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Report on adaptation measures
related to the management of
water resources in climate
change context through the
SRCAE ("*Schéma Régional
Climat, Air, Energie*") and the
PCET ("*Plan Climat-Energie
Territorial*") of collectivities

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*Office
International
de l'Eau*

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TECHNICAL SYNTHESIS

Report on adaptation measures related to the management of water resources in climate change context through the SRCAE ("*Schéma Régional Climat, Air, Energie*") and the PCET ("*Plan Climat-Energie Territorial*") of collectivités

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Résumé

L'eau est une ressource vulnérable et sensible aux changements climatiques. Les impacts sur la ressource pourront être multiples : diminution de la ressource en eau pour les différents usages (eau potable, irrigation, hydroélectricité, industries, ...), problèmes d'approvisionnement, augmentation des conflits d'usages et risques naturels (sécheresse, inondation). Pour répondre à ces enjeux environnementaux, l'Etat Français a mis en place des outils afin de fixer un cadre réglementaire encourageant les collectivités à s'adapter. Les grandes orientations et objectifs régionaux pour atténuer et s'adapter aux changements climatiques ont été définis par les SRCAE (Schémas Régionaux Climat Air Energie) et leurs déclinaisons territoriales, les PCET (Plans Climat Energie Territoriaux) introduits par la loi Grenelle II. Afin d'accompagner les acteurs locaux et les gestionnaires de l'aménagement du territoire souhaitant s'engager dans des projets d'adaptation de la ressource en eau aux changements climatiques, cette synthèse a pour but de recenser et proposer une typologie des actions répondant aux enjeux de la ressource en eau principalement dans le domaine de l'urbanisme, de la sensibilisation des usagers, la réduction des vulnérabilités et l'acquisition de connaissance. De plus, plusieurs actions sont étudiées pour déterminer les avantages et les inconvénients pour éviter de mettre en place des mesures "mal-adaptées".

MOTS CLES: changement climatique, SRCAE (*Schéma Régional Climat, Air, Energie*), PCET (*Plan Climat-Energie Territorial*), ressource en eau, adaptation de la ressource, Grenelle de l'environnement

Abstract

Water is a vulnerable resource and sensitive to climate change. The impacts can be multiple: drop in the supply in water for drinking water, irrigation, hydroelectricity, industry. This may cause conflicts of use or natural risks (drought, flooding). Responding to challenges related to climate change and water resources, the French State has set up different tools such as SRCAE and PCET which were introduced in the government policy, *Grenelle Environment*. For local authorities, these documents have several objectives and orientations in terms of mitigation and adaptation of climate change. To assist local authorities and policymakers that wish to start a water resource adaptation project, this report aims to show the work that has already been carried out at different levels of administration (regions, *departments*, urban areas or cities). In a climate change context, the aim of the study is to identify the important actions in terms of mitigation and adaptation and to draw up a 'typology of action' such as urbanization, user awareness and knowledge acquisition. Moreover, several actions are studied to determine the context and share the lessons learned by the local authorities, highlighting the advantages and bad practice.

KEYWORDS : climate change, SRCAE (*Schéma Régional Climat, Air, Energie*), PCET (*Plan Climat-Energie Territorial*), water resource, water adaptation, *Grenelle Environment*

Glossary of terms

adaptation : Adjustment in natural or human systems to a new or changing environment. Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation. (IPCC)

mitigation : An anthropogenic intervention to reduce the sources or reducing greenhouse gases. (IPPC)

greenhouse gas (GHG) : Greenhouse gases are those gaseous constituents in the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere, and clouds. This property causes the greenhouse effect. (IPPC)

IPCC : Intergovernmental Panel on Climate Change

maladaptation : Any changes in natural or human systems that inadvertently increase vulnerability to climatic stimuli; an adaptation that does not succeed in reducing vulnerability but increases it instead (IPCC)

PCET : "Plan Climat Energie Territorial"

PNACC : "Plan National d'Adaptation au Changement Climatique"

PLU : "Plan Local d'Urbanisme"

SAGE : "Schéma d'Aménagement et de Gestion des Eaux"

SCot : "Schéma de Cohérence Territoriale"

SDAGE : "Schéma Directeur d'Aménagement et de Gestion des Eaux"

SRCAE : "Schéma Régional Climat Air Energie"

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INTRODUCTION

The IPCC (Intergovernmental Panel on Climate Change) defines climate change as "any change in climate over time, whether due to natural variability or as a result of human activity". United Nations Framework Convention on Climate Change (UNFCCC) restricts this definition in terms of "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods" (United Nations, 1992). Today, climate change is included in the French policies after the publication of various studies of the ONERC ("*Observatoire National sur les Effets du Réchauffement Climatique*") that works in conjunction with the IPCC (Jouzel et Debroise, 2014). These activities are mainly to collect and disseminate information, studies and research on risks associated to climate change and extreme climate events. Despite the difficulty to simulate and to model the consequences and impacts of climate change, the cause of an increase in this phenomenon by human activities can be demonstrated. Adaptation is defined in the third assessment report of the IPCC as "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (Intergovernmental Panel on Climate Change, 2001). The French State has implemented laws to meet these environmental challenges, SRCAE ("*Schéma Régional Climat, Air, Energie*") and PCET ("*Plan Climat-Energie Territorial*") so that collectivities have a legal framework and tools to facilitate territorial adaptation to these changes. Water is a vulnerable and sensitive resource connected to climate change. The impacts can be multiple: drop in the supply in water for drinking water, irrigation, hydroelectricity, industry. This may cause conflicts of use or natural risks (drought, flooding). To assist local authorities and policymakers that wish to start a water resources adaptation project, this report aims to show the work that has already been carried out at different levels of administration (regions, *departments*, urban areas or cities). This synthesis identifies and draws up a typology of actions that respond to the water resource issues in term of (1) awareness of water users, (2) optimization of the resource, (3) reducing vulnerability of the territory (floods and coastal flooding) and (4) improve water knowledge and promote innovation. Moreover, it is interesting to have a report on adaptation measures to determine relevant adaptation strategies depending on the local situation and avoid the "maladaptation" phenomena.

CONTEXT OF CLIMATE CHANGE

SCIENTIFIC ASPECT AND REGULATORY FRAMEWORK

The work of the IPCC

On 27 December 2014, the IPCC submitted its fifth assessment report on climate change. In its latest report, the IPCC confirmed numbers and comments published in the four previous reports, that climate change and global warming are a reality with several effects. Climate change is mainly or largely due to human activities (IPCC, 2013). Mitigation and adaptation measures are necessary to meet the expected impacts of rising temperatures. Mitigation measures are used to limit the impacts of human activities while the objective of adaptation is to reduce the vulnerability of natural and economic resources (Mansanet-Bataller, 2010).

Water resources will be affected by climate change with a change in the hydrological cycles (Arnell et al., 2004), spatial and temporal variability of rainfall, an increase in extreme events such as floods and coastal flooding (IPCC, 2012) and pressure on the uses (Fabre, 2012). The challenges for the territories will be to adapt and improve their capacity to respond to pressure

on water resources in terms of quantity and quality, but also to meet the increased risks associated with increased climate hazards and thereby reduce collectivity exposure (Bates et al., 2008).

Regulatory framework

Policy makers, in reaction to the first IPCC report published in 1990, have recognized that there was a climatic problem and they have adopted The United Nations Framework Convention on Climate Change (UNFCCC) at the "Rio Earth Summit" in 1992. Its ultimate objective is the "stabilization of greenhouse gas (GHG) concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." (United Nations, 1992). The Kyoto Protocol was adopted in 1997 and countries have committed to reduce their anthropogenic greenhouse gas emissions by at least 5% below 1990 levels in the commitment period 2008 to 2012 (United Nations, 1998).

At the European level, the "Energy and Climate Package" or the European plan on climate change was adopted at the European Council in December 2008. The plan included the "three 20 targets" which means reducing emissions of greenhouse gases by 20% between 1990 and 2020, and increasing energy efficiency to save 20% of EU energy consumption by 2020, reaching 20% of renewable energy in the total energy consumption in the EU by 2020.

At the national level, to meet the commitments set by the Kyoto Protocol, France has implemented several texts including "*Programme National de Lutte contre le Changement Climatique*" (2000), "*Plan Climat*" (2004) and "*Loi Programme d'Orientation de la Politique Energétique*" ("*loi POPE*"). The law "POPE" sets the objective of Factor 4, which is divided by 4 GHG emissions between 1990 and 2050 representing a decrease of 3% per year on average GHG emissions to 2050 (Ministère de l'Écologie, du Développement Durable, des Transports et du Logement, 2005). After this, France has adopted a law, "*Grenelle I*" (03/08/2009) and the settlement legislation, named "*Grenelle II*" (12/07/2010). The main guidelines and regional objectives to mitigate and adapt the territories to climate change are defined by the SRCAE introduced by article 68 of the "*Grenelle II*" (Ministère de l'Écologie, de l'Energie, du Développement Durable et de la Mer, 2010). To engage local authorities in the fight against climate change, the decree No. 2011-829 requires collectivities with more than 50,000 inhabitants to set up the "*Plan Climat Energie Territorial*" (PCET). PCET serves as an operational tool to assist collectivities in a strategy of mitigation and adaptation to climate change. In a context of adaptation, the French State is implementing the National Adaptation Plan to Climate Change advocating practical and operational measures to implement over the period 2011-2015. This plan offers solutions to conserve resources including water resources (Ministère de l'Écologie, du Développement Durable, des Transports et du Logement, 2011).

WATER RESOURCES IN THE SRCAE AND THE PCET

The SRCAE analysis shows that issues related to the management of water resources are considered heterogeneously in the text guidelines. The main purpose of these texts is to guide the territorial approach to climate change towards mitigation and adaptation. In particular, for the purpose of improving energy efficiency, increasing the share of renewables in energy consumption and reducing their emission of greenhouse gases. The first observation, is that the majority of regions already give some guidance on the management of water resources in areas such as urban planning, risk management, agriculture and the optimization of water resources. Only the regions of Aquitaine (Conseil Régional Aquitaine, 2012), Bretagne (Conseil Régional Bretagne, 2013), Centre (Conseil Régional Centre, 2012) and Picardie

(Conseil Régional Picardie, 2012) exclude this dimension of water resources in their SRCAE. Although some regions have mentioned adaptation of water resources in their SRCAE, the majority of them don't propose concrete measures or strategic planning to adapt the management of water resources. However, these documents are suggesting the consideration of adaptation strategies of water resources in the collectivity urbanization policy. In fact, SRCAE is not an operational tool at the local level but it is more a global regional and territorial policy.

The approach of the PCET covers all levels, departments, municipalities and the associations of municipalities (Agence De l'Environnement et de la Maîtrise de l'Energie, 2013). According to Article L.229-26 of the Environment Code, a PCET must be compatible with the SRCAE and provide a framework of engagement for adaptation of territories to climate change. In the context of mitigation and adaptation planning, these tools are operational and aim to provide the development of short, middle and long-term work plans. The issues related to the management of water resources register as adaptation measures to climate change. Planning documents such as SCoT (*Schéma de Cohérence Territoriale*) or PLU (*Plan Local d'Urbanisme*) are major instruments of the PCET and must take into account the adaptation actions proposed.

'TYPOLOGY OF ADAPTATION ACTIONS'

THE PROPOSED TYPOLOGY OF ACTIONS

In a climate change context, the aim of this study is to identify the important actions in terms of mitigation and adaptation and to draw up a 'typology of action'. The PCETs studied are the main operational tools to see the measures implemented in the territories. In the literature, there is no previous work been carried out on a typology of actions implemented following the PCET. The collectivity only introduce it in its PCET as a section on water resources. Other documents are additional operational tools that guided the selection of this typology., such as the PNACC and its variant in Rhône-Méditerranée the "*Plan de Bassin d'Adaptation au Changement Climatique*" (Comité de Bassin Rhône-Méditerranée, 2014). The proposed classification, their issues and examples of actions implemented are shown in table 1. It is chosen to distinguish the actions under four themes:

- awareness of water users,
- optimization of the resource,
- reducing vulnerability of the territory (floods and coastal flooding)
- improve water knowledge and promote innovation

TABLE 1 : DESCRIPTION OF ACTIONS TYPOLOGY

	AWARENESS OF WATER USERS	OPTIMIZATION OF THE RESOURCE	REDUCING VULNERABILITY OF THE TERRITORY (FLOODS AND COASTAL FLOODING)	IMPROVE WATER KNOWLEDGE AND PROMOTE INNOVATION
GENERAL CHARACTERISTICS	Continue to promote the decrease of water consumption for all users (individuals, farmers, industrials, authorities ...)	Find solutions and alternative techniques for obtaining new water resources and / or optimize current resources and their management	<ul style="list-style-type: none"> - Improve infiltration of rainwater to the plot by alternative techniques by increasing the permeability of the soil - Reduce the input of infiltration / inflow clear water in public sewer systems - Submit planning strategies and / or operational measures to prevent and protect the territories against the risk of flooding 	<ul style="list-style-type: none"> - Continue to learn about the impacts of climate change on water resources - Improve knowledge of the needs and land uses to adapt consumption and practices
ISSUES	In a context of decreasing water resources and increasing treatment costs due to the degradation of water quality, it is important to optimize consumption	Rising temperatures in summer and the reduction of low flows may lead to a decrease in access to water resources. It is necessary to protect territories against shortages and conflicts of uses. The solutions are to optimize water systems, promote interconnections and improved water-harvesting techniques, to find new natural resources available in the territory to meet the water need	The increase in heavy rains and intense soil sealing these recent years will pose problems in terms of stormwater runoff on urbanized areas. It is important to develop tools and alternative techniques to prevent the risk of flooding. Floods could become more common in areas with strong pressure	<p>The impacts of climate change on water resources will be different depending on territories. It is important to know the issues related to the needs, the uses and the environment.</p> <p>Some solutions require innovation and improvement of current techniques that will meet the future challenges</p>
EXAMPLES OF ACTIONS PLANNED	<ul style="list-style-type: none"> - creating a kit of "good uses" : flyers, water frother (Communauté d'Agglomération Sarreguemines Confluences, 2012) - campaign in schools and creating a "Water House" (Communauté d'Agglomération de Calaisis, 2014) 	<ul style="list-style-type: none"> - reducing water losses in the production and distribution systems of drinking water to achieve an overall real rate of return of 80% in 2020 (Chambéry Métropole, 2013) - development of alternative watering systems with raw water (to replace drinking water) for irrigation (Perpignan Méditerranée Communauté d'Agglomération, 2012) 	<ul style="list-style-type: none"> - building vegetated swales and infiltration basins for stormwater management (Communauté d'Agglomération Grenoble-Alpes Métropole, 2013) - integrate flooding issues in urban planning documents (SCOT, PLU) and encourage new constructions to find solutions to limit soil sealing (Dunkerque Grand Littoral Communauté Urbaine, 2009) 	<ul style="list-style-type: none"> - request for innovative proposal about stormwater management (Conseil Général Finistère, 2013) - participate in studies and assessments carried out at regional level about the impacts of climate change on water resource (quantity and quality) (Conseil Régional Rhône-Alpes, 2013)

Awareness of water users

Climate change will lead to changes that will affect quantity, regularity, time distribution, shape and intensity of precipitation and mean annual flows (Leflaive et al., 2012). So it is important to mobilize and educate water users and to encourage individual to save water. The objective is to fight against water wastage in all sectors: agriculture, industry and households. Some collectivities have established user awareness programs. For example, they organize workshops and seminars between elected officials and local stakeholders on the theme of "Water and Climate Change" (Communauté d'Agglomération Ventoux Comtat Venaissin, 2012) or they have awareness campaigns with the general public distributing informative flyers, or visits around the wastewater treatment plant. Others encourage the installation of equipment for water saving such as inexpensive flow reducers, dual or mixing valve systems for toilet flushing (Communauté d'Agglomération de l'Albigeois, 2013). The purpose of these actions is to adapt practices and contribute to a reduction in water supply and the pressures on the resource.

The Water Agencies are also involved in these actions. For example, in its 10th intervention program (2013-2018), the Water Agency Adour Garonne planned financial support for water irrigation saving with the introduction of measuring equipment, improving practices: agro-weather stations, sensors and control software.

Optimization of the resource

Climate change will lead to a decrease in the quantity and quality of water resources. Major issues will be access to the raw water (for irrigation) and drinking water. To anticipate these challenges, several actions can be implemented. Firstly, it is important to secure networks and avoid shortages and, secondly, optimize current yields. The search for new sources and interconnections between the networks allow the sharing of the territory water resources to protect itself against any problems that may affect the production and distribution of drinking water. This solution is designed to secure drinking water systems (Mairie de Paris, 2012). To optimize the current network, the agglomeration community of Carcassonne is carrying out a 'director drinking water scheme' to understand the layout of their pipelines, their age and level of degradation. Today, this tool is more developed and used to define the priorities of network rehabilitation and replacement of leaking sections. In addition, a study is being conducted to the gradual establishment of remote radio transmission reading of residential water meters (Carcassonne Agglomération, 2012). The advantage of this method is to get a regular and frequent monitoring of consumption and thus more easily identify abnormal consumption and quickly detect leaks on networks.

Collectivities are also committed to control their drinking water consumption and use of untreated water for communal activities. This raw water comes from recovery of rainwater and can be used for the cleaning of roads or for watering parks. Another example, some municipalities offer financial aid to implement rainwater collectors in individual and industrial plots (Communauté d'Agglomération Grand Dax, 2012). Finally, an industrial site in Bourgogne has made a connection between the water system for fire and the raw water network in 2012 (Communauté Urbaine Creusot-Montceau, 2012).

Reducing vulnerability of the territory (floods and coastal flooding)

Different projections predict an increase of extreme weather events such as heavy rainfall and a rising level of the sea. These impacts will increase regional vulnerability to flood risk and coastal erosion.

One of the challenges in the fight against flooding, is to optimize the ability to drain rainwater in the territories to meet increasing intense precipitation. Alternative techniques of rainwater management are increasingly commonly used in urban development projects and they are opposed to the previous concept at all sanitation (Chocat, 1997). Now the idea is to retain stormwater in populated areas and allow infiltration into the soil (Maigne, 2006). Collectivities have developed alternative water retention systems such as green roofs on public buildings, public gardens, swales, green ditches or lagoons (Mairie de Paris, 2007). Communities can define rules to mitigate or compensate soil sealing through the urban planning documents that are the PLU and SCOT. These plans encourage the involvement of home builders (Communauté Urbaine de Bordeaux, 2011).

Another example, the Water Agency of Rhône Méditerranée Corse supports local authorities by offering financial incentives to encourage the development of appropriate measures to limit soil sealing. An additional tool that helps stormwater management, is the Wastewater Master Plan. This document puts into perspective the black dots of the network, overflow areas and age of sections (Communauté d'Agglomération Grand Paris Seine Ouest, 2010). This plan is not currently used and serves to establish a renovation plan for pipelines and propose the creation of retention basin which is used to manage stormwater runoff to prevent flooding and downstream erosion.

In Paris, other flood control systems relate to the management of the banks: parapet construction, raising bridges and quays, widening of the river bed and installing cofferdams to seal gaps. Another interesting example is the Integrated Risk Management with the urban project "Ode à la Mer" in Montpellier, started in 2014, and which is to equip the territory of hydraulic engineering to allow storage systems management and dynamic regulation of water protection systems against floods and the reclassification of former waterproofed areas (Montpellier Agglomération, 2014).

About adaptation measures in response to an increase in sea level, Saint-Brieuc provides for the establishment of coastal risk prevention plan prepared by the services of the Prefecture (Saint-Brieuc Agglomération, 2013).

Improve water knowledge and promote innovation

To effectively address the impacts of water resources, it is important to carry out local studies and improve knowledge about the different vulnerabilities of territories. For example, in 2014, the agglomeration of Aubagne plans to conduct a global study on the water needs to adjust the consumption of drinking water and raw water (Communauté d'Agglomération du Pays d'Aubagne et de l'Etoile, 2012). This research used develop and evaluate strategies by identifying the most appropriate adaptation measures to address the challenges identified while minimizing risks.

In 2013, the project Explore 2070, aimed to identify the impacts of climate change on aquatic environments and water resources by 2070. The results will allow the

anticipation of the main challenges and prioritize risks to the territories (Chauveau et al., 2013).

ACTIONS AT THE DIFFERENT LEVELS OF COLLECTIVITIES

Regions

Regions are directly involved in the adaptation of the territory to global warming with the legislative requirement to prepare a SRCAE. One of the limits of these tools is that they are planning documents that aim to provide a coherent regional framework for policies in the fields of climate, energy and air quality (Bordier et Leseur, 2013). Regulatory texts do not require water resource adaptation objectives and are not explicitly defined. So, during the drafting of these schemes, the regions decide whether or not to introduce a component on water. It is interesting to note that certain regions are implementing a regional strategy in terms of adaptation of the water resource. For example, in Languedoc-Roussillon, the Aqua Domitia project aims to diversify water resources in bringing the additional water from the Rhone. This solution secures regional water supply (Conseil Régional Languedoc-Roussillon, 2012). The Provence-Alpes-Côte d'Azur is committed to supporting local actors through the development of the SOURCE ("*Schéma d'Orientations pour une Utilisation Raisonnée et Solidaire de la ressource en Eau*"). This document aims to facilitate the implementation of planning tools (SAGE, SDAGEs, drinking water masterplans) and determine the priorities and methods of intervention for regional actors (Conseil Régional Provence-Alpes-Côte d'Azur, 2012). Other examples are the projects initiated by the Rhône-Alpes region by the action of French groups, GRAAC ("*Groupe de Réflexion et d'Action sur l'Adaptation au Changement Climatique*") and GRAIE ("*Groupe de recherche Rhône Alpes sur les Infrastructures et l'Eau*"). These structures are developing various missions such as research monitoring on the topic of climate change adaptation and support the authorities in the implementation of strategies. These two groups have developed an adaptation guide for communities, and also a follow up research on the vegetation in urban areas and in mountain water resources (Groupe de Recherche Rhône Alpes sur les Infrastructures et l'Eau, 2014).

Departments

Several departments are engaged in a process of adaptation and have developed their own PCET to encourage collectivities to carry out this planning document. The implication of this level of administration in the adaptation is mainly to provide financial assistance to communities and support to carry out studies on their territory. For example, the department Gironde launched a project to identify, study and propose action plans to maintain wetlands (Conseil Général Gironde, 2012).

Urban areas

At the collectivities level, PCET is an operational tool that needs to be consistent with the SRCAE. The implementation of these documents is required for communities (and associations of municipalities) of more than 50,000 inhabitants. However, the smaller territories who have decided to engage in a policy of adaptation to climate change can initiate a process of PCET. As with SRCAE, water resources is not necessarily a theme considered in these documents, however, many communities have incorporated these water issues in their PCET. The measures proposed in PCETs were presented in the previous sections. They are the basis of this study that allowed the proposal of an

actions typology. To be effective PCET must be integrated into the various planning documents (PLU and SCoT) but also in the SAGE and SDAGE to implement actions.

SEVERAL EXAMPLES

COMPARISONS OF MULTIPLE COLLECTIVITIES

To illustrate the adaptation actions of the water resource and understand the issues and barriers to strategies, it is proposed to study different heterogeneous collectivities (types, creation date) through their PCETs (Table 2) and the feedback.

TABLE 2: PRESENTATION OF ADAPTATION ACTIONS FOR WATER RESOURCES IMPLEMENTED IN THE PCETs

	PAYS D'AUBAGNE ET DE L'ETOILE¹	BASSIN DE POMPEY²	CHAMBERY METROPOLE³
DATE	October 2012	November 2010	October 2013 (2ème version)
AWARENESS OF WATER USERS	Workshops / seminars for adhering all players Promote the spread of water-saving equipment, inexpensive "water saving" Kits	implement awareness raising and public relations programmes about water: importance of preserving the resource (infrastructure visits for example)	Support the fight against waste of drinking water by implementing of awareness and communication targeted actions
OPTIMIZATION OF THE RESOURCE	Secure the territory diversifying Verdon and Durance resources continue interconnections networks and search local resources Secure local catchments and catchments finalize the establishment of protective perimeters of drinking water Limit water withdrawals and individual drilling	Regular monitoring of water systems to improve the management of drinking water and sanitation and allow the reduction of water leakage (opportunity to create a water observatory) Systematize the creation of the supply of drinking water master plans for new urban project	reducing water losses in the production and distribution systems of drinking water to achieve an overall real rate of return of 80% in 2020 Search additional resources and connections solutions of drinking water systems to ensure the continuity of water supply
REDUCING VULNERABILITY OF THE TERRITORY (FLOODS AND COASTAL FLOODING)	Implementation of a PAPI PAPI (" <i>Programme d'Action de Prévention des Inondations</i> ") Limit the vulnerability by regulating land use in urban planning (PLU/SCOT) Establish systems to the plot and innovative systems for rainwater retention	Opportunity to develop a model of standard agreement maintenance of riverbanks with resident volunteers	Continue the maintenance and renaturation of rivers (management of low flows, fight against flood risks) Identify the available land along the rivers Develop rainwater harvesting strategies based on collective and individual interests
IMPROVE WATER KNOWLEDGE AND PROMOTE INNOVATION	Drainage basin study: quality and quantity of water according to uses Carrying out preliminary studies to identify risk areas	XX	Conduct studies on the drinking water needs of the territory. Reflect on water discharges of industrial agreements

The actions that have been introduced in the PCET of the agglomeration community of Pays d'Aubagne et d'Etoile in 2012 are ambitious with the inclusion of a detailed chapter dedicated to the preservation and management of the water resource. Despite

¹ (Communauté d'Agglomération du Pays d'Aubagne et de l'Etoile, 2012)

² (Communauté de communes du Bassin de Pompey, 2010)

³ (Chambéry Métropole, 2013)

the willingness of the community to engage in a process of adaptation, no action has been implemented at this time (Deblais, 2014). The main obstacles mentioned are the time required to get involved in the process, a choice to promote mitigation actions and finance.

Regarding the Basin Pompey, the observation made at the halfway stage is that the means for adaptation are not sufficient. Several factors may explain these observations. First, the current environment justifies that no concrete action has been developed in the field of water management by the community of communes: it does not have the water competence.

The implementation of the law GEMAPI from January 2016, will bring a new competence over the management of aquatic environments and flood prevention justifying the intervention of the structure. This transfer of competence will allow the community to legitimize the implementation of actions to limit the vulnerability of flood areas and to preserve the water resource and its environment. In this context, projects were launched to complement the measures proposed in the PCET and adapt to the challenges of the territory. The transfer of the drinking water and sanitation competence has not been considered. Currently, the community of communes is acting on a consultant basis and states the requirements for authorities in heritage management. Other barriers identified are the complexity of the subject, the lack of internal expertise to carry out these projects to completion and the problem that the effects of adaptation actions are not immediately visible to the different mitigation measures (energy savings). The challenge is to provide for the authorities, less empirical evidence about the impacts of climate change to encourage them to carry out a process of adaptation of water management. However, following the various recurrent flooding the various municipalities planning programs have moved from reflection to action. Finally, a challenge to complete the project in the Bassin de Pompey is also an opportunity to have help from the Region. The Region is an important partner that provides financial and human resources to implement preventive, mitigation and adaptation measures (Colin, 2014).

Chambéry Métropole has the competence of drinking water production and distribution. The actions currently in place are varied. First there is the security of the resource with interconnections between distribution units. Secondly there is the sustainability of source protection areas, followed by the monitoring the resource to determine the quantities of fifty sources and for the detection of leaks to improve the performance of drinking water systems. In addition, important measures have been considered over user conflicts due to severe low water levels. Various action programs have been proposed, such as the study of extractable volumes, creating check dams and partnerships with agriculture and forestry worldwide (Cholin, 2014). An European project led by the National Office of Forestry in collaboration with Switzerland, aims to determine the role of the forest on the maintenance of water resources and provide good forestry practices for drinking water protection. For example, the proposed actions are to improve the regulatory protection, promote land purchase, invent bridges between the worlds of water and forest, to pay for appropriate forest management, solicit managers and to inform the public (Bligny et al., 2012). In addition, Chambéry Métropole has engaged in a process to achieve a competence for stormwater control

currently owned by the municipalities. Its action on stormwater management is to guide communities and the proposal of measures such as alternative management solutions.

THE SPECIFIC SITUATION OF GRAND LYON

Grand Lyon mentions the concept of adaptation in its PCET (*Grand Lyon*, 2013) but it does not propose concrete actions for water resources in the planning document. However, the collectivity is committed to an adaptation strategy of the resource and has already completed several water saving field operations (reducing leaks in the water system, individualization of water meters, work with direction of cleanliness on washing streets with raw water ...). In addition, it conducts research on use conflicts, thanks to the SAGE East Lyon recognized as a deficit area. This has been a water allocation area since December 2014. A significant portion of the share is conducted by the infiltration of rainwater to recharge groundwater and prevent storm spillage (*Grand Lyon*, 2012). In addition, several issues related to the impact of climate change on the quantity and quality of the resource have been identified. To date, the agglomeration thinking about the establishment of governance upstream / downstream of the Rhone resource with various users including a collaboration with Switzerland (*Ponsar*, 2014). In the case of this collectivity, PCET is not the best tool for management and action planning to preserve the water resource strategy. However there are other internal documents for proper integrated water resource management which allow the *Grand Lyon* to conduct important actions and own an adaptation strategy for the resource in view of global warming.

CONCLUSION

In view of the study of SRCAEs and PCETs, it appears that many local authorities have taken into account the issues related to water resources. Although the main purpose of these documents is to provide a coherent framework for regional and local policies in the climate, energy fields and air quality, different communities have also taken measures to adapt the water resource to climate change.

In this work, a typology of actions to implement for adaptation has been proposed. It is interesting to distinguish the actions under four themes (1) awareness of water users, (2) optimization of the resource, (3) reducing vulnerability of the territory (floods and coastal flooding) and (4) improve water knowledge and promote innovation. This study helps to support local authorities wishing to engage in water resource adaptation in view of climate change and to propose a list of actions that can preserve the resource (Annexe 1). Comparison of actions through PCETs are not the same across collectivities. Some communities don't mention the adaptation of water resources in their PCETs (*Le Grand Lyon*). However, they conduct this policy through other planning documents (water management plan, SAGEs, SDAGEs). PCET is not necessarily the best planning tool for certain territories. For others, it can initiate an adaptation policy and thus be an engine for development of actions on the territory. The study also shows that barriers to adaptation are; the choice of collectivities competences, for example, some have drinking water competence and non rainwater competence or sanitation competence. In this case, it's difficult to put a consistent policy on the territory for the adaptation of the water resource. The water competence transfer (rainwater, drinking water, sanitation, aquatic ...) to groups of municipalities can be a solution for the implementation of coherent and comprehensive actions on a territory.

Climate change is a complex process and the scenarios provide different predictions that are difficult to evaluate at the medium and long terms. Therefore, adaptation strategies perceived as relevant in a collectivity may be ineffective for another. The establishment of action should be planned according to the local context. The inclusion of water resources in a context of climate change seems to be at an early stage, however, to meet future challenges related to the vulnerability of the territories and to avoid user conflict, PCETs are good planning tools to engage in adaptation policies of water resources.

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ANNEX : LIST OF ACTIONS

AWARENESS OF WATER USERS	OPTIMIZATION OF THE RESOURCE	REDUCING VULNERABILITY OF THE TERRITORY (FLOODS AND COASTAL FLOODING)	IMPROVE WATER KNOWLEDGE AND PROMOTE INNOVATION
<ul style="list-style-type: none"> - promoting the use of tap water - mettre en place des actions de sensibilisation et de communication ciblées contre le gaspillage de l'eau potable set up conferences, events, distribution of flyers, writing articles and infrastructure visits (WWTP) - distribution of a kit with aerator shower and faucet or flow reducer - distribution or financial aid to acquire rainwater collectors - installation of flood marks, communication and education on the risks - organization of workshops with policymakers, actors and local users on the "climate change " 	<ul style="list-style-type: none"> - achieving master plan for drinking water - search interconnections and avoid any problems that could affect the production and distribution of drinking water - fight against leakage through the establishment of a network monitoring tool (remote reading) and the detailed program of maintenance - give a performance target on networks - financial assistance for investments related to the modernization of irrigation with a reduction of water consumption - develop alternative agricultural practices to reduce water requirements (encourage the installation of pivots and ramps most economical than guns, drip on cereals, collective irrigation modes) - encourage the establishment of municipal plans for water savings in public buildings and maintenance of green areas and roads - establishment of power converters on the pumps on the network - adapt water withdrawals in times of drought - protect priority catchments and major water resources by regulatory tools - develop alternative measures watering raw water for irrigation: water truck, green terminals connected to the raw water, optimize the use of wells and channels 	<ul style="list-style-type: none"> - reduce the input parasitic clear water into the sewerage system - continue the work of renaturation of rivers (management of low flows, fight against flood risks) - identify the available land along the rivers to predict the purchase of land for floodplain - define a strategy and implement recovery actions rainwater to the plot - limit sealing, fight against the artificial soil in coherence with the SCOT and PLU - setting up separate networks for risk areas for direct discharge of stormwater - promote alternative techniques in storm water management (green roofs, gardens, swales, vegetated ditches, lagoons) - development of coastal risk prevention plan - creation of upstream reservoir lakes to limit the flow of rivers - realization of public works of flood control systems relate to the management of the banks: parapets construction, raising bridges and quays, widening of the river bed and installing cofferdams to seal gaps - implementation of a PAPI (Plan of Development of Flood Prevention Watershed) 	<ul style="list-style-type: none"> - participate in regional studies on the impacts of climate change on water resources (quantity and quality) - improve knowledge of flood risk to implement a management strategy adapted on the territory - pursue studies to explore the reuse of treated water at the end of treatment (watering) - calls for innovative projects in terms of stormwater management - identification of sites (such as water sources, rivers, wells ...) to define and implement projects adapted to local conditions and be part of a sustainable development approach - know the risk in the territory (overflow of rivers, urban runoff, stormwater and marine submersion) - explore the possibility of establishing water breakers on irrigation sprinkler systems - make global studies on the water requirements of the territory - improve and develop knowledge about species and plant varieties adapted and efficient of water



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