The adaptive capacity of local water basin authorities to climate change: The Thau lagoon basin in France

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Highlights

(1) Adaptation to climate change is already an issue in Mediterranean coastal lagoons;

(2) Shifts in power are observed due to recent changes in water governance;

(3) Functional and local basin authorities have gained power and legitimacy;

(4) Local basin authorities clearly have a brokerage role;

(5) This mix of top-down and bottom-up governance is appropriate to deal with climate change adaptation, but not a direct consequence of WFD implementation.

Abstract

Climate change exacerbates climate variability, and makes water governance more complex. The French local water management plans (SAGE) developed an integrated approach that relies on a balance between bottom-up and top-down governance. The aim of this article is to question the actual role of the local basin authorities and ask whether they are central in water governance. The Social Network Analysis of the Thau basin shows that the key actors of the SAGE, namely the Rhone-Mediterranean-Corsica Water Agency, the local water agency and the local water commission, are the most powerful actors in the management of the river basin and play a crucial brokerage role in climate change adaptation. Integrated water resource management shifted power from territorial and central authorities to functional and local managers.

Keywords (5 max.): climate change, integrated water resource management, governance, Water Framework Directive, social network analysis

Introduction

Climate change is predicted to raise temperatures in many European regions and in particular in the Mediterranean with a reduction of rainfall, leading to a decrease in water yield and possibly worsening the situation of water resource shortages. This change is going to increase disputes between users and requires responsive water basin authorities which are able to play a brokerage role and provide adaptations to climate change.

Since 1992, the French Government has promoted water management and development plans (SAGE). In 2015, 179 SAGE were approved in the country of which 108 have already been implemented. These local plans developed an integrated and concerted water management that combines environmental protection with the human-induced water usages. In line with the Water Framework Directive, they rely on a water basin authority which designs and implements the plan in a consensual way and encourages the definition of common goals between the local managers and users.

The aim of this article is to question the actual role of the basin authority and ask whether it is central in the local water governance. Are local basin authorities pivotal? Alternatively, major stakeholders or public authorities may be the *de facto* decision-makers in the distribution of water uses. This question is raised with two basic assumptions in mind: (1) A discrepancy exists between formal and actual institutional arrangements, and (2) public authorities contribute to the allocation of water between users.

Empirically, the main contribution of this article is to observe whether the river basin authorities designated to implement integrated water resource management gained power and legitimacy and are able to bring appropriate answers in terms of climate change adaptation. The question of the role of river basin authorities in integrated water resource management is addressed with a case study on the Thau lagoon catchment in France. In 2012, users and managers within the basin were submitted to a specific survey designed to conduct a Social

Network Analysis (SNA) with the data in order to assess the power relationships. SNA is used to visualize and describe social structures and power relations. It identifies the position and reputation of each actor within the network. Specifically, the analysis uses three measures of centrality linked to different forms of power: degree centrality, closeness, and brokerage.

After a presentation of the analytical framework and the method, the Thau catchment will be extensively described in a third part. The result of the SNA will then be presented and discussed.

1 Local authorities in water governance

Institutions are mediating climate change adaptation. Climate change and water are related through water governance arrangements. Water governance has changed with the introduction of integrated water resource management (IWRM) that replaced the former sector-based approach (Gain et al., 2013). Water issues should no longer be addressed separately by sector departments in national governments (e.g. water for transport, water for agriculture, water for industry, and nature protection), but all sector interventions should be coordinated within a common structure. Integrated water resource management relies on planning activities as a support for coordination, i.e. a management plan, including a mapping of water uses and pressure, a monitoring program, common objectives and a list of specific measures. In local governance, the approach was territorial, which means that sector departments had deconcentrated units at lower levels which cooperated with local authorities (in France at the regional or department's level). Integrated water resource management is organized around watersheds or river basins. Management is not anymore territorial, but functional (Varone et al., 2013). It goes across the borders of the political and administrative territories in order to follow the rivers and water streams. With integrated water resource management, a functional and networked governance at the river basin scale has substituted to a former territorial and

89 hierarchical governance. It may also generate more decentralization, but this depends on the
90 institutional arrangement retained in each country (Sevä & Sandström, 2017).

91 The change is not only spatial (for territories to functional spaces), but also scalar and
92 possibly modifies power relationships among the stakeholders. Integrated water resource
93 management has modified the scales at which water is governed (Varone et al., 2013). The
94 institutional arrangement has become multi-level with combined dynamics of upscaling and
95 downscaling. First, the European Union is the level at which broad objectives and procedures
96 are set. Every public authority in Europe is bounded with the requirements of the Water
97 Framework Directive (2000/60/EC) (Voulvoulis, Arpon & Giakoumis, 2017; Moss, 2008).
98 The coordination within international river basins also imposes supra-national institutions that
99 decrease State sovereignty and oblige the Member States to cooperate.

100 Second, downscaling occurs in the implementation phase at the local level. Although the
101 water basin authorities usually remain the national or regional government, the institutional
102 arrangement set up local committees for managing local issues in smaller basins (for example,
103 local water commissions in France, *Commissions locales de l'eau*). Deconcentrated sector
104 administrations must cope with participatory mechanisms which involve the municipalities
105 and the users. They tend to become one stakeholder among others. Thus, water governance
106 operates at multiple levels, but the main steering activities were upscaled at the European
107 level. For example, the implementation of the Water Framework Directive is driven by a
108 committee composed of the national water directors which sets up common guidelines to
109 implement the directive the same way.

110 Moreover, a change in scale means a change in power distribution. The effects of institutional
111 arrangements on the positions of power of water users and managers must be stressed (Thiel,
112 2015). The rescaling of the governance structure of water management is a power-laden
113 process (Faure et al., 2007): *"The emergence of new territorial scales of governance and the*

redefinition of existing scales (like the nation-state) change the regulation and organisation of social, political and economic power relations" (Swyngedouw, 2004: 26; see also Brenner, 1999). Any reconfiguration of the regulatory regime, with upscaling of some regulatory process (e.g. definition of standards for the measurement of water quality or criteria for establishing exceptions to the objective of good quality of water as of 2015 at the European level) and the downscaling of others (for example, set up of the program of measures at the national or regional level and designation of natural areas, land-use planning, design of the sewage network at the local level) have impacts on the relative power position of the stakeholders. Some users benefit from tailored rules or a better access to the decisionmaking arenas, while others lose. The venue and scope of the issues are not power neutral. This is an empirical question worth being investigated. For example, one notable effect of policy forums at local scale is that they enhance collaboration between actors (Hamilton & Lubell, 2018). The nature and variation of the power relations between users become an empirical question.

As this article is approaching power through relational and reputational perspective (see below), we will follow Manuel Castells in his appreciation: "*Power is the relational capacity that enables a social actor to influence asymmetrically the decisions of other social actor(s) in ways that favor the empowered actor's will, interests, and values. Power is exercised by means of coercion (or the possibility of it) and/or by the construction of meaning on the basis of the discourses through which social actors guide their action*" (Castells, 2009: 10). This definition combines two sources of power exercise: coercion, that is close to Weber's understanding of power (Weber, 1978), but also discourse, and more specifically the issue framing conveyed in discourses (Jones & McBeth, 2010; Laws & Rein, 2003). *"Throughout history communication and information have been fundamental sources of power and counter-power, of domination and social change. This is because the fundamental battle being fought in society is the battle over the minds of the people. The way people think*

determines the fate of norms and values on which societies are constructed" (Castells, 2007: 238). This perspective opens the way to approach power empirically through the study of the interactions between stakeholders. The perceived influence of one actor by the community members as well as the position of this actor within the information flow are telling about the distribution of power among a community. This article looks at the fit between the power distribution perceived by the stakeholders within a river basin and the formal institutional arrangement governing water management in the basin. Who are the most powerful public authorities or users? Is it in line with the changes introduced by integrated management or are the former authorities still the most powerful?

Given the development of information flows and exchanges, it is hard to believe that interactions between actors are limited to formal procedures. In fact, there is a discrepancy or gap between formal and actual procedures. Actors are strategic and make the most of the rules in exploiting the grey areas of the law, and the *"areas of uncertainty"* (Crozier & Friedberg, 1977). These discrepancies between the formal institutional arrangement and the actual practice can be grasped with a specific method: Social Network Analysis (SNA). Uncertainties are not limited to climate change impacts, but also extend to power realignments in a context of change (Nightingale, 2017; Bulkeley, 2015).

In sum, the aim of this article is to assess if the river basin authorities introduced as agents of integrated management play a pivotal role in water governance. This role will be measured with SNA, which mobilizes a reputational and positional definition of power. The river basin authorities are considered as influent if they have a strong reputation in terms of problem solving capacity and if they are at the centre of the information flows.

2 A social network analysis to assess the actors' position and power

Social network analysis (SNA) is a quantitative method that formalizes the social structure of a particular network (Knoke, 1990). It allows visualizing the pattern of relationships among a defined set of actors. Grounded in graph theory, SNA uses mathematical procedures to explore actors' relational profile, the properties of the subgroups and the configuration of the whole network structure (Knoke & Yang, 2008; Wasserman & Faust, 1994). The method relies on the assumption that the actors positioned at the centre of the information flows and who have the best reputation are supposed to play a critical role in the decision-making process or the management structure (Knoke, 1990). Various scholars have used this method to assess actors' power and role in organizations (Krackhardt, 1990), in the decision-making process (Ingold & Varone, 2011) or management structure, specifically in the field of natural resource management (Bodin & Crona, 2008).

2.1 Relations and measures

To assess river basin authorities' power, four types of relations are studied: actor importance, impact on decision-making, exchange of information and frequency of contact. Actor importance measures the reputational power of the actor. It corresponds to the total number of actors within the network who point out this actor as the most powerful (Fischer & Sciarini, 2015). Based on the other actors' perception, it gives insight to actors' influence beyond their legal tasks or delegation.

The three other relations, that is impact on decision-making, exchange of information and frequency of contact, measure the positional power or location of the actor. These relations are measured with degree centrality and betweenness centrality (Freeman, 1977), and show who is perceived as the most important actor, who influences whom, where the different

actors get their knowledge from and with whom they stay in regular contact. Degree centrality measures the number of relations an actor has with others (Knoke, 1990). In-degree calculates how many times an actor is mentioned by the others, while out-degree is a self-assessment of the influence one has on every other actor. Betweenness centrality measures the number of times an actor is on the shortest path between two other actors. Actors with high betweenness have the potential to exert control over the others indirectly as they manage information flows. These indicators reveal the role each actor has in the network and her opportunities to influence other actors' behaviour (Knoke, 1990).

2.2 Data

Data collection starts with the delineation of the network boundaries, that is establishing the list of actors who must be included in the study (formal membership) (Rice & Yoshioka-Maxwell, 2015). The actors are not individuals but the organizations which take part in the policy process (Knoke et al., 1996: 7). For example, in the case of Thau, they are the organizations formally involved in the water basin governance.

For this specific case study, preliminary interviews took place in the Thau basin in July and September 2010. The SNA surveys were distributed in French to 26 actors in November 2011 over the 41 listed in the questionnaire (see Annex I). The reason is that some organizations cannot easily be represented regarding the influence on the Thau catchment (for example the European Commission or the Ministry of Health) or cannot appoint a representative given their lack of resources (for example CRPEM). Respondents were asked to indicate with whom they share the four types of relations previously defined. 14 actors fulfilled the questionnaire. The response rate of 54 % (14/26) is low, but this does not impede a reliable analysis as the main managers replied and no major local actor is missing. However, the results must be

considered with caution and do not allow inferential statistics. The use of in-degree calculation was privileged in the analysis because it is one of the most stable measures in relation to missing data (Costenbader & Valente, 2003).The survey results were coded as a matrix in Excel sheet. Information exchange is a dichotomous variable, and frequency of contact a discrete one (Likert scale). As betweenness centrality does not support valued numbers, this last variable was dichotomized for this specific calculation. The threshold was defined so as less than 50% of the relations are frequent contacts. The matrix was then imported into UCINET6 for data analysis and NETDRAW for visualization (Borgatti, 2002; Borgatti et al., 2002).

3 The Thau coastal lagoon and its catchment

This part presents how water is used and managed within the catchment, as well as the expected impacts of climate change.

3.1 Socio-economic activities in the Thau catchment

The Thau catchment is situated on the French Mediterranean coast (Figure 1). It covers 250 km² including a total population of 120,814 inhabitants with a half-concentrated in the city of Sète (about 450 inhabitants/km²). The total population doubles each summer with tourism mainly on the sea coast and around the lagoon. The catchment area's own water springs do not cover the population supply. Water from surges and aquifers has been imported from the department of Hérault for several decades. The main economic activities are vine-growing and shipping (Port of Sète). Chemical plants (fertilizers) are also installed on the lagoon's coast. The second thermal station of France is located in the catchment in the commune of Balaruc-les-Bains.

235 The Thau coastal lagoon covers 75 km² (Figure 1). It has a mean depth of 4 m and receives
236 freshwater from small and intermittent rivers. Except the Vène, the other rivers have no
237 ecological flow. They are difficult to access and do not attract any recreational use.

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239

240 **Figure 1***: Localisation of the Thau coastal lagoon and its catchment in the French Mediterranean Coast*

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242 Shellfish farming represents the main lagoon-based activity. Approximately one fifth of the
243 lagoon's area (1,500 ha) is farmed for shellfish production and occurring in three zones with

244 an annual production of 13,000 tons of oysters (the *Crassostrea gigas*, a Pacific oyster) and
245 2,500 tons of mussels, accounting for 1/10 of the national French production (Pernet et al.,
246 2014; Rey-Valette 2004 in Loubersac et al. 2007).

247 About half of the area's land surface is devoted to croplands. The forests in the Thau basin are
248 Mediterranean *garrigue*, a low, soft-leaved, scrubland plant community. This vegetation is
249 present both in continuous stretches in parts of the northeast quadrant of the basin as well as
250 interspersed with croplands. There are only minimal amounts of grasslands or pasturelands in
251 the area. Some land is neglected as a result from the abandonment of vineyards which is at
252 risk to spread fire.

253 Almost 70% of land devoted to agriculture is used for vineyards which make them the main
254 agricultural activity (40% of the catchment). Their use of fertilizers is limited. Winter wheat,
255 which is bare-fallowed in summer, and other cereals constitute the next largest use of
256 agricultural cropland after vineyards. Large areas of soil surface remain uncovered, even
257 during the growing season, due to the wide spacing of the plants and weeding. Today,
258 agriculture is mostly not irrigated in the Thau watershed, except in the vicinity of the village
259 of Villeveyrac which withdraws water from exploited quarries.

260 Also, shellfish productions are impacted by transfers of contaminants from the catchment
261 (bacteria, pesticides). Nutrients fluxes are contributing to the eutrophication leading,
262 depending on climatic conditions and the state of the sediments to anoxic crisis. The lagoon
263 water temperature has also been an important concern since 5 years as when it exceeds 16°C,
264 a virus which damages oysters is active. Over 29°C, mussels are dying.

265 The diverse and dense activities in the Thau catchment generate rivalries around water uses,
266 most of them related to the water quality of the lagoon (La Jeunesse et al., 2015). Between
267 1975 and 1990 shellfish activity has suffered major loss of production due to anoxic crises in
268 the lagoon in relation to eutrophication. Since 19 years, a virus affecting oysters has also

spread and is not contained yet (Pernet et al., 2014). Urban pressure due to both to the commuters to Montpellier and tourism is impacting water quality too, with increasing the demand for recreational uses (for example recreational boats and the necessity to preserve bathing water quality) which compete with shellfish breeding and professional fishing.

3.2 Impacts of climate change on the Thau water uses

Following the modelling of the impacts of climate change on the Thau hydrological cycle provided by Sellami et al. (2016a; 2016b) for the future period (2041-2070) to the baseline period (1971-2000), the projected magnitudes of change suggest that reference monthly temperature is likely to increase by 1.7 to 3.2°C depending on the season. A reduction of precipitation is also expected to range between -14% to -2%. These new warmer conditions will exacerbate the evapotranspiration process with a potential increase of irrigation needs in agriculture, comprising vineyards.

In general, due to the combined decrease in precipitation and increase temperature it is very likely that the Thau catchment will experience a general tendency toward less availability of freshwater in the future period with respect to the reference period. This will induce a decrease of freshwater input into the lagoon and an increase of the water salinity. Moreover, these results do not consider possible additional impacts of the decrease of runoff on the recharge of the karstic aquifer in both baseline discharge in the Vène River and unassessed volumes of freshwater entering the lagoon via underwater.

The impacts of climate change are major on water governance at the catchment scale. First, drinking water supply will increase and compete with irrigation as both uses rely on water imports from Bas-Rhône Languedoc (BRL). Massive irrigation will increase discharges of nutrients and pollutants through the run-off, notably if the vineyards are treated. Shellfish farming is at risk of disappearing if temperatures increase in the lagoon and could suffer from

discharges of pollutants (while nutrients are rather beneficial). A decrease in quality of the lagoon's water may harm recreational activities, and could tip the fragile balance between tourism and shellfish farming. Thus, local water governance needs to accommodate the multiple uses of the catchment water to guarantee sustainability. This SNA study identifies the managers who are brokering between these heterogeneous users in order to improve the management of climate variability, and organise adaptation to climate change.

3.3 Governance of the water quality in the Thau coastal lagoon

This section presents the stakeholders which are part of the governance of the Thau catchment.

France is a unitary state, but decentralized in regions and departments. Beyond this territorial organization, water governance has encountered a functional partition since 1992 with the Water Law (updated in 2006). The Rhone-Corsica-Mediterranean district is one of the twelve hydrographic districts. A river basin committee (*comité de bassin*) composed of representatives of the local authorities (40%), water users (40%) and state representatives (20%) manages the basin. It sets the water policy guidelines which implement the European and national standards and approves the water district master plan called SDAGE (*Schéma directeur d'aménagement et de gestion des eaux*). SDAGE are drawn up together by the national, regional and departmental authorities and implemented by the water agencies (*Agences de l'eau*), namely the Rhone-Corsica-Mediterranean Water Agency in this case (AE-RMC).

Within the territory of SDAGE, local authorities can elaborate local master plans called SAGE (*Schémas d'aménagement et de gestion des eaux*), a decision that the municipalities took in the Thau catchment. SAGE is a non-binding structure which acts through a local water

commission (*Commission locale de l'eau*, CLE) composed of representatives of the state (25%), local authorities (50%) and users (25%). Among the users, there may be consumer groups, industrials, farmers, and environmental associations.

In addition, a multitude of public managers is involved, mainly due to the administrative division of the territory at different scales from the region to the municipalities. In the Thau catchment, the territorial State management is made through deconcentrated services like DREAL (Regional Direction of Environment, Planning and Housing, *Direction régionale de l'environnement, de l'aménagement et du logement*,) and DDTM (Departmental Direction of the Territories and the Sea, *Direction départementale des territoires et de la mer*). Their activities are coordinated by the *Préfet*, the representative of the French government at the departmental level, through a coordination unit (*Mission inter-services de l'eau de l'Hérault*, MISEH). Both the Region and the Department have also their own elected authority with their own services and are referred as Departmental (*Conseil général*) and Regional Councils (*Conseil régional*).

The Thau catchment encompasses 14 different municipalities, separated into two main intermunicipal planning authorities: CCNBT (*Communauté de communes du nord du bassin de Thau*) and CABT (*Communauté d'agglomération du bassin de Thau*). In January 2005, the two district planning authorities set up a common management structure: SMBT (*Syndicat mixte du bassin de Thau*). Like a water agency at the local scale, SMBT conducts the day-to-day management of the SAGE and implements the decision of CLE, the local water commission. Their competences in water governance and land-use are to: (1) protect environmental resources in balance with the economic activities; (2) manage the population and economic growth; (3) implement the WFD; and (4) clarify the overall allocation of coastal space and resources.

About water supply and sewage, local authorities have also set up public companies or delegated these services to private companies with a limited-term concession. In the Thau catchment, these companies are SDEI, SIAE BL, SIE FB, SIAE FP, and SITEU (see Annex I). A major share of water supply has been routed from the Rhône since 2012 as part of the Aqua Domitia project and treated by BRL, Bas-Rhône-Languedoc, a public company.

A major specificity of the Thau catchment is the important concentration of scientific and technical experts (such as IFREMER and CEPRALMAR). IFREMER is the largest research institute of marine environment in France. It is researching and consulting about the various maritime activities and contribute to their development. IFREMER has a laboratory in Sète and accompanies shellfish farming in the lagoon. Also located in Sète, CEPRALMAR is a research institute on marine environment which was set up by the Regional Council of Languedoc-Roussillon. CEPRALMAR is committed in the integrated management of coastal areas and the development of fisheries (marketing, modernization, diversification, and risk management). The users' organizations are also very active in the Thau basin (*Section régionale de conchyliculture, Prud'homie de pêche Thau-Ingril*, etc.).

4 A shared influence between central and local authorities

The results of the SNA assess the actors' respective importance, influence on decision making, the flow of information between them and the frequency of contacts.

4.1 Actors' importance

In-degree centrality is used to measure the importance of an actor. It is the number of time an actor is mentioned as 'very important' or 'important' by the respondents. Using two

365 importance degrees independently differentiates the actors much better. An actor is
366 considered as very important or important if at least half of the respondents mentioned them.

367 The local water basin authority (SMBT) is the central actor with 12 over 14 respondents who
368 considered them as 'very important' (Table 1). Besides, the local water assembly (CLE) and
369 Rhone-Corsica-Mediterranean Water Agency (AE-RMC) are very important actors too with
370 scores of 10, just before the two intermunicipal planning authorities (CCNBT and CABT).
371 Next, the experts appear (IFREMER) as well as the services of the *Préfet* (MISEH). CRPEM,
372 a fishermen association is the only user group that is assessed as 'very important'. The highest
373 scores are attributed to functional and local authorities.

374 Among (only) 'important' actors, the Departmental Council (Cgal), and the coastal
375 conservatory agency (*Conservatoire du Littoral*) score the highest (9), closely followed by the
376 Regional Council (Crég), and the European Commission (CE). The regional office of the
377 Ministry of Food, Agriculture, and Forestry (DRAAF), also competent for fisheries, the raw
378 water supplier BRL, another fishermen association, PRUD SM, are cited as well. Expert
379 organizations IFREMER and CEPRALMAR are also perceived as 'important', by
380 respondents who didn't classify them in the 'very important' category. Within expert
381 organizations, CEPRALMAR is cited but below the threshold. Only IFREMER is considered
382 as a major player in water governance in the Thau catchment.

383 Overall, the key actor of the SAGE, SMBT, is the most important actor and the other public
384 authorities are perceived as being more 'important' than the users. Fishermen associations are
385 the only user groups which are closely associated to local water governance.

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		Centrality degree 'Very important'		Centrality degree 'Important'	
#	**Actors**	**Outdegree**	**Indegree**	**Outdegree**	**Indegree**
1	CE	0.000	3.000	0.000	*8.000*
2	MEDDTL	0.000	3.000	0.000	6.000
3	IFREMER	20.000	*7.000*	13.000	6.000
4	Littoral	0.000	1.000	0.000	*9.000*
5	MISEH	0.000	*8.000*	0.000	3.000
6	DRAAF	0.000	2.000	0.000	*7.000*
7	DREAL	13.000	6.000	13.000	5.000
8	Crég	0.000	3.000	0.000	*8.000*
9	Cgal	0.000	4.000	0.000	*9.000*
10	EID	0.000	1.000	0.000	5.000
11	CCNBT	21.000	*9.000*	17.000	2.000
12	CABT	10.000	*9.000*	14.000	3.000
13	CAHM	10.000	3.000	19.000	5.000
14	SIAE BL	8.000	6.000	16.000	3.000
15	SIE FB	0.000	5.000	0.000	5.000
16	SIAE FP	0.000	3.000	0.000	5.000
17	SITEU	0.000	4.000	0.000	4.000
18	AE-RMC	5.000	*10.000*	23.000	1.000
19	SMBT	23.000	*12.000*	15.000	1.000
20	CLE	0.000	*10.000*	0.000	3.000
21	Communes	0.000	1.000	0.000	1.000
22	SDEI	14.000	5.000	23.000	4.000
23	CAgriH	0.000	4.000	0.000	6.000
24	CCI	0.000	0.000	0.000	6.000
25	CEPRALMAR	10.000	4.000	7.000	6.000
26	BRL	0.000	3.000	0.000	*7.000*
27	FDC coop	0.000	1.000	0.000	6.000
28	SVH partic	0.000	1.000	0.000	6.000
29	CR Conchy	11.000	6.000	15.000	5.000
30	CRPEM	0.000	*7.000*	0.000	5.000
31	CLPMS	0.000	6.000	0.000	4.000
32	PRUD SM	2.000	4.000	10.000	*7.000*
33	APAPS	0.000	0.000	0.000	4.000
34	SNBT	0.000	0.000	0.000	4.000
35	AIChasse	10.000	0.000	1.000	3.000
36	Thermes	7.000	6.000	10.000	3.000
37	FFESSM	0.000	1.000	0.000	5.000
38	CPIE	0.000	3.000	0.000	5.000
39	SPN Thau	0.000	1.000	0.000	5.000
40	Industries	0.000	1.000	0.000	6.000
41	Ministère de la santé	0.000	1.000	0.000	0.000

389 ***Table 1: 'Very important' and 'important' actors in the Thau lagoon catchment***

390 **Remarks: Outdegree represents the number of actors a respondent considered as very important or important. In-degree**
391 **is the number of actors that considered the respondent as very important or important (in italic, actors who reach the**
392 **50% threshold (14 respondents in total).**

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394 ## *4.2 Impact on decision-making*

395 The identification of influential actors in the network relies on the measurement of the impact
396 on decision-making (in-degree). In-degree represents the number of actors which considers an
397 organization as having an impact on their decisions while out-degree is the number of actors a
398 respondent mentioned as having impact on her decisions.

399 With an in-degree of 10, AE-RMC is perceived as the most influential actor by the other
400 participants, along with CLE, MISEH and the European Commission (CE) (Table 2). They
401 are closely followed by MEDDTL and Cgal (in-degree of 9). With an in-degree of 7, SMBT
402 only appears at the 10th position. Users do not have any influence on the other actors. The
403 impact of the experts on decision-making is fairly high for IFREMER (8), but not for
404 CEPRALMAR (3). IFREMER appears as a 'big player' in the local water governance with an
405 influence score equivalent to those of the competent authorities.

406 These results also demonstrate to which extent the governance of the Thau basin is embedded
407 in multi-level governance. The highest scores are attributed to authorities of both the
408 European, national, subnational, and local levels (Figure 2): The European Commission (CE),
409 the French government (MEDDTL, MISEH, DREAL), the water agency (AE-RMC), the
410 regional and departmental councils (Crég and Cgal), as well as the local water authorities
411 (CLE and SMBT).The limited role of SMBT and the significant influence of the other public
412 authorities are congruent with the legal framework. Formally, SMBT coordinates stakeholder
413 demands, but does not take decisions. At least formally, this role belongs to CLE. SMBT is
414 only the secretariat and implements the decisions of CLE. The high score of CLE validates
415 the power of local water authorities in the Thau lagoon catchment.

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Centrality degree 'I receive influence from'			
#	**Actors**	**Outdegree**	**Indegree**
1	CE	0.000	*10.000*
2	MEDDTL	0.000	*9.000*
3	IFREMER	5.000	*8.000*
4	Littoral	0.000	3.000
5	MISEH	0.000	*10.000*
6	DRAAF	0.000	4.000
7	DREAL	16.000	*8.000*
8	Crég	0.000	*8.000*
9	Cgal	0.000	*9.000*
10	EID	0.000	2.000
11	CCNBT	16.000	5.000
12	CABT	13.000	5.000
13	CAHM	13.000	4.000
14	SIAE BL	4.000	6.000
15	SIE FB	0.000	4.000
16	SIAE FP	0.000	3.000
17	SITEU	0.000	4.000
18	AE-RMC	5.000	*10.000*
19	SMBT	26.000	*7.000*
20	CLE	0.000	*10.000*
21	Communes	0.000	0.000
22	SDEI	21.000	2.000
23	CAgriH	0.000	3.000
24	CCI	0.000	1.000
25	CEPRALMAR	3.000	3.000
26	BRL	0.000	1.000
27	FDC coop	0.000	0.000
28	SVH partic	0.000	1.000
29	CR Conchy	24.000	4.000
30	CRPEM	0.000	4.000
31	CLPMS	0.000	4.000
32	PRUD SM	6.000	3.000
33	APAPS	0.000	2.000
34	SNBT	0.000	0.000
35	AIChasse	9.000	0.000
36	Thermes	5.000	3.000
37	FFESSM	0.000	0.000
38	CPIE	0.000	2.000
39	SPN Thau	0.000	2.000
40	Industries	0.000	2.000
41	Ministère de la santé	0.000	0.000

Table 2: 'I receive influence from'

Remarks: Outdegree represents the number of actors a respondent considered as having influence on his/her decision. In-degree is the number of respondents that considered the actoras having influence on their decisions (in italic, actors who reach the 50% threshold (14 respondents in total).

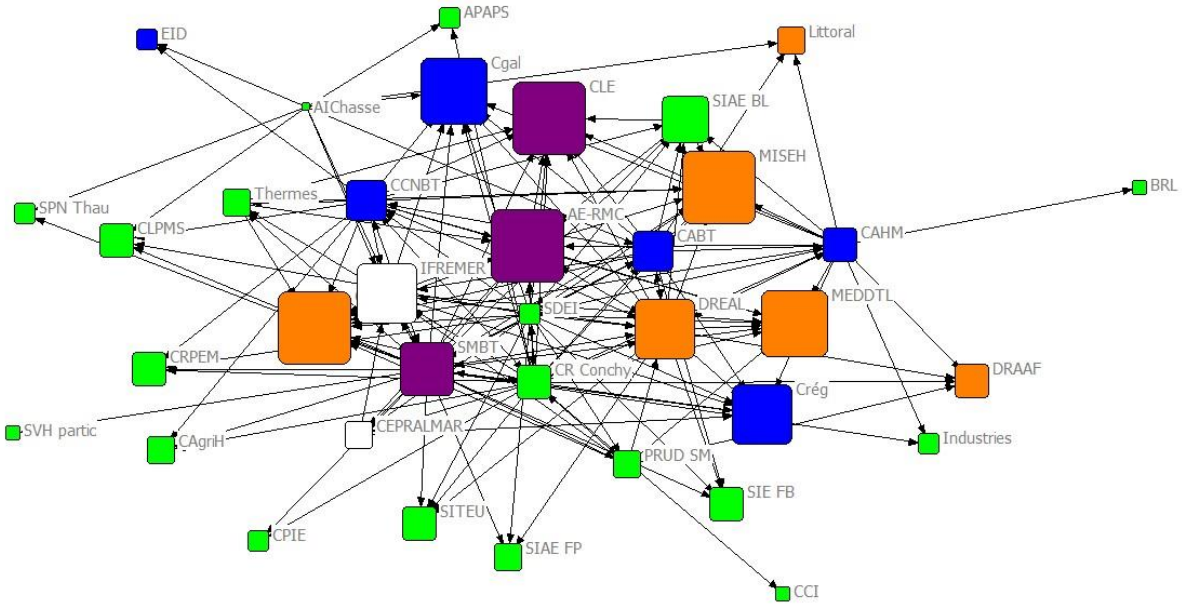

Figure 2: Representation of influential actors in the Thau basin ('I receive influence from') (Users are in green, experts in white, governments in orange, water agencies in purple and local authorities in blue).

4.3 Information flows

SNA enables to state which actors potentially control the information flow. Two networks are scrutinized here: The network of who receives information from whom ('I receive information from') and the network of who sends information to whom ('I send information to'). In the information reception network ('I receive information from'), the in-degree of an organization is the number of actors that have received information from this organization while the out-degree is the number of actors from whom the organization has received information. In the information sending network ('I send information to'), the in-degree of an organization is the number of actors that send information to it while its out-degree is the number of actors to whom the organization had sent information. With both networks,

interpretations are based on the in-degree as this indicator is less sensitive to nonresponse and respondent bias (Costenbader & Valente, 2003).

In the information reception network, SMBT, DREAL and IFREMER share the highest score with an in-degree of 10, which means that 10 actors declared that they "received information from" them (Table 3). In other words, these organizations are reported by most respondents as information suppliers. They are followed the Regional and Departmental Councils, the intermunicipal association CCNBT and the ministry of the Environment. The expert organization CEPRALMAR also scores 8 and appears among the most important information suppliers. Only very few actors received information from users.

The results of the information sending network differ substantively. Once again, SMBT is the actor who collects the most information (in-degree of 11). SMBT is followed by CLE (9), and below AE-RMC, MISEH, DREAL, and Crég (in-degree of 8). Subnational authorities are very much involved in information flows. CEPRALMAR scores above average (7) and plays a different function as IFREMER among the expert group. Environmentalists and fishermen (CPIE and CRPEM) are the first users cited with an in-degree of 5, meaning once again that few actors send information to users.

The high score of SMBT in both the receiving and sending networks is not surprising: being the coordinator of local water management, their role is to share information with the others. The results show that SMBT fulfils their role. The fact that DREAL and MISEH score high in both networks strengthens the idea that the French Government is still present in local governance through decentralized administrative units. The users' position within the flow of information is far less strategic. They are not considered as informants and only few actors send information to them.

Experts have a prominent role in information flows. IFREMER has the highest score in the receiving network and CEPRALMAR a fair score in the sending network. Although the

analysis reveals that both expert organizations are much committed in information flows, they have different informational practices. IFREMER is informing the network while CEPRALMAR tends to centralize information as they gather information from users. These respective positions are equally observed in the frequency of contacts.

		Centrality degree_ receive information from		**Centrality degree_ send information to**	
#	**Actors**	**Outdegree**	**Indegree**	**Outdegree**	**Indegree**
1	CE	0.000	6.000	0.000	2.000
2	MEDDTL	0.000	*8.000*	0.000	4.000
3	IFREMER	8.000	*10.000*	17.000	6.000
4	Littoral	0.000	4.000	0.000	2.000
5	MISEH	0.000	*7.000*	0.000	*8.000*
6	DRAAF	0.000	5.000	0.000	2.000
7	DREAL	0.000	*10.000*	5.000	*8.000*
8	Crég	0.000	*9.000*	0.000	*8.000*
9	Cgal	0.000	*9.000*	0.000	*7.000*
10	EID	0.000	2.000	0.000	2.000
11	CCNBT	17.000	*8.000*	1.000	*7.000*
12	CABT	15.000	6.000	5.000	*7.000*
13	CAHM	20.000	6.000	10.000	6.000
14	SIAE BL	9.000	4.000	8.000	0.000
15	SIE FB	0.000	2.000	0.000	1.000
16	SIAE FP	0.000	2.000	0.000	1.000
17	SITEU	0.000	2.000	0.000	1.000
18	AE-RMC	12.000	*7.000*	11.000	*8.000*
19	SMBT	20.000	*10.000*	20.000	*11.000*
20	CLE	0.000	*7.000*	0.000	*9.000*
21	Communes	0.000	0.000	0.000	0.000
22	SDEI	10.000	6.000	10.000	1.000
23	CAgriH	0.000	3.000	0.000	3.000
24	CCI	0.000	1.000	0.000	1.000
25	CEPRALMAR	6.000	*8.000*	13.000	*7.000*
26	BRL	0.000	3.000	0.000	1.000
27	FDC coop	0.000	0.000	0.000	0.000
28	SVH partic	0.000	0.000	0.000	0.000
29	CR Conchy	21.000	3.000	21.000	4.000
30	CRPEM	0.000	1.000	0.000	5.000
31	CLPMS	0.000	0.000	0.000	4.000
32	PRUD SM	16.000	3.000	15.000	4.000
33	APAPS	0.000	0.000	0.000	0.000
34	SNBT	0.000	1.000	0.000	0.000

35	AIChasse	5.000	0.000	0.000	0.000
36	Thermes	2.000	3.000	3.000	2.000
37	FFESSM	0.000	0.000	0.000	1.000
38	CPIE	0.000	4.000	0.000	5.000
39	SPN Thau	0.000	1.000	0.000	1.000
40	Industries	0.000	0.000	0.000	0.000
41	Ministère de la santé	0.000	0.000	0.000	0.000

Table 3: Centrality degrees: 'I receive information from' and 'I send information to' in the Thau basin

Remarks: Outdegree represents the number of actors a respondent received information from or send information to. In-degree is the number of actors that consider they received information from the respondent or that have send information to (in italic, actors who reach the 50% threshold (14 respondents in total).

4.4 Frequency of contacts

The frequency of contacts refers to the exchanges, conversations, meetings that actors have together. This article does not consider bilateral contacts, but looks at the brokerage roles that specific actors have within the network. Betweenness centrality measures the number of times that an actor is the intermediary between two actors who do not frequently interact with each other. Because there are several geodesic paths to reach one actor, the numbers are higher than the total number of actors (Table 4). For the analysis, the data has been dichotomized. Actors seeing themselves at least monthly are considered as actors with frequent contacts.

SMBT is the best performing actor with a score of 150.550. The organization plays the broker 150 times between two other actors. This confirms the coordinating role of SMBT. Most of the actors do not frequently interact between themselves but pass through SMBT. AE-RMC and CEPRALMAR are brokers as well, which is not the case of IFREMER. Compared with the two networks related to information exchange, AE-RMC is informing actors who do not mutually interact while CEPRALMAR centralizes information from actors who do not interact with each other. The results indicate that two users have a brokerage role as well, the shellfish farmer association CR Conchy and the drinking water suppliers SDEI. However their position should not be overestimated because all their contacts are also in contact with the two

main brokers, SMBT and AE-RMC (the exception being SDEI which establishes the connection with a peripheral user, SITEU).

In Figure 3, blue ties are reciprocated, which means that actors mutually agree as having a contact at least each month. The low figures are normal given the limited number of respondents. The actor size shows their degree of betweenness. SMBT is represented by the biggest square as it is the one which relates all the others. The water agency (AE-RMC) is also an important broker, but not CLE which is represented with a little blue square at the lower left of SMBT. Once again, users are peripheral to the network. They only reach the centre of the network through the intermediation of another actor, for example the expert organization CEPRALMAR. CEPRALMAR centralizes information from users and transfers them to the water managers, mainly SMBT and AE-RMC.

Freeman Betweenness centrality_contacts		
#	**Actors**	**Betweenness**
19	SMBT	150.550
18	AE-RMC	51.883
22	SDEI	42.333
29	CR Conchy	42.133
25	CEPRALMAR	38.833
13	CAHM	13.400
12	CABT	12.150
14	SIAE BL	11.000
7	DREAL	2.383
11	CCNBT	2.000
3	IFREMER	1.000
32	PRUD SM	0.333
	All other network members	0.000

Table 4: Frequency of contacts (betweenness centrality) in the Thau basin

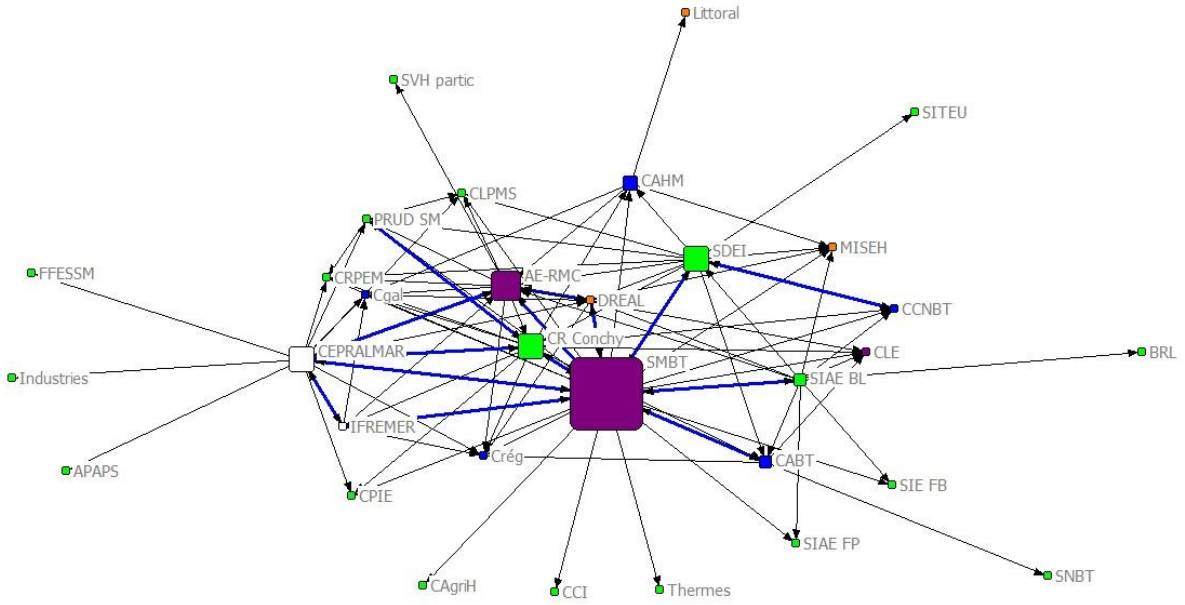

Figure 3: Representation of the betweeness centrality in the Thau basin (Frequency of contacts)

Remarks: Size depends on betweenness centrality. Ties in blue are reciprocal : the two actors mutually agree as having a contacts at least each month.

5 Discussion

The aim of this article is to question the central role of local basin authorities in water governance and in the context of climate changes, namely SMBT in the case of Thau which is the designer and facilitator of the local water management plan (SAGE). After a shift to integrated water resource management, did the downscaling of water governance to the local level empower SMBT (Faure et al., 2007)? The social network analysis (SNA) assessed the position and roles of specific actors within the existing network and whether or not this governance model is supportive for adaptation strategies to climate change.

Among the community of water users and managers of the Thau lagoon basin, SMBT is perceived as the most important actor (in-degree of 10 as 'very important'). However, the answers to the other questions challenge this leading position. In the actors' perception, this importance does not necessarily mean influence. SMBT only reaches the 10th position of

519 influence (in-degree of 7). Their importance relates more on the coordination and facilitation
520 role they play in the catchment. However, CLE, the assembly of local managers and users
521 scores high (in-degree of 10, and also a 'very important' actor). CLE is the board of the
522 SAGE while SMBT prepares and implements the decisions. Taken together, the power of the
523 functional local managers is strong. In the analysis of information flows, SMBT scores the
524 highest once again. Their leadership position is uncontested in terms of frequency of contacts.
525 In fact, SMBT has by far the highest betweenness centrality (150.550). This means that
526 SMBT is the broker between the different actors in the local arrangement. In conclusion,
527 SMBT has succeeded within a few years to become a central actor in local water governance
528 (it was established in 2005). Although, they are not exerting a direct influence on the other
529 actors, they play the broker in information flows between the actors. As such, they have a
530 great potential for framing issues and a potential influence on the way people think inside the
531 catchment area (Castells, 2007; Laws & Rein, 2003). SMBT and CLE are key brokers in
532 solving local disputes between users (Aubin & Varone, 2013).

533 Moreover, since years, SMBT used to invest in scientific studies to understand the
534 hydrological functioning of the Thau catchment and lagoon. This role has permitted to solve
535 water rivalries and even conflicts due to water quality issues (Mongruel et al., 2013; La
536 Jeunesse & Quevauviller, 2016). In fact, SMBT always welcomed research results, in
537 particular the projections of climate change impacts on the Thau catchment, as a support for
538 decision-making. They were key in developing the adaptation strategy that consists in
539 importing water from the Rhône River. However, if it has solved water quantity issues, this
540 strategy nowadays increases the vulnerability to water contaminations and will make it very
541 difficult to preserve all water uses at the horizon of 2040-2070. SMBT has always been
542 informed of the last research outputs on its territory and was aware about the risks for the
543 Thau water quality represented by the supply of water from the Rhône in the catchment.

However, while Bas Rhône Languedoc used to justify the arrival of water to face climate change, SMBT did not argue for another solution and even mentioned that this water could be useful for wetlands in case of extreme droughts.

In fact, despite their brokerage role, SMBT is not perceived as the most influential actor in the basin and shares power with other managers. Actually, the most influential actors are located at multiple scales. Locally, CLE is perceived as powerful, but this influence is shared with both functional and territorial authorities of upper levels: the water agency AE-RMC, the French government through the *Préfet* and decentralised offices (MISEH), and the European Commission as the law maker. These results demonstrate the multilevel dimension of integrated water resource management and how local users are able to identify the multiple levels of authority which govern their behaviour. As functional and participatory authorities, both CLE and AE-RMC gained power and legitimacy in multilevel setting (Varone et al. 2013).

The more classical territorial authorities remain influential too. Although not considered as 'very important', the French Government through the Ministry of the Environment (MEDDTL) and the decentralised administrations (DREAL and MISEH) is part of the influential actors. They are also involved in information flows, both as senders (MEDDTL, DREAL and MISEH) and receivers (DREAL and MISEH). However, central authorities are not in direct contact with users, except the drinking water suppliers (for example SDEI and SIAE-BL). This reinforces the brokerage position of SMBT between the users and territorial authorities.

Finally, the sub-national governments are involved too (Departmental and Regional Councils). Their role is secondary, but nonetheless perceived as influential actors as well as information brokers. Their role is not straightforward, as they don't have a specific function in the national architecture of water governance, but they own a set of related competences in

569 the environment, transport, and land-use planning. They also run hydraulic installations (for
570 example BRL). The presence of the two inter-municipal planning authorities (CCNBT and
571 CABT), the initiators of SMBT, means that the municipal officials keep a say in water
572 governance. Territorial authorities of multiple levels are still powerful, but they have learnt to
573 share their power with functional authorities. They still participate to the decision making
574 process, for example the elaboration of SDAGE and SAGE, but delegated the day-to-day
575 management.

576 Experts are involved in water governance in the Thau basin, but play a different role. Both
577 IFREMER and CEPRALMAR intervene in the decision-making process, even if only
578 IFREMER is perceived as an influential actor. IFREMER has a very important role as
579 information supplier. Their role consists of sending information to the actors, both users and
580 managers. If CEPRALMAR also provides information, their role is somewhat different.
581 CEPRALMAR collects information, notably from the users, and play an important brokerage
582 role between users and managers. In sum, experts fully take part to the local water governance
583 and contribute much to the information flows.

584 In general, users do not appear as powerful stakeholders in the SNA, to some exceptions.
585 Only the raw water supplier BRL and the fishermen associations PRUD SM and CRPEM are
586 pointed as (very) 'important' actors, but they are peripheral in the information flows and not
587 influential. Only the water suppliers (SDEI, and SIAE BL) and the shellfish farmer
588 association (CR Conchy) are in a brokerage position. Their influence is mostly mediated by
589 the local water managers, SMBT and CLE, where they are represented. Even if participation
590 has increased, integrated management did not empower users so far.

591 Formal rules and organization give a clear picture of the distribution of competence, but the
592 relative weight of each stakeholder could only be assessed with SNA. The territorial
593 authorities keep a power position, but they are overtaken by the functional water basin

authorities at two different scales: AE-RMC at the Rhône basin scale and SMBT/CLE for the Thau lagoon catchment. Both of them are not equally influential, but both located at the centre of the information flows and in a brokerage position between the users and managers. A share of power has shifted from the territorial to the functional managers, and the local managers are now part of the institutional arrangement. Users are consulted in the water commissions (CLE, and *Comité de bassin Rhône-Méditerranée*), but they are not key in the decision-making process. Another consequence of integrated water resource management is that the governance mode by territorial authorities shifted from hierarchical to more network-based and consensual, for example with MISEH which coordinates the national ministries at the departmental level and CLE which pushes the mayors to keep dialogue with local stakeholders (Bouckaert, Peters & Verhoest, 2010).

Although this paper demonstrates the relative importance of functional managers in the management of Thau lagoon catchment, limitations stems from the low response rate as social network analysis is rather sensitive to missing data (Huisman, 2009). This study addresses the problem by using in-degree centrality, a relatively robust indicator of network position in the context of low response rate (Costenbader & Valente, 2003). If the absolute in-degree of the actors are *de facto* underestimated, not exceeding the number of respondents, the relative position of the actors is likely to be close to the real situation, especially because non-respondent are often the less connected actors. It is therefore possible to identify the most important actors. In contrast, the result of the betweenness analysis must be carefully considered because of its relative instability to non-response (Costenbader & Valente, 2003). Non-respondent betweenness degrees are likely to be underestimated, and some actors are probably missing from the analysis. Still, it is possible to conclude that functional authorities act as brokers.

In the near future, the role of SMBT as problem-solver in the Thau catchment is going to increase. The projections of the influence of climate change on water in the Mediterranean regions at the horizon 2041-2070 put shellfish farming at risk. Above 16°C the oyster virus is awakened and above 29°C mussels are killed by the warm water. Moreover, the increase of hydrometeorological extreme events will provoke more erosion with the transport of contaminants into the lagoon and the inflow of more concentrated contaminants during low flow levels. While the governance challenges are many (see section 3.2), SMBT is now the only central actor to be capable to diffuse information on climate change threats. A few years ago, the Regional Council has cut the funds of the Lagoon Monitoring Network (LMN, 2013; La Jeunesse & Quevauviller, 2016) which was gathering data of water quality in all the French Mediterranean lagoons. This is a pity as the Thau lagoon needs a constant monitoring and would require a specific tool to integrate climate change characteristics in its integrated water management. Unfortunately, as this study shows, SMBT is probably in an uneasy position to promote radical changes in water uses. While recommendations would be to adapt to water scarcity, the existing "inexhaustible" water resource represented by the Rhône River allows an unlimited economic development, but also generates new associated vulnerabilities. Thus, the role of SMBT will be more to address and manage water rivalries and allow water to all water uses that to really promote ambitious adaptation strategies to face long term threats.

Conclusion

The Social Network Analysis of the Thau catchment has shown that integrated water resource management has caused a shift in power from the national authorities to more functional and local authorities. The Thau users and managers perceive the French water agencies like AE-RMC as one of the most important and influent actors in local water governance. The

agencies have been seconded by more local, but still functional agencies (SMBT). Despite the fact that the direct power of SMBT is limited, their position in the middle of the networks of information flows and contacts make them able to orientate the issue framing, and the set up an evolution of norms and values in the catchment. SMBT is also a broker between the different categories of users and is expected to play a major role in the resolution of future local disputes, even if their competences limit their capacity to promotion radical changes in water use.

These results confirm that the success of integrated water resource management relies on a combination of bottom-up and top-down approaches. This "bottom-up meets top-down" approach is particularly accurate to select adaptation measures at river basin scale (Girard et al. 2015: 132). A full downscaling of water management as a response to the legal duty of stimulating public participation would lead to suboptimal outcomes: *"[B]ottom-up governance and decentralization are not a straightforward solution to water management problems. There will probably always be the need for a certain degree of top-down governance (or centralization), where a central authority has the responsibility and resources for issues like facilitation of participatory processes, setting of standards, capacity building, conflict resolution, and cooperation across boundaries*" (Huntjens et al., 2010: 276). This balanced approach is closed to polycentric systems (Heikkila et al., 2018), which appear to result in better environmental outcomes (Newig & Fritsch, 2009).

The polycentric governance system observed in the case of Thau is not the simple result of the implementation of the WFD, but it is anchored in a local history of repeated crises, notably around shellfish farming and pollution (La Jeunesse & Elliott, 2004), and the long-lasting commitment of local authorities, which are the founders of SMBT and CLE. "*The supranational WFD did not play a role in the transfer and, therefore, only played a minor role in the way the coordination function of water governance is organized there*" (Thiel,

2014: 303). Domestic politics and the local context still shape the governance arrangements in an incremental way: "*In each case institutional arrangements have been created and modified by people over time in response to changed awareness and understanding of problems, changes in the set of tools available for addressing them, and changing public attitudes and preferences*" (Schlager & Blomquist, 2008: 187). The WFD was a trigger to this delegation of authority to lower administrative levels, but the resulting arrangements are contingent (Sevä & Sandström, 2017: 75; Kastens & Newig 2007; Franzén et al., 2015). There is no way in replacing current institutions to reach an adaptive and integrated water resource management, but one should cope with the existing institutional arrangement and learn how to encourage and support deliberative initiatives (Mees et al., 2017: 71). The issue at stake is to be able to enhance flexibility and adaptability of integrated arrangements which is required for climate change adaptation (Gain et al., 2013: 11).

Integrated water resource management has modified the traditional hierarchical public management of water in introducing a more local and network-based governance model. Even if integrated water resource management did not grant power to the users, this local governance will be an essential component for the resolution of the acute problems that climate change will provoke in the Mediterranean regions.

Acknowledgements

Data collection was financed by the project "Climate Induced Changes on the Hydrology of Mediterranean Basins" (CLIMB) under the 7th EU Framework Program (2010-2014, grant n°244.151).

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838 ANNEX I: List of stakeholders in the Thau catchment

CE	Commission européenne	***CAgriH***	Chambre d'agriculture de l'Hérault
MEDDTL	Ministère de l'écologie	**IFREMER***	IFREMER
AE-RMC*	Agence de l'eau Rhône-Méditerranée-Corse	**SDEI***	Société de distribution d'eau intercommunale
DREAL*	Direction rég. de l'environnement, de l'aménagement et du logement du Languedoc-Roussillon	**CR Conchy***	Comité régional conchylicole de Méditerranée
Littoral	Conservatoire du Littoral	**Thermes***	Thermes de Balaruc les Bains
MISEH	Mission inter-services de l'eau de l'Hérault	***CCI***	Chambre du commerce et d'industrie Sète-Frontignan-Mèze
DRAAF	Direction régionale de l'alimentation, de l'agriculture et de la forêt du Languedoc-Roussillon	**CEPRALMAR***	Centre d'étude pour la promotion des activités lagunaires et maritimes
Cgal	Conseil départemental de l'Hérault	***CLE***	Commission locale de l'eau
Crég	Conseil régional du Languedoc-Roussillon	***CLPMS***	Comité local des pêches maritimes et des élevages marins de Sète
SMBT*	Syndicat mixte du bassin de Thau	**PRUD SM***	Prud'homie des pêches Sète-Môle
EID	Entente interdépartementale pour la démoustication du littoral Méditerranéen	***SPN Thau***	Société de protection de la nature Languedoc-Roussillon Section du bassin de Thau
CCNBT*	Communauté de communes du Nord du Bassin de Thau	***FDC coop***	Fédération départementales des caves coopératives
CABT*	Communauté d'agglomérations du Bassin de Thau	***SVH partic***	Syndicat des vignerons de l'Hérault vinifiant en caves particulières
CAHM*	Communauté d'agglomérations Hérault Méditerranée	CRPEM	Comité régional des pêches en Méditerranée (CRPEM LR)

SIAE BL*	Syndicat intercommunal d'adduction d'eau des communes du Bas Languedoc	**AIChasse***	Association intercommunale de chasse de l'Etang de Thau
SIE FB	Syndicat intercommunal des eaux de Frontignan Balaruc	***APAPS***	Association des pêcheurs amateurs et plaisanciers de Sète
SIAE FP	Syndicat intercommunal d'adduction d'eau de Florensac Pomérols (SIAE Frontignan)	CPIE	Comité permanent d'initiatives pour l'environnement du bassin de Thau
SITEU	Syndicat intercommunal de traitement des eaux usées de Pinet-Pomerols	***FFESSM***	Fédération française d'études et de sports sous-marins Comité de l'Hérault
BRL	Bas-Rhône- Languedoc	SNBT	Société nautique du Bassin de Thau
Industries	Industries	Communes	Communes
Ministère de la Santé	Ministère de la Santé		

839 Bold: questionnaire submitted (not answered in italic)

840 Bold + *: questionnaire filled in

841