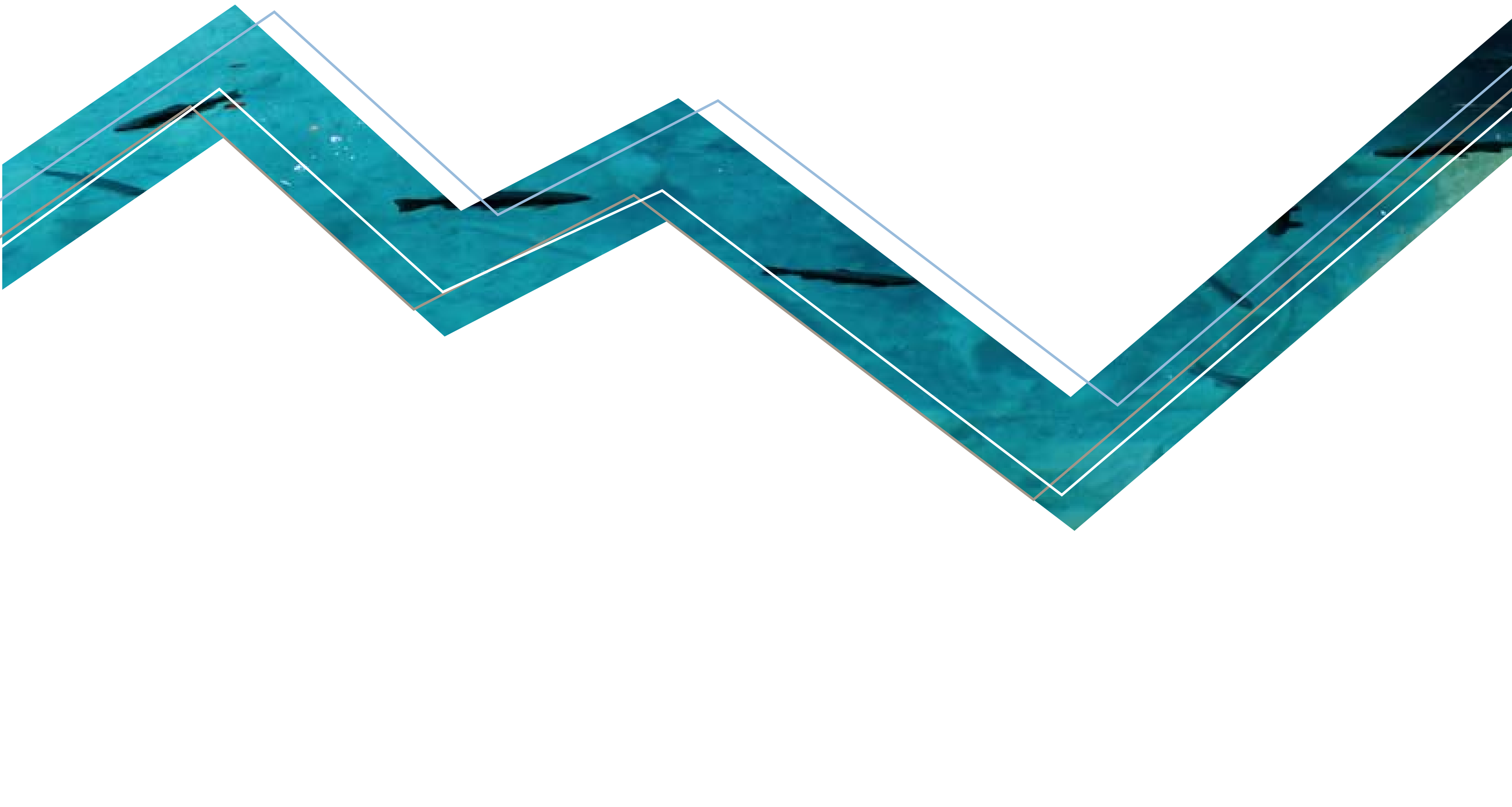
COMPACT NO 03/2011

WATER IN CLIMATE CHANGE

A BACKGROUND REPORT OF CIPRA



CIPRA

CONTENTS

Legal Notice
Editor: CIPRA International,
Im Bretscha 22, FL-9494 Schaan
T +423 237 53 53, F +423 237 53 54
www.cipra.org

Author: Antonio Massarutto,
University of Udine

Proof-reading: Suzie Holt
Design: IDconnect AG
Layout: Alexandre Druhen, Mateja Pirc
Cover picture: Joujou / pixelio.de
December 2011

cc.alps in a nutshell

The Project "cc.alps – climate change: thinking one step further!" is organised by CIPRA, the International Commission for the Protection of the Alps, and financed by MAVA Foundation for Nature. Through the Project, CIPRA is helping to ensure that climate response measures in the Alpine region are in harmony with the principle of sustainable development.

www.cipra.org/en/cc.alps/results-and-products/compacts

The print was financed by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety).

1

INTRODUCTION

Within the project "cc.alps – climate change: thinking one step further!" the International Commission for the Protection of the Alps (CIPRA) investigates climate response measures in the Alps. CIPRA compiles information on climate protection activities and adjustments to climate change in the Alps (hereinafter referred to as climate response measures) and analyses the impacts of these climate measures on the environment, economy and society. CIPRA's aim is to make climate response measures comply with the principles of sustainable development, to make these information accessible to a broader public, and to warn the public of those measures that have negative effects on nature, the environment, social cohesion and the economy.

The "CIPRA compact" series comprises several thematic publications that take a critical look at climate measures in the Alps. The series covers the following activities in addition to the subject of "water": energy, building and refurbishing, energy self sufficient regions, spatial planning, transport, tourism, nature protection, forestry and agriculture.

The Water in Climate Change compact deals with actual and proposed climate change response measures in the water sector. CIPRA's key concerns about trends in the water sector, given the region's role as the "water tower of Europe" and the expected impacts of a changing climate, are given in section 2. Section 3 begins with an overview of the water sector and projected impacts of climate change in the region, as well as summarising other inter-related trends in water management. It goes on to outline how stakeholders are responding to the situation, analyse the climate change response measures and address necessary policy changes. A summary of the situation and the author's main conclusions are given in section 4. Section 5 details exemplary projects that demonstrate effective ways to respond to climate change (and other inter-related development trends), which are compatible with sustainable development. Relevant references and links are listed in section 6.

2

IMPROVEMENTS IN EFFICIENCY INSTEAD OF DAMAGE TO THE ENVIRONMENT!

CC.ALPS: CIPRA'S DEMANDS ON THE SUBJECT OF WATER

The rivers of the Alps provide 170 million people with water. Climate change will greatly reduce the availability of water in the Alps and beyond, with less rain, longer dry periods in summer and greatly reduced snowfalls in winter among the predicted consequences. The demands made of this natural resource will increase accordingly, as will competition between the various user groups.

Today only about 10 % of the rivers and streams of the Alps can be considered ecologically intact, i.e. they are neither polluted nor over-engineered nor compromised in terms of their flow regimes. The ecological quality of watercourses and related habitats therefore calls for improvement, not further impairment. We cannot permit the last rivers to become engineered structures or depleted by the excessive abstraction of water. Together with other legal norms designed to protect the natural environment, such as the Habitats Directive and the Birds Directive, the EU's Water Framework Directive is a good instrument in support of the careful use of water, and the conservation and improvement of water ecosystems.

CIPRA's demands:

Stop the hydropower madness: no "final capacity" development!

Several countries of the Alps have plans for developing hydropower instead of promoting energy efficiency and savings. Nuclear energy phase-outs are the current argument for permitting the last near-natural rivers and streams in the Alps to be depleted. Instead of "final capacity" development at the expense of the natural environment, CIPRA is calling for the modernisation of existing hydropower plants in combination with compensatory ecological measures. This would enable a 50 % increase in energy efficiency to be achieved in the short term. There are even examples of refurbishment schemes that have resulted in a three-fold increase in power generation combined with an improvement to the ecological balance as a result of accompanying measures. In the case of all power plant rehabilitation projects, however, their environmental compatibility must always be thoroughly investigated and guaranteed, and where impacts are inevitable, they must be compensated in accordance with the Water

Framework Directive and national legislation. The legal provisions relating to green energy must also be changed to promote improvements to existing power plants and efficiency rather than the construction of new and environmentally harmful hydropower schemes.

Small power plants, big problems! Small is not always beautiful.

In many places the uncoordinated boom in the construction of small hydropower plants is the product of an approach to promoting alternative sources of energy that is undifferentiated and unsustainable. The result is often large-scale ecological damage for relatively low energy gains. The contribution of small hydropower plants to total generation is limited: 75 % of hydropower plants deliver just 4 % of hydroelectricity in the Alps. Permits for new small hydropower plants must therefore be made subject to compliance with ecological standards, and financial support must be clearly based on considerations of sustainability and environmental compatibility.

Water is not a private matter!

Water is not a commodity like any other; it is a part of our heritage that must be protected and treated accordingly. The resident population of the Alps and people living outside of the Alpine region who are dependent on its water resources have a right to an adequate supply of good-quality drinking water. Providing them with water is a fundamental duty of the public authorities, one which may not be jeopardised by privatisation.

Good governance instead of parish-pump politics

Water resource management must be made more professional. The needs of all concerned are important. For that reason, sovereignty over water resources may not be relinquished to single decision-making bodies like local authorities but must be exercised at a higher level. A policy of cooperation at the level of the catchment area, as provided for by the Water Framework Directive, ensures participation of all concerned. The French water agencies show how it can be done and prove that it works.

Restrict waste and luxury uses of water!

There are many ways of achieving savings in the use of water. Drip irrigation systems for high-grade agricultural produce like fruit or grapes, for example, can generate more additional income and consume less water than the wasteful irrigation of fields of cereals. Meaningful savings can also be made by private households, e.g through the use of rainwater to flush toilets and water gardens. And with regard to tourism, permits for new facilities should only be issued where it can be shown that the extra water consumption is sustainable and will have no negative impacts on existing uses, while adjustment to climate change must take the form of a better distribution of tourism activities over the year and the development of sustainable alternatives to the skiing industry. In this context it should be stressed that the growing use of snow guns – in terms of both new installations and longer operating periods – runs counter to the goals of climate change mitigation because of the unacceptably high levels of water and energy consumption. For that reason, CIPRA is calling upon the authorities to ensure that no public funds are spent on promoting snowmaking installations.

A strategy for the whole of the Alpine region!

CIPRA is calling upon the parties to the Alpine Convention to agree on a common Alps-wide strategy for the sustainable use of water and related habitats. The strategy should include improvements to the efficiency of existing power plants and provisions to ensure that permits for upgrades are made subject to consideration of the needs of the environment. The strategy should also provide for alternatives to the construction of large reservoirs and restrictions on the uncoordinated construction of small power plants.

Effective implementation of the strategy will only be possible on the basis of an Alps-wide inventory of those stretches of rivers and streams that can still be considered ecologically functional (intact watercourses in terms of biology and hydro-morphology) or have strong potential for regeneration. They must be treated as nogo-areas for all unsustainable impacts and facilities like power plants and for intensive uses of riverine landscapes.

3 CLIMATE CHANGE AND WATER RESOURCES MANAGEMENT

3.1 WATER AVAILABILITY AND DEMAND

The Alps have been described as the "water tower of Europe". Situated at the heart of the continent, they are the source of nationally important rivers such as the Rhine in Germany, the Rhone in France and, in Italy, the Po, Adige and smaller rivers flowing to the upper Adriatic e.g. the Soča-Isonzo shared with Slovenia. The Danube Basin alone occupies the north-east section; its rivers flowing through 14 countries.

Rivers from the Alps represent a significant share of the total runoff of the basins, providing water to 170 million people. The Alps ensure more regular outflow patterns: snow, glaciers, soil and lakes – supplemented by reservoirs – are the key sources of outflow during the summer, especially in the south. This implies a strong relationship between the Alps and surrounding areas: the lowlands are affected by upstream changes in supply; the Alps by decisions taken downstream. Overall, the Alps are water-rich with respect to the EU. Mean annual precipitation of 1.609 mm is more than double the EU average of 780 mm. Even the 'driest' areas, particularly in the inner Alps e.g. Valais in Switzerland, enjoy rates of 500-1.000 mm, while some reach up to 1.500-2.700 mm (EEA, 2009a; Alpine Convention, 2009).

Pictures 1 + 2:
Glaciers extend over 3.600 square kilometers in the Alps, providing fresh water for millions of people in the lowlands.

Regarding water use, 75 % of abstraction is for hydropower, followed by public supply (circa 10 %), irrigation and industry. Increasing importance is attached to so-called 'non-consumptive' uses: ecology, recreation and landscape services generated by the water environment. To assess water stress, the two indicators normally used exist only on a national basis (i.e. per-capita availability and the Water Exploitation Index - WEI: the ratio of annual abstraction to available resources). Using Switzerland and Austria as representative of the region, usable freshwater amounts to 7500 and 10,500 m^3 per capita respectively (European average: 4200 m^3), while the WEI is circa 5 %, far below the stress threshold norm of 40 %.

The situation is different at the local level. The resource is unevenly distributed and human influence is often concentrated in areas with insufficient capacity to meet demands: it is difficult and costly to bridge this gap in mountain regions. Historically, human settlements developed in areas where water resources met population needs and hazard protection was easier: a sustainable equilibrium. But during the last century, regional development has hardly considered water issues, e.g. in relation to tourism facilities in high mountain areas. The fragile Alpine environment, together with obstacles posed by orography and climate, enhance the vulnerability of supplies.

Water demand has been affected by spatial development trends in the Alps. In the last 30 years, these have been characterised by both polarization, the concentration of population and development around main centres / tourism hubs, and also regional integration, the concentration of economic activities in fewer areas and increasing specialization of surrounding areas as commuter communities (Pfefferkorn et al. 2005). Although the region cannot be defined as water stressed, in the specific circumstances of low natural availability and high demand, Alpine communities may already be experiencing difficulties. Resource-led rather than demand-led management and assessment of availability and stress at the local scale are crucial.

Picture 3:
Only scarcely ten percent of the length of the most important Alpine rivers is in natural or near-natural state.

In terms of quality, Alpine resources generally enjoy a far better status than downstream; problems may arise due to concentration of discharge from settlements especially under low-flow conditions (Alpine Convention, 2009). EU directives have led to substantial improvements in wastewater treatment. Diffuse pollution, mainly agricultural, is less of an issue than downstream; it still occurs, particularly in areas of intensive agriculture e.g. Bavaria. Lake eutrophication has almost been eradicated thanks to treatment and diversion of discharges, fostered by tourism development and bathing water requirements.

The Water Framework Directive

The Water Framework Directive WFD (Dir. 2000/60/EC) is a milestone in EU water policy. Making water protection a major priority, it aims to protect and enhance all water bodies to the level of good status – in ecological, chemical and quantitative terms – by 2015. It requires all aspects of water management to be organized at the basin level, through integrated river basin management (IRBM) plans, and highlights economic approaches and public participation. For the Alps, this affects both pressures on water and capacity to adapt.

The constraints imposed on all water uses are significant: many will need to be limited and numerous other pressures, such as pesticide pollution, should decrease or disappear. Significant flows will be returned to rivers and many artificial management schemes will require dismantling or adaptation. Effort will be directed at restoring natural habitats and ecological functions, accompanied by a boost in demand for ecosystem services, perhaps introducing fundamental changes in land use patterns. The requirement for full cost recovery – including environmental externalities and resource scarcity – is likely to have significant impacts. Demand is not to be considered simply as a need to be satisfied regardless of cost. Potential value is to be weighed up against full cost and, as far as possible, this cost passed on to the user.

The move to basin-scale participatory governance will also have consequences. Although progress varies across countries, IRBM is becoming the fundamental principle for decision-making, management and problem perception. Participatory IRBM is likely to prevent actions that impact severely on the weakest areas: in the past, many large projects promoted in the name of industrial development have gone ahead despite strong adverse impact on communities. IRBM implies problems and solutions should be shared at the basin level, fostering upstream-downstream interdependence. This scaling-up is motivated by the need to reach compromises between diverging interests (opposing sectors and regions). The critical issue for the Alps here is to develop basin institutions in which Alpine regions and their stakeholders receive due attention and exercise adequate political influence.

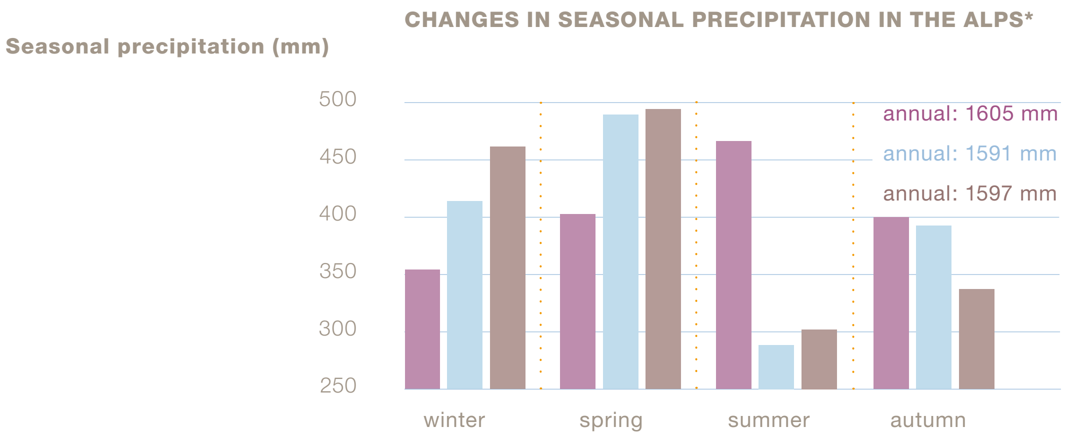
3.2 IMPACTS OF CLIMATE CHANGE

According to the European Environment Agency (EEA, 2009a) and the Alpine Convention (2009), the Alpine region experienced a 2°C rise in temperature in the 20th century – more than twice that for the Northern Hemisphere and twice the European mean. A further 2.6-3.9°C rise is expected this century, again much higher than forecasted means for Europe (EEA, 2009a). Along with changes to seasonal temperature variability, projections show a decrease in overall precipitation and increased occurrence of extreme events (droughts, floods etc).

3.2.1 IMPACTS ON HYDROLOGY

Climate change is predicted to have a major impact on Alpine hydrology over this century: rainfall is expected to decrease by 1-11 %, with a 36 % increased incidence of summer droughts (more than five consecutive

Figure 1:
Changes in seasonal precipitation in the Alps, 2071 - 2100, in various emission scenarios.



* 2071 - 2100 in various emission scenarios. (HIRHAM Regional Circulation Model)

Source: Beniston, M. (2006)

days without precipitation), involving comparatively higher increases in the Northern Alps where it is currently least common. Quantity of snow is expected to reduce significantly: by 40 % in the North; 70 % in the South (EEA, 2009a). Research on projected changes in seasonal precipitation undertaken by Beniston (2006) is shown in Figure 1.

The combination of higher temperatures and altered seasonal precipitation patterns will dramatically affect outflow. Less snow and more rainfall in winter will result in a substantial increase in winter run-off (up 19 %) and a corresponding reduction in spring (down 17 %) and especially summer (forecasted to decrease by 55 % in southern and central Alps by end of 2100). The German Federal Environment Ministry (BMU, 2007) has predicted a slightly different outcome: annual totals close to constant, with seasonal variations of +15 to +30 % in winter, +23 to +24 % in spring, -36 to -39 % in summer and -1 to -15 % in autumn.

In the short term, these changes may be compensated by glacier and permafrost melt. In the long term, there is concern for the survival of this fundamental water store. Glaciers have lost 20-30 % of their ice since 1980; the peak temperatures of summer 2003 alone caused the loss of 10 % of the surviving mass. According to Haeberli (2009), remaining glacier surface may reduce by 50-75 % by 2050. Together with deep warming of permafrost, this is expected to drastically alter flow patterns and increase hazards from rockfalls and glacial lake outburst floods, as has occurred in the Bernese Oberland and Saas Valley, Valais in Switzerland. The nature of such events will diverge from historical trends and cannot be modelled from existing records.

Groundwater levels were also systematically decreasing throughout the 20th century: Harum et al (2007) found levels in some parts of the Southern Alps had fallen by 25 % over 100 years. Although mainly due to increased abstraction, soil imperviousness and drainage to protect settlements (EEA, 2009), climate change is a consideration. Research is limited and modelled groundwater data is difficult to interpret, however Swiss studies have indicated levels are expected to show slight declines (OcCC/ProClim (ed.), 2007).

An increased frequency and intensity of extreme events has been connected to climate change (EEA, 2009) and related with soil erosion, landslides and sedimentation. However, the evidence as to whether recent Alpine landslides are caused by usual processes or related to changes in climate is not straight-forward.

3.2.2 IMPACTS ON ECOLOGY

The altered hydrological cycle has consequences for ecology and related ecosystem services. Temperature and snow cover changes are predicted to result in an upward movement of plant communities, squeezed into a smaller alpine zone; significant losses of endemic species are predicted (EEA, 2009a). Reduced summer outflows are likely to cause hydromorphological changes, such as interruption of river continuity, leading to a reduced capacity to support biological communities and dramatically impacting Alpine ecosystems (see the Nature Protection compact). In addition the water temperatures at the surface of lakes will increase and lead to a stabilization of the circulation conditions, which will alter oxygen concentration and conditions for microorganisms, fish etc. in lakes.

3.2.3 CLIMATE CHANGE AND WATER DEMAND

Increased demand for Alpine water may stem from a greater need within the Alps or to compensate water stress downstream. Climate change interacts with both drivers, which are also subject to general development trends. In considering future impacts, we need to assess short term trends for the main pressure factors and how climate change is likely to affect them; technical improvements must also be addressed. The combined impact will depend on local and sectoral circumstances.

Much work has been done on the likely impacts of climate change on water management (Smith et al., 2009) and on the Alpine region in particular (EEA, 2009a; Alpine Convention, 2009). Climate change is expected to increase pressures on water demand across sectors in order to compensate for reduced or less regular rainfall. Increasing difficulty in accessing water at a local scale may be experienced, the result of lowering of the water table, drying up of wells and reduced outflow from springs in critical seasons. The structure of management systems is also likely to be affected: more people will have to rely on collective supplies rather than private wells (as is already the case in Eastern Styria, Austria, according to Oberauner et al, 2006). Many collective systems will require interconnection and the sharing of more reliable supply sources, necessitating enlarged management units covering greater geographical areas.

Picture 4:
Financial incentives resulting from renewable energy laws encourage new construction projects.

Hydropower

Hydropower was intensely developed in the last century. Representing 75 % of Alpine water abstractions, its impact has been severe, resulting in increasingly tight regulation in all countries. Following relative stagnation in the 1980-90s, demand is now booming for new installations and the improvement of existing potential e.g. the Ravedis site in Friuli, Italy; large TIWAG projects in Tyrol, Austria; other projects in Slovenia (on the Idrijca river, Trebuša and the Soča river) and many new projects in Switzerland. There is also a surge in demand for small plants using flowing water, and a critical threshold is likely to be reached in terms of low flows, interruption of river continuity and alteration of morphology. Consequently, water authorities in all countries are restricting licenses and insisting on higher requirements for minimum flows and duties of care. The boom is driven in part by the ability of large plants to supply energy in peak periods in the framework of increasingly interconnected EU electricity networks and markets. Such plants are likely to specialise in producing this high-value energy, substantially increasing the potential economic value of storing water in reservoirs and enhancing the trend for repumping. Climate change mitigation is also a factor: as with all renewables, hydropower is strongly subsidized; more than 50 % of revenue from small facilities comes from direct and indirect subsidies, thus creating an economic incentive for new projects (Bano and Lorenzoni, 2008).

Despite this demand boom, there is evidence of diminishing returns: the increased quantity of energy that can be produced by expanding existing capacity is rather small, while the environmental impact (in terms of length of river affected and artificialisation of flows) is proportionally higher. In general, there is a need to be cautious about issuing further permits, and more strict rules for existing ones are required i.e. mandatory minimum flows and restoration of river continuity and natural morphology.

Within this complex situation of restraints and development, climate change is likely to introduce a limiting pressure by reducing available flows and therefore productive potential of existing facilities. In many cases, imposing stricter requirements on existing facilities may impede recovery of investment costs already committed and cause legal conflicts.

Public water supply

Public water supply accounts for less than 10 % of abstractions for consumptive use in the Alpine context (EEA, 2009a). Such a limited quantity cannot impact on the overall water balance. However, the highly fragmented distribution of management systems is the critical issue: it is not always possible to compensate local shortages with transfers from nearby areas. Therefore impacts should be assessed at the local scale.

Picture 5:
There is no guarantee water will always be at our beck and call.

Alpine population in the 1990s increased by 7.8 % (Alpine Convention, 2006) comprising a sharper rise in the north-west and lesser increases in the south and east. This trend constitutes a potential pressure, even if unevenly distributed and eventually offset by improved efficiency and reduced per-capita demand. A substantial increase in overall demand is not expected; but rather a transformation of its seasonal structure (peaks in winter and summer when natural availability is lowest) and in its sub-regional distribution.

Many Alpine communities are already experiencing water shortages (e.g. Savoy region in France or Carnia in Italy). However this is often due to technical deficiencies, such as insufficient storage capacity, low pressure, inadequate treatment or leakage. There is no evidence that climate change is significantly correlated with shortages to date but it cannot be excluded in the future: it will likely affect the hydrological regime of springs and wells on which most systems rely. Pressure for water transfers to downstream regions for public supply is likely to increase to secure supplies for urban areas, especially for quality reasons. This is already the case with the Combanera project in Italy, which involves the creation of a large dam and reservoir in the Lanza valley, upstream of Torino, to supply the metropolitan area. The urban area currently relies on water from the Po and the local water table, where the level of contamination requires costly treatment.

Rainwater management and sanitation are also likely to be affected since e.g. more frequent and intense rainfall events have consequences for water quality. The concentration of population and infrastructure in lower valleys will probably increase vulnerability to storm events (and other extreme events), putting pressure on technical systems.

Tourism and recreation

Tourism in the Alps results in greater water demand, particularly in winter and summer when natural availability is low. The tendency for tourist developments to be concentrated in the highest and most remote areas, where supply is less reliable and seasonal storage more difficult, adds to the problems. Artificial snow production is an important driver of demand, even if insignificant in terms of the regional water balance. Climate change is expected to result in fewer resorts being snow-reliable and a shortened winter season, leading to a greater demand for artificial snow and the likelihood that tourism pressure will increase in the higher resorts (see the Tourism compact). This may foster local conflicts with other water uses in the winter season, especially with public supplies (Alpine Convention, 2009; OECD, 2007).

For summer tourism, increasing value is placed on water-related activities such as fishing, sailing, bathing and hiking, which lead to their own resource conflicts. A typical example is management of artificially regulated lakes and reservoirs. Tourism demands that water levels remain as constant as possible, while energy, agriculture and flood protection require maximization of storage potential and ability to release water when needed. This is pertinent for a future where climate change results in a more unreliable natural supply.

Agriculture

Picture 6:
During dry summer days immense quantities of water are being used to produce often low profitable crops.

With respect to downstream areas, pressure to expand irrigation is high, especially for high-value crops such as fruit or wine. However, large-scale irrigation of low-value crops, such as wheat or maize, is likely to decline due to the changing economic balance induced by agricultural policy reform. The combined effect will probably be an overall reduction in absolute quantities but an increased rigidity of demand (Massarutto, 2003; Berbel Vecino, 2004). This may not be met by existing Alpine outflows, or future climate change affected flows, resulting in pressure to increase storage and abstraction systems from mountain reservoirs.

The increase of irrigation of high-value products is expected to occur in the driest sub regions, such as the Southern Alps and the Valais (see the Agriculture compact). While negligible for the overall water balance, local effects could be significant, especially since demand occurs in the driest periods. Increased frequency of dry periods caused by climate change is expected to increase irrigation demand, especially for high-value crops.

Industry

Overall, industrial water demand is reducing, in both absolute value and per-employee, as a result of de-industrialization and adoption of cleaner techniques in the manufacturing sector (EEA, 2009b). However, downstream demand for cooling may increase and become more rigid – especially if new thermal facilities are built – requiring more constant flows and putting constraints on upstream use (Energylab, 2008).

Once new downstream facilities are in place, the social cost of interrupting them is greater than losses incurred by upstream users; the latter may be forced to adapt and release water in times of necessity. In 2003, upstream hydropower plants in the Po Basin were forced to release extra water and abstraction for irrigation was restricted in order to restore required flows (Massarutto and de Carli, 2009). Recently, proposals for thermal (nuclear) facilities have been reprised in all European countries, particularly Italy, making this issue potentially more serious in the future. One solution would be to prohibit cooling with running water and prescribe new hybrid cooling towers. The tsunami and subsequent accident at the Fukushima nuclear power plant in Japan (March 2011) and the outcome of the popular referendum in Italy (June 2011) have dramatically changed the situation. Many countries have now downsized, and in some cases abandoned, the development of nuclear energy projects. CIPRA has been demanding the abandonment of nuclear energy for many years.

3.3 RESPONDING TO CLIMATE CHANGE

Water policy aims to accommodate demand, natural supply and ecology. Climate change is expected to affect all three: demand will increase, become more rigid and vulnerable; supply will, at the very least, become less reliable, and possibly diminish, and finally, ecological requirements will be more demanding.

The status quo cannot be sustained and adaptation measures are required:

- Measures aimed at compensating reduced availability
- Measures aimed at meeting extra water demand
- Measures aimed at improving the efficiency of water use
- Measures aimed at reducing pressure factors that generate demand

Table 1 provides a breakdown of proposed and adopted measures. Each measure has the potential to cause a positive or negative effect on each water use sector. The table shows the relative importance of climate response measures that are specific to each sector and cannot be generalized. However, many items in the first two categories of response measures show negative consequences for ecological and recreational use.

Table 1: Climate response measures and their relevance for sectoral water uses

Type of measure	Measure	HP	PWS	RW-SAN	AGR	TOU	IND	REC	ECO
1. Compensating reduced availability	Increasing abstraction from Alpine groundwater sources and rivers		+			+		–	– –
	Upgrading treatment facilities		+	+				+	+
	Multifunctional use of reservoirs	–			+		+	– –	– –
	Interconnection of systems		++	+			+		
	Redirection of non-household use of public supply to other sources		+	+					+
2. Meeting extra water demand	New abstractions	+			+	++		–	– –
	Artificial snow production		–			+		–	–
	Adaptation of dams to allow rapid outflows	++		+	+	+		–	–
	Hydro-peaking	++						– –	– –
3. Improving water use efficiency	Reducing leakage from pipes		+						
	Adoption of water conservation in households & hotels		+			++			
	Rainwater harvesting and reuse		+	++	++	++	+		
	Wastewater reuse		++	++	++	++	+		+
	Adoption of water-saving irrigation techniques				++				
	Installation of micro hydropower facilities in pipelines		+						
	Reallocation of water and phase-out of low-value water uses				– –		–	+	+
	Installation of more efficient turbines	++							
4. Reducing pressure factors generating demand	Imposition of minimum flow requirements	– –		+	+			++	+
	Imposition of mitigation practices for maintaining river corridors	–						++	+
	Localized treatment of effluents in constructed wetlands			++	++	++	+	++	
	Campaigns and moral persuasion to encourage water conservation by tourists		+			++			
	Stricter regional planning controls on development in vulnerable zones					+		++	

Source: Own elaboration
Key:
HP = hydropower; PWS = public water supply; RW-SAN = rainwater management and sanitation; AGR = agriculture;
TOU = tourism; IND = industry; REC = recreation; ECO = ecology.
+ or ++ indicates a relevant or very relevant impact for mitigating sectoral water stress;
- or - - indicates a potentially negative side-effect of the measure;
An empty cell indicates that no relevant impact is expected.

3.3.1 VULNERABLE SUPPLIES: MEASURES TO COMPENSATE REDUCED AVAILABILITY

The different measures variously impact water sectors. Further abstraction can only have a negative impact on ecology, with the potential to also damage recreational uses. Public water supply and sanitation may benefit from many of the measures, especially structural improvements such as network interconnection and facility upgrades e.g. by reducing the impact of discharges in low flow conditions. Such measures are unlikely to significantly alter outflow patterns or negatively impact ecology but cost may be a prohibitive factor. The use of upstream reservoirs to secure downstream flows (e.g. for cooling or irrigation) could negatively affect hydropower, recreational use and ecology.

Vulnerability can occur where non-household demand is met through the public supply or from sources used for public supply. This is particularly true for artificial snow production when groundwater or direct abstraction from rivers and ponds is used. Alternative sources, e.g. rainwater storage, could be an effective way to alleviate competition with household use and reduce the need to upgrade facilities. Sharing of resources with other large users, such as hydropower facilities, might also compensate local deficits; water transfers for this purpose are already used in France (EEA, 2009a). However, landscape impacts require consideration.

3.3.2 NEW DEMANDS: MEASURES TO MEET THE EXTRA WATER DEMAND

The case for new abstractions has to be weighed up against severe negative ecological impacts. The picture is complex: given that the rate of Alpine water exploitation is generally low, there may be places where further abstractions will be less damaging. Proposals must be carefully assessed for impact on flows, ecology and recreation. Further licenses for the fast-growing hydropower sector should be discouraged and strict criteria and economic (dis)incentives introduced: diminishing returns in energy production and rising environmental costs mean it cannot be regarded as a convenient solution for reducing CO_2 emissions. More intensive use of hydropower comes with a high environmental cost: a more artificial flow regime downstream of reservoirs (hydro-peaking). This conflict is likely to dominate in the future.

Picture 7:
Reduced availability and water demand are being regulated by the use of upstream reservoirs.

Climate change increases the need to protect downstream settlements from flooding: upstream storage capacity is required to act as a buffer. To avoid the need to keep reservoirs empty far in advance to maintain this spare capacity, rapid discharge facilities could allow them to be emptied quickly in the case of a flood alert. While alleviating upstream/downstream conflicts, this may adversely affect recreation, given the frequent wavering of lake levels. Keeping reservoirs empty will also limit other productive uses.

3.3.3 RAISING THE STANDARDS: MEASURES TO IMPROVE WATER USE EFFICIENCY

Measures to deliver the same environmental functions with less water input have the potential for major savings in some sectors e.g. the use of drip irrigation on high value crops (see 5.4 and the Agriculture compact). Urban efficiencies can be improved through domestic water saving opportunities - not just a case of using less water but reducing the impacts of using tap water, rainwater and sanitation (see 5.6). Wastewater reuse (for toilet flushing or garden watering), rainwater harvesting and similar actions can dramatically reduce peak demand, positively affecting ecology through reduced need for abstraction. Hydropower efficiency can be enhanced through innovative turbines.

The cost of such measures will be prohibitive in many cases and it will prove more convenient to phase-out certain practices than invest in ways to improve their water efficiency: low-value crop irrigation and heavy industry are the most obvious candidates.

3.3.4 DEALING WITH THE PRESSURES: MEASURES TO REDUCE FACTORS GENERATING DEMAND

In some cases, moral persuasion can promote virtuous behaviour e.g. in the tourism sector; in others, economic incentives can play a role e.g. in irrigation. Given the structure of the Alpine water sector, dominated as it is by hydropower, command and control measures such as regulations on minimum flows and river restoration are also essential (see 5.1 and 5.2) and would benefit both ecology and recreational use.

3.4. POLICY ISSUES FOR IMPLEMENTING CLIMATE RESPONSE MEASURES

3.4.1 INSTITUTIONS AND GOVERNANCE

Water management institutions in and around the Alps have developed within a context of general water abundance. Policies have been dominated by an infrastructure-led and sectoral approach (separation between environment, flood protection and water supply) and by fierce localism. The new challenges call for a more integrated approach focused on integrated river basin management, a strategy strongly pushed by the WFD. Although not solely related to climate change, climate change-induced water stress does represent a further reason for developing a more integrated framework. Integration in the Alps requires:

(i) Scaling-up of water services management e.g. from municipal to inter-municipal or even regional scale. This allows deficit areas to be supplied from sources located elsewhere and facilitates the concentration of wastewater facilities to reach minimum efficiency levels i.e. in the order of 10s of 1000s equivalent inhabitants.

Picture 8:
A challenge for the Alpine region: the water management sector needs to be professionalized.

(ii) A closer cooperation between sectoral users to facilitate sharing of resources (e.g. storage facilities: costs can be divided between competing sectors - see 3.4.2) and coordination of actions aimed at recovering water quality (e.g. by adopting integrated measures that address point and non-point sources of pollution in order to reduce overall load).

Professionalization of the water management sector is needed and represents a further challenge for water governance. In the Alpine region, the dominant model remains local public management operated by municipalities using in-house labour: an approach that hardly covers the cost of maintaining the professional skills. A more professional framework will result in loss of direct control by local communities, either through scaling-up and/or the increasing need to delegate specific tasks to the private sector. Water is not a conventional marketable good, but a scarce good inherited by us all. Therefore public authorities must remain responsible for drinking water supply, even if they contract out the water supply service to third parties. This is a sensitive issue everywhere but particularly in mountain areas where local control of water is often regarded as a key element of identity. The institutional challenge is to make territorial integration and professionalization (if not privatization) more acceptable through participated governance and alternative regulatory institutions, possibly focused on the community and common ownership (see 5.7). This is further prompted by an increasing need to rely on full-cost recovery tariffs, as compensation and subsidies from general taxation become less feasible due to budget constraints.

Instruments such as river contracts have been tested out in many countries as a convenient framework for facilitating voluntary agreements (see 5.7). Compensation for ecosystem services is also increasingly regarded as a suitable approach to address conflicts arising when local communities are forced to give up control in the name of "superior" interests. Similar schemes have been adopted to recognize the ecological value of agricultural services and compensate farmers for the loss of potential alternatives. As well as reconciling costs and benefits with the inclusion of environmental externalities, economic instruments can be used to share costs and benefits in a more equitable way and raise revenue for compensation.

3.4.2 FINANCING AND COST SHARING

Since most climate change adaptations require technical upgrades (as mentioned in Table 1), finance is an obvious consideration: it will be increasingly difficult to rely on public budgets and taxation. Interconnection entails long pipelines, often to be constructed in areas with difficult geology and accessibility. Concentration of demand in upstream locations, the result of tourist development, also involves higher operational costs (see 5.3). Once again, climate change is not the sole factor but it certainly plays a part in requiring management adaptations; for example through higher requirements imposed on wastewater treatment and the growing need to interconnect systems to reduce vulnerability.

Providing an estimate of required investment is a challenge; however we can say that it will impact severely on existing water charges, probably far beyond the affordability threshold. In Lombardia, Italy, Massarutto et al (2008) have estimated that if full cost recovery was undertaken in mountain areas, without financial help from other areas, the cost per capita could reach up to 3 % of average incomes and up to 8 % for poor families. In Slovenia, while the average cost of water services (supply and sanitation) is estimated at approx. 2 €/m^3, the cost in municipalities with low population densities could be much higher (IREET, 2009). Finding a way to share out such a cost burden is vital. This does not contradict the principle of cost recovery or the idea that water pricing should be used to promote efficient water-use behaviour; yet prices should be designed to make sure these factors are compatible with affordability (Massarutto, 2007).

We envisage three strategies, which could be combined to varying degrees:

1. Inter-regional management units

Adopted in Italy, this involves creating larger management units encompassing both mountain communities and larger downstream cities within the same unit. A single tariff across the unit means urban services subsidize services in low density areas and the larger scale mobilises higher financial flows. Water services would be centralised and managed by a single water company for each unit.

© CIPRA International

Picture 9: Tourism industry offers a significant potential for reduction of the water use.

2. Water taxes

As adopted in parts of France, large-scale financial institutions collect a water tax from each local user and redistribute funds to finance investments on a rotational base (see 5.7). On the one hand, it allows the decentralized management system to be retained; but on the other, it creates fewer opportunities for cost sharing since the size of financial transfers is strictly limited by the agency's budget, agreed on by all users each year. Incentives could be designed into the system e.g. promoting adoption of eco-labelling in the tourism and hydropower sectors or installation of water-saving devices in domestic premises (OECD, 2010). For Alpine regions, the value of ecosystem services provided to the rest of the basin could be considered as a criterion for designing incentive schemes (Massarutto, 2009).

3. Sharing costs between sectors

This innovative approach to water pricing comprises alternative ways to divide-up the cost of services between sectors that share the same technical facility e.g. tourism and households. Instead of charging each user the same tariff, prices can be differentiated to fall proportionally more on those users able to afford a higher price. Connection charges could be differentiated between categories of use e.g. by charging tourists and second home-owners higher rates than the resident population (OECD, 2010). To our knowledge, this approach has not yet been used in the Alps, but is common in water-stressed coastal and island tourist locations. A 1 €/m^3 tariff increase, for example, would have little impact on tourism, since it corresponds to 25 cents/day/tourist: if this was to be recovered through the cost of a hotel room or via a special tax (e.g. on tourist beds), it would be negligible in the total cost of the stay.

3.4.3 REALLOCATION OF WATER RIGHTS AND PHASING-OUT OF USES

Since accommodating all new demands (including ecological quality) will become increasingly difficult, some restrictions are likely to take place. Those uses which cannot afford to invest in water-efficient technologies will have to be left unsatisfied. For example in the irrigation sector, investing in drip irrigation is only feasible for high-value crops; the value added to cereal production hardly covers costs. For downstream irrigation, a return to rain-fed systems would be a feasible alternative. Since the value added for many crops with high water demands is quite low, the economic cost of phasing them out is also relatively low, and losses to farmers could be easily compensated through the payment of subsidies for non-irrigated products. This would result in an overall change in cropping patterns e.g. from corn fields to poplar woodland. This would significantly reduce the economic loss from water unavailability for the sector as a whole; even if some specific farmers would suffer losses (see Agriculture compact).

Picture 10:
Every abstraction license should be evaluated for its environmental impact.

Recent studies indicate major losses to farmer's incomes from the 2003 drought (EEA, 2009b). Yet a more careful analysis shows that though some lost out, the agricultural sector as a whole gained, since price rises induced by the sudden decrease in production more than compensated for loss of yields. It was consumers, not farmers, who were the net losers (Massarutto and De Carli, 2009).

The same study shows net loss could have been six times lower if available water had been prioritised for high value crops (fruit, horticulture). To address this, a system of tradable water rights could be set up, enabling farmers to bargain with each other. This observation leads to a key statement: in order to minimize the economic impact of water-use conflict between uses in times of scarcity, effective water allocation planning could be far more efficient than simply investing to increase supplies or improve irrigation systems. Such a system should involve compensation schemes, insurance and inter-sector trading of water rights.

Restrictions are also needed in the hydropower sector. With the current boom in proposals for new small facilities, stemming from favourable prices and renewable energy subsidies, only a small fraction of applications can be approved. Careful use of economic instruments (e.g. abstraction licenses evaluated for environmental impact on a per case basis) could be helpful in selecting the most appropriate projects. A fee levied on successful applicants could finance some form of recompense for rejected applicants. A similar approach has been launched by the Piemonte Region administration (see 5.1).

The cost-benefit of small hydropower projects varies depending whether energy is sold to the market or used locally. In the former case, studies suggest potential contribution to the national and EU energy balance is very limited and contribution to reducing emissions almost negligible (Bano and Lorenzoni, 2008). However, it can be far more important as a locally available source that aids self-sufficiency and contributes to local industrial and tourism development. Water policies should take this factor into account by establishing a preference, and perhaps an economic incentive, for projects that entail local use. Of course in either case, the development of hydropower projects should not be encouraged without taking into account impacts on river ecology. Many Alpine watercourses are classified as heavily modified, failing to reach good ecological status because of altered morphology. Further development could be allowed through some sort of "trading approach", in which developers are requested to re-invest part of their revenue into river restoration projects that also aim to improve already compromised sites.

4 CONCLUSIONS

"The Rich Cry Too" was the title of a popular 1979 TV series that could be used as an analogy for Alpine water problems today. Despite the proverbial abundance of water resources, the Alps are already suffering from water stress at the local level and will probably suffer more in the future due to climate change. We can say with some confidence that climate change is likely to significantly alter outflow patterns and the seasonal distribution of water availability. Winter run-off is expected to increase, while the vitally important summer outflows are likely to decrease, resulting in significant consequences for the way water is utilised and managed in the Alps and downstream. This will probably be especially important for the Southern part (strong summer drying in the Mediterranean). Climate models suggest for the Alps that temperatures rise more compared to the European means; overall decrease in precipitation, particularly snowfall; possible increased occurrence of extreme events and reduction in glacier mass.

Alpine water stresses are not dependent on scarcity but rather on increased competition among demand sectors and, above all, changes to the hydrological cycle and therefore river ecology. These impacts emanate from the complex interplay of general development trends, new legislation and climate change. Climate change cannot be viewed or addressed in isolation. Resource-led rather than demand-led management of resources and assessment of availability and stress at the local scale are crucial.

The impact of climate response measures is specific to each sector and cannot be generalised. Given its lion's share of consumption and the boom in demand for new installations, the hydropower sector is the one on which most concerns are concentrated. Hydropower is also the use that impacts the most on river morphology, thus severely affecting both ecological function and recreational aspects. Some reconciliation of ecology and landscape with productivity is possible and can be promoted using soft instruments (such as eco-labelling and incentives). However, the trade-off remains in favour of development because of the increasing economic value of hydroelectricity, further boosted by incentives paid to renewable sources. A more adequate planning framework for water concessions is required, as well as instruments that ensure that demand is concentrated and facilitated on the most productive sites. It will be difficult to achieve this without a more effective command and control regulatory framework focused on the conservation of ecological requirements.

Hydropower aside, compensation measures to mitigate water stress (i.e. mobilizing water from nearby areas and concentrating management systems and technical networks) seem the most immediately accessible response (see Table 1). Technical solutions are available in principle (especially in agricultural and household supply / sanitation sectors); however, their feasibility is constrained by cost, at least for the local user.

Strategies for accommodating human demand and ecological requirements, given the natural availability, therefore involve a mixture of actions on both the technological and institutional fronts. Regarding technology, effort should be focused on adopting solutions appropriate to the specific human and natural environment of mountain regions. Innovative approaches are needed, based on local solutions (e.g. wastewater and grey water reuse, rainwater harvesting and constructed wetlands) and less on traditional facilities where economies of scale can be easily outweighed by connection costs. On the institutional side, the most challenging issue in our opinion is the need to upgrade the technical, managerial and financial skills of water service operation and at the same time agree methods for sharing costs among the wider community. The move to a more integrated approach across basins and sectors, being driven by the WFD, is an important process in this.

5

EXAMPLES OF GOOD PRACTICE

5.1

HYDROPOWER IN PIEMONTE: INTEGRATED APPROACH TO LICENSING

Since 1933, Italian legislation has required water use for hydropower production to be subject to a fee proportional to installed capacity, paid to the relevant administration (Region). An additional fee provides compensation to communities affected in terms of loss of opportunities. Thus, the national framework does not consider actual abstraction or environmental damage, only energy production as a basis for taxation.

The booming demand for new installations, especially small ones, is particularly critical in Piemonte where installed capacity has grown 20 % since 1997 and 407 applications for new installations are pending. The exploitation ratio of available outflow is already critical, demonstrated by clear signs of diminished ecosystem capacity: reduced microhabitats due to reduced flow velocities; decreased self-purification rates; impoverished biodiversity and continuous interruptions in river continuity.

Consequently, Piemonte Region has adopted an innovative and participatory approach for licensing new facilities and administering demand focused on the carrying capacity of river ecosystems. A ban on new concessions above certain thresholds and more demanding minimum flow requirements for existing ones are accompanied by economic incentives. It implies a reform of abstraction fees based on stream length affected and fraction of natural flow subtracted. Fees will be differentiated according to location following priorities in the Regional Water Resources Plan and degree of artificialisation already reached; rebates will reward good practice. Part of the revenue will go to local authorities as compensation for lost opportunity. For other water uses, fees will be based on effort made to save water or reduce pollution. For more details, view or contact:

www.regione.piemonte.it/ambiente/ (it)
Contact: Elena Porro elena.porro@regione.piemonte.it

Pictures 11: Carrying capacity of river ecosystems is the crucial criterion of the new approach to licensing of the Piemonte region.

5.2 ENVIRONMENTAL CERTIFICATION SCHEMES: GREENING HYDROPOWER

In recent years, the electricity market has become very complex and various ‘green energy’ certification schemes have sprung up around the world in an attempt to provide producers and consumers with ways to measure the ‘green’ credentials of the energy being produced. In a 2009 review of such certification labels led by PricewaterhouseCoopers (PwC), most were found to be rather weak with respect to ecological criteria. However, Switzerland’s Naturemade star scored highly in their comparative analysis. Of the 19 labels analysed worldwide in 2008-9, it was the only scheme shown to have “very strict and concise rules concerning hydroelectricity” (PwC 2009). Naturemade star aims to provide a quality mark for ecologically produced energy. It is awarded after thorough inspection by the Verein für Umweltgerechte Energie (VUE) and guarantees compliance with strict and comprehensive ecological requirements based on scientific test criteria developed for the scheme. In the case of hydropower, managers of individual power plants, working with a hydro-ecological expert, draw-up a preliminary study and management plan that is then presented to VUE for assessment and auditing. Considerations include minimum flow requirements, hydropeaking issues, reservoir management and power plant design. Once certification is awarded, control audits take place every year and recertification is required after five years. The process looks at the entire lifecycle of the energy produced and local and regional criteria are included. The scheme also includes a Fund for Ecological Improvements.

www.naturemade.ch (en/de/fr/it)

Picture 12:
The CH2OICE methodology has among others been tested on the Moso Hydropower plant in South Tyrol.

At present, a major limitation of most schemes is that they are confined to the country in which they have been developed and at present cannot easily be transferred across national borders. The CH2OICE project has been tasked with developing a framework for implementing a certified management system for hydropower in several European countries. Defining criteria and principles to ensure impacts are sustainable, it is financed by the EU within the Intelligent Energy Europe programme. Most Alpine countries are involved, as well as Spain. Its philosophy is rooted in the definition of good ecological status as required by the WFD i.e. not just chemical quality but aspects such as adequate flow, continuity and ecosystem services. The project adopts a participatory approach, involving policymakers and stakeholders. Outcomes so far include a review of the regulatory and planning framework in Alpine countries and an inventory of mitigation solutions. Next phases involve reviewing nationally defined sectoral guidelines and applying a protocol at several locations.

www.ch2oice.eu (en)

Contact: Giulio Conte giulio.conte@ambienteitalia.it

5.3 WASTEWATER MANAGEMENT IN PUSTERTAL: IMPROVING ENVIRONMENTAL PERFORMANCE

Wastewater treatment in mountain areas with intense tourism is problematic, especially in winter since low temperatures reduce efficiency and low flows increase environmental impacts. Climate change is likely to exacerbate the problems as tourism pressure is expected to increase in the higher resorts as lower resorts become less snow reliable. An innovative approach has been adopted in Pustertal (South Tyrol) where facilities have been housed in closed environments with controlled temperatures to realise environmental benefits. At one plant, close to Brunico, a cavern was constructed inside Mount Tobl (requiring extraction of 200.000 m^3 of solid material). Treatment for 26 municipalities of 130.000 equivalent inhabitants is facilitated via a 90 km sewer network and involves tertiary treatment (denitrification) and sludge-based anaerobic digestion allowing heat recovery for functioning purposes. Implementation was divided among building contractors and overseen by a consortium of municipalities plus individual communities. Operational costs are around 10 % higher than in an open build plant. However significant environmental benefits are gained: the optimized abatement capacity negates the issue of low temperatures and smell and landscape issues are avoided.

www.arapustertal.it (de/en/it)
Contact: Lucia Soravia LuciaS@arapustertal.it

5.4 IRRIGATION IN TRENTINO: SWITCHING TO GIS AUTOMATED DRIP SYSTEMS

Picture 13:
Irrigation in the vineyards is governed from a remote control facility

Faedo and Pilcante are Trentino districts dedicated to vineyard cultivation with a long history of irrigation. Consortiums supply water to farms that have traditionally used manually-operated spray systems, both labour intensive and restricted to a rigid rotation that follows predetermined schedules regardless of actual need. With the new GIS drip system, irrigation is governed from a remote control facility in constant dialogue with sensors monitoring soil humidity and assessing water requirements: a much more flexible application. Smaller amounts released more frequently allow it to penetrate in depth and reach plant roots.

Water saving is estimated at 40-50 % for Faedo and 50-60 % for Pilcante. Uniquely, this allows the consortium to rely solely on rainwater from ponds, thereby now avoiding conflicts with public supply during summer droughts. Energy saving is significant since its use is directly related to the quantity of water mobilized. This saving is an important source of initial finance for equipment. Product quality has also improved (more fruit, less leaves), thanks to the ability to coordinate irrigation with fertilization.

www.claber.it (en/fr/it)
Michele Chiariello michele.chiariello@gmail.com

5.5 CONSTRUCTED WETLANDS IN SLOVENIA: SOLUTIONS FOR WASTEWATER TREATMENT

Constructed wetlands are systems for wastewater treatment composed of small, interconnected, water-tight treatment beds with subsurface water flow and open-water lagoons. Beds filled with sand and gravel substrates are planted with species that utilise organic and nutrient materials in the sewage and stimulate indigenous microbial flora to mineralise organic matter and wastewater nutrients. Purified water can be returned to the natural cycle or reused. This technology has been developing in the last few decades, either as an alternative to traditional centralized systems or to complement them, supplying tertiary treatment. Given its low investment and operating costs, it is particularly suited for small and scattered settlements, where transporting sewage to the main treatment facility would imply prohibitive costs. Carried out appropriately, it circumvents the problem of low temperatures affecting treatment and can deal with the high load oscillations experienced in seasonal tourist centres.

Within the Alpine region, this technique has been applied most thoroughly in Slovenia, favouring the development of specialized companies such as LIMNOS, which has now become an exporter and market leader. Over two decades, the company has initiated nearly 20 installations, from wetlands for houses and mountain huts to small villages and agri-industrial facilities (e.g. milk production plants), some providing treatment for up to 1.000 equivalent inhabitants.

www.limnos.si (sl)

Picture 14:
Constructed wetland in the Slovenian village Sveti Tomaž is in operation since 2001 and provides treatment for 350 equivalent inhabitants.

5.6 DOMESTIC WATER EFFICIENCY: GERMANY'S EXPERIENCE AND THE ECOSAN SUSTAINABLE SANITATION PROJECT

Often trivialized as "using less water", the efficient use of water requires one not only to "save water" but also to investigate how it is used and why. It includes wastewater recycling and ecological sanitation i.e. using alternative means to dispose of human excreta in place of flushing toilets. Rainwater management also offers interesting applications: for irrigation, garden watering, flushing toilets etc.

Some countries, such as Germany, strongly promote these solutions through technical regulation and economic incentives. Here, building regulations require adoption of best available technologies for water management including interruptible flush devices, water-saving taps and wastewater recycling. The high cost of water (as well as electricity) provides a strong incentive to families to install less resource demanding appliances. Special taxes encourage rainwater harvesting and infiltration e.g. Germany's rain tax is levied on a property's impervious surface cover. Households can reduce this tax by replacing impervious surfaces with porous pavement and green roofs, thereby reducing run-off and sewer construction and repair costs.

The Sustainable Sanitation - Ecosan project, led by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ, former GTZ), promotes sustainable sanitation all over the world. Run on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ) since 2001, this program seeks to establish a new approach that views human excreta and domestic wastewater as resources that can be recovered and safely reused – requiring lower water input; improving soil fertility and food security and potentially generating energy. Technologies include urine diversion dehydration toilets (UDDTs), rainwater harvesting, constructed wetlands, composting, vacuum sewers and biogas reactors and others. In Austria, Alpine Ecosan projects have installed UDDTs at mountain tourist huts in Pretulgraben and also Karwendel Alpine Park, where greywater treatment was also established.

www.gtz.de/ecosan (de/en/fr)

Picture 15:
Improvement of the urban climate: all the rainwater from approximatelly 3.000 m² sealed surface is led to the flowerbeds where it evaporates. Each evaporated cubic meter takes 680 kWh thermal energy from the surroundings.

5.7 AGENCES DE L'EAU IN FRANCE: SHARING INFRASTRUCTURE COSTS

To meet the challenges of climate change and also WFD requirements, an integrated approach is necessary, both inter-regionally and across sectors. Given this need for restructuring, the French water management system offers some good practice examples. Since 1964, their system has been framed around the country's six large river basins. Despite the huge fragmentation of water management systems, integration at the basin scale is fostered through dedicated basin-wide institutions: the Agences de l'Eau. Self-financing, they generate revenue from water-related taxes (on pollution, abstraction, fertilizer use etc) which is used to fund those involved with water use and management, particularly municipalities and farmers. Subsidies are paid on a contractual basis according to agency priorities e.g. per unit of pollution effectively abated or where farmers agree to adopt environment-friendly techniques. Decisions on financial intervention and taxation, as well as spending priorities, are voted on annually by a Water Parliament (Basin Committee), in which all major stakeholders have a seat.

The system has many advantages. It engenders solidarity, helping to temper disparities arising from the fact that each management system (organized on a communal or inter-communal basis) has to recover full costs. Agency grants are an important source of capital for new investment, especially in sanitation: since they are generated through taxation and operated as rotation funds, the costs are minimal compared to funds on the open market. It also achieves integration at the basin scale without giving up local management autonomy, so important to small communities. The system allows for a vast range of contractual agreements: priority is given, for example, to projects with an integrated network of facilities across a sub-basin or which address Basin Plan priorities. Payments are made when targets are achieved e.g. pollution reductions or adoption of environment-friendly farming techniques, rather than capital grants. Funds are co-financing, complementing rather than substituting user investments. They nonetheless provide a significant source of finance for new investments (30-40 %) especially in the wastewater sector. More information is available from the Rhone-Mediterranean and Corsica Water Agency.

www.eaurmc.fr (fr/en)

Picture 16: Funds were also invested into the river Bleone in the Alpes-de-Haute-Provence département.

6 BACKGROUND INFORMATION

- **A current listing of links, further examples, and compacts on other topics is available on www.cipra.org/cc.alps (de/en/fr/it/sl)**

- Alpine Convention Permanent Secretariat (2008): Mitigation and adaptation to climate change in the Alpine space. Innsbruck. www.alpconv.org/documents/Permanent_Secretariat/web/AlpineSignals5/Alpsig5_it.pdf
- Alpine Convention Permanent Secretariat (2009): Water and water management issues. www.alpconv.org/documents/Permanent_Secretariat/web/RSAII/20090625_RSA_II_long.pdf
- Bano L., Lorenzoni A. (2008): I costi della generazione elettrica da fonti rinnovabili. In: Economia delle fonti di energia e dell'ambiente, 3/08.
- Beniston M. (2006): Climatic change in the Alps. Presented at the workshop: Adaptation to the Impacts of Climate Change in the European Alps in Wengen, Switzerland, 4-6 October 2006.
- Berbel Vecino J. (ed.) (2004): WADI – Sustainability of European irrigated agriculture under the WFD and Agenda 2000, Final report. www.uco.es/investiga/grupos/wadi
- BMU (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety) (2007): Climate change in the Alps: Facts, impacts, adaptation. Berlin. Downloadable from: www.alpconv.org/documents/Permanent_Secretariat/web/library/klimawandel_bmu_en.pdf
- CH2OICE project (2008): Report on existing tools and regulatory framework, on national (IT, ES, FR, SK, SL) legislation and analysis of hindrances for joint WFD and RES-e. www.ch2oice.eu
- Conte G. (2008): Nuvole e sciacquoni, Edizioni Ambiente. Milano.
- EEA (European Environment Agency) (2003): Europe's water: An indicator-based assessment, Topic report 1/2003. www.eea.europa.eu/publications/topic_report_2003_1
- EEA (2009a): Regional climate change and adaptation - The Alps facing the challenge of changing water resources, EEA Report no. 8, 9/2009. www.eea.europa.eu/publications/alps-climate-change-and-adaptation-2009
- EEA (2009b): Water resources across Europe - Confronting water scarcity and growth, EEA Report no. 2, 3/2009. www.eea.europa.eu/publications/water-resources-across-europe
- Energylab Foundation (2008): Le condizioni per il ritorno all'energia elettronucleare in Italia. Energylab Foundation, Milano. www.energylabfoundation.org
- European Small Hydropower Association (ESHA) (2008): Current situation of small hydropower in the EU-15. www.esha.be/fileadmin/esha_files/documents/publications/position_papers/ESHA_contributionDGTREN.pdf
- Haeberli W. (2009): Climate change and high-mountain regions – Adaptation strategies for the Alps. In: Kreutzmann H., Hofer T., Richter J.: Meeting of minds - Decision-makers from Asian and Alpine mountain countries sharing policy experiences in regional cooperation for sustainable mountain development, 59-66. Bonn.
- Harum T., Poltnig W., Ruch C., Freundl G. and Schlamberger J. (2007): Variability and trends of groundwater recharge in the last 200 years in a south alpine groundwater system: Impact on the water supply. Presentation at the International Conference on Managing Alpine Future in Innsbruck, 15–17 October 2007.
- INEA (National Institute of Agricultural Economics, Italy) (2008): L'impatto della Dir. 2000/60 sull'irrigazione in Italia.
- INEA (2009): Lo stato dell'irrigazione in Italia. www.inea.it
- IPCC (Intergovernmental Panel on Climate Change) (2008): Climate change and water, Technical report VI. www.ipcc.ch/pdf/technical-papers/climate-change-water-en.pdf
- IREET (2009): Predlog oblikovanja in določanja cen javne službe odvajanje in čiščenjekomunalne odpadne vode, 1. delovno poročilo v okviru projektne naloge Izdelava metodologije za oblikovanje in spremljanje cen komunalnih storitev. Inštitut za raziskave v energetiki, ekologiji in tehnologiji, d.o.o. Ljubljana, maj 2009.
- Marangon F., Tomasinsig E., Vecchiet M. (2002): Valutazione tecnico-economica

ed ambientale della fitodepurazione a servizio di piccole utenze. Analisi della situazione in Friuli Venezia Giulia, Forum, Udine.

- Massarutto A. (ed.) (2002): Ciclo integrato delle acque: regole di mercato e strumenti operativi a confronto. Franco Angeli, Milano.
- Massarutto A. (2003): Water pricing and irrigation water demand: Efficiency versus Sustainability. In: European Environment, 13/2003, 100-119.
- Massarutto A. (2007): Water pricing and full-cost recovery of water services: Economic incentive or instrument of public finance? In: Water Policy, 9, 591-613.
- Massarutto A, Paccagnan V., Linares E. (2008): Private operation and public finance of the Italian water industry: a marriage of convenience? In: Water Resources Research, 44, W12425, doi:10.1029/2007WR006443.
- Massarutto A., de Carli A. (2009): I costi economici della siccità: il caso del Po. In: Economia delle fonti di energia e dell'ambiente, L11 (2009), 123-143.
- Massarutto A. (2009): La compensazione dei servizi eco sistemici: un criterio innovativo per impostare i trasferimenti economici a sostegno della montagna. In: Borghi E. (ed.): La sfida dei territori nella Green Economy, 157-172. Il Mulino, Bologna.
- Massarutto A. (2010): An ecological economic understanding of urban water conflicts. In: Barraqué B. (ed.): Urban water conflicts. Routledge, London.
- Oberauner I., Prettenthaler F. et al. (2006): Adaptation in the water supply sector of Eastern Styria (Austria). Presentation at the workshop: Adaptation to the Impacts of Climate Change in the European Alps in Wengen, Switzerland, 4-6 October 2006.
- OcCC/ProClim (Advisory Board on Climate Change/ Swiss Forum for Climate and Global Change) (ed.) (2007): Climate change and Switzerland 2050: Expected impacts on environment, society and economy. Bern.
- OECD (Organisation for Economic Co-operation and Development) (2007): Climate change in the European Alps: Adapting winter tourism and natural hazards management. OECD, Paris.
- OECD (2010): Pricing water resources and water and sanitation services. OECD, Paris.
- Pfefferkorn W., Egli H. R., Massarutto A. (2005): Regional development and cultural landscape change in the Alps: The challenge of polarisation. In: Geographica Bernensia, G74 (special issue).
- PricewaterhouseCoopers (2009): Green Electricity: Making a difference – An international survey of renewable energy labels.
- Smith J., Howe C., Henderson J. (2009): Climate change and water: International perspectives on mitigation and adaptation. IWA Publishing, London.
- World Commission on Dams (2000): Dams and Development: A new framework for decision-making. Earthscan Publications, London.

LINKS

- Alpine Convention: www.alpconv.org (de/en/fr/it/sl)
- Energy Lab Foundation: www.energylabfoundation.org (it)
- European Environment Agency (EEA): www.eea.europa.eu (en)
- Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU): www.bmu.de (de)
- Intergovernmental Panel on Climate Change (IPCC): www.ipcc.ch (en)
- US Environmental Protection Agency (EPA) support website for small water management systems: http://water.epa.gov/type/drink/pws/smallsystems/managementhelp.cfm (en)

CASE STUDIES

- ARA Pustertal: www.arapustertal.it (de/en/it). Contact: Lucia Soravia (LuciaS@arapustertal.it).
- CH2OICE Project (Certification for HydrO: Improving Clean Energy): www.ch2oice.eu (en). Contact: Giulio Conte (giulio.conte@ambienteitalia.it).
- Claber irrigation company: www.claber.it (en/es/fr/it). Contact: Michele Chiariello (michele.chiariello@gmail.com).
- Ecosan project of the Deutsche Gesellschaft für Internationale Zusammenarbeit (German Agency for International Cooperation - GIZ, incorporating the former Agency for Technical Cooperation – GTZ): www.gtz.de/ecosan (de/en/fr).
- LIMNOS Applied Ecology: www.limnos.si (sl).
- Naturemade Star: www.naturemade.ch (de/fr/en/it).
- Piemonte Region, Environment Directorate: www.regione.piemonte.it/ambiente (it). Contact: Elena Porro (elena.porro@regione.piemonte.it).
- Rhone-Mediterranean and Corsica Water Agency: www.eaurmc.fr (fr/en).

CIPRA
LIVING IN
THE ALPS