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Évaluation des services écosystémiques fournis par les complexes lagunaires dans un processus de restauration écologique

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ABSTRACT

In the context of conservation, management, ecological restoration and others, ecosystem services (ESs) valuation and ranking, when meaningfully possible, allow to better frame our relationship with nature. The general objective of the thesis is to identify the demand in terms of ESs in order to achieve coherent, integrated and accepted public decisions. It is made of three case studies. The first case study identifies levels of consensus and divergence among stakeholders on the prioritization of ecosystem services provided by two French Mediterranean coastal lagoons areas. The second one investigates the impact of familiarity and academic information supply on citizens' preferences for ESs issued by the Palavas lagoons complex. Finally, the third case study explores elicitation and aggregation methods of individual preferences for the Palavas lagoons complex. The thesis mobilizes the ordinal preference and behavioral economics theoretical frameworks. Data were analyzed using descriptive statistics, Q methodology and a multinomial logit model. The results show the usefulness of the concept of ESs and its valuation using non-monetary methods. Indeed, monetary approaches do not take into account the heterogeneity of preferences because they flatten the various values of nature by projecting them on the single monetary dimension, an approach which is often rejected by stakeholders. Also, depending on the non-monetary valuation and ranking of ESs, stakeholder types, academic information supply and familiarity with the ecosystems, the results show that preferences vary especially for provisioning and cultural services. On the other hand, there is a relatively high consensus of high interest for regulation and maintenance services. I recommend that public policies should use more the concept of ESs in the decision-making process. ESs translate the complexity of the environment into a series of functions in a common language understandable to all stakeholders in decision-making processes. Another recommendation is to take into account the diversity of stakeholders' preferences for ESs. Indeed, such an integrative practice can prevent or contribute to reduce conflicts among stakeholder groups.

Keywords: ecosystem services, non-monetary preferences elicitation and aggregation methods, decision making, coastal lagoons.

RÉSUMÉ

Dans un contexte de conservation, de gestion ou de restauration écologique des écosystèmes, l'évaluation des services écosystémiques (SEs) permet de mieux encadrer notre relation à la nature. L'objectif principal de la thèse est d'identifier la demande en termes de SEs afin de contribuer à des décisions publiques cohérentes, intégrées et acceptées. Elle comporte trois études de cas. La première identifie les niveaux de consensus et de divergence, entre les parties prenantes, sur la priorisation des SEs fournis par deux sites lagunaires méditerranéens situés au Sud de la France (le complexe lagunaire palavasien et le site de Biguglia). La seconde analyse l'impact de l'information académique et de la familiarité sur les préférences des résidents locaux et non-locaux pour les SEs fournis par le complexe lagunaire palavasien. Enfin, la troisième étude de cas explore les méthodes non monétaires d'évaluation des préférences avec une application au contexte du site lagunaire palavasien. La thèse mobilise les cadres théoriques des préférences ordinales et de l'économie comportementale. Les données ont été analysées à l'aide de statistiques descriptives, de la méthodologie Q et d'un modèle logit multinomial. Les résultats montrent l'utilité du concept des SEs et de son évaluation à l'aide de méthodes non monétaires. En effet, les approches monétaires ne montrent pas la diversité des préférences car elles les réduisent à leur seule dimension monétaire. Elles sont ainsi souvent rejetées par les parties prenantes. Aussi, les résultats montrent qu'en fonction de la méthode d'évaluation des SEs, de la typologie des parties prenantes, de l'apport de l'information académique et de la familiarité avec les écosystèmes, les préférences varient pour les services d'approvisionnement et culturels. D'autre part, il ressort un fort consensus relatif à l'intérêt pour les services de régulation et de maintenance. Les politiques publiques devraient davantage utiliser le concept des SEs dans les processus de prise de décision relatifs aux problèmes environnementaux. Les SEs traduisent la complexité d'un écosystème en une série de fonctions, dans un langage commun et compréhensible par toutes les parties prenantes. Une autre recommandation consiste à prendre en compte la diversité des méthodes d'agrégation des préférences pour les SEs. En effet, la comparaison des pratiques intégratives, notamment l'apport des méthodes délibératives permettrait d'anticiper ou contribuer à réduire les conflits entre différents groupes de parties prenantes.

Mots-clés : services écosystémiques, évaluation non monétaires des services écosystémiques, aide à la décision, lagunes côtières.

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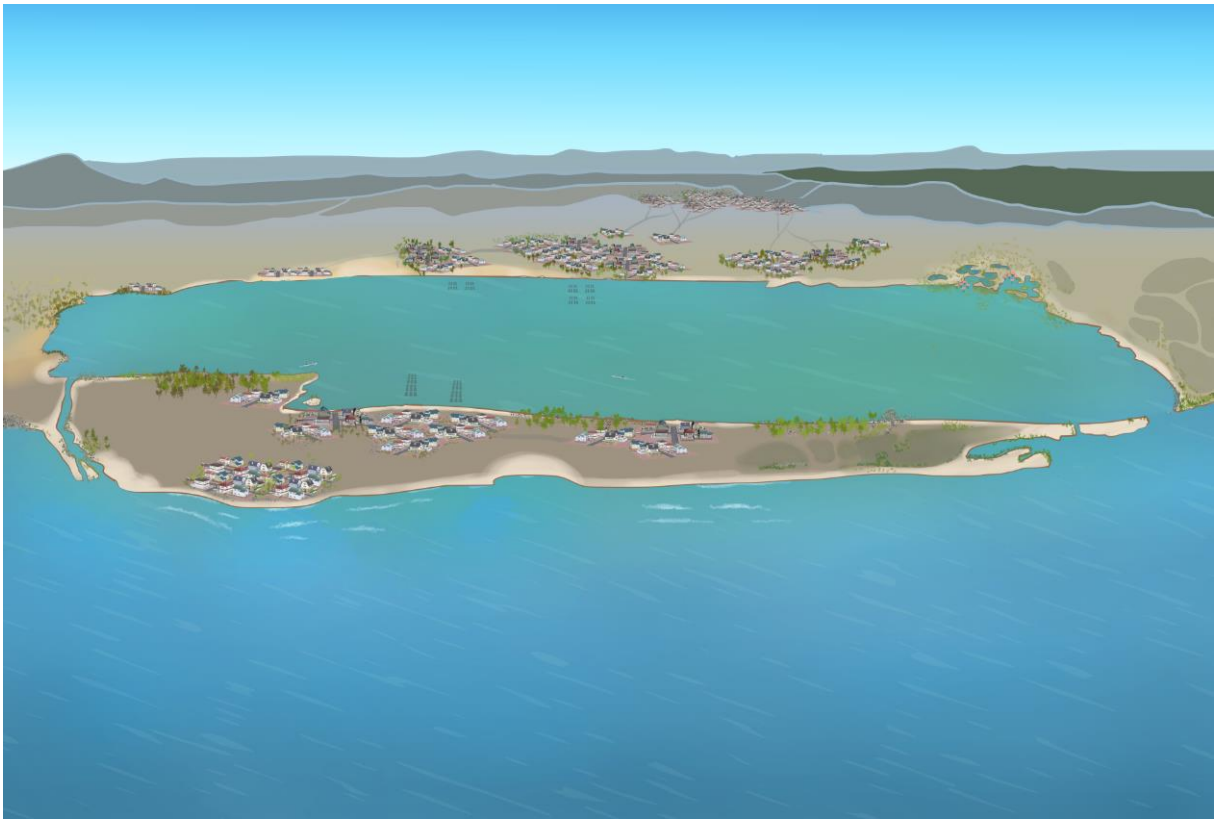
Table des matières

Chapitre 1 : Introduction



Dessin d'une lagune côtière / © Courboulès Justine

1 Zoom sur le concept des services écosystémiques

1.1 Origine et évolution

Le terme «services écosystémiques» est apparu pour la première fois dans Ehrlich et Ehrlich (1981) et plus systématiquement dans Ehrlich et Mooney (1983) (Costanza et al., 2017) mais a pris de l'ampleur dans la littérature scientifique dans les années 1990 (De Groot et al., 2010).

Même si l'émergence du concept des services écosystémiques (SEs) est relativement récente, le lien entre l'environnement, les ressources naturelles et les activités humaines avait déjà été observé depuis l'antiquité. Certains auteurs remontent au 18ème siècle avec les réflexions du Marquis de Condorcet sur le lien entre les activités économiques, le commerce du blé notamment, et la qualité de l'environnement (Sandmo, 2015). D'autres vont encore plus loin, entre le 16 et 17ème siècle, où la terre était considérée comme la première source de richesse (Gómez-Baggethun et al., 2010) et jusqu'à 400 ans av. J.-C. avec le lien établi par Platon, entre la déforestation de l'Attica et l'érosion du sol ainsi que l'assèchement de l'eau des sources (Mooney et Ehrlich, 1997).

La prise en compte de l'environnement et des ressources naturelles dans l'histoire de la pensée économique a été marquée par les réflexions issues de plusieurs courants de pensées. Pour les Physiocrates au milieu du 18ème siècle, le rôle de l'environnement était limité à la protection de la terre, facteur de production essentiel pour l'économie (Hamaide et al., 2012). Par la suite, les économistes de l'école classique comme Malthus (1766 - 1834) et Ricardo (1722 - 1823) avaient une vision plutôt pessimiste par rapport aux limites environnementales relatives à la bonne qualité des terres agricoles et donc aux rendements décroissants issus de la production agricole (Halkos, 2011). Malthus (1803) a par exemple formulé une théorie de la population et de l'environnement en mettant l'accent sur le fait que la croissance démographique dépassera la capacité de ce dernier (à travers la production agricole) à fournir de la nourriture et qu'un manque de ressources suffisantes entraînera une diminution de la population (VanWey et al., 2005). Par ailleurs, qu'il s'agisse d'A. Smith (1723 - 1790) ou de Karl Marx (1818 - 1883), la plupart des travaux issus de cette époque étaient surtout axés sur les déterminants de la création de la richesse en montrant l'apport du travail et du capital manufacturé à celle-ci (Méral, 2016). Par contre J. S. Mill (1806 – 1873) avait une vision relativement plus optimiste comparé

aux autres dans le sens où, selon lui, le progrès technique et la connaissance pourraient être des facteurs pouvant retarder les contraintes liées à la rareté des ressources (Halkos, 2011).

Dans la pensée néoclassique, avec l'apport des économistes marginalistes tels que Léon Walras, Carl Menger, Stanley Jevons, l'économie devient une discipline dont le programme de recherche se concentre sur les conditions de détermination des prix sur les marchés, basées sur une conception dite subjective de la valeur (Méral, 2016). C'est à partir de la seconde moitié du 20ème siècle que l'économie de l'environnement a étendu le cadre orthodoxe conceptuel de l'économie néoclassique, notamment à partir de la notion d'externalité (introduite préalablement par Pigou en 1920) pour traduire les impacts des activités économiques sur l'environnement (Froger et al., 2012). Suivant la logique de Pigou et de nombreux économistes de l'environnement, la biodiversité n'est pas suffisamment protégée car sa valeur n'est pas incluse dans les signaux du marché qui guident les décisions économiques des producteurs et des consommateurs et donc dans le fonctionnement général du système économique (Costanza et al., 1997b). En effet, pendant que certaines ressources naturelles sont échangées sur le marché à des prix largement sous-évalués, d'autres sont souvent considérés comme gratuites et donc surexploitées car ne disposant pas de prix (Bontems et Rotillon, 2007).

L'émergence du concept des SEs, spécifiquement en économie, renvoie précisément à cette prise de conscience de la surexploitation des ressources naturelles et de la nécessité de raisonner de manière globale (Méral, 2012). Il s'en suit l'institutionnalisation de la discipline « Economie écologique » avec la création de la Société internationale d'économie écologique en 1988 (première conférence en 1990) et de la revue Ecological Economics (premier numéro en 1989) (Røpke, 2004). La problématique était de réintégrer les nombreux fils académiques nécessaires pour mieux appréhender la durabilité (Costanza et al., 1997b). Ainsi la logique derrière l'utilisation du concept des SEs consiste principalement à démontrer dans quelle mesure la disparition de la biodiversité affecte directement les fonctions écosystémiques qui sous-tendent les SEs essentiels au bien-être humain (Braat et De Groot, 2012).

La médiatisation du concept des SEs a débuté avec la publication, dans la revue Nature, de l'évaluation monétaire de l'ensemble des écosystèmes par Robert Costanza et ses collègues (Méral, 2012). Il y a eu, depuis, une utilisation croissante du concept dans la

littérature scientifique (voir Figure 1) ainsi que dans les arènes politiques avec notamment le lancement de l'évaluation des écosystèmes pour le millénaire en 2001 qui se terminera en 2005 (Gómez-Baggethun et al., 2010; Méral, 2012). D'autres initiatives internationales ont été mises en place à savoir notamment l'Économie des écosystèmes et de la biodiversité (TEEB) en 2010 et la Plateforme intergouvernementale sur la biodiversité et les services écosystémiques (IPBES) en 2012. A ces travaux s'ajoutent d'autres pistes de recherche favorisant également des approches pluridisciplinaires et axées sur la notion de la pluralité de la valeur (Dendoncker et al., 2014; Jacobs et al., 2018, 2016; Spash, 2012, 2009).

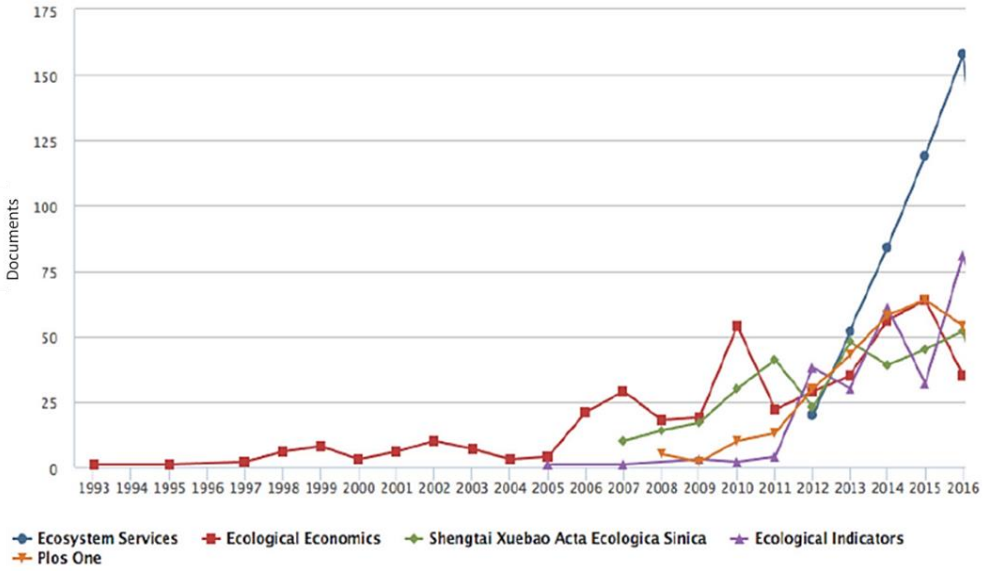


Figure 1. Les meilleures revues publiant des articles sur le concept des services écosystémiques de 1993 à 2016 (Costanza et al., 2017).

1.2 Définitions, cadres conceptuels et classifications

Il existe plusieurs définitions du concept des services écosystémiques (SEs) dans la littérature scientifique ainsi que dans des rapports issus d'initiatives internationales axées sur leur évaluation (ex. l'Évaluation des écosystèmes pour le millénaire, EM). Cependant, même si ces différentes définitions sont appréhendées différemment selon les disciplines, les études s'accordent en général sur le fait qu'on ne peut parler de services sans bénéficiaire humain (Fisher et al., 2009, 2008).

Figure 2. Quelques exemples de services écosystémiques. De gauche à droite : 1) service lié aux aspects esthétiques des écosystèmes, (2) la pollinisation des plantes par les abeilles, essentielle pour l'agriculture et (3) le bois prélevé des forêts pour la construction d'un chalet par exemple.

Quelques éléments de définitions du concept des SEs, notamment ceux qui sont les plus cités dans la littérature, sont listés dans le Tableau 1.

L'une des définitions du concept des SEs les plus acceptées et citées dans la littérature est sans doute celle de l'EM qui les considère comme étant les « bénéfices que les humains tirent des écosystèmes » (Évaluation des Écosystèmes pour le Millénaire, 2005).

Tableau 1. Quelques définitions du concept des services écosystémiques

Quelques éléments de définition du concept des services écosystémiques	Références
"Conditions and processes through which natural ecosystems, and the species that make them up, help sustain and fulfill human life"	Daily (1997)
"Benefits human populations derive, directly or indirectly, from ecosystem functions"	Costanza et al. (1997a)
"Benefits people obtain from ecosystems"	MA (2005)
"Components of nature, directly enjoyed, consumed, or used to yield human well-being"	Boyd and Banzhaf (2007)
"Aspects of ecosystems utilized (actively or passively) to produce human well-being"	Fisher et al. (2009)
"Direct and indirect contributions of ecosystems to human well-being"	TEEB (2010b)
"Direct and indirect contributions of ecosystems in interaction with contributions from human society to human well-being"	Braat (2014)
"Conditions and processes of ecosystems that generate—or help generate— benefits for people"	Guerry et al. (2015)
"Benefits (and occasionally losses or detriments) that people obtain from ecosystems"	Díaz et al. (2015)
"Contributions that ecosystems (i.e. living systems) make to human well-being"	Haines-Young and Potschin (2018)
"Contributions of ecosystems to benefits obtained in economic, social, cultural and other human activity"	Maes et al. (2018)

L'EM est une initiative du Secrétaire général des Nations Unies, Koffi Annan en 2000, ayant réuni au moins 1360 experts dans le monde de 2001 à 2005. Son cadre conceptuel

repose sur l'identification de l'impact des changements des SEs sur le bien-être humain. L'écosystème y est défini comme un « complexe dynamique de composé de plantes, d'animaux, de micro-organismes, et de la nature morte environnante agissant en interaction en tant qu'unité fonctionnelle » (Évaluation des Écosystèmes pour le Millénaire, 2005).

Les services découlant des travaux réalisés dans le cadre de l'EM ont été classés en quatre grandes catégories et reliés aux différentes composantes du bien-être par des flèches dont la largeur indique l'importance relative du lien (voir Figure 3[1]). Les quatre catégories de SEs sont : des services de *prélèvement* tels que la nourriture, l'eau, le bois de construction, ou encore la fibre ; des services de *régulation* qui affectent le climat, les inondations, la maladie, les déchets ou encore la qualité de l'eau ; des services *culturels* qui procurent des bénéfices récréatifs, esthétiques, et spirituels ; et des services d'*auto-entretien* tels que la formation des sols, la photosynthèse, le cycle nutritif, etc. (Évaluation des Écosystèmes pour le Millénaire, 2005).

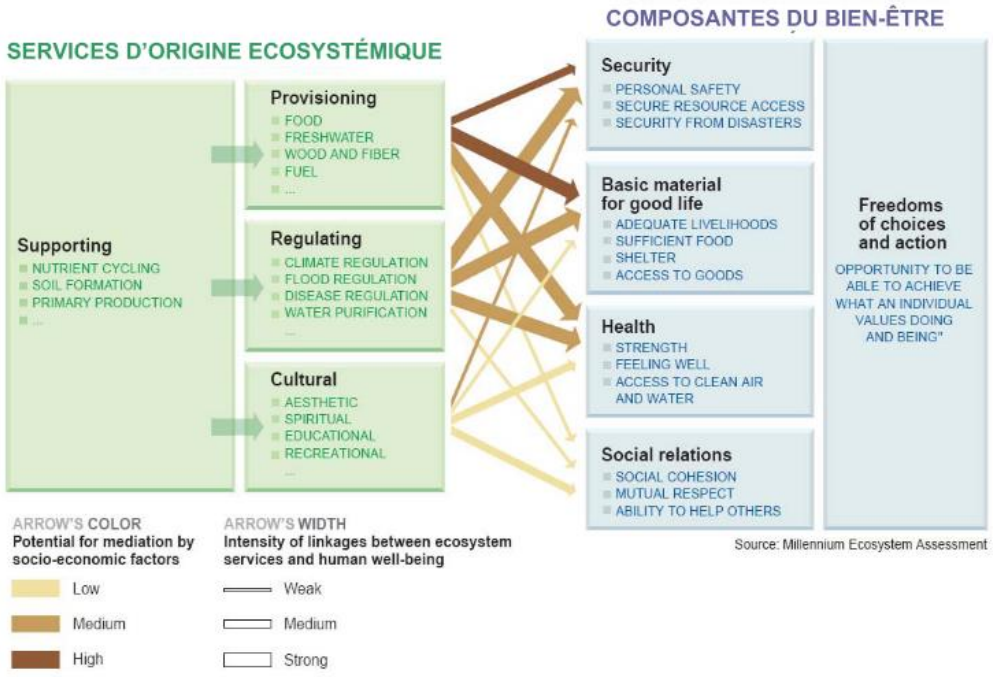


Figure 3 : Cadre conceptuel du concept des services écosystémiques de l'Évaluation des Écosystèmes pour le Millénaire (Évaluation des Écosystèmes pour le Millénaire, 2005).

[1] La figure a été reproduite telle qu'illustrée dans le cadre de l'EM. Les termes utilisés n'ont pas été traduits dans la thèse car différentes terminologies sont notamment utilisées dans la littérature française sur les services écosystémiques pour indiquer un même concept (ex. les termes "services écologiques" et "services environnementaux" désignent tous les services écosystémiques tels que définis dans l'EM).

La définition ainsi que la tentative de classification des SEs dans le cadre de l'EM ont fait l'objet d'un large débat dans la littérature. La définition telle que fournie dans le rapport synthétique de l'EM (2005) est notamment considérée comme vague et difficile à appliquer surtout lors des processus d'évaluation (Costanza, 2008; Haines-Young et Potschin, 2009). Ainsi, il y a eu depuis plusieurs tentatives pour apporter plus d'éléments de précision (Boyd et Banzhaf, 2007; Fisher et al., 2009, 2008; Haines-Young et Potschin, 2009).

Dans une perspective comptabilité environnementale, Boyd et Banzhaf (2007), par exemple, ont défini les services écosystémiques comme étant à la fois les produits finaux de la Nature et les éléments et caractéristiques écologiques (ex. la surface de l'eau, les océans, les différentes type de végétation, …). Ces éléments écologiques sont différents des fonctions écologiques, considérés comme les interactions biologiques, chimiques et physiques entre les éléments écologiques. Les auteurs estiment qu'il est nécessaire de distinguer les *services intermédiaires* des *services finaux* et des *bénéfices*. Ils avancent que les services finaux sont des « composants de la nature, directement appréciés, consommés ou utilisés pour assurer le bien-être humain » et que les services intermédiaires correspondent aux fonctions écologiques qui les fournissent. Par exemple, les *bénéfices* liés à la pratique de la pêche récréative à la ligne découlent de l'utilisation conjointe des services finaux (stock de poissons, surface de l'eau, …) et des biens et services classiques (le temps alloué à l'activité, le matériel de pêche, …). Ainsi, le stock de poissons, le cadre (relatif à la beauté des paysages) et la masse d'eau sont les «produits finaux de l'écosystème» directement utilisés par les pêcheurs à la ligne pour produire des *bénéfices* en termes de loisirs (Boyd et Banzhaf, 2007).

Aussi, Fisher et al., 2009 se sont largement appuyés sur les travaux de Boyd et Banzhaf (2007) notamment sur le fait de dissocier les services intermédiaires des services finaux. Ils définissent les SEs comme étant les aspects des écosystèmes utilisés (de manière active ou passive) pour créer le bien-être humain. Cependant, contrairement à Boyd et Banzhaf (2007), ils considèrent les fonctions et processus écologiques comme des SEs à condition qu'ils soient utilisés (directement ou indirectement) par l'Homme. Distinguer ainsi les *services finaux* et les fonctions et processus écologiques permet d'éviter les biais liés au double comptage lors des processus d'évaluation des SEs (Haines-Young et Potschin, 2009).

Haines-Young et Potschin (2009, 2010, 2018) adhèrent également à la réflexion initiée par les auteurs mentionnés plutôt à savoir la nécessité de faire une distinction entre, d'un côté, les processus et structures écologiques créés ou générés par les organismes vivants et, de l'autre, les bénéfices qui en découlent pour les humains. Ils assimilent le cadre conceptuel des SEs qu'ils proposent, appelé « Cascade » (voir Figure 4[2]), à une « chaîne de production ». Les deux extrémités correspondent aux processus et structures écologiques et les bénéfices qui en découlent pour les humains (les éléments du bien-être comme la sécurité ou la santé par exemple). Il existe deux principaux concepts entre les deux que sont les fonctions écologiques (la capacité de l'écosystème de générer des éléments potentiellement utile pour l'Homme) et les services finaux (les contributions des écosystèmes au bien-être humain). L'exemple fournit par les auteurs pour illustrer leur modèle est celui des services relatifs au rôle des zones humides (au niveau du bassin versant) dans la protection contre les inondations. Ils avancent que la présence des structures et processus écologiques (des zones humides) peut avoir la capacité (ou fonction) d'atténuer l'intensité de l'eau des crues. Cette « fonction » des zones humides est donc considérée comme un SE uniquement si elle constitue un bénéfice pour les humains. Par conséquent, pour définir un service, il devient alors aussi important de comprendre le contexte spatial (localisation géographique) de l'écosystème, les choix de la société et les différentes valeurs qu'elle attribue à ce SE (monétaire ou non monétaire) que la connaissance de la structure et des dynamiques inhérentes aux systèmes écologiques (Haines-Young et Potschin, 2009).

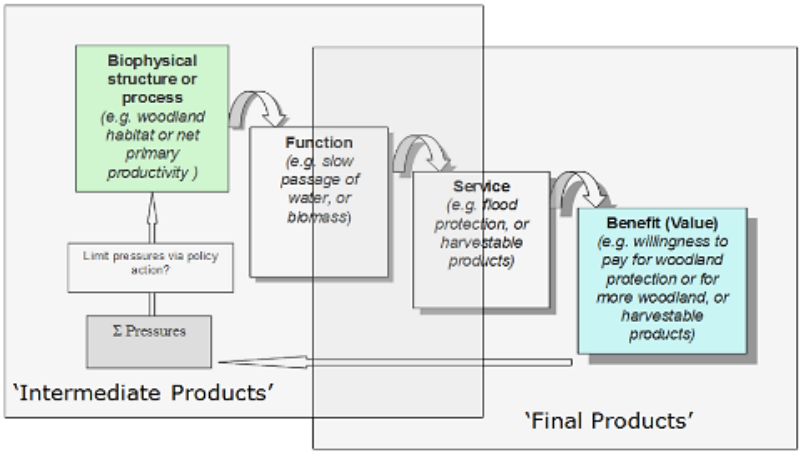


Figure 4 : Cadre conceptuel des services écosystémiques « Cascade » (Haines-Young et Potschin, 2009).

[2] Idem.

Il existe diverses autres initiatives internationales telles que celles initiées dans le cadre de l'Économie des écosystèmes et de la biodiversité (TEEB), de la Plateforme intergouvernementale sur la biodiversité et les services écosystémiques (IPBES), de la Classification internationale commune des services écosystémiques (CICES),…. En plus d'un objectif de sensibilisation relative à l'importance de la biodiversité et à l'impact des activités humaines sur les écosystèmes, ces initiatives visent également, entre autres, la prise en compte de la valeur des SEs dans la conception des politiques publiques, dans les décisions au niveau des entreprises, …. Différentes définitions, cadres conceptuels et classifications du concept des SEs sont proposées dans le cadre de ces initiatives. L'initiative TEEB par exemple a été initiée en 2007 par les ministères de l'Environnement des pays du G8+5[3] qui ont convenu « d'engager le processus d'analyse des bénéfices économiques globaux de la diversité biologique, les coûts de la perte de biodiversité et l'échec à prendre des mesures de protection par rapport aux coûts de conservation efficace » (TEEB, 2010a). Le cadre conceptuel du TEEB présente ainsi une claire connotation économique (Braat et De Groot, 2012).

Le schéma proposé dans le cadre du TEEB est considéré comme une extension du modèle « Cascade » par Haines-Young et Potschin (2009). En effet, tel que explicité par Braat et De Groot (2012), le modèle Cascade est souvent interprété sans prendre en compte la boucle de rétroaction relative aux effets négatifs et positifs, respectivement, des pressions ainsi que des institutions, jugements, gestion et restauration écologique. Cette boucle relierait alors la vision des «sciences sociales» à celle des «sciences naturelles» par rapport aux SEs (Braat et De Groot, 2012).

Braat (2014) va plus loin dans ce raisonnement en intégrant « l'argent » au cadre conceptuel. Il estime que les propriétaires et les gestionnaires devraient utiliser de l'argent pour «acheter» des ressources pour restaurer les stocks de l'écosystème et aussi du temps pour reconstruire les structures et ainsi améliorer les processus écologiques associés. Ainsi, les exportations (bénéfices issus de l'écosystème) génèrent des flux d'argent pour payer ces importations (ressources et temps). Toutefois, il avance que si aucun investissement ni aucune gestion compensatoire n'est exécuté (et suffisamment financé), le système ne peut être maintenu.

[3] Le G8+5 comprend les chefs de gouvernement des nations du G8 (Canada, France, Allemagne, Italie, Japon, Russie, Grande- Bretagne et Etats-Unis) ainsi que les chefs de gouvernement de cinq économies émergentes (Brésil, Chine, Inde, Mexique et Afrique du Sud) (TEEB, 2010a).

Par ailleurs, suivant principalement le schéma de classification de l'EM, TEEB propose une typologie de 22 SEs repartis en 4 principales catégories que sont les services d'approvisionnement, de régulation, liés à l'habitat, et culturels. Cependant, la catégorie relative aux services de support de l'EM a été omise car considérée dans le cadre du TEEB comme partie intégrante des processus écologiques. Par ailleurs, la catégorie de services associés à « l'habitat » a plutôt été mise en avant soulignant ainsi l'importance des écosystèmes à fournir un habitat aux espèces migratrices (par exemple en tant que pépinières) et un patrimoine génétique (TEEB, 2010b).

Tout comme TEEB, l'IPBES est également une initiative intergouvernementale. L'IPBES combine science, politique, connaissances indigènes, locales et autres (ONGs, secteur privé, …) afin d'évaluer l'état de la biodiversité et des SEs fournis à la société, en réponse aux demandes des décideurs[4]. En plus des bénéfices que les humains tirent des écosystèmes, la définition proposée dans le cadre de l'IPBES intègre également les inconvénients et pertes occasionnels issus des interactions Homme-nature. Les SEs y sont définis comme une partie des « contributions de la nature pour les humains » (Nature's contributions to people (NCP), en anglais). Ainsi, en plus des SEs, ce terme NCP inclus également d'autres visions du monde sur les relations Homme-nature ainsi que d'autres systèmes de connaissance comme par exemple les *dons de la nature* dans de nombreuses cultures autochtones (Pascual et al., 2017). La culture joue un rôle central et omniprésent dans l'identification de tous les liens entre l'homme et la nature (Díaz et al., 2018).

Les discussions qui ont abouti au cadre conceptuel de l'IPBES se sont appuyées sur les expériences acquises dans l'élaboration et l'utilisation du cadre conceptuel de l'EM et de divers autres processus, notamment deux ateliers internationaux informels à Tokyo (2011 et 2012) (Díaz et al., 2015). Les différentes catégories de SEs adoptées dans l'EM ont été remplacées par les aspects liés à la régulation (régulation du climat, pollinisation, …), aux éléments matériels et non-matériels des NCP, considérant que la culture est inhérente de l'ensemble de ces catégories (Díaz et al., 2018). Le nouveau cadre conceptuel utilisé dans la cadre de l'IPBES est axé sur six éléments que sont (Díaz et al., 2015) : la Nature, le Capital manufacturé, les bénéfices de la nature pour les humains, les institutions et les systèmes de gouvernance et d'autres facteurs indirects, les facteurs directs et la bonne

[4] https://www.ipbes.net/

qualité de vie (Díaz et al., 2018). Les liens entre les différents éléments du cadre conceptuel de l'IPBES sont présentés dans la Figure 5[5].

A l'échelle de l'Union Européen (UE), le groupe de travail en charge de la cartographie et de l'évaluation des écosystèmes et de leurs services (MAES) a été mis en place dans le cadre commun de mise en œuvre de la stratégie Biodiversité 2020 (Maes et al., 2013). L'objectif étant de maintenir et d'améliorer les SEs en Europe (Maes et al., 2018). Le MAES s'appuie fortement sur les résultats l'EM et du TEEB. Comme le cadre conceptuel du TEEB, celui du MEAS (voir Figure 6[6]) relie les systèmes socioéconomiques aux écosystèmes par le biais du flux de SEs et des facteurs de changement qui affectent les écosystèmes, soit en conséquence de leur utilisation, soit en tant qu'impact indirect dû aux activités humaines en général (Maes et al., 2013).

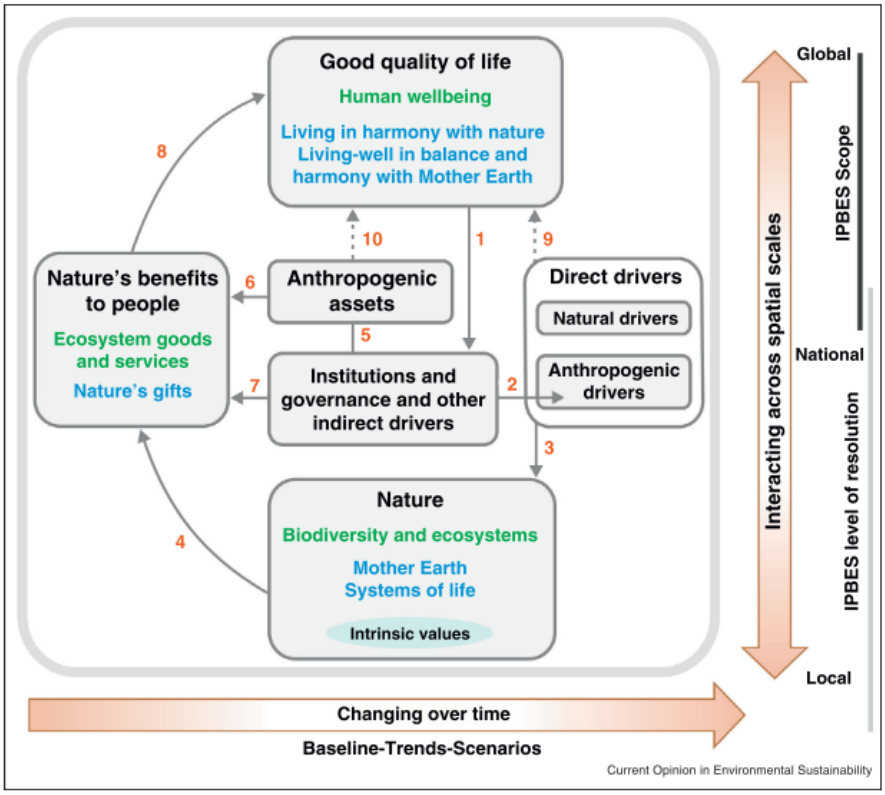


Figure 5 : Cadre conceptuel de la Plateforme intergouvernementale sur la biodiversité et les services écosystémiques (IPBES).

[5] La figure a été reproduite telle qu'illustrée dans le cadre de l'IPBES. Les termes utilisés n'ont pas été traduits dans la thèse car différentes terminologies sont notamment utilisées dans la littérature française sur les services écosystémiques pour indiquer un même concept (ex. les termes "services écologiques" et "services environnementaux" désignent tous les « services écosystémiques »).

[6] Idem

Cependant, d'autres modifications du cadre conceptuel ont été nécessaires en raison du contexte particulier de la gouvernance européenne. (Maes et al., 2016). Le concept des SEs est ainsi défini dans ce contexte comme étant les contributions des écosystèmes aux avantages obtenus dans les activités économiques, sociales, culturelles et autres activités humaines. Aussi, la biodiversité joue un rôle central dans ce cadre conceptuel. En effet, elle conditionne le maintien des processus écosystémiques de base et le soutien de leurs fonctions, définies comme la capacité ou le potentiel des écosystèmes à fournir des SEs (Maes et al., 2013).

Par ailleurs, les différentes terminologies utilisées dans la littérature telles que les « biens et services écosystémiques », les «contributions de la nature pour les humains (NCP)», les « services écosystémiques finaux » sont considérées comme synonymes dans le cadre du MAES (Maes et al., 2018).

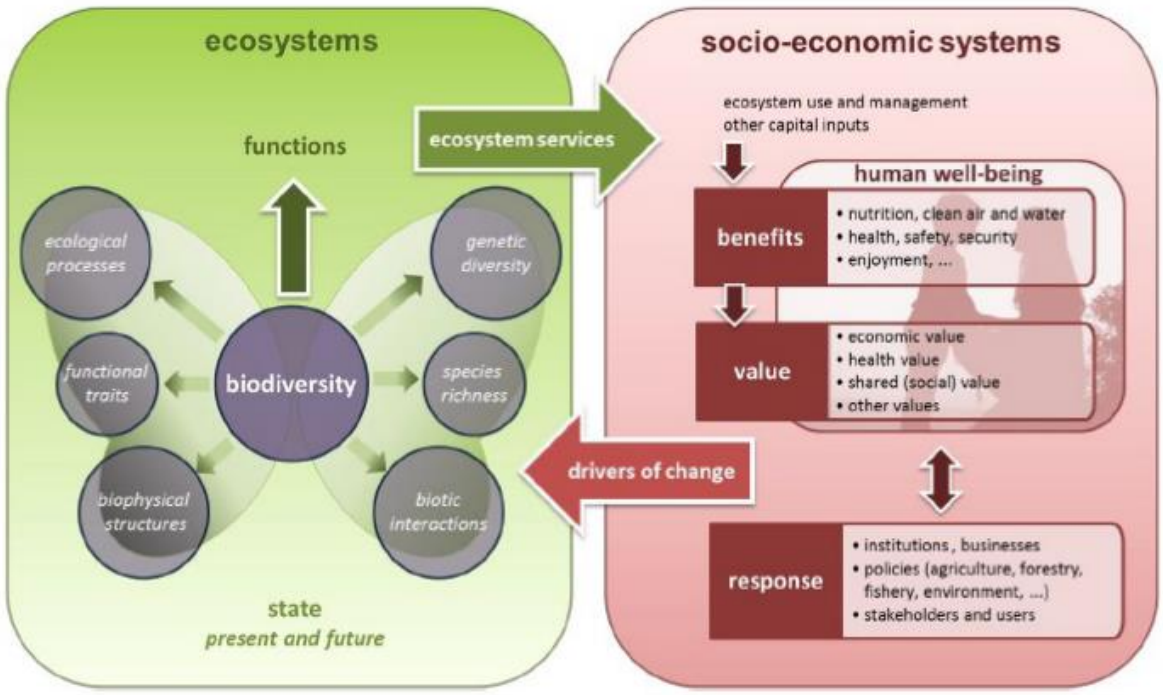


Figure 6 : Cadre conceptuel la Cartographie et de l'évaluation des écosystèmes et de leurs services (MAES) en Europe

Le schéma de classification des SEs adopté dans le cadre du MEAS est celui du Common International Classification of Ecosystem Services - CICES (Maes et al., 2016) qui est l'un des schémas de classification les plus utilisés. Comme TEEB, le modèle *Cascade* fournit le cadre conceptuel dans lequel le CICES est défini. Plus précisément, le schéma

de classification du CICES a été proposé dans le but de fournir un outil flexible pouvant être adapté et affiné en fonction de la situation et des besoins spécifiques des États et des régions (Maes et al., 2016). De plus, il a été largement utilisé dans la recherche sur les SEs pour la conception d'indicateurs, la cartographie et l'évaluation (Haines-Young and Potschin, 2018).

Le CICES n'inclut pas la catégorie des services de soutien de l'EM (2005), mais fusionne les catégories «Habitat» du TEEB (2010) avec les services de régulation de l'EM, dans une catégorie appelée «régulation et maintenance» (La Notte et al., 2017). Ainsi, il y a trois grandes catégories de services identifiées dans le schéma de classification du CICES que sont les services d'approvisionnement, les services de régulation et de maintenance et les services culturels.

En France, la définition, la conceptualisation, la classification ainsi que l'évaluation des SEs en vue d'appuyer les décisions publiques sont appréhendées à travers le projet de l'Évaluation française des écosystèmes et des services écosystémiques (EFESE). En plus de la réponse de la France à ses engagements dans le cadre de la Stratégie européenne pour la biodiversité ainsi qu'à l'atteinte de ses objectifs internationaux vis-à-vis de la Convention pour la diversité biologique (CDB), ce travail constitue également une contribution à la plateforme IPBES et au groupe de travail du MAES (Puydarrieux, 2012). Le cadre conceptuel de l'EFESE (voir EFESE, 2017) a été conçu en cohérence avec celui proposé par CICES, IPBES et le groupe de travail MAES en prenant en compte toutefois, entre autres, les boucles d'interactions entre les SEs et les changements globaux, les interactions entre SEs (bouquets de services), …

Il présente une distinction claire entre les grands types de bénéfices (Puydarrieux, 2012), que sont :

- les fonctions écologiques : correspondent aux services de support de l'EM et soutiennent la production des biens et SEs. Elles ne sont pas évaluées en tant que SEs mais en tant que telles.
- Les biens retirés des écosystèmes : présentent un caractère tangible avéré (e.g. eau, aliments, matériaux).
- Les SEs retirés des écosystèmes : présentent un caractère intangible (e.g. purification de l'eau, séquestration du carbone atmosphérique).

- le patrimoine naturel : correspond à certains services culturels relatifs aux interactions identitaires majeures ou spirituelles à dimension incommensurable.
- Bouquets de biens et SEs : un groupe de plusieurs biens et SEs qui sont régulièrement observés ensemble dans le temps et/ou dans l'espace.

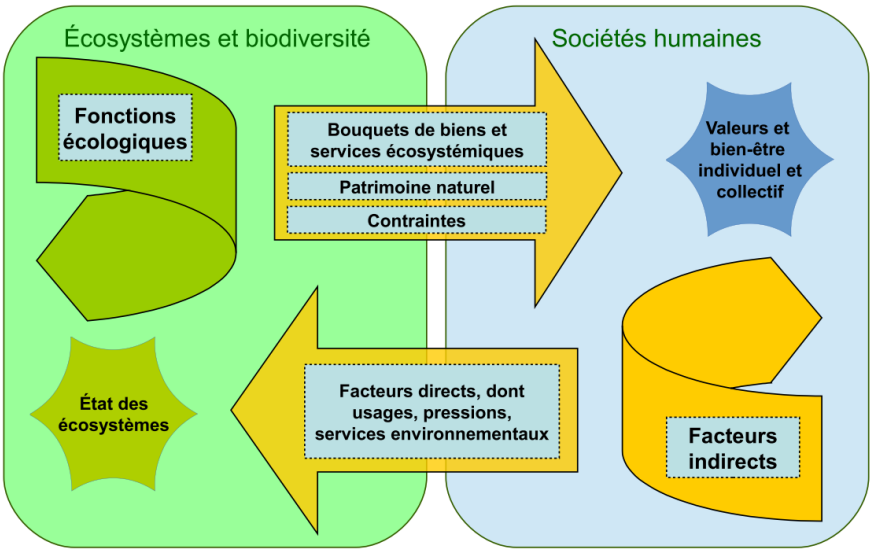


Figure 7 : Cadre conceptuel simplifié de l'Évaluation française des écosystèmes et des services écosystémiques (EFESE, 2017)

Les biens et SEs y sont ainsi définis comme des avantages socio-économiques retirés par l'homme de son utilisation durable des fonctions écologiques des écosystèmes. La figure 7 présente le cadre conceptuel simplifié de l'EFESE. La classification adoptée par l'EFESE est adaptée de celle de CICES v4.3 (Haines – Young et Potschin, 2013).

Tableau 2 : Correspondance entre les principales catégories de services écosystémiques de la CICES v4.3 et de l'EFESE

Les principales catégories de services – CICES	Les principales catégories de services - EFESE
Approvisionnement	Biens issus des écosystèmes
Régulation et maintenance	Régulation Fonctions écologiques
Culturels	Culturels Patrimoine naturel

2 Evaluation des services écosystémiques

2.1 Rôle dans les processus d'aide à la décision

Dans une optique de conservation, de gestion, de restauration écologique des écosystèmes, etc., l'évaluation des SEs permet de mieux comprendre notre relation à la nature (Salles et Figuieres, 2013). Elle ambitionne d'agréger les préférences individuelles pour aboutir à une préférence collective. Les principales causes du recours à l'évaluation des SEs sont sans doute les dégradations environnementales dues aux défaillances de marché qui échouent à intégrer les SEs dans les calculs économiques relatifs à l'aide à la décision. Ces défaillances entraînent, dans la plupart des cas, la sous-estimation de la valeur des SEs (Bontems et Rotillon, 2007; O'Neill et Spash, 2000).

Les SEs présentent des dimensions de biens publics et d'externalités négatives, des sources de défaillance de marché (Bontems et Rotillon, 2007; Laurans et Mermet, 2014; Madrian, 2014; Turner et al., 2000). Les biens publics sont à la fois non rivaux (l'utilisation du bien par une personne n'empêche pas celle par les autres) et non excluables (on ne peut exclure quiconque de la jouissance de ces bienfaits) (Ostrom, 1990). Lorsqu'il n'est pas possible d'empêcher les gens d'accéder à un SE une fois qu'il a été fourni, on peut craindre alors sa surexploitation et la sous-estimation de sa vraie valeur. De même, les problèmes environnementaux relatifs aux externalités négatives peuvent survenir lorsque les actions d'un individu (ou groupe d'individus) nuisent au bien-être d'un autre individu (ou groupe d'individus) (Lele et al., 2013).

En l'absence de signaux prix de marché fiables pour guider les sociétés vers des décisions socialement optimales, l'évaluation des SEs joue ainsi un rôle de substitution central pour les problèmes environnementaux. Elle permet, dans certains cas, l'internalisation des externalités à travers, par exemple, la mise en place de mesures de compensation relatives aux dommages engendrés par les pollueurs. De plus, lorsqu'elle est réalisée de manière intégrée (i.e. impliquant divers acteurs et résidents d'un territoire), elle contribue à l'acceptabilité des décisions publiques ainsi qu'à la sensibilisation de l'opinion publique du territoire concerné. L'utilisation du concept des SEs constitue ainsi un moyen d'instaurer un langage commun accessible à toutes les parties prenantes dans les processus de prise de décision (Granek et al., 2010; Klain et Chan, 2012; Posner et al., 2016). Par ailleurs, l'évaluation des SEs engendre une prise de conscience à l'échelle

mondiale en chiffrant notamment la valeur de l'ensemble des services écosystémiques et du capital naturel en termes monétaires (ex. Costanza et al., 1997a).

2.2 Les cadres théoriques de l'évaluation des services écosystémiques

2.2.1 Les préférences individuelles : définition et formulation

La notion de « préférence » fait référence à un classement subjectif et relatif exprimé sous la forme de : l'« Agent A préfère X à Y » (Hansson et Grüne-Yanoff, 2018). Plus précisément, les préférences sont considérées comme : (i) subjectives, car elles sont généralement exprimées par un agent (un individu de la société, un décideur public, …) et (ii) relatives parce qu'elles expriment le classement d'un élément X par rapport à un autre élément Y. Les éléments (ou options ou alternatives) peuvent, par exemple, désigner les SEs dans le cadre spécifique à leur évaluation. On suppose que la relation de préférence entre options obéit à un certain nombre d'axiomes (cf. Encadré 1) que sont la transitivité, la complétude, la continuité et la stricte monotonie (Figuières et Salles, 2012). La notion de préférence ainsi définie est basée sur des énoncés mathématiques (ou axiomes) qui peuvent s'accommoder de diverses interprétations (voir Encadré 1). Celles -ci varient selon les disciplines telles que l'Économie, la Philosophie politique et morale, et mêmes les auteurs à l'intérieur d'une discipline… Les préférences peuvent être associées à la notion de l'utilité, notion importante notamment en Économie de l'environnement et en Économie écologique. Dans la théorie « utilitariste » selon Bentham (1789) par exemple, l'utilité d'un individu pour une option X est assimilée au bonheur qui lui est procuré suite au choix pour X.

Par ailleurs, les fonctions d'utilité qui représentent les préférences peuvent être, selon leurs interprétations, cardinales ou ordinales. Dans le premier cas, Il est possible par exemple d'affirmer qu' « une option X vaut cinq fois une option Y ». Tel est le cas dans la théorie « utilitariste » où l'utilité d'un individu pour une option est mesurée en fonction d'une unité de mesure quantitative (ex. unité monétaire, ou « utils »). La théorie ordinale est relativement moins précise dans le sens où elle consiste plutôt à établir un classement des options avec des énoncés du type « l'option X vaut mieux que l'option Y » (Figuières et Salles, 2012). Dans ce cas, il est problématique d'additionner l'utilité d'un individu

pour les options X et Y (comparaisons intra-personnelles). Il y a aussi débat sur la question de savoir s'il est possible d'additionner les utilités d'individus différents pour une même option (comparaisons interpersonnelles). On rencontre la théorie ordinale dans la théorie du choix social ou encore celle des préférences révélées introduite par Samuelson (1938). Par exemple, une méthode issue de la théorie ordinale des préférences et récemment utilisée dans la théorie du choix social, appelée le « Jugement majoritaire » et introduite par Balinski et Laraki (2007) repose sur le principe que chaque électeur (ou individu) exprime explicitement ses préférences en fonction du mérite de chaque candidat (ou option), sur une échelle de mesure ordinale. Cette échelle de mesure est traduite en utilisant un langage commun compréhensible de la même manière par tout le monde du style « Exceptionnel, Excellent, Très bon, Bon, Moyen, Moyen, À rejeter ».

2.2.2 Rôle de facteurs cognitifs

La manière dont la notion de préférence est appréhendée varie en fonction des courants de pensée. La théorie des préférences révélées par exemple analyse le comportement d'un agent compte tenu de ses préférences, mais ne dit pas grand-chose par rapport à la provenance de ces préférences. Autrement dit, on suppose généralement que les préférences sont données de manière exogène (Dietrich et List, 2011) et ne changent pas avec le temps (Gimpel, 2007).

Toutefois d'autres courants de pensée adhèrent au fait, qu'en fonction d'un certain nombre de paramètres et de biais, les préférences peuvent évoluer ou être fausses. Cela concerne les effets du traitement de l'information par les enquêtés tels que la complexité et la familiarité; les effets associés à la présentation de l'information aux enquêtés, tels que le format et le cadrage du questionnaire (ex. versions papier vs. numérique); les facteurs contextuels, y compris l'ancrage, les biais hypothétiques ainsi que l'apprentissage (Valatin et al., 2016). Par exemple les préférences exprimées pour des options d'aménagement et de relocalisation des habitations exposées à la submersion marine et aux inondations, dans une période où ces phénomènes naturels extrêmes sont fréquents, sont sûrement influencées par le contexte. De même, les individus peuvent avoir une fausse perception de la réalité surtout s'il s'agit d'exprimer leurs préférences pour des options complexes et peu connues du grand public.

Encadré 1 : Les axiomes de la notion des préférences

Soient deux options Xet Ydans l'ensemble des option admissibles A, un indice i pour chaque individu, et une relation de préférence $X \succcurlyeq_i Y$ qui signifie que, pour l'individu i, l'option X est préférée ou indifférente à l'option Y[7]. On suppose que les préférences d'un individu obéissent à 4 axiomes :

Axiome 1 : Transitivité
Soient X, Yet Ztrois options dans A. Si $X \succcurlyeq_i Y$ et $Y \succcurlyeq_i Z$ alors $X \succcurlyeq_i Z$.

Axiome 2 : Complétude
Pour tout Xet Ydans A, soit $X \succcurlyeq_i Y$ ou $Y \succcurlyeq_i X$, i.e. tout individu i est capable de classer toutes les alternatives qui se présentent à lui.

Axiome 3 : Continuité
Pour toute option $x^0 \in A$, les ensembles $\{x \in A / x^0 \succcurlyeq_i x\}$ et $\{x \in A / x \succcurlyeq_i x^0\}$ sont fermés dans A, i.e. qu'il n'est pas possible par une trajectoire continue de passer d'options strictement meilleures que x^0 à des options strictement moins bien sans passer par une option qui lui sera indifférente.

Axiome 4 : Stricte monotonie
Pour tout Xet Ydans A, si $X \geq Y$ alors $X \succcurlyeq_i Y$, tandis que si $X > Y$ alors $X \succcurlyeq_i Y$ et non $(Y \succcurlyeq_i X)$.
Un individu est favorable à acquérir des quantités additionnelles de chaque option (ex. avoir une meilleure qualité de l'eau par exemple).

Sources : Figuières et Salles, 2012; Hansson et Grüne-Yanoff, 2018

[7] Les relations de préférence et d'indifférence entre les alternatives (ou options) sont généralement désignées par les symboles $\succ$ et $\sim$, respectivement. Conformément à une tradition philosophique ancienne, $X \succ Y$ est supposé représenter «Y est pire que X», ainsi que «X est meilleur que Y» (Hansson et Grüne-Yanoff, 2018).

Un écosystème peut être perçu comme sans intérêt par un individu qui ne dispose pas assez d'information sur, par exemple, le rôle de nurserie de cet écosystème à maintenir le cycle de vie de plusieurs espèces animales. Cet individu peut ainsi préférer d'autres options alternatives à la préservation de cet écosystème naturel.

Ainsi, plusieurs études attestent de l'impact de l'information sur les préférences (e.g. Ami et al., 2018; Blomquist et Whitehead, 1998; Hanley et Munro, 1992; LaRiviere et al., 2014; Lewan et Söderqvist, 2002; Spash et Hanley, 1995; Whitehead et Blomquist, 1991). Par exemple, Whitehead et Blomquist (1991) ont mis en évidence un impact significatif de l'information fournie, sur des zones humides de qualité variable (caractéristiques et SEs), sur les préférences des individus enquêtés. D'autre part, Rollero et De Piccoli (2010) ont montré que les dimensions cognitives (encore appelées « identification ») et affectives (ou « attachement au lieu ») sont strictement associées aux perceptions du lieu et des habitants. Ces préférences peuvent également être construites lors de discussions entre les individus suite à des échanges d'information (Cuppen et al., 2010; Howarth et Wilson, 2006 ; Kenter et al., 2016, 2015, 2014; Lo et Spash, 2013; O'Neill et Spash, 2000).

2.2.3 Agrégation des préférences individuelles

A préférences données, obéissant aux axiomes de transitivité, de complétude, de continuité et de stricte monotonie (cf. Encadré 1), la question centrale relative à l'agrégation des préférences individuelles est de savoir comment aboutir à un classement collectif ou choix social ? Cette question renvoie aux cadres théoriques issus de, notamment, la Philosophie politique et morale, l'Économie du bien-être, et de la Théorie du choix social. Elle est cruciale pour l'évaluation des SEs lorsqu'elle est censée informer le décideur public.

En Économie, l'agrégation des préférences individuelles pour aboutir à un classement collectif, lorsqu'elle est possible, peut être considérée comme une fonction de bien-être social (Bergson, 1938; Samuelson, 1983). Cette fonction permet entre autres d'évaluer ou de comparer différentes options (SEs, scénarios de gestion ou de conservation, …) en fonction des préférences individuelles exprimées pour ces options. Elle permet ainsi d'orienter la décision en identifiant par exemple le scénario de gestion ou de conservation

à mettre en place, jugé meilleur par rapport à d'autres scénarios, en fonction de l'agrégation des préférences individuelles des populations concernées. Dans la théorie « Utilitariste » (Bentham), cette fonction correspond à la somme des utilités cardinales individuelles exprimées en général en termes monétaires.

L'agrégation des préférences est appréhendée à travers la théorie du choix social. Quelques modalités d'agrégation connues dans ce cadre théorique sont la règle à la majorité, la règle de Borda, …. Dans le cas de la méthode du jugement majoritaire (MJ) par exemple (cf. point 1.2.1), le résultat qui découle de cette méthode correspond à un classement collectif des différentes options considérées (ex. les candidats à l'élection présidentielle, différentes marques de vins, …).

En dehors des paradoxes et limites des approches d'agrégation des préférences, certains auteurs trouvent ces approches peu convaincantes pour aboutir à un classement ou à une fonction de bien-être social. Amartya Sen, par exemple, considère que la démocratie ne consiste pas simplement en une agrégation d'opinions individuelles, mais en un processus de délibération dans lequel chaque membre apporte une contribution active (Bonvin, 2005). Le but du processus délibératif est également d'aboutir à un classement collectif de différentes options à travers une discussion entre les individus, réunis en général en petits groupes. Cependant, contrairement à la théorie des préférences révélées par exemple, les préférences sont construites durant le processus délibératif (Howarth et Wilson, 2006).

3 Cadrage et structure de la thèse

3.1 Les écosystèmes lagunaires

Les lagunes sont des milieux aquatiques peu profonds situés à l'interface continent-mer généralement reliés à la mer de façon permanente ou temporaire par des graus et soumis à un flux d'eau douce par le bassin versant (voir Figure 8). Elles représentent 13% des zones côtières mondiales et seulement 5,3% des côtes européennes (Barnes, 1980). Leur profondeur peut atteindre 30 m, bien que la moyenne dépasse rarement 2m (Pérez-Ruzafa et al. 2011). Les côtes méditerranéennes sont parmi les principales régions lagunaires d'Europe avec environ 600 lagunes (Gaertner-Mazouni et De Wit, 2012 ; Pérez-Ruzafa

et al., 2011). En France, on dénombre 22 complexes lagunaires (les lagunes et leurs zones humides périphériques) le long du littoral méditerranéen sur environ 129 344 ha[8].

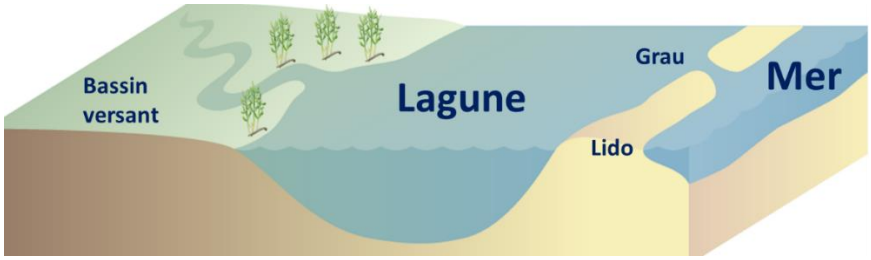


Figure 8 : Lagune côtière / © Sy Mariam Maki.

Les zones lagunaires constituent un habitat et un lieu de nidification (ou une nurserie) pour un ensemble d'organismes vivants (oiseaux, poissons, …). Plusieurs espèces emblématiques (les flamants roses par exemple, plus 39 000 individus en France sur les régions PACA, Languedoc-Roussillon et Corse) et protégées (32% des 115 espèces de plantes présentes sur le site des lagunes méditerranées sont protégées en France) y sont répertoriées. En plus de soutenir une riche faune et flore, les zones lagunaires ont toujours été d'un grand intérêt pour les humains (Newton et al., 2014). On dénombre ainsi plusieurs types d'usages au niveau des écosystèmes lagunaires tels que les activités récréatives (pêche amateur, observation des oiseaux, …) et commerciales (pêche professionnelle, conchyliculture, …).

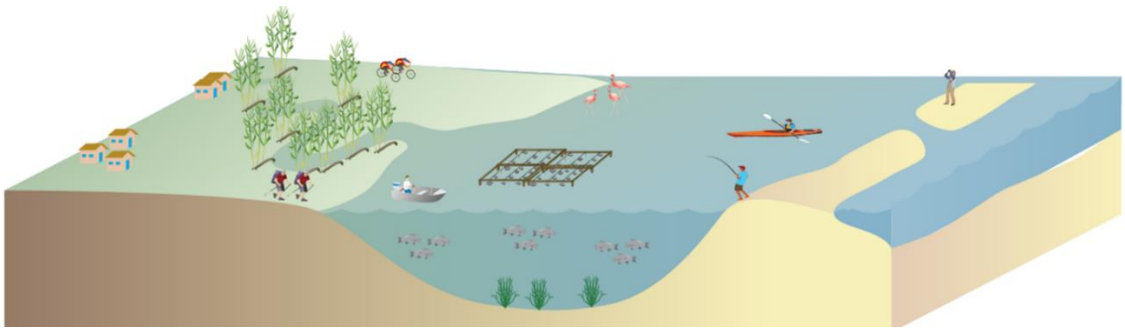


Figure 9 : quelques services écosystémiques fournis par une lagune côtière/ © Sy Mariam Maki.

[8] Chiffres fournis par le Pôle Relais lagunes (2008). http://www.occitanie.developpement-durable.gouv.fr/IMG/pdf/PL_Mieux_gerer_les_lagunes_mediterraneennes_cle0df2a9.pdf

Les paysages lagunaires comprennent souvent les zones humides et riveraines périphériques, des dunes de sables ou un simple banc de sable au niveau du lido. Dans certains cas on y retrouve des zones périphériques agricoles et/ou boisées ainsi que des habitations.

3.2 Problématiques

Bien que le rôle des complexes lagunaires dans la fourniture des SEs soit largement reconnu, ils figurent parmi les écosystèmes les plus affectés par l'activité humaine. Ne pas tenir compte de la valeur de ces écosystèmes pour la société dans les processus de prise de décisions publiques ou privées est l'un des principales causes de leur dégradation (Moseley et Valatin, 2013).

Les principaux facteurs de stress anthropiques sur les écosystèmes lagunaires comprennent l'aménagement du littoral, les rejets liés à l'agriculture, le rejet des eaux usées dans les lagunes, les contaminants chimiques, la surpêche, les espèces invasives introduites par l'activité humaine, l'aquaculture intensive, le changement climatique, le tourisme… (Kennish et al., 2014; Turner et al., 2000). Dans la majorité des cas, l'apport de nutriments comme le phosphore ou encore l'azote à travers le rejet des eaux usées dans ces milieux entraînent une eutrophisation de l'écosystème, qui constitue peut-être la plus grande menace à long terme pour l'intégrité écologique des lagunes côtières (Kennish et Pearl, 2010). Ce processus se traduit aussi par un fort enrichissement des sédiments en éléments nutritifs, ce qui pose des problèmes lors de la restauration écologique (De Wit et al., 2017).

Le concept d'eutrophisation a été étudié depuis plus de 20 ans (Nixon, 1995). Si les causes de l'eutrophisation sont bien identifiées (apport de nutriments), les conséquences sont diverses. Au premier niveau on trouve le développement de phytoplancton et de macrophytes. Au second niveau on trouve les conséquences (les nuisances) de ces développements lorsqu'ils deviennent excessifs : gênes directes pour l'utilisation de l'eau ou du domaine aquatique, hypoxie ou anoxie du milieu mortelle pour la faune, poussées d'espèces opportunistes toxiques (Aminot et al., 2001). Les effets relatifs à l'eutrophisation occasionnent ainsi la dégradation de l'état et la fourniture durable des SEs issus des écosystèmes lagunaires (Ferreira et al., 2011).

Pour faire face à ces enjeux, la gestion des complexes lagunaires implique une grande variété d'institutions et d'unités administratives, ainsi que de connaissances issues de plusieurs disciplines scientifiques (Gooch et al., 2015). A l'échelle de l'Union Européenne en général et en France en particulier, la prise de conscience des risques liés à la dégradation de la qualité des milieux lagunaires a abouti à la mise en œuvre d'actions concrètes relatives à la restauration écologique, la gestion, et l'aménagement et/ou la conservation de ces milieux. Ces mesures visent entre autres la réduction les apports en nutriments même si le temps nécessaire à la restauration écologique de ces milieux dégradés en vue d'atteindre le bon état écologique au sens de la Directive Cadre sur l'Eau (DCE) reste inconnu (De Wit et al., 2017). Ce foisonnement d'initiatives s'accompagne de la mise en place d'instruments destinés à faciliter l'application des directives européennes (banques de données environnementales, listes d'espèces menacées, outils financiers, délimitation de zones biogéographiques) (Fortier, 2009).

Ainsi, les investissements dans la conservation, la restauration écologique et l'utilisation durable des écosystèmes lagunaires sont de plus en plus considérés comme une situation "gagnant-gagnant" qui génère des avantages écologiques, sociaux et économiques importants (De Groot et al., 2010). Toutefois, de tels investissements nécessitent un arbitrage entre plusieurs options alternatives (projets de restauration écologique, scénarios de gestion, SEs, …). Ce type de compromis peut se faire à travers l'évaluation des SEs dans la mesure où elle permet d'identifier ce que les humains perçoivent de l'impact des écosystèmes sur leur bien-être (Turner et al., 2000). Dans le cadre d'une analyse coûts-bénéfices d'un projet de restauration écologique par exemple, la valeur monétaire attribuée aux SEs est utilisée pour estimer les bénéfices que pourraient engendrer la réalisation du projet. Ces bénéfices sont ensuite comparés aux coûts à engager pour réaliser le projet. L'évaluation des SEs permet également d'inclure les populations locales (acteurs économiques locaux, résidents, associations, …) en instaurant un cadre de communication et induire ainsi une meilleure acceptabilité des différentes mesures à implémenter.

La question centrale est alors de savoir comment aboutir à une évaluation et une hiérarchisation collective des SEs à partir des préférences individuelles. En général, cette question est traitée, lorsque c'est possible, à travers les approches d'agrégation de préférences individuelles non-délibératives et délibératives des SEs (cf. section 2.3). Ces

approches peuvent être appréhendées à travers des méthodes monétaires et/ou non monétaires. Cependant, force est de constater que les deux approches d'agrégation aboutissent à des résultats différents (Howarth et Wilson, 2006; Kaplowitz et Hoehn, 2001; Kenter et al., 2016; Lo et Spash, 2013; Mavrommati et al., 2017). L'étude de ces différences a été réalisée dans très peu de travaux, notamment le fait de systématiquement caractériser le degré de variation des préférences individuelles agrégées avant et après la délibération (voir Murphy et al., 2017).

Par ailleurs, le processus d'évaluation des SEs est un exercice difficile surtout quand il s'agit des écosystèmes complexes et peu connus du grand public. Les préférences sont en général limitées et les individus n'ont pas souvent assez d'information sur ces types d'écosystèmes (Costanza, 2004). Il s'agit d'étudier dans quelle mesure l'apport d'information sur les usages et les activités de la zone. Ceci correspond à de l'information externe que les individus ne possèdent pas et dont ils acquièrent à travers la familiarité avec l'écosystème (à travers des visite régulière par exemple) ainsi que l'information académique. Par conséquent, fournir de l'information académique sur le fonctionnement écologique des écosystèmes ainsi que les caractéristiques sociodémographiques et économiques du site dans lequel ils sont implantés présente-t-il un impact sur les préférences des individus ? De même, est-ce que le fait d'être familier ou non avec un écosystème a un impact sur les préférences des individus pour cet écosystème ?

3.3 Cadre conceptuel de l'évaluation des services écosystémiques mobilisé dans la thèse

Le concept des SEs tel que considéré dans le cadre de cette thèse est un outil permettant d'appréhender l'interaction entre la société humaine et les écosystèmes lagunaires. Les SEs sont définis dans la thèse comme les contributions des écosystèmes lagunaires au bien-être des humains. L'idée du cadre conceptuel de la thèse est de considérer ces écosystèmes lagunaires comme des processus et structures écologiques desquels découlent des bénéfices pour les humains. Les SEs finaux et les fonctions écologiques sont considérés comme des étapes intermédiaires dans ce cadre conceptuel (e.g. Haines-Young et Potschin 2009, 2010, 2018). Les premiers sont définis comme les contributions

des écosystèmes lagunaires au bien-être des humains. Les fonctions écologiques sont définies comme la capacité de ces écosystèmes lagunaires à fournir des éléments potentiellement utiles pour l'Homme, elles ne sont considérées comme SEs finaux que lorsqu'elles contribuent au bien-être des humains.

La liste des SEs utilisée (cf. encadré 4) dans les différents chapitres de la thèse a été co-construite à travers deux groupes de travail composés de chercheurs ainsi que de parties prenantes (surtout des gestionnaires) et une série d'entretiens individuels (cf. Chapitre 2). Par ailleurs, les préférences individuelles et leur agrégation, constituant un input pour l'aide à la décision relative à la mise en place de mesures (ex. de conservation, restauration écologique, …) ainsi que les pressions anthropiques ou autres (ex. le changement climatique), sont également prises en compte. L'identification des préférences et leur prise en compte dans le processus de prise de décision constituent un input permettant d'aboutir à des mesures mieux acceptées par la société. Les aspects cognitifs comme l'information et la familiarité jouent également un rôle important dans l'évaluation des SEs surtout lorsqu'il s'agit d'un écosystème complexe peu connu. Toutefois, les mesures de gestion ou encore de conservation, lorsqu'elles ne sont pas efficaces, pourraient également constituer une source de pressions anthropiques, cet aspect ne sera pas traité dans la thèse.

3.4 Objectifs et organisation de la thèse

La thèse est structurée autour de trois principaux objectifs :

Le premier objectif consiste à identifier les SEs, fournis par le complexe lagunaire palavasien et la lagune de Biguglia (cf. encadré 2 et 3, respectivement), pour lesquels les préférences des parties prenantes convergent ou divergent.

Le second objectif est d'étudier l'impact de l'information académique et de la familiarité sur les préférences de résidents locaux et non-locaux pour les SEs.

Le troisième objectif aborde principalement l'étude des résultats issus de deux approches, souvent utilisées pour l'évaluation non-monétaire et la hiérarchisation des SEs pour renforcer la légitimité du processus de l'évaluation.

Les zones étudiées sont le complexe lagunaire palavasien et le site de la lagune de Biguglia[9] (cf. encadrés 2 et 3). Elles sont situées au sud de la France et bordent la mer méditerranéenne (cf. Figure 10). En plus des lagunes (sept pour le complexe palavasien et une pour le site de Biguglia), ces sites comprennent, au niveau de leurs zones périphériques adjacentes, des zones agricoles, riveraines et humides telles que les marais salants et les roselières. En plus, le complexe lagunaire palavasien est traversé par le canal du Rhône-à-Sète.

Les deux sites d'étude, de par leur localisation, sont proches de zones urbaines (Montpellier et Bastia, respectivement). Le site de la lagune de Biguglia est une réserve naturelle relativement peu fréquenté comparé au complexe lagunaire palavasien. Il y a une volonté de conservation et de restauration écologique au niveau des deux zones qui font déjà l'objet d'importants investissements, d'études scientifiques et d'une politique de gestion durable (sites Natura 2000, convention internationale Ramsar, …).

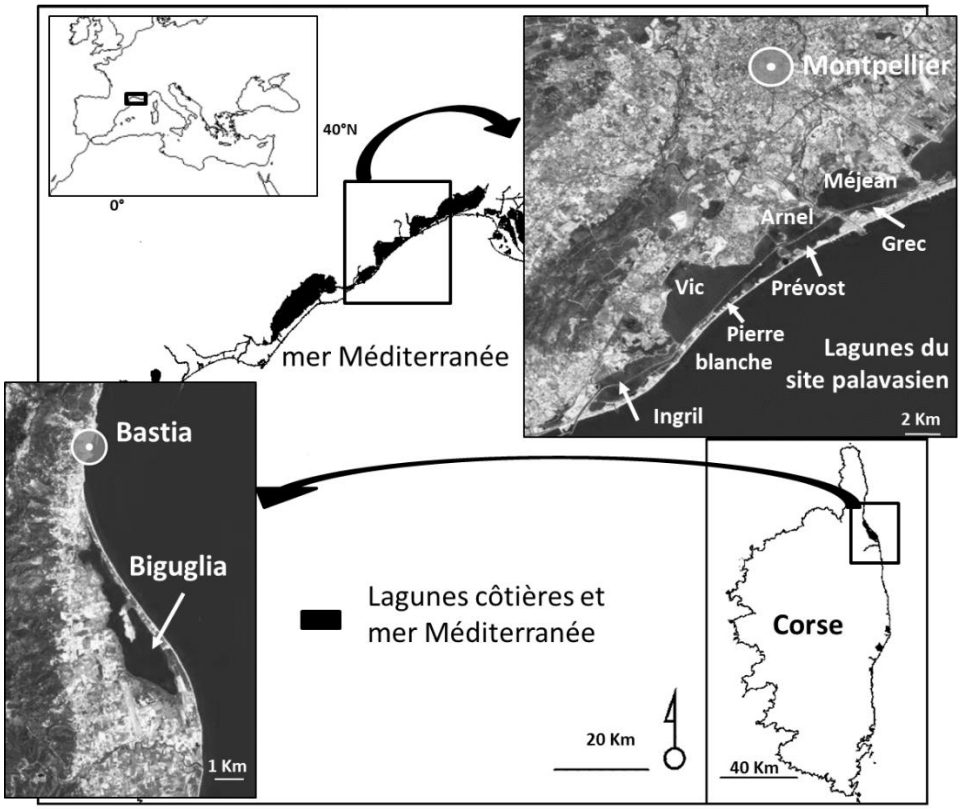


Figure 10 : Cartographie des zones étudiées (Le complexe lagunaire palavasien et le site de la lagune de Biguglia)[10]

[9] Etudié uniquement dans le second chapitre de la thèse.
[10] Adaptée de Sy et al. 2018 (cf. chapitre 2).

Encadré 2 : Le complexe lagunaire palavasien

Le complexe lagunaire palavasien (voir Figure 10), tel que étudié dans le cadre de la thèse, comprend (i) sept lagunes côtières peu profondes (entre 0,4 et 1,2 mètre de profondeur) que sont : Ingril, Vic, Pierre-Blanche, Arnel, Prévost, Méjean et Grec, (ii) des zones riveraines, agricoles et humides périphériques et enfin, (iii) le canal du Rhône-à-Sète. Les lagunes et zones humides du complexe reçoivent les eaux d'un bassin versant d'environ 600km² composé à l'Est par le bassin versant du Lez et de la Mosson, et à l'Ouest par le massif de la Gardiole qui culmine à 234 m. Les lagunes sont en communication avec la mer par le biais du port de Carnon, de l'embouchure du Lez et du grau du Prévost, situés à Palavas, ainsi que par le grau du port de Frontignan.

Il est localisé à proximité des agglomérations de Sète (126 000 habitants) et de Montpellier (457 839 habitants) et son territoire comprend sept communes en forte évolution démographique (jusqu'à 30,38% en 2006). Cette situation fait de ces milieux lagunaires, des zones fortement urbanisées et fréquentées. On récence ainsi sur la zone une série d'activités récréatives que sont la chasse aux gibiers d'eau, le tourisme avec 245 sites d'hébergement et un total de 18 010 lits en période estivale, les activités nautiques, la pêche de loisir, la randonnée pédestre, la découverte de la nature, etc. Le complexe lagunaire fait également l'objet d'une importante activité de pêche professionnelle (une quarantaine de pêcheurs au filet et une dizaine de pêcheurs de palourdes), quelques productions conchylicoles (sur la lagune de Prévost). Le trafic fluvial y est aussi présent à travers le canal du Rhône à Sète (marchandise et plaisance). Le trafic marchand par exemple connaît un ressort d'activité, passant de 18 228 tonnes en 1979 à 289 936 tonnes en 2007. L'agriculture pratiquée sur la zone concerne principalement la viticulture, le maraîchage et l'élevage. Cependant, même si le recensement agricole de 2000 indique que les surfaces agricoles couvrent environ 30% de la superficie totale des sept communes environnantes du complexe lagunaire, l'activité agricole reste relativement limitée dans les périmètres immédiats du complexe.

On y retrouve une faune et flore riches et souvent remarquables avec des espèces végétales patrimoniales telle que la Saladelle de Gérard, une avifaune d'au moins 250 espèces d'oiseaux, plus de 20 000 oiseaux d'eau en période d'hivernage (notamment le Flamant rose, l'Avocette élégante, …). Le site lagunaire palavasien classé en zone Natura 200 et est ainsi reconnu comme Zone d'intérêt communautaire (ZIC – FR9101410) et aussi, comme de protection spéciale (ZPS - FR9110042) dans le cadre de la Directive « Oiseaux ». Sa zone humide est également reconnue comme d'importance internationale selon la convention Ramsar depuis 2008.

Par ailleurs, le complexe est en grande partie la propriété de l'Etat sous différents régimes de propriété (domaine maritime public, domaine public du conservatoire du littoral et le domaine privé de l'Etat). Une partie du complexe est également la propriété de municipalités environnantes et des propriétaires privés (référence mémoire Peneloppe).

Sources :

- Les données de cet encadré sont issues du DOCOB SIEL sauf mention contraire *(http://www.siel-lagune.org/IMG/pdf/tome1_rapport_docob_janvier_2010.pdf)*. Les chiffres sur le tourisme datent de 2006 et ceux du trafic marchand fluvial de 2007
- Sète agglopôle méditerranée (*http://www.agglopole.fr/l-agglo-pole/le-territoire-2/la-collectivite/)*.
- Montpellier Méditerranée Métropole *(https://www.montpellier3m.fr/conna%C3%AEtre-territoire/31-communes)*.
- Pôle-relais lagunes *(https://pole-lagunes.org/les-lagunes/cartographie-interactive/les-etangs-palavasiens/*).

Encadré 3 : Le site de lagune de Biguglia

S'étendant sur une superficie de 14,5 km² avec un bassin versant d'environ 170 km², la lagune de Biguglia, située au Nord-Est de la Corse, est la plus grande lagune de Corse. Comme les lagunes du site palavasien, elle est peu profonde (environ 1 à 1,8 m en moyenne). Elle est partagée en deux masses d'eau par la presqu'île de San Damiano dont la première au Nord fait l'objet de fortes variations de salinité.

Le site de la lagune est localisé à proximité d'une zone urbaine s'étendant sur quatre communes que sont Furiani, Biguglia, Borgo et Lucciana. Son bassin versant comprend un une grande agglomération et présente un taux de croissance démographique d'environ 3,3% en moyenne (de 2000 à 2006). Plusieurs activités économiques sont réalisées sur le site. Au niveau de la lagune, la pêche professionnelle artisanale y est pratiquée. Sur les trois techniques différentes de pêche réalisée sur la lagune, la plus utilisée est l'utilisation de capétchade. Un piège à poisson couramment utilisé sur l'ensemble des lagunes méditerranéennes du sud de la France. L'agriculture et l'élevage extensifs sont pratiqués sur la rive ouest. L'activité agricole est surtout importante au niveau du bassin versant, en particulier au niveau de la plaine de Marana.

La presqu'île de San Damiano dispose d'un sentier de promenade et d'observation en accès libre. Cependant, l'accès de la réserve naturelle au public est encadré toute l'année avec des visites pédagogiques, expositions, etc. Le cordon dunaire de Biguglia est une zone touristique. Le nombre de lits recensés en 2007 était d'environ 10500 sur le lido de la Marana.

La lagune de Biguglia est implantée dans une réserve naturelle et classée en zone Natura 2000. Elle est répertoriée dans l'inventaire ZIC (zones d'importance communautaire pour les oiseaux) actualisée en 1991 (n° CS 07) et classée en ZPS (zone de protection spéciale) au titre de la Directive « oiseaux » (FR 9410101) depuis avril 1996, pour une étendue correspondant très précisément à celle de la réserve naturelle. On y récence 224 espèces d'oiseaux, 41 espèces de poissons ainsi que deux espèces végétales rarissimes : la fléchière (Sagittaria sagittifolia) et le thelipteris des marais (Thelipteris lacustris). Sa zone humide périphérique est protégée par une convention internationale Ramsar depuis 1991. Le département de la Haute-Corse est propriétaire de la lagune de Biguglia depuis le 20 octobre 1988.

Sources :

- Rapport de l'inspection générale de l'environnement *(https://www.ladocumentationfrancaise.fr/var/storage/rapports-publics/034000571.pdf)*
- Pôle-relais lagunes *(https://pole-lagunes.org/les-lagunes/cartographie-interactive/etang-de-biguglia/)*
- L'évaluation environnementale du Sage de l'étang de Biguglia *(http://www.haute-corse.fr/site/uploads/telechargements/SAGE/Rapport-Eval-Env-Sage-BIGUGLIA-Janvier-12.pdf)*

Encadré 4 : La liste des services écosystémiques utilisée dans la thèse[11]

Catégorie	Sous-catégorie	Service écosystémique	Définition générale
Approvisionnement	Approvisionnement en nourriture	Coquillages Biomasse pour le pâturage Cultures **Conchyliculture** Poissons **Pisciculture**	La fourniture de ressources pour la consommation humaine et les conditions pour la cultiver. Il s'agit principalement de la culture, de l'élevage et de la pêche.
	Approvisionnement en eau	Navigation fluviale* ou régulation hydrologique**	L'approvisionnement en eau pour la consommation humaine et pour d'autres usages.
	Matériaux biotiques et biocarburants	**Produits non alimentaires**	La fourniture de biomasse ou d'éléments biotiques à des fins non alimentaires.
Régulation et maintenance	Purification de l'eau	Epuration de l'eau Décomposition des déchets organiques	Processus biochimiques et physicochimiques permettant l'élimination des déchets et des polluants du milieu aquatique.
	Protection côtière	Protection contre les inondations et autres événements extrêmes Protection contre l'érosion	Protection contre les inondations, les sécheresses, les ouragans et autres événements extrêmes ainsi que la prévention de l'érosion côtière.
	Réglementation du climat	Régulation du microclimat	Régulation du gaz à effet de serre à travers notamment l'apport, le stockage et la séquestration du dioxyde de carbone.
	Maintenance du cycle de vie	Habitats et nurserie	Lieu de reproduction et de refuge des espèces.
Culturel	Valeurs symboliques et esthétiques	Valeur paysagère Identité locale Valeur esthétique d'espèces remarquables Sites historiques et culturels	Exaltation des sens et des émotions par les paysages, les habitats ou les espèces.
	Loisirs et tourisme	**Balade et excursion en bateau** **Sports nautiques non motorisés** Observation des oiseaux Balade à vélo Promenade équestre Chasse aux gibiers d'eau et oiseaux Sentiment de relaxation Camping Promenade et randonnée **Pêche amateur et collecte de coquillages**	La fourniture d'un environnement naturel pour la détente et les loisirs.
	Effets cognitifs	Source d'inspiration artistique Opportunités pour la recherche scientifique Education à l'environnement	Processus cognitifs comme connaître, développer, percevoir ou être conscient résultant de paysages naturels ou d'organismes vivants.

Notes :

- Les services Navigation fluviale* et régulation hydrologique** concernent, respectivement, le canal du Rhône-à-Sète sur le site Palavasien et la régulation du débit d'eau pour l'agriculture au niveau des zones périphériques du site de Biguglia.
- Les SEs en bleu sont considérés comme potentiels. Les activités liées à ces services sont actuellement interdites dans la lagune de Biguglia en raison de la réglementation des réserves naturelles. De même, les SEs indiqués en bleu « Pisciculture » et « Produits non-alimentaires » n'existent pas ou ne sont pas utilisés au niveau du site Palavasien.

[11] Cette liste de services écosystémiques a été co-construite avec des gestionnaires et scientifiques des deux sites étudiés (le complexe lagunaire Palavasien et le site de la lagune de Biguglia). Elle a été utilisée telle quelle dans le chapitre 2 et adaptée pour les chapitres 3 et 4 (cf. Chapitres 2, 3 et 4).

La thèse comprend cinq principaux chapitres. **Le premier chapitre** présente un aperçu général du concept des SEs (origine, intérêt, principaux cadres conceptuels et définitions), une revue de la littérature sur l'évaluation des SEs (cadres théoriques, rôle des facteurs cognitifs, …) et le cadrage et la structure de la thèse (problématiques, cadre conceptuel mobilisé, …). Les trois chapitres suivants sont présentés sous forme de trois articles scientifiques dont un publié (chapitre 2) et un autre soumis (chapitre 3) dans des revues internationales. Le chapitre 4 a fait l'objet d'une communication orale à une conférence internationale.

Le second chapitre porte sur l'identification des consensus et points de divergence en termes de préférences déclarées d'un ensemble de parties prenantes pour les SEs en utilisant la méthode Q. Ce papier est présenté sous forme d'une étude comparative au niveau de deux écosystèmes lagunaires situés au sud de la France (le complexe palavasien et la lagune de Bigulia). Les parties prenantes dans cette étude concernent tout individu qui interagit fortement à travers sa profession et/ou ses activités de loisirs avec les sites étudiés. Il s'agit des gestionnaires, pêcheurs, chasseurs, résidents qui fréquentent le site étudié, … .

Le but n'est pas de chercher la représentativité auprès de l'ensemble des parties prenantes des zones étudiées. Il s'agit plutôt de faire remonter une diversité de points de vue en termes d'importance attribuée aux SEs fournis par les zones étudiées. Les cadres théoriques mobilisées de manière implicites sont celles du Choix social et de l'Utilité ordinale.

Deux questions de recherche sont traitées dans ce chapitre :

- Quelles sont les priorités de conservation et de restauration écologique des milieux lagunaires en termes de SEs pour lesquelles les avis convergent et/ou divergent?
- Quels sont les différents regroupements des parties prenantes ayant des avis convergents et/ou divergents en termes de priorités des SEs?

Les résultats issus de ces travaux ont fait l'objet d'une publication[12] dans la revue Ecological Economics intitulée : *« Identifying Consensus on Coastal Lagoons Ecosystem Services and Conservation Priorities for an Effective Decision Making: A Q Approach ».*

Le troisième chapitre concerne l'étude de l'impact de l'information académique et de la familiarité sur les préférences pour les SEs. Les préférences sont supposées mal informées dans ce chapitre. Les aspects internes ou psychologiques propres à chaque individu qui relèvent plus de la psychologie ne sont pas pris en compte. Les cadres théoriques utilisés sont ceux de l'Économie comportementale et du choix social (implicite).

[12] Sy, M.M., Rey-Valette, H., Simier, M., Pasqualini, V., Figuières, C., De Wit, R., 2018. Identifying Consensus on Coastal Lagoons Ecosystem Services and Conservation Priorities for an Effective Decision Making: A Q Approach. Ecol. Econ. 154, 1–13. doi:10.1016/j.ecolecon.2018.07.018

La principale question de recherche abordée dans ce chapitre est la suivante : Quelle est l'impact de l'information académique et de la familiarité sur les préférences pour les SEs ?

Trois types d'échantillons sont utilisés pour cette étude. Deux séries de données ont été collectées à travers un questionnaire lors d'ateliers avec des résidents locaux habitant les communes environnantes du site des lagunes palavasiennes (cf. chapitre 2). Les données ainsi obtenues lors de ces ateliers ont été collectées avant et après l'apport de l'information académique sur les aspects liés au fonctionnement de l'écosystème, aux dimensions socio-économiques et à la gestion de la zone d'étude. L'information académique a été fournie aux participants sous forme de présentations PowerPoint et de documents de synthèse sur la zone étudiée. La troisième série de données a été produite suite à une enquête en ligne auprès des résidents des communes non littorales (France métropolitaine) avec le même questionnaire utilisé lors des ateliers. Cette population n'a reçu aucune information académique sur la zone d'étude lors de l'enquête.

Les statistiques descriptives et un modèle économétrique (le modèle logit multinomial) ont été mobilisés pour traiter les données collectées.

Ce chapitre rédigé sous forme d'un article scientifique et a été soumis pour une éventuelle publication dans une revue internationale[13].

Le quatrième chapitre a pour objectif de proposer un protocole d'évaluation non monétaire des SEs à l'échelle locale, mobilisant les approches d'agrégation des préférences délibérative et non délibérative. L'approche d'agrégation des préférences individuelles non délibérative proposée, le Jugement majoritaire, n'a jamais été utilisée dans un problème environnemental. Dans ce papier, il est question d'analyser et de comparer les résultats issus des deux différentes approches d'évaluation non monétaires des SEs. L'étude de ces différences a été réalisée dans très peu de travaux, notamment le fait de systématiquement caractériser le degré de variation des préférences individuelles agrégées avant et après la délibération (voir Murphy et al., 2017). Ce travail mobilise les cadres théoriques du Choix social et de l'Économie écologique ainsi que, de manière implicite, la théorie de l'Utilité ordinale.

Les questions traitées sont les suivantes :

- Quels sont les SEs pour lesquels les préférences ne varient pas quel que soit l'approche d'agrégation utilisée (délibérative ou non délibérative) ?

[13] Sy, M.M., Figuières, C., Rey-Valette, H., De Wit, R., 2019. The Impact of Academic Information Supply and Familiarity on Ecosystem Service Preferences. *Soumis pour publication*.

- Dans le cas des SEs pour lesquels les préférences varient, dans quelle mesure les résultats issus de l'agrégation des préférences individuelles diffèrent avant et après la délibération ?

Les données utilisées dans ce papier ont été collectées à travers un atelier regroupant des résidents locaux choisis de manière aléatoire. L'ensemble des participants habitent un rayon inférieur à 20 km du complexe lagunaire palavasien).

Ce travail a fait l'objet d'une communication orale à la 13ème conférence internationale de l'association européenne pour l'Économie écologique (ESEE) à Turku (Finlande). Il est intitulé en anglais *« Valuation of Ecosystem Services and Social Choice: An Original Protocol Combining Deliberative and Individual Preferences »*[14].

Enfin, les principaux résultats, les recommandations en termes de politiques publiques, les limites de la thèse et les perspectives de recherche sont explicités dans le **cinquième chapitre**.

Par ailleurs, j'ai contribué à deux autres papiers pendant la thèse et dont je suis co-auteure. Ces papiers traitent principalement les aspects liés aux structures et fonctionnement écologique des lagunes y compris celles de la zone d'étude. Les résumés de ces papiers sont présentés en annexe (cf. Annexe IV).

Le tableau 3 présente une synthèse des différentes études de cas réalisées dans le cadre de la thèse.

[14] https://esee2019turku.fi/

Tableau 3 : Récapitulatif des principales études de cas réalisées dans le cadre de la thèse.

Chapitre	Principale question de recherche	Cadre théorique	Données	Méthode d'analyse des données	Zone d'étude
2	Quelles sont les priorités en termes de SEs pour lesquelles les préférences convergent et/ou divergent?	-Choix social -Utilité ordinale (Implicite)	30 interviews individuelles avec des parties prenantes (deux heures en moyenne)	Méthode Q	-Complexe lagunaire palavasien -Lagune de Biguglia (réserve naturelle)
3	Quel est l'impact de l'information académique et de la familiarité sur les préférences pour les SEs ?	-Économie comportementale -Choix social (implicite)	-38 résidents locaux choisis de manière aléatoire Questionnaire de 45 mn répliqué deux fois -404 résidents des communes non littorales (enquête en ligne de 30 mn)	-Statistiques descriptives -Modèle logit multinomial	Complexe lagunaire palavasien
4	Les résultats issus de l'agrégation des préférences individuelles délibératives et non délibératives diffèrent-ils?	-Choix social (théorie du vote) -Utilité ordinale (Implicite)	21 résidents locaux choisis de manière aléatoire Questionnaire de 45 mn répliqué 2 fois	-Jugement majoritaire -Approche délibérative	Complexe lagunaire palavasien

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Chapter 2: Identifying consensus on coastal lagoons ecosystem services and conservation priorities for an effective decision making: a Q approach

Quelques activités pratiquées sur les lagunes méditerranéennes et leurs zones périphériques / © Syndicat Mixte des Étangs Littoraux (SIEL).

Identifying consensus on coastal lagoons ecosystem services and conservation priorities for an effective decision making: a Q approach

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Abstract

Coastal lagoons ecosystems, while representing benefits for the local populations, have been subjected to high anthropogenic pressures for decades. Hence, conservation measures of these ecosystems are urgently needed and should be combined with their sustainable uses. To address these issues, new research avenues for decision support systems have emphasized the role of the assessment of ecosystem services for establishing conservation priorities by avoiding monetarization approaches. These approaches, because they flatten the various values of nature by projecting them on the single monetary dimension, are often rejected by the stakeholders. We undertake a Q analysis to identify levels of consensus and divergence among stakeholders on the prioritization of ecosystem services provided by two French Mediterranean coastal lagoons areas. The results highlighted that there is a strong consensus among categories of stakeholders in the study sites about the paramount importance of regulation and maintenance services. Three groups of stakeholders, each sharing the same points of view regarding ecosystem services conservation, were identified for each study site. As a non-monetary valuation, Q methodology is very instrumental for the new pluralistic approach of decision support by capturing the values expressed by the stakeholders, without triggering a rejection reflex due to the monetarization.

Keywords: decision making; value plurality; non-monetary valuation; Q methodology; coastal lagoons, ecosystem services

1 Introduction

Natural areas in densely populated territories create a strong challenge for public policies. On one hand, conservation measures and management are needed to safeguard the ecosystems. On the other hand, it is important to consider the benefits that the local populations obtain from these ecosystems and to know their desires for the future in order to reconcile these with the conservation objectives. Therefore, the concept of ecosystem services (ESs) provides an operational analysis framework for thinking and assessing the relationships between human society and ecosystems. It facilitates the assessment of the values an ecosystem represents for humans. Traditionally, the cost-benefit approach has been considered as a central tool for decision-making for public action, involving the mobilization of economic methods to assign monetary values to environmental impacts. This involves integrating the costs or benefits of conservation measures and ecological restoration (De Groot et al., 2013; De Wit et al., 2017) into the traditional investment decision-making or planning tools. Ecological restoration is an intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity and sustainability (Society for Ecological Restoration International Science & Policy Working Group, 2004), and thus includes actions for improving water quality in aquatic ecosystems. However, whether for good or bad reasons, monetarization is often met with skepticism, when it does not trigger rejection, particularly in the area of ecological economics. Recent work emphasizes the need for other approaches for decision support systems, which focus more strongly on the values that are legitimate for individuals (Jacobs et al., 2018; Keune et al., 2015; O'Neill and Spash, 2000). These new research avenues (Guerry et al., 2015; Madrian, 2014; Rey-Valette et al., 2017) encourage the need for concerted approaches or the implementation of new types of information and awareness-raising incentives. Behavioral economics and environmental psychology provide concepts and tools that are very promising in this respect. To address these new challenges for the decision support systems of the management of ecosystems, the quality of the procedures implemented within the deliberative forums is very important for the legitimacy of such decisions. The evaluation of the quality of decision support systems depends on the tools used to gather individuals' points of view,

expression of arguments, analysis of convergence and divergence, and transparency of the trade-offs criteria. Unfortunately, most publications do not provide sufficient detail about the ESs assessment procedures.

We used Q methodology which, so far, has been little used in the field of ESs assessment (e.g. Armatas et al., 2016, 2014; Bredin et al., 2015; Buchel and Frantzeskaki, 2015; Pike et al., 2014). The advantage of the Q method is that, unlike approaches where deliberation is based on open discussions, the assessment is done individually. The collected data and the subsequent analysis allow then to identify possible consensus. Moreover, the variety of opinions is explicitly inventoried in the Q-method. Therefore, using Q method in decision making is more transparent than using methods based on open discussions. The Q method creates a kind of virtual forum where the protocol is strictly controlled in order to collect all the points of view. Thus, Q methodology allows to investigate the diversity of discourses and facilitates public participation (Zabala and Pascual, 2016). In other words, it does give insights into the range of opinions that exist about some issues within a sample population, and how those opinions differ and converge (Bredin et al., 2015).

The Q method is a semi-qualitative approach created by a physicist-psychologist William Stephenson in 1935 (Brown, 1980). The method was primarily used in the field of psychology and has more recently been applied in many disciplines involving subjective science such as ecological and environmental economics. This method proposes a technique for small samples and thus broadens and statistically strengthens the potentials of the analysis. It is therefore a pertinent method in the study of public opinion and attitudes, groups, roles, decision making, values and other self-involving domains (Brown, 1980). It is indeed important for the decision-makers not only to be able to prioritize the perceptions and preferences of stakeholders regarding environmental preservation policies but also to be able to assess the degree of consensus and the structure of the agreements around these preferences and shared values. Facing an increasing development of participatory approaches, decision makers seek in fact quality and representativeness of results (consensus) stemming from these methods (Dryzek and Tucker, 2008; Faehnle and Tyrväinen, 2013; Font et al., 2016).

The aim of this paper is to describe the variety of views among stakeholders on ESs that are considered as important in the future and identify consensus among them on the prioritization of these ecosystem services. The Q methodology was used, because, as mentioned before, this method is particularly promising for this purpose. Our article is not intended as a methodological assessment of Q methodology. However, as it is still very little used in the environmental science community, we will describe its stages and its statistical specificities with some detail. This study focuses on French Mediterranean coastal lagoons areas and their fringing wetlands in two different densely populated areas, which are described below in the section context. In both areas, measures for conservation and ecological restoration have been implemented, largely related to European Directives. Section 3 then presents the material and methods, with a wealth of details about the Q methodology. Section 4 contains the results, discussed and put in perspective in Section 5. Section 6 concludes the paper.

2 Context

The study area comprises two major coastal lagoons close to urban and sub-urban centers, i.e. the Palavas lagoon complex close to Montpellier (South of France) and Biguglia lagoon on the North-East coast of Corsica close to Bastia (see Fig. 1 and Table 1). In addition to the coastal lagoons, the areas considered for this study comprised the agricultural, semi-natural and natural areas in their immediate surroundings. The latter particularly included the peripheral wetlands as e.g., the salt marshes and reed beds along the littoral zones of the lagoons. In addition, it also included the Rhône-to-Sète canal running through the Palavas lagoons.

Coastal lagoons are productive and highly vulnerable ecosystems that constitute a transitional interface between terrestrial and marine domains (Gaertner-Mazouni and De Wit, 2012). Palavas and Biguglia lagoons are representative of a certain type of lagoons i.e. shallow, predominantly natural and recreational and bordered by an urban area. Biguglia lagoon was recognized as a very important site for waterfowl and as a consequence it obtained the Ramsar designation in 1991. It was acquired by the Haute Corse Department, and a Natural Reserve was created in 1994. Since then, the whole lagoon surface and a small part of the fringing wetlands (1,790 ha total surface) are no-entry zones with the exception of a small number of professional fishermen allowed for this traditional use. Recreational access is limited to

footpaths along very small portions of the littoral zone in the northern part only, allowing walking, bird-watching, appreciating the aesthetics of the landscape, etc. In contrast, for the Palavas lagoon complex, protection measures are currently less stringent and have been implemented later, mainly as Natura 2000 sites following designations by the Birds and Habitats European Directives. Traditional uses include professional fishing, recreational hunting and some oyster farming. The area is also important for recreation and parts of the lagoon surface are currently used for kite-surfing, kayaking etc., while motorized navigation is only possible in the Rhône-to-Sète canal. Nevertheless, in 2008, a large part of this area also received the Ramsar designation.

Water quality in both lagoons had been strongly impacted by the human development mainly due to nutrient over-enrichment. The nutrient over-enrichment of the Palavas lagoon complex occurred during more than four decades since the 1960's (De Wit et al., 2017). The degradation of the water quality in Biguglia lagoon is reflected by a shift from a dominance of aquatic angiosperms in the 1970's to varying dominance of phytoplankton and opportunistic macroalgae in the early 2000's (Pasqualini et al., 2017). Hence, the context of both studied sites is characterized by public policy focusing on improvement of water quality and ecological restoration particularly (Audouit et al., 2017; De Wit et al., 2017; Leruste et al., 2016; Pasqualini et al., 2017) and the application of nature conservation measures. For the Palavas lagoon complex for example, a major improvement was realised by the end of 2005 by the upgrading of the waste water treatment plant (WWTP) of the Montpellier agglomeration and its effluent diversion through an 11-km offshore outfall. The total costs of this improvement were 150 M€ and it resulted in an estimated reduction of nitrogen (N) by 83 % and of phosphorus (P) by 70 % (Meinesz et al., 2013 cited in De Wit et al., 2017). The actions towards a better water quality and conservation of nature remain the principal focus of public policy for the Palavas and Biguglia study areas. The implementation of these actions undoubtedly requires stakeholders' involvement. The identification of stakeholders' points of view as part of the implementation of such public policies is thus a key step towards a better acceptability of measures for conservation and ecological restoration particularly improvement of water quality.

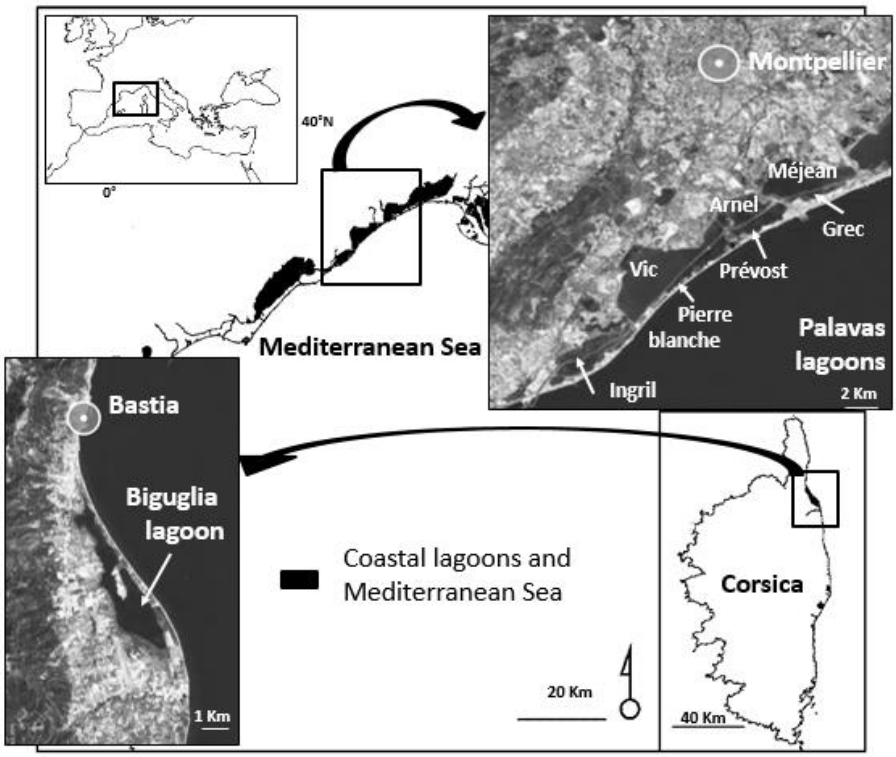

Figure 1: Location of the Palavas and Biguglia lagoons in the Western Mediterranean Sea (satellite images obtained from IGN-Géoportail).

Table 1: Main characteristics of the two study zones.

	Palavas site[1]	Biguglia site
Total lagoon surface	3,880 ha	1,460 ha
Geographic coordinates	43.51°N – 3.88 °E	42.60 °N – 9.48 °E
Average depth	0.4 m [2] *to* 1.2 m[3]	1.5 m
Fringing wetland surface	2,120 ha	518 ha
Main urban center (population size)	Montpellier (260,000)	Bastia (40,000)
Watershed surface	60,000 ha	18,000 ha
Total population in watershed	420,000 inhabitants	26,663 inhabitants
Trophic status before management implementation	mesotrophic[4] to hypertrophic[5]	eutrophic to hypertrophic
Years of major management implementation	2005	2007
Nature Reserve		Since 1994
Natura 2000	SAC[6]- 6,600 ha (FR9101410); SPA[7]- 6,600 ha (FR9110042)	SAC - 1,808 ha (FR9400571); SPA – 1,978 ha (FR9410101)
Ramsar	since 2008	since 1991

(1) *The Palavas lagoon complex comprises7 different lagoons that were created by compartmentalization of a historic large lagoon; (2) Grec and Arnel lagoons; (3) Prévost lagoon; (4) Ingril lagoon; (5) Méjean and Grec lagoons; (6) SAC = Special Area of Conservation (Habitats Directive); (7) SPA = Special Protection Area (Birds Directive). Note: the total area of the Natura 2000 site includes the Estagnol nature reserve.*

3 Material and methods

Fig. 2 shows the eight steps and work flow of our overall approach. The five steps depicted in grey include stakeholder participation, while the other three steps shown in white correspond to the work done by the authors of the study alone.

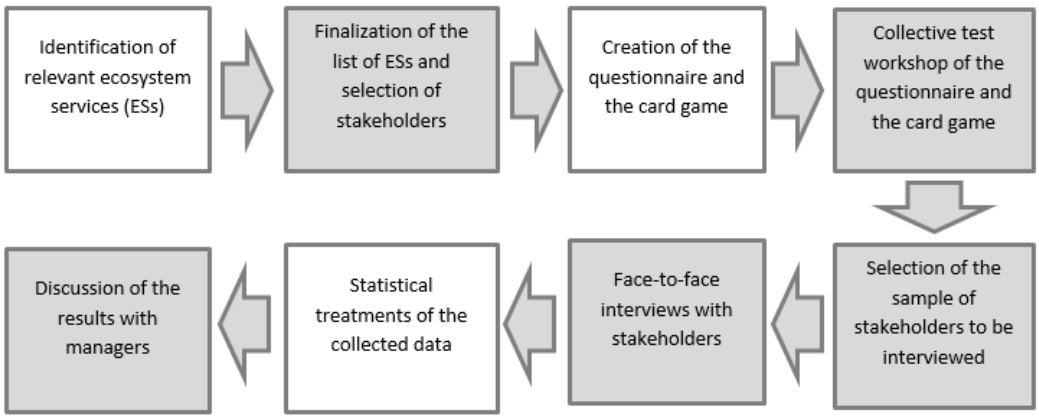

Figure 2. Scheme of the overall approach representing the different steps and work flow.

3.1 An overview of Q methodology

Q methodology is based on a serious card game. Its implementation in this study of ESs assessment followed the five steps described for the implementation of Q-methodology in general (Exel and Graaf, 2005). The first step involved creating the so-called concourse, which is generally defined as a collection of statements that could be proposed about the subject at hand (Exel and Graaf, 2005). In this study these statements are designations of ESs. Second, a subset of ESs, also called the Q-set, was listed from the concourse to be used in the serious card game by the participants. As typically for a Q study, we boiled down the concourse to a selection between 20 and 60 ESs for the Q-set (Webler et al., 2009). In our case, each card in the game represented a different ES, with a random number attributed to it. The ES was described on the card by words combined with an image to illustrate it. The third step consisted of defining the set of participants in the game, the so-called P-set, which represented the respondents for our analysis. Large number of participants are not required for a Q methodological study (Watts and Stenner, 2005) and the set of participants does not necessarily have to be representative of all the stakeholders. The participants in Q methodology were sampled based on nonprobability sampling (Du Plessis, 2005). Different from probability sampling, nonprobability sampling does not attempt to select a random sample from the population of interest (Battaglia, 2011).

Instead, it operates on the assumption of "finite diversity" (Barry and Proops, 1999) within a sample population.

The fourth step, called Q-sorting, consisted of the process of rank-ordering of the cards from the Q-set by the respondent (Brown, 1996; Exel and Graaf, 2005). Therefore, each respondent placed the cards with the different ESs on a triangular shaped grid according to the relative rank he or she attributes to these ESs, ranging from most important to least important. This step is usually followed by an exit interview where respondents are asked to explain the reasons for selecting the two most and least important ESs. Finally, the last step consisted of statistical and discourse analysis of the filled grids (called Q-sorts) in order to identify the number of natural groupings between the respondents (Exel and Graaf, 2005).

3.2 The selection of Q-set and P-set

3.2.1 Concourse creation and the selection of Q-set

The concourse was created from a wide range of sources such as scientific and grey literatures, newspaper articles or interviews. In this study, a primary set of ESs was identified following Liquete et al., 2013 who developed their scheme based on a comparison of previous classification of ESs (Millennium Ecosystem Assessment – MA, Beaumont et al., 2007, The Economics of Ecosystems and Biodiversity – TEEB and the Common International Classification of Ecosystem Services version 3– CICES) and adapted it for marine and coastal ecosystems.

Once listed, these primary ESs were then adapted to the study sites. For that purpose, through two focus group and several pilot testing meetings (see Fig. 2), some stakeholders and colleagues reviewed, selected, narrowed down and grouped the identified list of ESs. In addition, a review of local newspaper articles and grey literature referring to any ecosystem services provided by Palavas and Biguglia lagoons was carried out. The peer review phase was conducted with colleagues not involved in the project but having a good knowledge of the study areas. Some ESs were adjusted to the context of the study zones.

A final list of 31 ESs (See Table 2) was thus identified for the Q-set. Six of these ESs, in bold in Table 2, were considered as potential ones, as they are currently forbidden in Biguglia lagoon because of the Natural Reserve regulations. In contrast, for the Palavas lagoons most of these ESs exist and are used at present with the exception of fish farming and the harvesting of non-food products. In general, 30 ESs were entirely shared by the Palavas lagoon complex and Biguglia, while only one ES (number twenty-nine) had different meanings dependent on the context. This ES concerns commercial inland navigation linked to water provision services for uses other than human consumption (on the Rhône-to-Sète canal) for Palavas, and water-flow regulation service for agriculture in the zone adjacent to the fringing wetlands of Biguglia. The thirty-one services are grouped into three main categories i.e., (1) provisioning services, (2) regulating and maintenance services, and (3) cultural services. The Q-set was then presented to the participants in order to achieve the rank-ordering process or Q-sorting explained in section 3.3.

3.2.2 P-set characteristics

The set of participants also called P-set is obtained by strategic sampling, not random sampling, of a large number of participants (Armatas et al., 2014). The sample of respondents is neither based on representativeness nor quantity but rather on diversity (Eden et al., 2005; Zabala, 2014). Q participants are a sample of a population, but not in the same way as respondents in large survey studies (Webler et al., 2009). The aim of Q methodology is to capture a wide range of viewpoints within the P-set. In keeping the P-set to smaller numbers, an emphasis on quality is maintained, pattern and consistency can still be detected within the data (Watts and Stenner, 2005).

The P-set is usually built through an association of approaches such as grey literature review, focus groups meetings or snowballing through which the participants were asked to provide contacts of others. However, in the literature, there are no fixed rules about the choice of the right number of respondents in the P-set (Eden et al., 2005; Watts and Stenner, 2005; Webler et al., 2009). Webler et al., 2009 suggest for example to have fewer Q participants than Q ESs with a ratio of 3: 1. For instance, for a study with 45 ESs, the ideal number of participants would be 15.

Table 2. *The Q-set composed of the final list of ecosystem services proposed to the participants for the Palavas and Biguglia study areas.*

ES categories	ES subcategories	S#	Statement	General definition
Provisioning services	Food provision	*15*	Shellfish resources	The provision of biomass for human consumption and the conditions to grow it. It mostly relates to cropping, animal husbandry and fisheries.
		19	Biomass for grazing	
		21	Crops	
		22	**Shellfish farming**	
		23	Fish resources	
		30	**Fish farming**	
	Water provision	29*	Commercial inland navigation or Hydrological regulation	The provision of water for human consumption and for other uses.
	Biotic materials and biofuels	**31**	**Non-food products**	The provision of biomass or biotic elements for non-food purposes.
Regulation and maintenance services	Water purification	14	Purification capacity	Biochemical and physicochemical processes involved in the removal of wastes and pollutants from the aquatic environment.
		20	Wastes decomposition	
	Coastal protection	5	Flooding and other extreme events regulation and protection	Protection against floods, droughts, hurricanes and other extreme events. Also, erosion prevention in the coast.
		13	Banks reinforcement	
	Climate regulation	25	Microclimate regulation	Regulation of greenhouse and climate active gases. The most common proxies are the uptake, storage and sequestration of carbon dioxide.
	Life cycle maintenance	3	Nursery and biodiversity maintenance	Biological and physical support to facilitate the healthy and diverse reproduction of species.
Cultural services	Symbolic and aesthetic values	2	Aesthetic value of landscapes	Exaltation of senses and emotions by landscapes, habitats or species.
		7	Local identity	
		9	Aesthetic value of habitats or species	
		11	Historical sites	
	Recreation and tourism	**4**	**Recreational boat navigation**	Opportunities that the natural environment provide for relaxation and amusement.
		8	**Non-motorized water sports**	
		12	Bird watching	
		16	Cycling	
		17	Horse riding	
		18	Waterfowl hunting	
		24	Sentiment of relaxation	
		26	Camping	
		27	Recreational hiking and walking	
		28	**Recreational fishing**	
	Cognitive effects	1	Artistic inspiration	Trigger of mental processes like knowing, developing, perceiving, or being aware resulting from natural landscapes or living organisms.
		6	Research opportunity	
		10	Environmental education	

** ES #29 refers to: (a) water-flow regulation service for agriculture in the zone adjacent to the fringing wetlands of Biguglia and (b) commercial inland navigation linked to water provision services for uses other than human consumption (on the Rhône-to-Sète canal) for Palavas. ESs in bold are potential ESs which uses are currently forbidden in Biguglia lagoon because of Natural Reserve regulations. Likewise ESs #30 and #31 do currently not exist or are unused in Palavas lagoons.*

A way larger number was considered necessary in some other studies in order to capture the breadth of viewpoints within each stakeholder category (see Armatas et al., 2016, 2014; Pelletier et al., 1999; Simpson et al., 2016).

The identification of the typology of interest groups of participants on the Palavas and Biguglia areas required grey literature review and three focus group meetings with several scientists and managers. The interest groups of participants includes only stakeholders defined as "any group or individual who can affect or is affected by the ecosystem's services" (Hein et al., 2006). The identified list of stakeholders are grouped into 7 categories, namely: (1) local government; (2) private sector; (3) NGOs; (4) scientists; (5) public and para-public sectors; (6) managers and (7) local residents. A total of 57 interviews were conducted on the study sites, 30 on the Palavas lagoons and 27 on Biguglia. The characteristics of the P-set are presented in Table 3.

Table 3. *Main characteristics of the P-set comprising the stakeholders that participated in the surveys.*

	Palavas	Biguglia	Mean
Demographic characteristics			
% of female	37%	27%	33%
Average age (years)	47	46	46
% > 60 years	20%	22%	21%
% Degree > High school diploma	77%	85%	81%
% Degree > Bachelor	53%	74%	63%
Average years of experience in relation to the study site	13	14	13
Institutional characteristics			
% involved in conservation (NGOs, managers, local government)	47%	33%	40%
% involved in resource exploitation (Private sector)	10%	30%	19%
% involved in institutional management arrangements	43%	52%	47%
% of local and government authorities services	17%	26%	21%
% of researchers	10%	11%	11%
% of local residents and NGOs representatives	27%	19%	23%
% of Managers	17%	15%	16%

3.3 Face-to-face interviews, Q-sorting and questionnaire

The identification of stakeholders' perception regarding the importance of the ESs provided by the study sites was the principal module of the face-to-face interviews.

Table 4. *General information about the two surveys carried out for Palavas and Biguglia study zones.*

	Palavas	Biguglia
Numbers interviewed	30	27
Survey period	January-February 2017	May-June 2017
Survey location	Work place	
Questionnaire method	Face to face	
Survey duration	1h30 – 2h00	
Questionnaire type	Closed and semi-open questions (34 questions)	
Number of services listed	31	

This part was presented to the respondents as the serious card game asking the participating stakeholders to rank-order the set of the selected ESs (Q-set) on a triangular-shaped grid that is specific to the Q method (see Fig. 3). There were exactly the same number of illustrated cards as cells in the grid. This exercise followed three steps. First, the participant was given the selection of 31 cards illustrating each a different ES, with its randomly attributed number. The participant was then asked to roughly divide the pile of 31 cards into three piles corresponding to relatively important, neutral and not important. Using this pre-selection, the respondents then distributed the cards on the grid with cells scaled from relatively most important (+4) to relatively least important (-4). Once all the cards were distributed on the grid, the participant was allowed to modify the relative order of the cards. At the end, the filled grid, also called the Q-sort, had to represent his or her relative perceived importance of all the illustrated ESs.

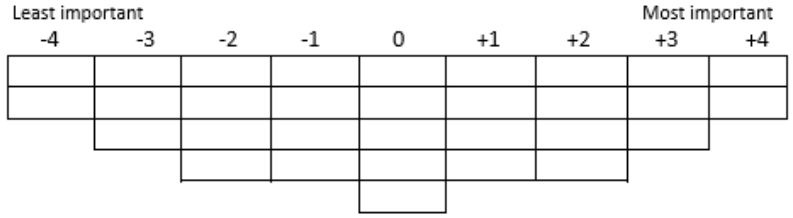

Figure 3. The grid presented to the respondents for the Q sorting exercise. After Q-sorting, each cell of the grid holds a single card.

The Q-sorting exercise was followed by an exit interview during which each participant was asked to fill in a questionnaire for obtaining the general socio-economic characteristics of the stakeholders and to explain the reasons behind his or her choices about the two relatively most important (score +4) and relatively least important (score -4) ESs. The verbal expressions of the participants were written out by the interviewer, examined through a discourse analysis and categorized.

3.4 The analytical process

The aims of the analytical process was to identify groupings among the Q-sorts obtained for the two different sites and to identify the levels of agreement or disagreement that may exist among the stakeholders concerning their perception of the importance of the different ESs. The analytical process uses different terms with names that may vary according the authors. In this study, we follow the terminology used by Zabala and Pascual (2016) with the exception mentioned before, i.e. we use "ESs" instead of "statements". The grouping is based on the identification of factors, which are defined as sets of individual Q-sorts. Each factor captures the stakeholders' perspective for a different group of respondents. This is based on the assumption that participants who are like-minded about the importance of ESs, will have similar Q-sorts and they will show up as a factor (Brown, 1980), allowing to identify them as a group. This analytical process followed two major steps (see Table 5). Firstly, a two-dimensional matrix was created that listed for all the 31 ESs, the value attributed by the different individual respondents in their Q-sorts. The Q-sorts were correlated, instead of variables as it is more common in multivariate analysis, to create a correlation matrix. From this correlation matrix, so-called unrotated factors were extracted by Principal Component Analysis (PCA). However, to be meaningful only a limited number of factors should be used. We selected these factors by a combination of three criteria: at least two significantly Q-sorts loadings, eigenvalues higher than 1.00, and visual inspection of the scree plots. The selected factors were mathematically rotated using varimax, in order to render the data structure clearer. This rotation solution maximizes the amount of variance explained by the selected factors (Watts and Stenner, 2005). The second step of the analysis is specific for the Q-method and consists of three parts (see Table 5), i.e. (i) flagging the Q-sorts that will define each component (factor), (ii) calculating the scores of the ESs for each factor and (iii) finding the distinguishing and consensus statements (Zabala and Pascual, 2016). The process of flagging consists of deciding whether or not a given Q-sort is representative for one of the rotated factors. Flagging a Q-sort on a specific factor is based on two criteria, i.e. the loading of that Q-sort for that specific factor is significantly high and this loading is much larger than the loadings of the same Q-sort on the other factors (Zabala and Pascual, 2016). This way, each individual Q-sort was either flagged to one of the factors or not flagged at all. In the latter case the Q-sort was excluded from subsequent calculations as it was considered as a less representative Q-sort. Factor scores and z-scores were used to calculate the ranking of ESs within each factor, i.e., to indicate the relative

position of each ES within the different factors. The z-score is the weighted average of the values of the Q-sorts most closely related to each factor and it represents a real number. Factor scores are integer numbers which are used to construct the Q-sort of a factor. They are obtained from the ordering of z-scores. These Q-sorts are considered as archetypal for the group that is presented by the factor (Zabala and Pascual, 2016). The individual Q-sorts within this group show similarities with the Q-sort of the factor without necessarily being the same. Finally, agreement and disagreement about ESs is judged by comparing the z-scores of ESs according their different factors. Similar z-scores for different factors thus indicate consensus, and strongly different z-scores indicate disagreement. Only, higher absolute values of z-scores were used to describe salient results.

Table 5. *The different steps of the analytical process of Q methodology.*

	Main steps of the analytical process of Q method	Description and definition of the key terms
Step 1	The principal component analysis (PCA)	• Creation of a two-dimensional matrix that listed, for all the 31 ESs, the value attributed by the different individual respondents in their Q-sorts The cell values are the scores, ranging from (-4) to (+4). • Calculation of the correlation matrix from the initial data and factors extraction The Q-sorts were correlated, instead of variables as it is more common in multivariate analysis, to create a correlation matrix. • Selection of the extracted factors according to a combination of 3 criteria and the use of rotation routine "Varimax" to maximize the variance explained by the extracted factors
	Flagging	Flagging the Q-sorts defining each extracted factor The process of flagging consists of deciding yes or no whether or not a given Q-sort is representative for one of the rotated factors.
Step 2	Calculation of z-scores and factor scores	Calculation of the ranking of ESs within each factor The z-scores are the weighted average of the values of the Q-sorts within each factor. The factor scores are integer numbers used to construct the Q-sort of a factor.
	Identification of distinguishing and consensus ESs	Identifying consensus and distinguishing ESs by comparing the corresponding z-scores of each factor In this step, similar z-scores for different factors thus indicate consensus, and strongly different z-scores indicate disagreement.

More recently, the standard analytical process of Q methodology has been reviewed and improved using an innovative approach of bootstrapping Q (Zabala and Pascual, 2016). This new analytical perspective allows to obtain additional and detailed measures of variability for a better understanding of the data. Therefore, Q factor analysis was carried out in this study using the package "qmethod" developed on the software R (see Zabala, 2014; Zabala and Pascual, 2016), using 5000 iterations for both of our study cases. A full Q analysis was then carried out for each iteration and all the relevant statistical estimates were calculated for the different ESs: the mean of the bootstrapped values of the z-scores on the different factors, the associated error bars characterizing its variability and the pairwise comparisons of z-scores.

4 Results

The Q-factor analysis, improved by bootstrapping, allowed us to meaningfully extract three factors for both study cases that explained in total 61% and 63.1% of the variance in the individual Q-sorts for the Palavas and Biguglia cases, respectively. Based on these three factors we were able to identify for each site three distinct groups of stakeholders regarding their ESs' conservation priorities. The Q-sorts of the different factors are depicted in Fig. 4. How to read these grids is explained for the Q-sort of group 1 in Palavas as an example. Accordingly, the ESs considered as "most important" by this group are regulation and maintenance type (dark grey). The randomly-attributed numbers in the corresponding cells indicate (see Table 2) that these ESs correspond to Flooding and other extreme events regulation and protection (5) and to Nursery and biodiversity maintenance (3). The ESs scored as "least important" by this group are two cultural services (white), i.e., waterfowl hunting (18) and Camping (26). However, exit interviews indicated that many respondents in this group, actually rejected ESs with very negative scores, rather than considering those as simply not important. For instance, a respondent in this group states that the "site is too fragile to accept camping". The frequency distribution of these individual Q-sorts among the different groups is listed in Table 6.

In general, there was consensus about the importance of regulation and maintenance services for both case studies. Strikingly, for the Palavas lagoons, Nursery and biodiversity maintenance (3) scored as one of the most important ESs for all three groups. We characterized group 1 of stakeholders in Palavas as having an "environmental and hedonic vision", because in addition to the regulation and maintenance services they valued the aesthetic and symbolic ESs very high (i.e. ESs, Sentiment of relaxation (24) and Recreational hiking and walking (27). Compared to the other groups, these stakeholders are mainly public and para-public agents as well as local residents (see Table 6). We characterized group 2 in Palavas as adopting an "environmental and territorial approach", because of the heavy emphasis on the importance of regulating and maintenance ESs (dark grey). Such a vision is typically focused on considering the environment as a quality indicator for a territory. NGOs and local government representatives were proportionally more present in this group (see Table 6). Finally, the environmental and heritage sensitivity vision is shared by stakeholders who mainly favor regulation and maintenance services together with local identity (7). There was no clear pattern within this group in terms of composition.

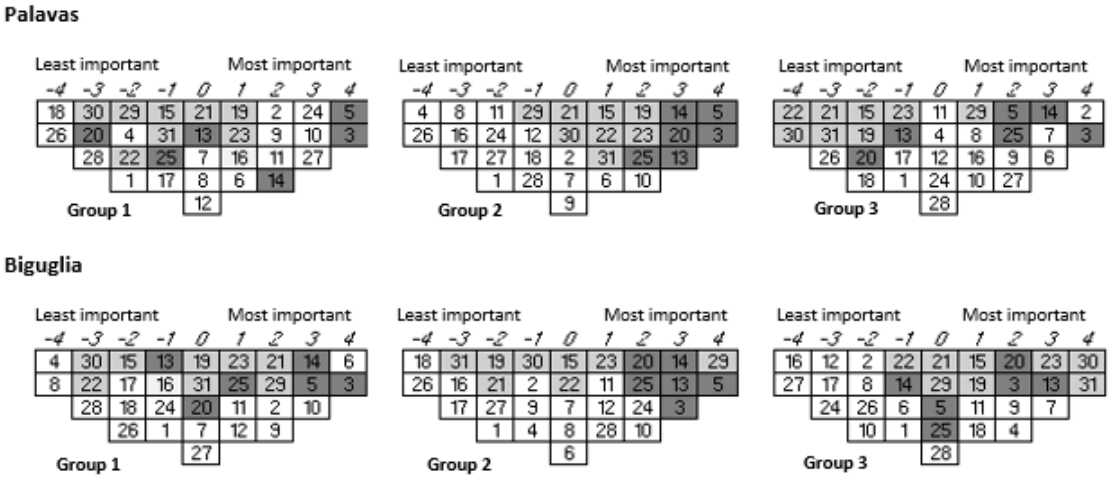

Figure 4. Q-sorts of factors that are representative for the different groups of stakeholders sharing similar points of view regarding ESs conservation priorities in the Palavas and Biguglia study areas. Points of view of the groups of stakeholders in Palavas case study can be characterized as (1) Environmental and hedonic vision; (2) Environmental and territorial approach; (3) Environmental and heritage sensitivity. Similarly, for the Biguglia case study we characterized the groups as: (1) Environmental and long term conservation vision; (2) Environmental and territorial approach; (3) Economic and tradition vision. See Table 2 for the correspondence between the random numbers attributed to the cards and the ESs, with background colors indicating ESs category: i) light grey = provisioning services, ii) dark grey = regulation and maintenance services, and iii) white = cultural services.

Likewise, three different groups of stakeholders were identified for the Biguglia case study. Group 1 has an environmental and long-term conservation vision based on placing regulation and maintenance services as Nursery and Biodiversity (3), Purification capacity (14) and Protection against flooding and other extreme events (5) among the highly important together with Research opportunities. Group 2 in Biguglia presents some similarities with group 2 in Palavas both sharing the environmental and territorial approach vision. Group 3 in Biguglia has a vision valuing economy and tradition. Accordingly, they support economic activities such as Fishing (23), Fish farming (30) and Value local identity (7). Table 6 presents in detail the number of significant Q-sort loadings per stakeholder type and per group.

Table 6. *Significant Q-sort loadings per stakeholder type and per group for both Palavas and Biguglia case studies.*

	Palavas			Biguglia			Total
	Group 1 *Environmental and hedonic vision*	Group 2 *Environmental and territorial approach*	Group 3 *Environmental and heritage sensitivity*	Group 1 *Environmental and long term conservation vision*	Group 2 *Environmental and territorial approach*	Group 3 *Economic and tradition*	
Stakeholder Type							
Public and parapublic	4	1		3	1	2	11
Local civic organisation		2	1	3	1		7
Local government	2	3	1				6
Local resident	4						4
Commercial operator	1	1	1	4	2	2	11
Managers	2	2	1	3	1		9
Scientist	1	1	1	2	1		6
Total	14	10	5	15	6	4	54

For a better understanding the similarities and differences of points of view among the stakeholders we analyzed consensus and distinguishing ESs among the stakeholder groups for both case studies. For that purpose, in Palavas case study, we used the plot in Fig. 5 along with Table I. 1 (in Appendix I) which presents significant consensus and distinguishing ESs among the groups. See Fig. I. 1 (in Appendix I) for Biguglia case study.

To check whether the valuation of a given ES is consensual among stakeholder groups requires that the z-scores on the different factors are comparable, i.e. statistically speaking this means that after testing we retain the null hypothesis that the z-scores are the same for all factors (see Table I.1 in Appendix I). This is the case when the error bars associated with bootstrapped estimates are overlapping (see fig.5) and all pairwise comparisons are non-significant. In contrast, when the error bars of z-scores on different factors show no overlap, we reject the null hypothesis and accept that there is a significant difference of z-scores indicating statistically differences for the valuations of the given ES among the stakeholder groups. The top part of Fig. 5 shows ESs with non-overlapping error bars, indicating divergent points of view among stakeholders. The top one, ES 27, i.e. Recreational hiking and walking, illustrates a case with a significant and particularly strong difference between group 1 and group 2 in Palavas. Accordingly, the difference of z-scores between the two groups for this ES (see Table I. 1 in Appendix I) is equal to 1.96, which is highly significant ($p < 0.01$). Factor loadings of both groups are also very different for this ES, i.e. +3 and -2, for groups 1 and 2, respectively (see Fig. 4). In contrast, the bottom part of Fig. 5 lists consensual ESs with overlapping error bars. Table I. 1 (in Appendix I) indeed confirms that for these ESs there are no significant differences when comparing pairwise the different groups of stakeholders. Among

these consensual ESs, ES3 which stands for “Nursery and biodiversity maintenance” showed the highest z-scores. In agreement, the Q-sorts of the three groups show factor loadings of +4.

The Venn diagram in Fig. 6 synthesizes the consensus on ESs among the identified groups of stakeholders for both case studies. Out of the ESs on which there was a consensus (see fig.5), we retained in the diagram only those who have a high absolute score (see Fig. 4). These include consensus on ESs that are scored (–4), (-3), (+3) and (+4) by at least one group of stakeholder. The aim is to highlight the position of the lower and higher ranked ESs across the different groups of stakeholders.

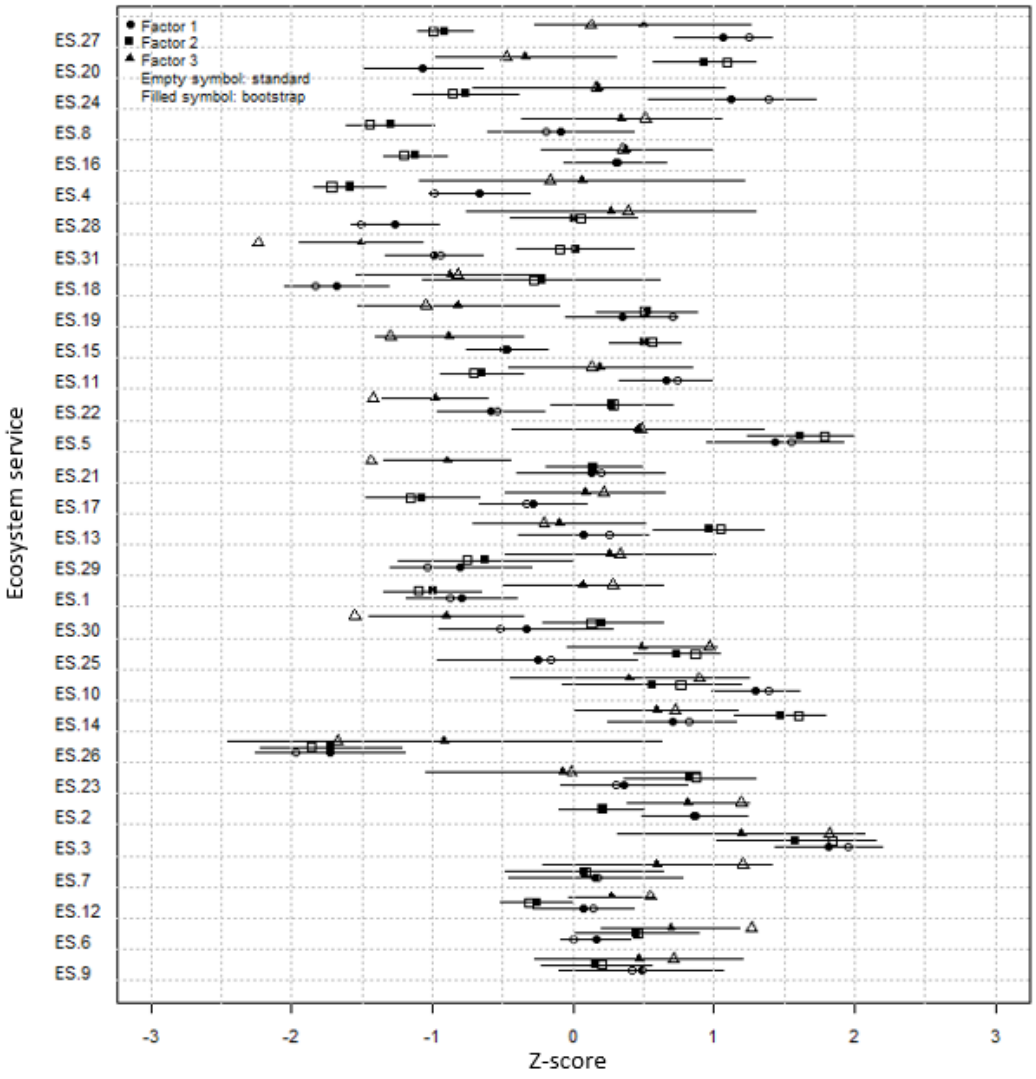

Figure 5. Plot illustrating consensus and distinguishing ESs among the three stakeholder groups identified (selected factors) in the Palavas case study. As shown in the figure, the bootstrapped scores of an ES are indicated by filled round, square and triangle shapes for stakeholders' group 1, 2 and 3, respectively (see Fig. 4 and Table

6). "The bars characterize the variability of the estimates in the bootstrap. An ES is consensual among the groups of stakeholders when the corresponding error bars overlap. ESs at the top of the plot distinguish the most the groups of stakeholders and the ones at the bottom are the most consensual ones. For example, there is a consensus on ES 9 (Aesthetic value of habitats or species) whereas ES 27 (Recreational hiking and walking) distinguishes the most all the stakeholder groups. See Fig. I. 1 (Appendix I) for Biguglia's case study and Table 2 for the correspondence between the numbers used and the ESs.

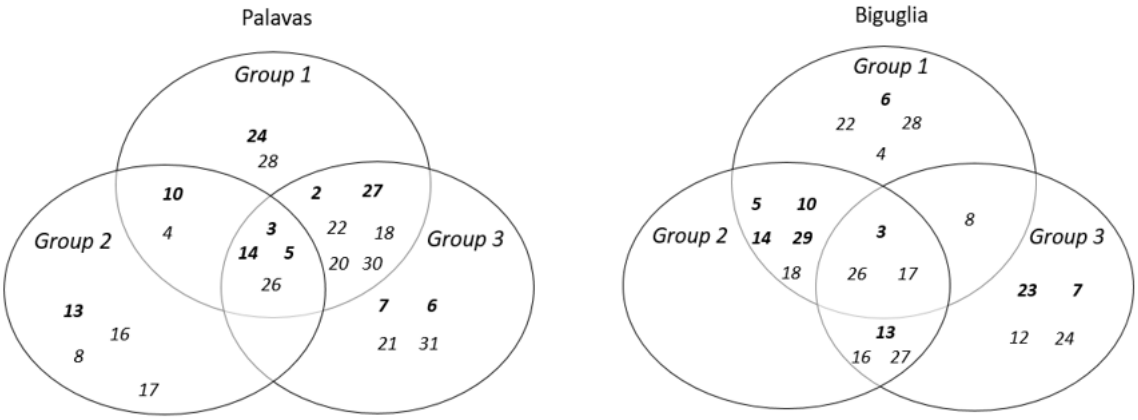

Figure 6. The Venn diagrams presenting consensus on relatively higher and lower ranked ESs by the identified groups of stakeholders for both Palavas and Biguglia case studies. The numbers in the diagram correspond to the numbering of the set of ESs used in the study (see Table 2 for correspondence). The bold and the plain numbers are seen as consensus ESs that are, respectively, relatively important (scored +3 or +4 by at least one group) and relatively less important (scored -3 or -4 by at least one group) across the groups of stakeholders.

Furthermore, the method provides the possibility of explaining choices made during the Q-sorting process with an open question (see section 3.3). The discourse analysis of all the comments and their classification allowed to identify 5 categories of arguments; the frequency distributions of the occurrence of these categories is shown in Fig. 7 for the Palavas and Biguglia study cases, respectively.

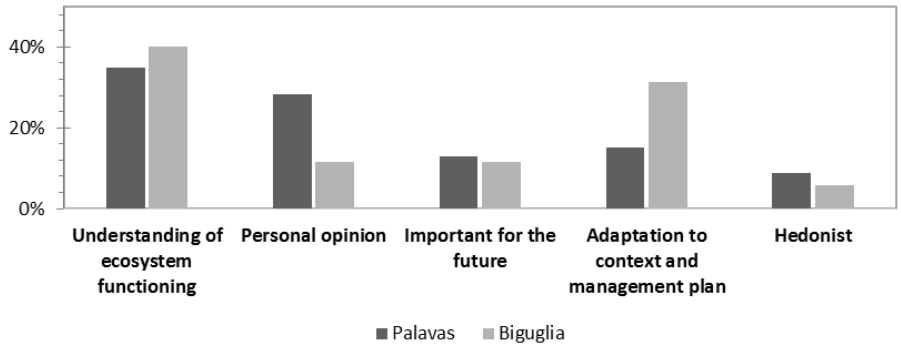

Figure 7. Frequency distributions of the occurrence of different categories of arguments stemming from the exit interviews for Palavas and Biguglia.

5 Discussion

The Q-methodology has proven to be a valuable tool for measuring in relative terms, the importance attributed to different ESs by stakeholders or other participants in a serious card games. The choices allowed are constrained by the geometry of the grid permitting a very limited number of ESs to be valued as “most important” and as “least important” with a larger choice for more neutrally valued ESs. The selection of ESs presented to the participants (Q-set) is of course of utmost importance and this was prepared carefully. Nonetheless, the face-to-face interviews with possibilities of open spontaneous expressions by the participants represents a way to check if no important ESs have been overlooked. This was apparently not the case in our study. On the other hand, the exit interviews clearly revealed a problem in the context of the assessment of ESs, as we detected ambiguity for the meaning attributed by the participants to negative scores. While, in general the negative scores have been presented as relatively “least important” we detected that these scores were sometimes used to express rejection. For example, for ES26 Camping in Palavas many stakeholders chose -4 as the score to express strong rejection believing that such activities are not in agreement with the conservation of the ecosystems and the benefits of other ESs. Accordingly, for future studies on this subject it appears more appropriate to formulate the grading of the scores from “lowest priority” (-4) to highest priority (+4).

We show that Q methodology is particularly well suited to identify convergences among the points of view of the stakeholders. The identification of consensus among stakeholders is particularly important for public policy to facilitate the acceptability of the management measures and helpful to design new management measures. Indeed, to adapt ESs conservation measures, it is necessary to know the issues for which the population agrees and those for which it is necessary to provide accompanying measures. These measures may include environmental education or awareness-raising, or even more formal economic incentives.

In general, the results highlighted that all the identified stakeholders groups of the study sites favored regulation and maintenance services. This observation is strengthened by the results of the analysis of the exit interviews where some stakeholders argued for instance that nursery and biodiversity maintenance are inestimable in ecological terms and thus have to be protected and reinforced. Moreover, others emphasized for example the usefulness of the protection provided

by coastal lagoons, against flooding and other extreme events. This is particularly important considering their geographical location on the coast and the rapid urbanization of the adjacent areas. In spite of these high degrees of agreements among stakeholders, there are also some discourses that differed. There are disagreements between some groups regarding recreational services. Nevertheless, as indicated in the results of the analysis of the exit interviews, there are relatively very few discourses approving the hedonic vision that seemed to prevail for group 1 in Palavas. In the case of Biguglia, the hedonic vision was not approved. However, some groups are relatively more tolerant about less impacting recreational activities (e.g. walking, nature observation), while others are strongly against all types of recreational services. The visions prevailing in the different groups may relate to differences in the perception of temporality and importance of individualistic versus collective approaches linked to scale differences. Hence, for the Palavas case study, the hedonic vision of group 1 is at the individual level, whereas the territorial and heritage sensitivity perspectives of groups 2 and 3, respectively, are rather based on a collective or territorial approach. On the other hand, groups 1 and 2 of stakeholders identified in the Biguglia case study hold a long- to mid-term conservation perspective, whereas group 3 has a short-term conservation perspective.

Some strong similarities emerged among stakeholders' priorities in terms of ESs between Palavas and Biguglia case studies, regardless of the fact that a major part of the latter is a nature reserve. Hence, many of the potential ESs (e.g. in bold in Table 2, see section 3.2.1) were not selected as important in Biguglia, but often as relatively not important. Other ESs, including Horse riding (ES 17), Cycling (ES 16) and Hunting (ES 18) are currently restricted in Biguglia, as these are forbidden in the reserve itself but do occur in its close surrounding. Among these, Horse riding was rejected by full consensus among all three groups in Biguglia (see Fig. 4). This showed that stakeholders accepted the current regulations prohibiting such ESs in Biguglia lagoon, related to its protection status as a natural reserve. Thus, Biguglia stakeholders did not put these potential ESs on the agenda to increase human uses of the lagoon in the future. Similarities in stakeholders' points of view about the desired state of the study sites can be mainly explained as a consequence the social dynamics in the territory, which has been initiated by public authorities and is currently focused on the improvement of water quality and the application of nature conservation measures. These actions tend to implicate all the major stakeholders categories through advisory boards for instance, organized by the managers of the lagoon sites. The advisory boards gather stakeholders around the table in order to express their points of view, to provide advice about issues at stake, and propose possible solutions, etc.

Furthermore, our results showed that there are no typical groupings of stakeholders based on their institutional backgrounds contrary to some previously published reports (e.g. Blayac et al., 2014; Martín-López et al., 2012; Mathe and Rey-Valette, 2015; Prévot and Geijzendorffer, 2016). We noticed, for example, that the vision of residents is not different from that of the public and parapublic actors. This convergence of visions can be partly linked to the fact that a large part of the interviewed stakeholders are institutionally involved (Table 3), and therefore actively participate, e.g. through advisory boards, in discussing different management measures. This phenomenon can also be explained as the result of a collective learning process in favor of conservation policies which are publicly advocated to promote the establishment of a local common good and effective conservation measures (Bierry and Lavorel, 2016). Thus the analysis of the arguments used to justify the positive or negative opinions shows that the choices are mainly based on the mobilization of knowledge, the adaptation of measurements to regulations or related to the context. The nature of the highlighted arguments thus demonstrates a collective regulatory capacity which constitutes an important asset for the effectiveness and legitimacy of policies in favor of conservation. In fact, the high level of consensus around the services to be primarily protected is, for the decision-makers, an important information in order to identify the potential sources of conflicts and the need for informative actions.

Thus, this integrated valuation method argues in favor of conservation policies in the study sites as widely acknowledged in the literature (Bark et al., 2016; Blancher et al., 2011; Jacobs et al., 2016). In this respect, the focus on long- to mid-term conservation perspectives and the collective approach expressed by several stakeholder groups are supportive and encouraging for conservation policies. On the other hand, the results lead to the conclusion, that there is no statistical relation between stakeholders' affiliation to a group and control variables such as their age, level of education, working experience on the study sites, etc. This implies that, there are no control variables explaining the differences between stakeholder groups on both of our study sites. Finally, while ESs are characterized and often criticized for involving a utilitarian vision of nature, it is interesting to note that the majority of the stakeholder groups favor rather collective visions that put forward the idea of the quality of the territory, either for the quality of its ecosystems or its natural and cultural heritage. These properties show stakeholders' sensitivity in favor of environment but also their ability to project into the long term, which is less common.

6 Conclusion

The use of the Q method allowed to point out the existence of a strong consensus for the Mediterranean lagoons areas' ESs considered as a priority in terms of protection. This consensus occurs between mobilized stakeholders, member of groups regardless of their institutional or demographic characteristics. There are also strong similarities between the results of the two types of lagoons studied, even if the Biguglia lagoon, with its status as a natural reserve, witnesses a stronger awareness of environmental values.

With recent growth in the field of ESs, a variety of decision support tools has emerged to perform more systematic ESs assessment (Bagstad et al., 2013). However, the meaning and reliability of ESs valuation techniques are subject to a growing scientific debate (Salles and Figuieres, 2013). This mainly concerns the flattening of values by projection on the single monetary dimension. Researchers acknowledge this reluctance among stakeholders and their commitment to plurality of values in ecosystems and biodiversity (e.g. Arias-Arévalo et al., 2018; Chan et al., 2012; Jacobs et al., 2016; Spash, 2009). This issue can be addressed via non-monetary methods (Kelemen et al., 2014). Not only the economic importance of nature but also its social and cultural importance, as well as the ethical rules which govern the bonds between nature and society can be appraised (Rey-Valette et al., 2017). On the other hand, as pointed out by Jacobs et al., 2016 it is crucial in ESs assessments to achieve the inclusion of stakeholders in research design in order to deal with power asymmetries and improve societal relevance of the valuation results. The Q-methodology itself does not provide a method to analyze power dynamics. However, if care is undertaken to create a large and pluralistic group of participants, it may provide a good mean for the expression by stakeholders groups that have less power in the political and socio-economic arena. Q methodology follows this decision support trend by capturing the various value dimensions of ESs expressed by stakeholders including cultural ESs (e.g. Pike et al., 2014). In particular, it allows the valuation and ranking of ESs according to the levels of consensus (Fig. 5), which is a way of prioritizing them other than by their monetary values. Its interest and originality are primarily based on its capacity to identify similarities, construct broad categories of stakeholders' points of views and explore patterns and relationships within and between these categories (Shinebourne, 2009). Hence, the Q-methodology by identifying the points of convergence between all participants and the

construction of broad categories' points of view is a great first step for consensus building and we believe that it can be used as a decision support tool in participatory methods.

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Chapter 3: The Impact of Academic Information Supply and Familiarity on Preferences for Ecosystem Services

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Abstract

Preferences elicitation can be a challenging exercise for citizens participating in assessment surveys, especially when it comes to complex and unfamiliar ecosystems and the ecosystem services they provide. Making people aware of the characteristics of the ecosystem services being valued is determinant for the assessment process. We investigated the impact of familiarity and academic information supply on people's preferences for twenty selected ecosystem services of French Mediterranean coastal lagoons. Independent of familiarity and information supply, there is strong consensus about the highest importance of regulation and maintenance ecosystem services as well as environmental education and research opportunity ecosystem services. By contrast, nine of the cultural ecosystem services, together with two provisioning ecosystem services showed heterogeneous preferences among the different citizen groups. Using a combination of descriptive and inferential statistics these eleven ecosystem services split up into three clusters characterized as (i) contemplative leisure, (ii) heritage, and (iii) consumptive activities. Familiarity and academic information supply had a strong impact on the preferences for these three clusters of ecosystem services.

Keywords: preference elicitation, coastal lagoons, citizens' workshop, paternalism, cultural ecosystem services (CES), veil of ignorance

1 Introduction

Ecosystems are essential for human well-being. Therefore, understanding the link between ecological processes of ecosystems and human welfare is critical for a wide range of decision-making contexts (Fisher et al., 2009). This is even more important in a context of global environmental change such as sea-level rise due to climate change (Kuhfuss et al., 2016). Gathering information on complex ecosystem functioning and translating it into benefits society obtains from Nature has been widely carried out using the concept of ecosystem services (ESs) and through its economic valuation (see Daily et al., 1997; Dendoncker et al., 2014; La Notte et al., 2015). More recently, the concept of Nature's Contributions to People (NCP) has been introduced in recognition of the pervasive role of culture for the link of humans with nature and to better accommodate indigenous knowledge (Díaz et al., 2018). ESs valuation includes assessing trade-offs between values, some of which are clearly perceived by people while others are not (De Groot et al., 2012). Hence, in general, it is based on assigning relative importance to nature's diverse values (Jacobs et al., 2016). This could allow more efficient conservation choices (Salles and Figuieres, 2013). The development of the ESs economic valuation approaches have been advocated to support decision making and management (Marre et al., 2015). Economic valuation is often understood as a process used to attribute a monetary figure to one or several ESs, though some argue that its contribution to decision making remain uncommon (Laurans et al., 2013). Moreover, it has been argued that the value of nature cannot be reduced to a single value expressed as a monetary metrics (Daily et al., 1997, 2009; Jacobs et al., 2018, 2016; Rey-Valette et al., 2017; Sy et al., 2018), and this criticism is particularly common within the ecological economics school of thoughts (e.g. Daily et al., 1997, 2009; Gowdy and Erickson, 2005; Martinez-Alier et al., 1998). Responding to this criticism, many studies have proposed integrated valuation schemes based on trans-disciplinary approaches focusing on value plurality and on integrating preferences and social representations (e.g. Arias-Arévalo et al., 2018; Dendoncker et al., 2014; Jacobs et al., 2018, 2016; Liu et al., 2010; Turner et al., 2000). Hence, this area of transdisciplinary research relies particularly on the contributions from economy and ecology, but also on important contributions from sociology, psychology, ethnobiology, geography and others. This has often created difficulties of understanding the meaning of the different terms among researchers from the different disciplines (Jacobs et al., 2016). To overcome such difficulties, we provide descriptions of the terms used in Box 1.

In environmental valuation practice, there is an ongoing debate about the process on how to achieve the outcome. Nevertheless, so far, little is known on how existing valuation methods actually elicit the different values (Jacobs et al., 2018). Preferences elicitation can be a challenging exercise for citizens involved in assessment surveys especially when it comes to complex and unfamiliar goods or services. For instance, nature services like water purification or climate regulation are generated by a complex interplay of natural cycles (Daily et al., 1997), which is often hardly understood by the majority of the citizens. In the economic literature, the easiest-to-study situation is when individuals are well-informed about the various characteristics of the objects and when their preferences are exogenous and reliable (O'Neill and Spash, 2000). This ideal situation is considered as the benchmark for which it is assumed that individuals behave rationally by maximizing their self-interest (Yamagishi et al., 2014). However, many findings show that respondents involved in preference elicitation surveys are often not familiar and often do not hold appropriate information on the ecosystem goods and services being assessed (Ami et al., 2018; Blomquist and Whitehead, 1998; Brahic and Rambonilaza, 2015; Hanley and Munro, 1992; LaRiviere et al., 2014; Lewan and Söderqvist, 2002; Spash and Hanley, 1995; Whitehead and Blomquist, 1991).

The citizen's lack of knowledge of and familiarity with ecosystems have prompted some scientists and public authorities to plead for a predominating role of experts in environmental decision making. This often reflects the belief that public policies ought to be grounded on scientific-based assessments, rather than on citizens' "erroneous" preferences. Such an approach could result in paternalism (Dworkin, 1972), which conflicts with the democratic ideal. The situation is particularly problematic when expert knowledge and advice diverge from the opinions and preferences of a majority of citizens. In one way or another, politicians must respond to citizens' preferences, regardless of their accuracy. Hybrid forms do exist that allow to overcome stubborn discrepancies between experts and citizens. An example of such a hybrid form is known as libertarian paternalism that combines experts' knowledge and people's freedom of choice. Accordingly, the work of Sunstein and Thaler (2008) on nudges falls half way between paternalism and liberalism. It exploits the most recent advances of Behavioural Economics to design an architecture of choices in a way that preserves freedom of choice and at the same time navigates people towards the goals that are considered socially desirable. However, Thaler and Sunstein (2008) underline the need for information. They stressed that "people make good choices in contexts in which they have experience, good information, and

prompt feedback". They emphasized conversely that "people are most likely to need nudges for decisions that are difficult, complex, and infrequent, and when they have poor feedback and few opportunities for learning".

Note that both the paternalism and libertarian paternalism approaches assume that only the experts possess the knowledge of what ought to be done. In contrast, we assume that at least part of the relevant knowledge emanates from the citizens themselves, i.e. from their experience and the familiarity they have acquired with the natural environment. Hence, not only indigenous people (Díaz et al., 2018), but also citizens in Western countries that are familiar with ecosystems have often acquired local knowledge that is complementary to the scientific knowledge. Such local knowledge may include both the ecological knowledge, i.e., the ethno-biological local ecological knowledge (Narchi et al., 2014), as well as the knowledge about the benefits citizens obtain from the ecosystems. Nevertheless, the citizens' preferences, which are sometimes based on a lack of knowledge about ecosystems and the services they provide, could change progressively as more information is provided. This corresponds to the external information that citizens often do not possess a priori (Costanza, 2004) and which they can acquire through increased familiarity with the ecosystems, from academic information or from a combination of both. Citizens who live in the proximity of the focal ecosystem or regularly visit them during holidays become familiar, meaning that they have become well acquainted with this ecosystem. Hence, depending on the individual, familiarity may result in increased cognitive knowledge, give rise to appreciations based on affection of the focal ecosystem or to a combination of both (Van Giesen et al., 2015). In contrast, the supply of academic information only targets to increase the cognitive knowledge of the recipient citizens. For instance, Ami et al. (2018) reported that the impact of scientific information about the effects of air pollution on respondents' willingness to pay (WTP) values was strong. A proportion of people (30%) receiving scientific information revised their WTP upwards relative to the mean WTP value. Similarly, presenting survey participants with information about wetlands of varying quality (characteristics and services) significantly impacts their WTP (Whitehead and Blomquist, 1991).

Furthermore, besides familiarity and academic information supply, Hanley and Munro (Hanley and Munro, 1992) distinguished several ways information should be expected to affect true

WTP. First, making people aware of the existence of a similar environmental good may change their WTP for the one being assessed. Another way information impacts preferences is when people are told about relative expenditure (e.g. their income, budget for other public goods and others) as they may not be aware of how their WTP compares to their spending. Information about the availability of the good and thus supply uncertainty may as well change people's WTP. Finally, information about the behaviour of others can affect people's incentive to behave strategically and influence their WTP. Individuals' preferences or preferences elicitation issues may as well result in uncertainty related to internal or psychological aspects specific to each individual. These aspects do not fall into the scope of this paper and will not be addressed because we rather focus on the impact and type of information in preference elicitation processes.

This study analyses the determinants of preferences for ESs in a context of global environmental change. More precisely, the aim is to test whether familiarity and academic information impact citizens' preferences for the relative importance of the different coastal lagoon ESs. Therefore, we used the Palavas lagoons' complex, which comprises seven coastal lagoons on the Mediterranean coast close to the city of Montpellier (South of France), as our case study. We carried out an analysis combining descriptive statistics and an econometric model to test our hypothesis. Section 2 details the material and methods used. Sections 3 to 5 presents, discuss, justify and conclude the main results that were obtained from the data analysis.

Box 1 - Explanation of terms used

Citizens' workshops = a meeting, often organized by scientists, where the citizens receive and contribute to the production of knowledge through questionnaires, serious card games, learning, discussions and exchanges both among the citizens as well as with the organizers.

Coastal lagoon = an often shallow water body located on the coastline but separated from the adjacent sea by a coastal barrier, temporarily or permanently exchanging water with the sea through an inlet (Kjerfve, 1994). These ecosystems can be brackish, saline or hypersaline and provide home to rich aquatic vegetation and animal communities.

Cultural ecosystem serves (CES) = the nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences (Millenium Ecosystem Assessment, 2005).

Familiarity (with an ecosystem) = being acquainted with the ecosystem by living in its proximity or regular visits resulting in affective links with, and/or increased cognitive knowledge of, the ecosystem acquired through experience.

Libertarian paternalism = an approach according to which it is both possible and legitimate for private and public institutions to affect behaviours while also respecting freedom of choice (Thaler and Sunstein, 2008).

Nudge = a concept introduced by Thaler and Sunstein (Thaler and Sunstein, 2008) and defined as any aspect of the choice architecture that alters people's behaviour in a predictable way without forbidding any options or significantly changing their economic incentives. Hence, nudges are not mandates.

Paternalism = the interference with a person's liberty of action justified by reasons referring exclusively to the welfare, good, happiness, needs, interests or values of the person being coerced (Dworkin, 1972).

Perception = a thought, belief, or opinion, often held by many people (Cambridge Dictionary, 2019).

Preference elicitation = the process of drawing out individual or group preferences, based on their perceptions, through surveys, citizen workshops and others.

Single and double loop learning processes = single loop refers to learning that is applied straightforwardly, while double loop refers to learning that provokes a profound change in the reference systems of individuals and their understanding of the subject (definitions adapted from Argyris and Schön (1996)).

Value pluralism = the recognition of different and often conflicting value domains that are neither reducible to each other nor to some ultimate value (Arias-Arévalo et al., 2017).

Veil of ignorance = a procedure according to which individuals do not know how the various alternatives (e.g. different ecosystem services) will affect their own particular case. Hence they can evaluate principles solely on the basis of general considerations (definition adapted from Rawls, 1971).

2 Material and methods

2.1 Study area

Palavas lagoons' complex is located in the southern part of France bordering the Gulf of Lion in the Mediterranean Sea (see Figure 1). In addition to the lagoons, the study site comprises as well peripheral riparian zones such as agricultural and natural areas. Palavas lagoons are representative of a certain type of lagoons i.e. shallow, predominantly natural and recreational nearby an urban area. Water quality in the lagoons had been strongly impacted by human activities mainly due to nutrient over-enrichment which occurred during more than four decades since the 1960's (De Wit et al., 2017; Sy et al., 2018). Climate change effects, in particular sea-rise level, the increase in temperature or the variation in freshwater availability, could also have ecological consequences on the lagoons (Kuhfuss et al., 2016). In response to these issues, ecological restoration targeting good water quality and good ecological status were initiated by decision makers (De Wit et al., 2017; Leruste et al., 2016). For instance, in 2005, the implementation of an 11 km offshore outfall system diverted the treated sewage effluents leading to a drastic reduction of anthropogenic inputs of nitrogen and phosphorus into the lagoons (Leruste et al., 2016). Moreover, the area is a Natura 2000 site and also received the Ramsar designation in 2008 (Sy et al., 2018). The main characteristics of the Palavas lagoons are presented in Table 1 (adapted from Sy et al., 2018).

Table 2. Main characteristics of Palavas lagoons' complex.

	Palavas lagoons
Surface	
Total lagoon surface	3,880 ha
Fringing wetland surface	2,120 ha
Watershed surface	60,000 ha
Geographic coordinates	43.51°N – 3.88 °E
Average depth	0.4 m [(2)] to 1.2 m[(3)]
Population	
Main urban center (population size)	Montpellier (260,000 inhabitants)
Total population in watershed	420,000 inhabitants
Trophic status before management implementation	Mesotrophic[(4)] to hypertrophic[(5)]
Natura 2000	SCI[(6)] - 6,600 ha (FR9101410); SAC[(7)] - 6,600 ha (FR9110042)
Ramsar	Since 2008

Note: (1) The Palavas lagoon complex comprises 7 different lagoons that were created by compartmentalization of a historic large lagoon; (2) Grec and Arnel lagoons; (3) Prévost lagoon; (4) Ingril lagoon; (5) Méjean and Grec lagoons; (6) FR9101410 - SAC = Special Area of Conservation (Habitats Directive); (7) FR9110042 - SPA =

Special Protection Area (Birds Directive). Note: the total area of the Natura 2000 site includes the Estagnol nature reserve.

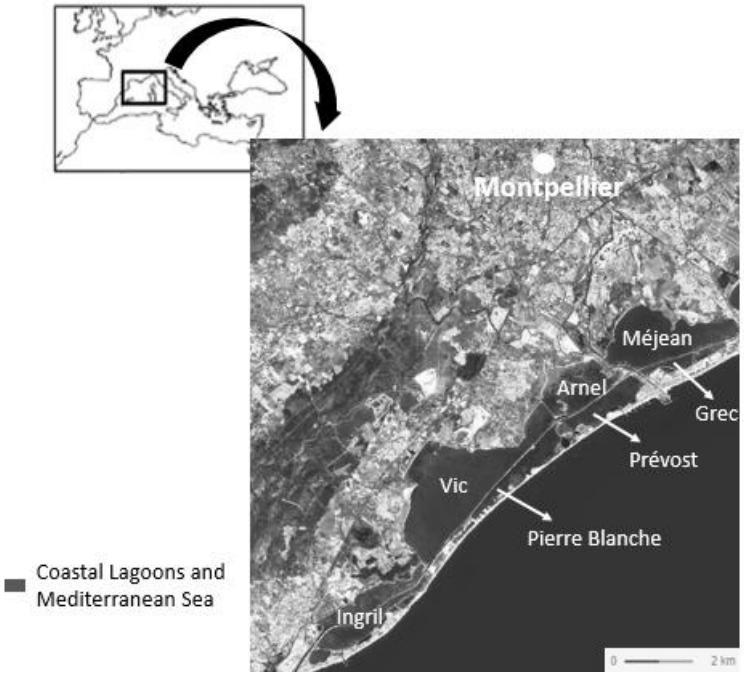

Figure 11. Palavas lagoons complex. Satellite images from IGN-Géoportail.

2.2 Survey characteristics and data collection process

The surveys were conducted among randomly selected local citizens near the Palavas lagoons and non-local citizens living in non-coastal municipalities in France. The former was carried out in May and June 2017 involving 38 local residents living within a radius of 15 km from the study site. The survey involving non-local citizens comprised 803 individuals was carried out in June 2018. From the data set obtained, the responses of two groups were used for the analysis. These groups were (i) a subsample of 115 non-local citizens that are familiar with the lagoons and (ii) a subsample of 289 non-local citizens that are unfamiliar with the lagoons. We introduced the notion of familiarity to indicate the proximity and frequency of visits of these lagoons. Non-local citizens who are familiar with the lagoons reported that they visit them very regularly. The Coarsened Exact Matching (CEM) technique was applied afterwards to allow non-biased comparisons among the local and non-local groups (see section 2.3.1).

Table 3. Initial characteristics of the surveyed population types

Population type	**Non-Local Residents**		**Local Residents**	
	Unfamiliar	Familiar	Local	Local bis
Number of surveyed individuals	289	115	38	
Familiarity with the study site	Never visited	Regularly visit	Familiar	
Data collection method	On line		Workshop	
Survey period	June 2018		May-June 2017	
Perception type	Existing		Existing	Constructed
Information supply	None		None	Academic

Data were collected for both surveys using the same questionnaire which was composed of two series of questions as recommended in the literature on perceptions of ESs (see Blayac et al., 2014): open and spontaneous as well as closed questions, mainly on, perceptions of the activities and the characteristics of the lagoons area. A list of twenty ESs (see Table 3) was selected before by focus groups of scientists and lagoon managers, considering these ESs as the relatively most important ESs provided by Palavas lagoons (see Sy et al., 2018). The general definition of the ESs presented in Table 3 was adapted from Liquete et al. (2013), who constructed a classification scheme of coastal and marine ESs based on a review of the main existing ones (e.g. the Economics of Ecosystems and Biodiversity – TEEB and the Common International Classification of Ecosystem Services – CICES). The twenty selected ESs (see Table 3) were presented in a randomized order in the survey, without any reference to ES categories. The respondents were asked to indicate their preferences for the different ESs on an ordinal scale selecting one of the five modalities for each, i.e. ‘high priority’, ‘priority’, ‘neutral’, ‘low priority’, ‘not a priority’.

Responses of local citizens were obtained during a workshop where these respondents first filled out the questionnaire before receiving academic information about the study area. The academic information was then provided by the authors of the study in the form of oral presentations with the use of a PowerPoint support. The information supply session lasted about an hour. The presentations focused on ESs as well as aspects related to the ecological functioning, socio-economic dynamics and management of the Palavas lagoons and their immediate surrounding areas. In the other hand, data were collected for the non-local populations group through an online survey.

Table 4. The set of the twenty ecosystem services (ESs) used in this study. The ESs have been categorized according to the classification designed for coastal and marine ESs by Liquete et al. (2013).

ES category	ES subcategory	Ecosystem services	General definition
Provisioning	Food provision	Biomass for grazing Shellfish farming Fish resources	The provision of biomass for human consumption and the conditions to grow it. It mostly relates to cropping, animal husbandry and fisheries.
Regulation and maintenance	Water provision	Water purification capacity	Biochemical and physicochemical processes involved in the removal of wastes and pollutants from the aquatic environment.
	Coastal protection	Flooding and other extreme events regulation and protection Banks reinforcement	Protection against floods, droughts, hurricanes, erosion and other extreme events.
	Climate regulation	Microclimate regulation	Regulation of greenhouse and climate active gases. The most common proxies are the uptake, storage and sequestration of carbon dioxide.
	Life cycle maintenance	Nursery and biodiversity maintenance	Biological and physical support to facilitate the healthy and diverse reproduction of species.
Cultural services	Symbolic and aesthetic values	Aesthetic value of landscapes Local identity Aesthetic value of habitats or species Historical sites	Heritage and aesthetic values of the natural environment.
	Recreation and tourism	Non-motorized water sport Bird watching Waterfowl hunting Sentiment of relaxation Recreational hiking and walking Recreational fishing	Opportunities that the natural environment provide for relaxation and amusement.
	Cognitive effects	Research opportunity Environmental education	Trigger of mental processes like knowing, developing, perceiving, or being aware resulting from natural landscapes or living organisms.

2.3 Data treatment process

The overall work flow for data collection and treatment is presented in Figure 2. First, disparities in sample sizes and characteristics of the different resident groups (see section 2.2) were corrected using Coarsened Exact Matching (CEM) (see section 2.3.1). The second step consisted of identifying ESs for which preferences were either homogeneous or heterogeneous among the different groups of respondents. Then, we assumed that there were no impact of academic information and familiarity on those ESs for which preferences were homogeneous (see sections 2.3.2). The final step of the analysis consisted of identifying factors explaining the heterogeneity of preferences for the remaining ESs using a logit multinomial model (see section 2.3.3).

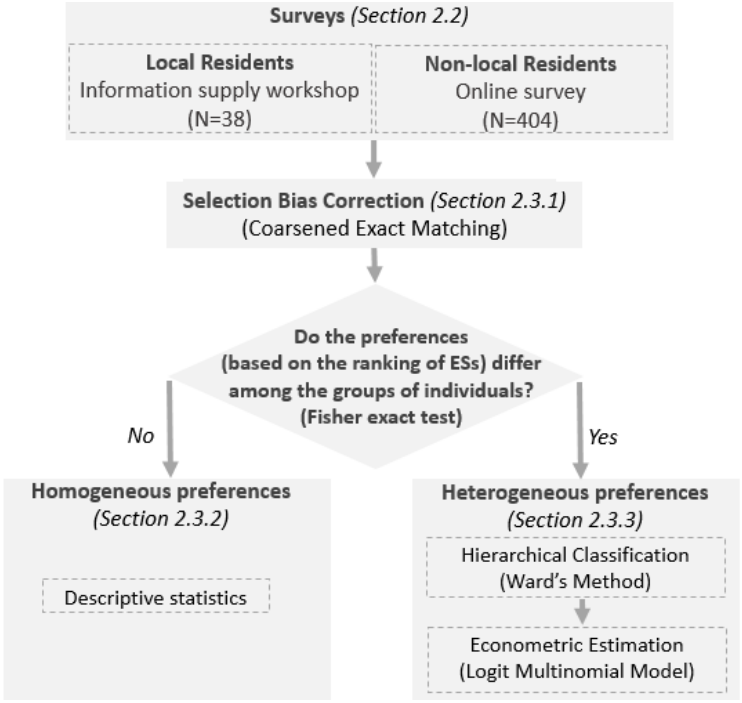

Figure 12. The work flow for data collection and treatment processes

2.3.1 Correcting selection bias

The characteristics and number of observations of the surveyed populations are different (see Table 2). This selection bias was corrected using CEM approach introduced by Iacus, King and Porro (2011). The main results are presented in the online supplementary material. The key goal of matching is to prune observations from the data so that the remaining data have better balance between the matching groups (Iacus et al., 2012). The authors demonstrated how CEM generates matching solutions that are better balanced than methods under the older existing

class based on propensity scores, Mahalanobis distance, nearest neighbors, and optimal matching (Iacus et al., 2011).

We applied CEM using four main covariates which are age, gender, level of education and income. First, each covariate was coarsened using discrete values associated to the corresponding nominal categories. For instance, the covariate age was coarsened replacing the nominal categories 18 – 39 years, 40 – 59 years and 60 by 0, 1 and 2 respectively. Second, exact matching between the treated and control groups was applied using the values of the coarsened covariates. This step required sorting each observation into a stratum which includes unique values of the coarsened covariates. Finally, the selected strata were those containing at least one control and treated units. The strata with only control units were discarded. Treatment units that did match simultaneously with control units from both the non-local resident groups were also discarded. The control and treated groups are specified in Figure 3.

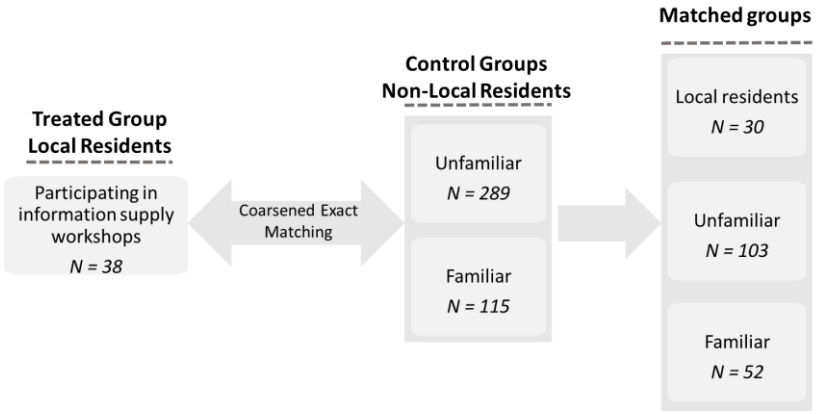

Figure 13. Coarsened Exact Matching (CEM) of the control and treated groups

2.3.2 Identification of ecosystem service presenting homogeneous preferences

Cross-tabulations and Fisher's exact tests allowed to test the correlation of each ES with the variable corresponding to the typology of the surveyed populations. In other words, the aim was to identify ESs for which preferences were homogeneous regardless of population type. The groups of respondents in question were informed and uninformed local citizens as well as familiar and unfamiliar non-local citizens with the Palavas lagoons (see Figure 3). Further

Fisher's exact tests were realized to analyze the relation between the identified homogeneous preferences for ESs and the other explanatory variables presented in Table 4.

2.3.3 Analysis of ecosystem service presenting a heterogeneous preferences

The remaining ESs that did not present homogeneous preferences for ESs among the groups of respondents were analyzed separately. The aim was to identify explanatory factors that might explain this heterogeneity in preferences for these ESs. More precisely, we tested the impact of several explanatory variables on the respondent choices for these ESs for with preferences were heterogeneous. The considered explanatory variables included the variable "population type" (informed, uninformed, familiar or unfamiliar), "age", "gender", "level of knowledge of Palavas lagoons" … (see Table 4). To this end we used a logit multinomial model as in Blayac et al. (2014). The dependent variable which comprised different levels of ES categories was created through identifying different clusters (or categories) of these ESs using Principal Component Analysis (PCA) followed by Ward's hierarchical classification (HC) method. Hence this clustering of ESs, in contrast to the use of standard classification schemes (e.g. Liquete et al., 2013; Millenium Ecosystem Assessment, 2005; TEEB, 2010), emerged from the respondents' preferences, based on the attributed levels of priority. Only ESs within the identified clusters that contributed the most to the PCA axis were retained. The dependent variable was then constructed by calculating an average score for each cluster of ESs which were generated using Ward's HC method. The preference for a cluster of ESs for each respondent corresponded to the one with the maximum mean score.

A multinomial logit model was then used to estimate the preference for a cluster of ESs given a set of qualitative explanatory variables (see Table 4). The model corresponds to choice probabilities for the different ESs clusters (Blayac et al., 2014). Formally, the choice probabilities are:

$$Prob(Y = Cluster\ 1) = \frac{\exp(Z_{Cluster\ 1})}{1 + \exp(Z_{Cluster\ 1}) + \exp(Z_{Cluster\ 2)})}$$

$$Prob(Y = Cluster\ 2) = \frac{\exp(Z_{Cluster\ 2})}{1 + \exp(Z_{Cluster\ 2}) + \exp(Z_{Cluster\ 1})}$$

$$Prob(Y = Reference\ cluster) = \frac{1}{\exp(Z_{Cluster\ 1}) + \exp(Z_{Cluster\ 2})}$$

where Z is the coefficient vector including the intercept.

Table 5. Factors explaining preferences for ecosystem services. The referent levels are indicated in bold.

Variable	Sub-Category	Full name	Level
Dependent	Ecosystem services clusters	Ecosystem services clusters	Cluster 1
			Cluster 2
			Reference cluster
Explanatory	Population type	Type	**Unfamiliar non-local residents**
			Familiar non-local residents
			Local residents
			Informed local residents
	Sociodemographic characteristics	Age *(years)*	**18-39**
			40-59
			60 and up
		Gender	Female
			Male
		Education	**High school degree or none**
			Bachelor
			Master and up
		Income *(euros per month)*	**750-1500**
			1500-3000
			3000 and up
	Behavior towards environment	Donation to an environmental association	**No**
			Yes
	Level of knowledge	Perceived knowledge of Palavas lagoons	**Limited**
			Average
			Good
		Heard of the concept of ecosystem services	**No**
			Yes

To verify whether or not there was a multicollinearity (correlation within the explanatory variables), we performed the Cramer's V test.. Hence, interaction effects were observed for the variables 'population type' and 'donation to an environmental association' as well as both variables characterizing levels of knowledge. In addition, there were interaction effects between the variables 'donation to an environmental association' and both variables characterizing levels of knowledge. Finally, there was an interaction effect between both variables characterizing levels of knowledge.

The overall quality of the multinomial logit model was verified using Akaike Information Criterion (AIC). The aim was to progressively remove crossed and single explanatory variables that have no significant impact on the dependent variable from the general model, until the final model with the lowest AIC criterion was reached. The obtained final nested model was then validated based on two hypothesis testing. First, the choice for the nested model relative to the initial model was verified through the Likelihood ratio test. The null hypothesis consisted of choosing the final nested model. Secondly, the final nested model was validated through the independence of irrelevant alternatives (IIA) assumption using the Hausman and McFadden test (Hausman and McFadden, 1984). This hypothesis is tested to ensure that removing any alternative (here, a cluster of ESs) from the dependent variable does not affect the odds of the remaining alternatives.

3 Results

3.1 Coastal lagoon ESs: homogenous versus heterogeneous preferences of ESs among groups of respondents

Table II. 1 in Appendix II lists the results of the Fisher's exact tests, which allowed us to identify whether the preferences of these different ESs were homogeneous among the four groups (ESs marked in italics, H_0 retained, $p > 0.05$) or heterogeneous (ESs marked in bold, H_0 rejected, $p < 0.05$). Eleven out of the twenty ESs presented heterogeneous preferences, and the remaining nine ESs presented homogeneous preferences. Interestingly, the latter included all five regulation and maintenance ESs as well as both environmental education and research opportunity ESs. Thus, regardless of familiarity and academic information supply, regulation and maintenance services as well as cognitive effects related services were judged as a priority by at least 90% of the respondents (see Table II. 2 in Appendix II). In addition, preferences of recreational hiking and walking ES and of fish resources ES were homogeneous, although both ESs were favored to a lesser degree compared to the former ones. These results were also valid when comparing the matched and unmatched data (see Table II. 2 in Appendix II). Thus, preferences of these services are stable and did not change even after applying CEM (see the results of CEM in Appendix II).

Specific questions allowed to study the pertinence of possible factors explaining choices for those ESs presenting homogeneous preferences among the four groups of citizens (see Table 5). Hence, more than 98% of the respondents, who declared having either a good or a limited level of knowledge of the Palavas lagoons and the associated ESs, favour the regulation and maintenance ESs. The level of priority attributed to environmental education and research opportunity ESs increases with age. For instance, 70.6% of the respondents that are 18–39 years old favour these services against up to 90.6% for the 60 years and up.

3.2 Descriptive and inference statistics for ESs showing heterogeneous preferences among groups of respondents

The clustering of the eleven ESs, for which preferences were heterogeneous among the respondents, resulted in the identification of three clusters i.e. three levels of the dependent variable (see Figure 4). We attributed descriptive qualifications to these three clusters based on the following interpretations. The cluster comprising two cultural ESs, i.e. historical site and local identity, is referred to as cultural heritage and was, therefore, named as ‘Heritage’. The cluster comprising the cultural ESs ‘aesthetic value of habitats or species’, ‘aesthetic value of landscapes’, ‘bird watching’ and ‘sentiment of relaxation’ relates to leisure activities based on the contemplation of the lagoon ecosystem rather on the consumption of its resources. Therefore, this cluster has been defined as ‘contemplative leisure’. The cluster with the remaining five ESs all of which imply consumption of natural resources, either for provisioning or for leisure. This cluster has been defined as ‘consumptive activities’.

Table 6. Factors explaining the level of priority attributed to ecosystem services presenting homogeneous preferences among groups of citizens. P, N and NP stand for "Priority", "Neutral" and "Not a priority" respectively.

Explanatory variable	Level	Regulation and maintenance			Fish resources			Recreational hiking and walking			Environmental education and research opportunity		
		P *(%)*	N *(%)*	NP *(%)*	P *(%)*	N *(%)*	NP *(%)*	P *(%)*	N *(%)*	NP *(%)*	P *(%)*	N *(%)*	NP *(%)*
Heard of the concept of ecosystem services	*P-Value*	***0.0300*****			*0.9636*			*0.8081*			*0.1205*		
	Yes	98.8	1.2	0.0	38.4	41.9	19.8	60.5	25.6	14.0	90.7	8.1	1.2
	No	91.5	8.5	0.0	37.2	41.1	21.7	59.7	28.7	11.6	80.6	14.7	4.7
Perceived knowledge of Palavas lagoons	*P-Value*	***0.0018*****			*0.746*			*0.8837*			*0.5428*		
	Good	98.6	1.4	0.0	31.9	45.8	22.2	58.3	29.2	12.5	88.9	8.3	2.8
	Average	86.8	13.2	0.0	42.1	39.5	18.4	61.8	23.7	14.5	81.6	13.2	5.3
	Limited	98.5	1.5	0.0	38.8	38.8	22.4	59.7	29.9	10.4	83.6	14.9	1.5
Age (years)	*P-Value*	*0.7182*			*0.6668*			*0.4743*			***0.0123****		
	60 and up	94.2	5.8	0.0	40.6	39.9	19.6	61.6	28.3	10.1	90.6	7.2	2.2
	40-59	93.3	6.7	0.0	35.0	41.7	23.3	60.0	23.3	16.7	75.0	20.0	5.0
	18-39	100.0	0.0	0.0	23.5	52.9	23.5	47.1	35.3	17.6	70.6	23.5	5.9

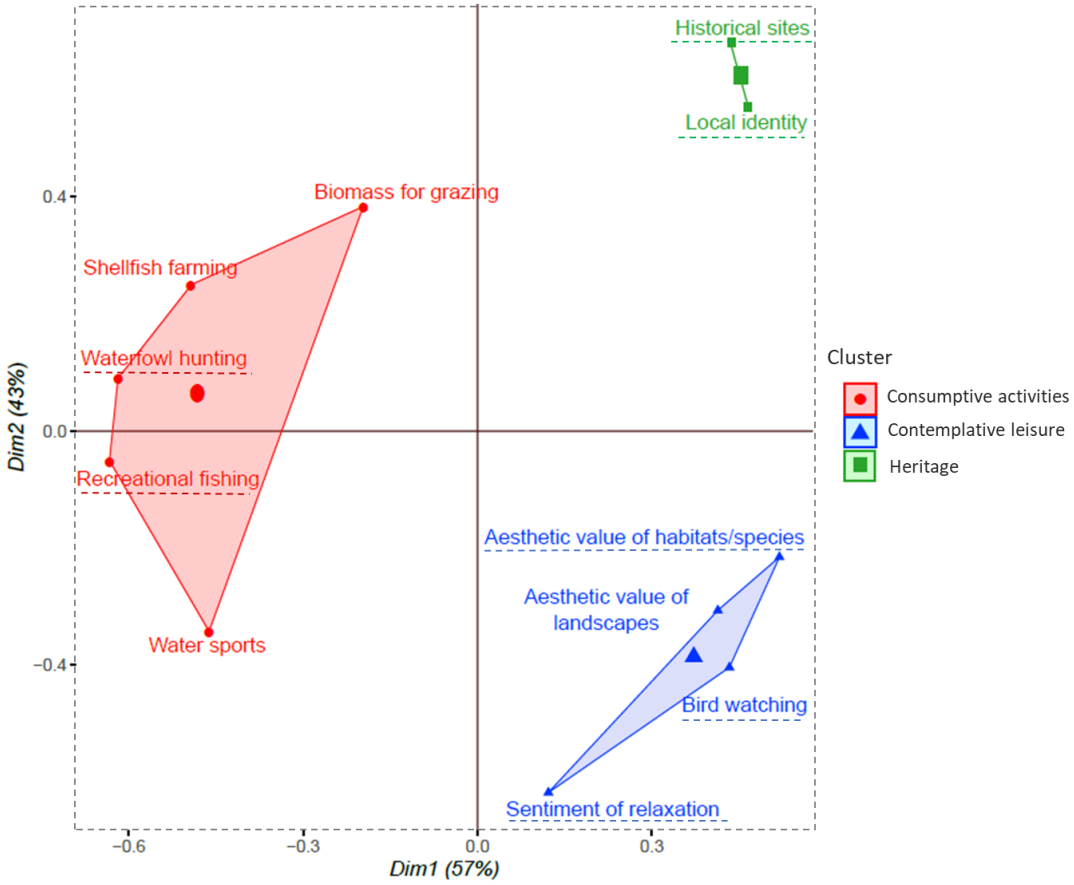

Figure 14. Classification of the 11 ecosystem services (presenting heterogeneous preferences among the groups of respondents, in bold in Table II.1) based on the results of the principal component analysis (PCA). The underlined ecosystem services are the ones that contributes the most to the two axes. See Table 3 for the definitions of the corresponding ecosystem services.

The general logit multinomial model includes all the explanatory variables listed in Table 4. The reference variables are indicated in bold. Also, the 'heritage' cluster was used as the reference level of the independent variable. The final nested logit multinomial model was validated based on the results of the two hypothesis testing: the Likelihood ratio test and the IIA test. First, the choice for the nested model relative to the initial model was verified through the Likelihood ratio test. The null hypothesis consisted of choosing the final nested model. It was accepted based on the fact that the likelihood ratio test statistic (see "Chi2" in Table 6) is smaller than the theoretical chi-square with a margin of error of 5% and a degree of freedom (Df) of 54 in our case. Secondly, the final nested model was validated through the independence of irrelevant alternatives (IIA) assumption using the Hausman and McFadden test (Hausman and McFadden, 1984). This hypothesis is tested to ensure that removing any alternative (here, a cluster of ESs) does not affect the odds of the remaining alternatives (e.g. the outcome of

cluster A vs. cluster B). Note that the test statistic relative to the cluster consumptive activities is negative (-0.015, in Table 6). This is evidence that the IIA holds (Hausman and McFadden, 1984, P.1226 cited in Franses and Paap, 2003).The econometric estimations are presented in Table 6.

Table 6 describes the main results for this final nested model. Accordingly, compared to unfamiliar non-local residents, local residents are 5.8 times more likely to choose the 'contemplative leisure' ESs over 'heritage' ESs. However, this odds ratio decreased to 2.8 after academic information supply during the citizens' workshops. In other words, relative to the 'heritage' ESs cluster and after receiving academic information, local residents' preferences of the level of priority towards 'contemplative leisure' ESs decreased. Moreover, unfamiliar non-local residents were 0.23 and 0.21 times less likely to choose contemplative leisure ESs and 'consumptive activities' ESs, respectively.

Table 7. The final nested model issued from the econometric analysis. It explains the choices for the three clustered categories of ecosystem services that presented heterogeneous preferences among the groups of citizens.

Variable	**Contemplative leisure vs. Heritage**				**Consumptive activities vs. Heritage**			
	Estimate (SE)	Odds Ratio	Z value	Pr (>|Z|)	Estimate (SE)	Odds Ratio	Z value	Pr (>|Z|)
Type								
Unfamiliar	Ref.				Ref.			
Familiar	0.014 (0.471)	1.014	0.029	0.9771	-0.054 (0.502)	0.947	-0.1084	0.9136
Informed local residents	1.055 (0.476)	2.872	2.217	0.0265*	-0.584 (0.791)	0.557	-0.7309	0.4648
Local residents	1.759 (0.461)	5.807	3.817	p < 0.001***	-7.281 (23.018)	0.001	-0.3163	0.7517
_intercept	-1.490 (0.277)	0.225	-5.386	p < 0.001***	-1.555 (0.284)	0.211	-5.4725	p < 0.001***

Final nested model validation tests	**Df**	**Chi2**	**P-value**
Likelihood ratio test	54	62.544	0.199
Independence of irrelevant alternatives (IIA) assumption			
Heritage	1	< 0.001	0.999
Contemplative leisure	1	< 0.001	0.999
Consumptive activities	4	-0.015	

4 Discussion

Nine out of the twenty ESs considered in this study showed homogeneous preferences among the four groups of citizens, based on the use of Fishers exact test. These nine ESs included all 5 ESs of the category Regulation and maintenance services, 1 out of 3 provisioning services (i.e., fisheries) and only 3 out of 12 cultural ESs. There was a clear consensus regarding the outmost relative importance of regulation and maintenance services in the Mediterranean coastal lagoon ecosystems (see Table II. 2). This pattern of preferences was thus independent of familiarity and information supply and appeared to be accepted *a priori* by an overwhelming majority. This may reflect that nowadays, particularly within the French society, a large majority (85 %) of the general public attaches a high importance to biodiversity and is convinced of the need for its conservation (Croutte, 2015). But while recognizing the importance of biodiversity for supporting life on earth, knowledge of biodiversity and awareness of its importance for well-being is less developed among the general public (Croutte, 2015). It appears that, even when possessing little precise knowledge themselves, the general public trusts the messages delivered by the biodiversity experts and also supports them for their studies. The latter may explain that the ESs research opportunities and environmental education were also homogeneously perceived as relatively very important (see Table II. 2). A recent study using Q-methodology among highly-involved stakeholders, including different experts, in Palavas lagoons also showed a strong consensus concerning the major relative importance of regulation and maintenance ESs (Sy et al., 2018). Hence, concerning biodiversity and the regulation and maintenance ESs of emblematic ecosystems, there is no major conflict of preferences and opinions between the general public and the experts.

The eleven remaining ESs, which showed heterogeneous preferences among the four groups of respondents, were further analyzed using econometric analysis. These eleven ESs, i.e. nine cultural services (CES) and two provisioning services, were clustered through a PCA followed by Ward's hierarchical classification method. A multinomial logit model was then developed to determine factors explaining the choice for the identified clusters issued from these eleven ESs. Local residents strongly favored contemplative leisure compared to the unfamiliar citizens (see Table 6). This can be related to hedonic motivations related to individualistic behaviors. However, this trend decreased with academic information supply which led the local citizens to prioritize more the collective services (heritage services) at the expense of the self-centered

ESs. Interestingly, consumptive leisure (hunting and recreational fishing) as well as provisioning services, grouped together in the cluster 'consumptive activities', were relatively less favored by the respondents (see Table 6). This is probably related to the fact that these ESs benefit only a limited number of practitioners in the Palavas lagoons' site. Also, their activities often induce disturbances to the natural system and nuisance to other people.

The central question we addressed concerned the impact of information on the preferences and preferences of individuals as well as the forms of information appropriation, depending on its nature *per se*. Information acquired by familiarity with a natural environment according to the frequency of visits can be differentiated from those resulting from academic trainings or those that are more contextualized and are brought within awareness-raising measures. The issue is then to question learning processes, which, may be the result of single or double loop processes defined in Box 1 (Argyris and Schön, 1996). Hence, information supply can reduce bias by making individual choices more informed and may lead to the reorganization of preferences. This may even lead to changing the value systems of the citizens (i.e., double loop processes). Knowledge related to the functioning of ecosystems and the contribution of ESs to the well-being of society in general, individuals' preferences are influenced by cultural dimensions. These include the links of individuals to nature as well as their cultural proximity to ESs.

The fact that heterogeneity of preferences was particularly the case for CES calls for further thinking. The concept of CES has recently been subjected to a large debate and controversy in the literature. Some authors suggest revising and broadening the standard frameworks of the concept. Other authors advocate discarding the term "cultural" itself (Chan et al., 2012a, 2012b; Fish et al., 2016; Small et al., 2017; Winthrop, 2014) or even abandoning the concept (Kirchhoff, 2019). One of the main criticism is that it tries to combine all notions of cultural value (e.g. moral, religious, aesthetic) under a single term (Small et al., 2017). In addition, (Díaz et al., 2018) insisted on the role of culture and local knowledge in the way people understand the importance of all ESs, including those that have been classically categorized as provisioning and regulating services. Therefore, the cultural background strongly determines how people assess the need for their conservation. The paramount role of these cultural factors justifies understanding the preferences and levels of knowledge that involve psychological and sociological approaches in order to explain determinants of these preferences. The anthropocentric nature of ES is often put forward for its ability to rally individuals more easily

in favor of their conservation, while the link between well-functioning ecosystems and their ability to provide ESs is not always well understood. Furthermore, this relationship is not necessarily equivalent depending on the type of ESs, the contexts or the state of conservation of the ecosystems (Barnaud and Antona, 2014). In addition to the lack of information on ecological processes, individuals have a limited ability to process information. And the instability of their elicitation preferences over time and the varying context should also be taken into account.

Inductive approaches have been used to empirically study people's preferences about CES (Dou et al., 2019; Maraja et al., 2016; Pike et al., 2015; Stålhammar and Pedersen, 2017). Comparably, we used such an inductive approach for the 11 ESs with heterogeneous preferences, which indicated that the 9 CES split up into 3 main clusters based on people's preferences. Thus, our results propose a categorization of CES according to whether they imply individual or collective benefits, and whether these are consumptive (implying consumption of natural resources and often creating a higher level of disturbance) or contemplative (enjoyment of nature based on observation and sensitivity for surroundings causing only relatively little disturbance). Interestingly, the two provisioning services (biomass for grazing, shellfish farming) were grouped together with consumptive leisure ESs to constitute the cluster 'consumptive activities'. Hence, the fact that unfamiliar populations attributed a greater consideration for heritage services is striking. We think that this is because these populations are not directly concerned by these ecosystems and therefore not influenced by their own interest and affection for these natural areas. The question of concernment can be linked to the veil of ignorance theory introduced by Rawls (1971). More precisely, it is assumed that unfamiliar populations do not know how the various alternatives will affect their own particular case and they are thus obliged to evaluate principles solely on the basis of general considerations (Rawls, 1971). This observation advocates the need to involve diverse populations in preference elicitations surveys. In fact, mobilizing only local knowledge when carrying out ESs assessment might present a risk of favoring particular individual interests. Also, our findings encourage deliberative assessments through focus groups which allow to share information and compare points of view.

The splitting up of the CES and the differential impacts of familiarity and information supply on preferences for the different CES raises the question on the mechanisms which allow the citizens to perceive and value these CES. Information economists dealing with goods traded on

markets have adopted a classification scheme based on the difficulty with which consumers can assess their quality or obtain the pertinent information. Accordingly, at least three types of goods have been identified i.e. (i) *search goods*, (ii) *experience goods* and (iii) *credence goods*. The *search goods* category (Nelson, 1970) comprises the goods for which the attributes can be ascertained *prior* to consumption, i.e. by inspection and information gathering. This category comprises most products and typical examples include clothing and staple food. *Experience goods* (Nelson, 1970) can be accurately evaluated only *after* they have been used or consumed (e.g. restaurant, holiday). Finally, *credence goods* (Darby and Karni, 1973) are difficult or impossible to evaluate even after consumption has occurred. That is, the consumer might lack the knowledge or the expertise, or because the information is too costly to acquire compared to its expected benefits (e.g. medical treatments). This approach may be inspiring when assessing ESs. To our knowledge, non-market goods and services and particularly ESs have never been investigated through the lens of this typology. We propose that future studies could be useful to develop a similar typology for ESs. For example, it appears obvious that the sentiment of relaxation can be considered as an experience ESs. Many of the maintenance and regulation ESs, for which most citizens lack the detailed ecological knowledge, can perhaps been categorized as credence ESs. However, for the ESs microclimate regulation and flooding and other extreme event regulation the situation is more ambivalent. Most people living in the coastal zone experience how the lagoons contribute to temper the climate (lower maximum and higher minimum temperatures than in more continental settings), which means that microclimate regulation could also be considered as an experience ES. Some people that live in the coastal area since a long time may recall disastrous extreme flash floods from rivers and have experienced how coastal lagoons can store large quantities of water and thus prevent dangerous submersions. Their experience of such dramatic events often has a long-lasting impact on their preferences. Finally, for some ESs it will be easier for the citizens to search for information, e.g. particularly for several provisioning services which could therefore be categorized as search ESs.

5 Conclusion

In this study we assumed that local populations are familiar with the focal ecosystem and that they possess knowledge about their ecology and benefits for society. The main results that emerged from our analysis show that there is a high interest for regulation and maintenance as well as environmental education and research opportunity services regardless of population type. By contrast, nine of the cultural ESs (CES) together with two provisioning ESs showed, however, heterogeneous preferences among the different groups of citizens. These eleven ESs were split up into three clusters comprising (i) contemplative leisure, (ii) heritage and (iii) consumptive activities.

We addressed two main questions, i.e. (i) Does familiarity impact citizens' preferences of the relative importance of the different coastal lagoon ESs? and (ii) do the preferences of familiar citizens change after receiving academic information? Familiarity with the ecosystem particularly impacted the CES. Thus, familiar local citizens valued the contemplative leisure much more than others, presumably because of their hedonic self-centered approach. This effect was attenuated by academic information supply. Finally, non-locals who never visited Palavas lagoons attribute greater priority to heritage services compared to consumptive activities and contemplative leisure. Hence, our hypothesis about the impact of academic information supply and familiarity on preferences is verified for heritage services, contemplative leisure and consumptive activities.

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Chapter 4: Valuation of Ecosystem Services and Social Choice: an Original Protocol Combining Deliberative and Individual Preferences

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Abstract

A long-lasting problem, in environmental and ecological economics, is to achieve a collective valuation of ecosystem services. The two most used traditions in the literature are the non-deliberative and deliberative aggregation of individual preferences in order to achieve, when meaningfully possible, a collective ranking or choice over these alternatives. We address an issue raised by very few researchers that is to systematically characterize the degree to which non-deliberative individual preferences evolve as a result of deliberation. Furthermore, we investigate whether the determinants related to the deliberation groups' composition (e.g. sociodemographic characteristics) might explain these changes in preferences. The aim of this paper is to use an original protocol combining Majority Judgement, an approach borrowed from social choice theory, and a deliberative non-monetary valuation technique. Our results show a stability in the elicited preferences, among groups of residents, for Palavas lagoons complex located in south of France.

Keywords: ecosystem services, preference elicitation, non-monetary methods, deliberation, social choice theory, coastal lagoons.

1 Introduction

Valuation of ecosystem services (ESs) corresponds to the "means of improving the choices our societies and the public bodies, that design and implement conservation policies, make to frame our relation to nature" (Salles and Figuieres, 2013). It is an important practice when choosing among competing alternatives (ESs, ecological restoration projects or scenarios, …) that lead to different outcomes (Dendoncker et al., 2014). These trade-offs are based on individuals' preferences[15] which hold different meanings according to its interpretation among disciplines (e.g. Economics, Political and Moral Philosophy …). Individual preferences might refer to comparative evaluation, prioritization or favoring, and choice ranking (Hansson and Grüne-Yanoff, 2018). Thus, in general, the main goal in every valuation study is to achieve a collective comparative valuation, prioritization and ranking of different competing alternatives from a collection of individual preferences. In other words, the question is to know how to achieve a social ranking or a social choice based on individual preferences?

In general, two main traditions might be considered when identifying a social ranking or choice over a set of alternatives (Dryzek and List, 2003). The first one consists of computing individual preferences in order to achieve a collective ranking or choice over these alternatives. In the "Welfarist" theory (according to Bentham, 1789) for example, this social ranking or choice corresponds to the sum of the individual cardinal utilities expressed in general in monetary terms. Likewise, in the voting theory, according to the Borda rule of aggregation for instance, the collective ranking or choice is identified using each voter's a score to each alternative, which depends on its rank in the voter's preference ranking. Alternatives are then socially ordered in terms of the sums of their scores across voters: the alternative with the largest sum-total is top, the alternative with the second-largest sum-total next, and so on (List, 2013).

In the other hand, research avenues advocate the use of deliberative valuation and ranking of ESs as an alternative to non-deliberative individual preference elicitation methods (Howarth and Wilson, 2006; Kenter et al., 2016a; Lo and Spash, 2013; Mavrommati et al., 2017). Amartya Sen for instance considers that democracy is not simply about the aggregation of individual opinions, but a process of deliberation in which every member makes an active contribution

[15] Individual preferences comply with four axioms: transitivity, completeness, continuity and strict monotony (see Figuières and Salles (2012) for more details).

(Bonvin, 2005). Accordingly, for Wilson and Howarth (2002), when ESs are at issue, the most appropriate value-articulating methodology will be one that most closely mirrors Rawls's 'original position': a procedurally based public forum in which people are brought together to debate before making value judgments. A deliberative preference elicitation process for ESs could be carried out by mobilizing utility (usually expressed in monetary terms) or voting methods (usually rank based numerical preferences). For instance, during a deliberative task, individuals could be asked to discuss and agree on the importance of each ES from a given set of ESs using either monetary (e.g. Kenter et al., 2016b; Lo and Spash, 2013) or non-monetary units (Mavrommati et al., 2017; Murphy et al., 2017; Randhir and Shriver, 2009). Preferences are thus formed during the discussion process (Spash, 2007). That is, deliberation facilitates information sharing among participants since they are exposed to a wide range of ideas, perspectives and viewpoints (Lienhoop et al., 2015). It explicitly aims to give participants the opportunity to revise their preferences after having explored the problem at hand (Parks and Gowdy, 2013).

There is a widely shared assent that, when meaningfully possible, the outcomes of aggregating individual preferences and that of deliberative preference elicitation methods differ (Howarth and Wilson, 2006; Kaplowitz and Hoehn, 2001; Kenter et al., 2016a; Lo and Spash, 2013; Mavrommati et al., 2017). We address an issue raised by very few researchers (see Murphy et al., 2017) that is to systematically characterize the degree to which non deliberative individual preferences evolve as a result of deliberation. Furthermore, we investigate whether the determinants related to the deliberation groups' composition (e.g. sociodemographic characteristics) might explain these changes in preferences.

We carried out an original protocol by considering both deliberative and non-deliberative individual preferences in the same ESs valuation process. More precisely, we applied MJ and a deliberative valuation and ranking approach to identify the aggregate individual and collective preferences for Mediterranean coastal lagoon ESs, respectively. We believe MJ has so far never been used in an environment problem. Our study site includes Palavas lagoons complex, which comprises seven coastal lagoons, and its immediate surroundings located in south of France. The next section of the paper briefly presents the context of the study. The following section provides details about the applied deliberative and non-deliberative methods. Then, we analyze and discuss our findings. The last section presents the concluding remarks.

2 Materials and methods

2.1 Study site

The study area comprises the Palavas lagoon complex and its immediate surroundings located in South of France. These lagoons suffered more than four decades nutrient over-enrichment due to their proximity with urban and sub-urban centers (De Wit et al., 2017). However, awareness of the risks associated with the degradation of these ecosystems resulted in policies focusing on the improvement of water quality (Leruste et al., 2016), ecological restoration (De Wit et al., 2017) and nature conservation measures (Sy et al., 2018). Moreover, there is a dynamic of involving stakeholders' preferences including residents for a better acceptability of these restoration and conservation policies.

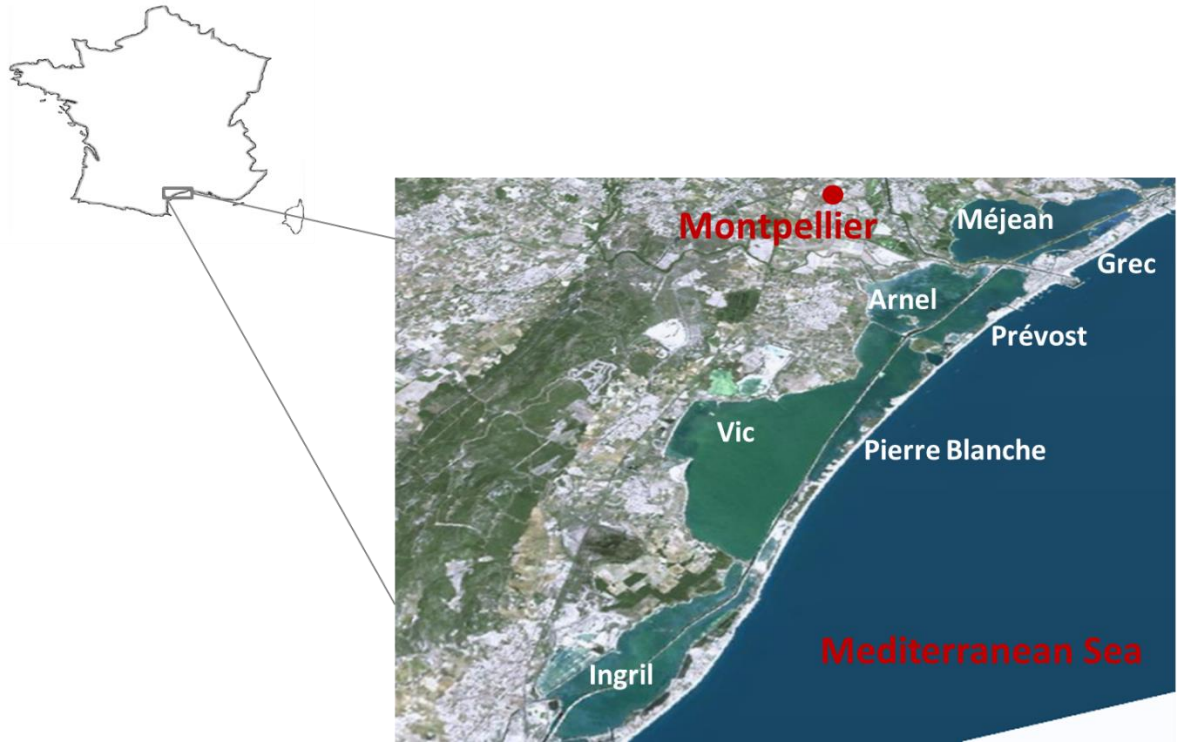

Figure 1: Palavas coastal lagoons.

2.2 Data collection process

The data were collected during two workshops that took place in May and June 2017 with local residents selected randomly in the municipalities of the Montpellier metropolitan area around the Palavas lagoon complex. There was a total of 42 participants that showed up during the first workshop session. Eight groups of participants were formed. Two of the eight groups were discarded because they did not reach an agreement during the deliberation process and thus adopted a different aggregation rule during the deliberation process. Only four of the eight groups (21 participants) attended the whole process (i.e. the two workshop sessions) and reached an agreement during the deliberation process. The data of only those groups were analyzed. Each group of participants had a different sociodemographic characteristics profile. A show up fee of fifteen euros was given to each participant.

Each of the two workshop sessions lasted around 3 hours. After welcoming the participants during the first workshop, a brief introduction was realized by the authors about the overall process of the session. All participants were informed about the anonymity of their answers. The first part of the session consisted of filling out individually a questionnaire which mainly included questions about general sociodemographic characteristics, preferences for ecosystem services provided by the Palavas lagoon complex … We used a list of ESs judged as a priority in terms of conservation by a diversity of stakeholders in the site of Palavas lagoons complex (see Sy et al., 2018). A total of 20 ESs was used. The second part of the session comprised a lecture, given by the authors of this work, on ecological and sociodemographic information on the study area. This lecture was followed by a deliberation process within each group of participants. This process involved a discussion and information exchange about the relative importance of the listed ESs in order to achieve collective preferences and ranking of these ESs.

The second session was set up six days after the first one. It started with a warm up session where the authors briefly lecture about the same information provided during the first workshop. Each participant then filled out the same questionnaire with additional questions. These included the quality and the contribution of the workshops and the deliberation process in particular to their perception of the Palavas lagoon complex. The session ended with a general deliberation process gathering all the participants together in a single group.

2.3 Preference elicitation and aggregation methods applied for each participant and deliberative group

Preferences were elicited using the MJ method which was introduced by Balinski and Laraki (2007, 2014). The principle of this theory is that instead of a pairwise comparison of candidates or alternatives, voters explicitly express their opinions by the merit of every candidate in an ordinal scale of measurement or language of grades (e.g. Outstanding, Excellent, Very Good, Good, Fair, Poor, To Reject) (Balinski and Laraki, 2017, 2007). We used different levels of priority as an ordinal scale that is: High priority, Priority, Neutral, Low priority and Not a priority. See the Box 1 for the detailed formulation of the MJ method.

We adapted and applied MJ to the non-monetary preference elicitation and ranking of ESs provided by the Palavas lagoon complex. Each respondent had a table (see Figure 2) where the ESs were listed in the first column and the appreciations in the top row. Each respondent checked the right appreciation she or he attributed to each ES. These appreciations were then coded in order to facilitate the aggregation of the individually elicited preferences.

ESs	High Priority	Priority	Neutral	Low Priority	Not a Priority
ES1	✓				
ES2				✓	
…					

Figure 2: The preference elicitation table

For the deliberative approach in the other hand, there was a discussion within each subgroup of participants regarding the level of priority of each ES using the same table filed individually (see Figure 2). Then each subgroup agreed on the level of priority and ranking of each ES. Groups that did not reached a consensus were discarded (see section 2.2). Participants were free to ask questions, during the whole process, when in doubt about a particular subject.

Box 1: Formulation of the Majority judgement method

Consider a set of finite number of ecosystem services $S = \{SE_1, \dots, SE_m\}$; a finite number of voters $V = \{1, \dots, n\}$; and a common language of grades $\Lambda = \{\alpha, \beta, \gamma, \dots\}$ which is a totally ordered set. The grades or words are "absolute" (Balinski and Laraki, 2014) in the sense that every voter uses them to measure the level of priority of each ES independently.

The *matrix of inputs* is formulated as:

$$\varphi = \begin{bmatrix} \alpha_{11} & \cdots & \alpha_{1m} \\ \vdots & \ddots & \vdots \\ \alpha_{n1} & \cdots & \alpha_{nm} \end{bmatrix}$$

Where $\alpha_{ij} = \varphi(ES_i, v) \in \Lambda$ is the grade assigned by voter $v \in V$ to $ES_i \in S$.

The *majority grade* attributed to an ES by all the voters correspond to its middlemost or median grade when n is odd and its lower middlemost when n is even (Balinski and Laraki, 2014).

Suppose an ES majority grade is α^*, and that $p\%$ of his grades are higher than α^* and $q\%$ are lower. Then its *majority gauge* is (p, α^*, q), where $p > q$ implies α^* is endowed with a "+", and otherwise it is endowed with a "-"(Balinski and Laraki, 2010, 2014). It is formulated as follow:

$$\alpha^* = \begin{cases} \alpha^+ & \text{if } p > q, \\ \alpha^- & \text{if } p \leq q. \end{cases}$$

The majority gauge (p, α^*, q) determine the *majority-gauge-ranking* of ESs.
Consider two ESs ES_1 and ES_2 with majority gauges (p, α^*, q) and (r, β^*, s), respectively. The majority-gauge-ranking "$\succ_{mg}$" places ES_1 ahead of ES_2, $ES_1 \succ_{mg} ES_2$, or (p, α^*, q) ahead of (r, β^*, s), $(p, \alpha^*, q) \succ_{mg} (r, \beta^*, s)$ when:

- $\alpha^* \succ \beta^*$, or
- $\alpha^* = \beta^* = \alpha^+$ and $p > r$, or
- $\alpha^* = \beta^* = \alpha^\circ$ and $p < r$
- $\alpha^* = \beta^* = \alpha^-$ and $q < s$.

2.4 Data analysis

After the two workshops, the data related to preferences elicited individually, both, before and after the deliberation process were generated. In addition, the collective ranking of the considered ESs issued from the deliberation process was produced.

The first step of the data analysis consisted of identifying ESs for which preferences did not vary using the two aggregation methods (computed individually elicited preferences or deliberative aggregated preferences). For that, for each ES, the difference between its grade (or appreciation) elicited collectively during the deliberation process and its *majority grade* (α^*) was computed. The latter corresponds, for each group, to the median grade when the number of participants (n) of the group is odd or to the lower middlemost grade when n is even (see Box 1). When the sum, across all the four groups, of the difference between the two grades equals to zero or one, then the related ES was considered as holding stable preferences. Otherwise, preferences for that ES were unstable.

The second step of the analysis consisted of identifying whether the changes in preferences for the ESs holding unstable preferences (i.e. ESs for which the computed individual preferences varied from the deliberative preferences) occur as a result of deliberation. First, following Murphy et al. (2017), the level of variability of preferences within each group of participants and for each ES was calculated. This calculation was done for, both, the computed individually elicited preferences before and after the deliberation process. Also, the level of the association between the rankings of each group according to the computed individually elicited preferences before and after the deliberation process was identified. The correlation as well as the Kendall rank correlation coefficients were used. Furthermore, the determinants of these changes were explored. These determinants included sociodemographic, the perceived knowledge of the Palavas lagoons and the membership to an environmental association related factors. The association, between each of these factors and the changes for each ES, was established using Fisher's Exact test. A variable with three levels of change (increased, none and decreased) was thus created for each ES. These levels were identified based on the difference in the majority grades computed, for each group, before and after the deliberation process.

In the last step, the perception of the participants regarding the deliberative process and the workshops in general were examined. Six variables were used: (i) the quality of the supplied academic information, the freedom of speech during the deliberation process (ii) the composition of the groups (in terms of diversity) (iii) the complexity of the questionnaire (in terms of understanding) (iv) the convenience related to the organization of the workshops and (v) the satisfaction with the show up fee.

3 Results

3.1 Stable preferences for ecosystem services

Table 1 presents a comparison of the preferences of the twenty ESs, issued from the deliberation process and the computed individual preferences before the deliberation. The values in the table correspond to the difference between the majority grades of the two aggregation methods. For each ES, the symbols (+) and (-) indicate, respectively, to an increase and a decrease in the corresponding majority grade when passing from the computed individual preferences aggregation method to the deliberative method. The symbol (0) denotes no change in the grades issued from the two aggregation methods. The total sum of the number of changes among the four groups are also listed.

Table 1: Stability of the preferences for ecosystem services across of the computed individual preferences before deliberation, the deliberation process and the computed individual preferences after deliberation.

ES category	Ecosystem Service	Group 1	Group 2	Group 3	Group 4	Number of changes
Regulation and maintenance	**Flooding regulation and protection**	**0**	**0**	**0**	**0**	**0**
	Water purification	**0**	**0**	**0**	**0**	**0**
	Nursery and biodiversity maintenance	**0**	**0**	**0**	**0**	**0**
	Microclimate regulation	**0**	**0**	**+**	**0**	**1**
	Banks reinforcement	**0**	**0**	**0**	**0**	**0**
Provisioning	Fish resources	0	-	+	+	3
	Shellfish farming	0	-	-	0	2
	Biomass for grazing	0	-	0	-	2
Cultural	**Aesthetic value of habitats or species**	**0**	**0**	**+**	**0**	**1**
	Waterfowl hunting	**0**	**0**	**0**	**0**	**0**
	Recreational hiking and walking	+	0	+	0	2
	Recreational fishing	+	-	-	0	3
	Bird watching	**0**	**0**	**+**	**0**	**1**
	Sentiment of relaxation	**0**	**0**	**0**	**0**	**0**
	Non-motorized water sports	**+**	**0**	**0**	**0**	**1**
	Local identity	**0**	**0**	**+**	**0**	**1**
	Historical sites	+	-	+	0	3
	Environmental education	**0**	**0**	**0**	**0**	**0**
	Aesthetic value of landscapes	0	+	0	-	2
	Research opportunity	**0**	**0**	**0**	**0**	**0**

There is a total of thirteen ESs, marked in bold in Table 1, for which preferences did not vary (or hardly vary, when the total number of changes equals 1) among all the four groups and according to the outcomes of the two aggregation methods. These ESs include all the regulation and maintenance, research opportunity and environmental education as well as some cultural services. The remaining seven ES showed two or more changes of the preferences, which include all three provisioning ESs and four CES (see Table 1).

3.2 Achieving convergence in preferences through deliberation

For the remaining seven ESs for which preferences varied, the level of convergence between the rankings of the members of each group, averaged across both ESs and groups, are presented in Table 2 and Table 3, respectively.

Table 2: coefficient of variation of the majority grade attributed by the four groups before and after the deliberation

Group	Coefficient of variation Before deliberation	Coefficient of variation After deliberation	Change
1	0.21	0.26	0.06
2	0.24	0.19	-0.05
3	0.17	0.17	0.00
4	0.35	0.27	-0.08
Average	0.24	0.22	-0.02

Our results show an overall stability of preferences among the rankings of the respondents before and after the deliberation process across both the groups of respondents and the considered ESs. There is a slight convergence in terms of preferences after the deliberation. The averaged differences in related the standard deviations equals (-0.05). These levels of convergence were significantly high for group 1 and 4, which present a Kendall rank correlation coefficient of (0.75) and (0.87) respectively.

Table 3: coefficients of variation of the individual preferences for the seven different ecosystem services before and after the deliberation

ES category	Ecosystem Service	Before deliberation	After deliberation	Change
Provisioning	Fish resources	0.36	0.12	-0.24
	Shellfish farming	0.33	0.17	-0.17
	Biomass for grazing	0.23	0.25	0.02
Cultural	Recreational hiking and walking	0.19	0.25	0.07
	Recreational fishing	0.30	0.39	0.08
	Historical sites	0.24	0.16	-0.07
	Aesthetic value of landscapes	0.27	0.22	-0.05

The composition of each group based mainly on sociodemographic is detailed in Table 4. The results of the Fisher's Exact test show very few associations between the variables presented in Table 4 and the changes in terms of preferences for each ESs before and after the deliberation process. Hence, the variable "Group" was significantly associated with only the variable presenting changes in "Recreational hiking and walking" service. That is, the members of Group 3 did not change their preferences for this ES after the deliberation process (three of them hold a neutral preference while, only one member, consider the service as a priority). Likewise, the grades attributed to the service by the remaining groups were relatively lower after the deliberation process (for, respectively, 71.43%, 80% and 60% of group 1, 2 and 4).

Table 4. Characterictics of the analysed groups of participants

Group	Participants	Age	Gender (%)	Education (%)	Income (%)	Association (%)	Knowledge (%)	Housing (%)
		Mean	*Women*	*Bachelor and up*	*3 000 euros and up*	*No*	*Good*	*Owner*
Group 1	7	55	43	57	71	100	43	86
Group 2	5	56	60	40	60	40	40	60
Group 3	4	65	50	50	25	100	0	50
Group 4	5	35	40	40	80	80	20	60
Total	21	53	48	48	62	81	43	67

In general, the results show that while the participants were satisfied with the two workshops (see figure 3), they found, however, the questionnaire moderately complex (in average).

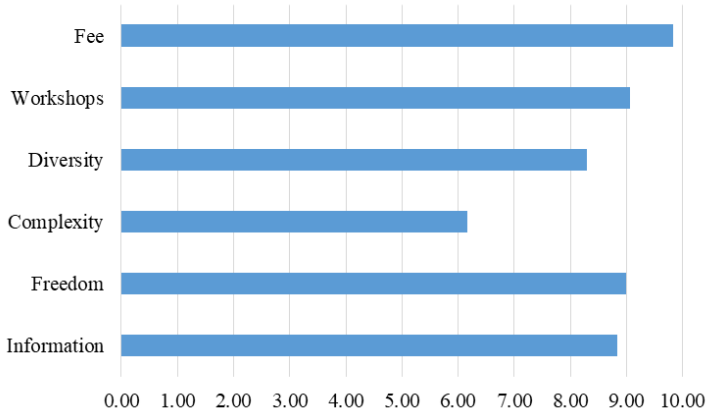

Figure 3: workshops valuation by the participants (averaged).

4 Discussion and conclusion

This paper responds to the requirement of recent work which emphasize the need for other approaches for decision support systems, which focus more strongly on the values that are legitimate for individuals (Jacobs et al., 2018; Keune et al., 2015; Sy et al., 2018). Therefore, it was necessary to adopt non-monetary approaches with ordinal ranking of values and use methodologies from social choice theory. Hence, the aggregation of individual raking of preferences has been compared to the outcome of deliberative approaches.

As we had a high number of ESs (a list of 20 ESs) to be ranked three times by the participants, we did not use the other non-monetary valuation methods as they are mainly based on pairwise comparison. We used instead MJ to avoid a long and tiresome ranking exercise. More precisely, MJ differs from pairwise comparison of ESs methods in the sense that each ES is judged by its merit in a common language (e.g. an ordinal scale of measurement) independently from the other services. Consequently, it avoids the "incomparability" issue related the ranking of ESs it is not based on direct pairwise comparisons. The results show a low level of variation in the outcomes of the pre-deliberation, the deliberation and the post-deliberation might be due to the supply of academic information supply. This was confirmed by their high level of satisfaction of the supplied information.

There is a widely shared assent that it is impossible to theoretically achieve a collective ranking of different competing alternatives from a collection of individual preferences. This issue was raised by some pioneers in social choice theory since the 18th century (List, 2013) such as Condorcet (1785) and Arrow (1951). Very few studies in environmental or ecological economics explored these drawbacks (e.g. Figuières and Salles, 2012; Murphy et al., 2017). Moreover, many of these non-deliberative preference elicitation methods might lead to counter-intuitive results as demonstrated in the case of MJ for instance, the alternative chosen by the majority of the voters might not be the winner (Mohajan, 2011). Another drawback for these methods, especially for median based ones, the results might represent the opinions of just half plus one of the voters (Laslier, 2017).

Deliberative preference aggregation methods present also some limits. One of the main drawbacks concern the issue representation and inclusiveness of the approach (Kenter, 2014; Mavrommati et al., 2017; Schläpfer, 2017), the question of how to design a series deliberative processes that can make legitimate recommendations on behalf of a whole nation has not been addressed in the literature so far (Bunse et al., 2015). Moreover, there are a number of technical challenges that face practitioners when undertaking deliberative methods and which might misdirect the formation of preferences (Bunse et al., 2015; Kenter et al., 2016a). These challenges might include the domination of the discussion process by one or more participants, power asymmetry issues among participants.

The simultaneous use of the two aggregation methods has been widely documented in the literature in seeking more legitimacy in the deliberation process. Indeed, as Proctor and Drechsler (2006) pointed out “a logical progression to overcome the problems and to enhance the advantages of both methods is to combine the two approaches”. Similarly, (Dryzek and List, 2003), argue that deliberative democracy and non-deliberative preference aggregation methods are mutually supportive. However, very few aothors investigate the degree to which these outcomes vary or not (Murphy et al., 2017).

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Chapter 5: Conclusion

Paysage lagunaire / © Syndicat Mixte des Étangs Littoraux (SIEL).

1 Objectives of the thesis

In the context of conservation, management, ecological restoration of ecosystems or others, ESs valuation and rankings, when meaningfully possible, allows to better frame our relationship with nature (Salles and Figuieres, 2013). In general, the SE concept is used as a tool to capture the interaction between human society and ecosystems in a common language accessible to all stakeholders in decision-making processes related to environmental issues (Granek et al., 2010; Klain and Chan, 2012; Posner et al., 2016).

In this sense, in order to implement coherent, integrated, and accepted public policies, ESs valuation and ranking take into account the demand (i.e. aggregate preferences) of society. Hence, many authors argue that it should play a central role in decision-making on environmental issues. In some cases, it allows the internalization of externalities through, for instance, the introduction of compensation measures for damages caused by the polluters. Moreover, when meaningfully carried out in an integrated way (i.e. involving various actors and residents), it contributes to public awareness raising on both local and global scales (e.g. Costanza et al., 1997).

The general objective of the thesis is to identify demand in terms of ESs for coherent, integrated and accepted public decisions. The study sites comprise two French Mediterranean coastal lagoons areas: the Palavas lagoons complex and the Biguglia lagoon area. The second chapter of the thesis identifies levels of consensus and divergence among stakeholders on the prioritization of ecosystem services provided by these two French Mediterranean coastal lagoons areas. The third chapter investigates the impact of familiarity and academic information supply on citizens' preferences for ESs issued by the Palavas lagoons complex. Finally, the fourth chapter explores elicitation and aggregation methods of individual preferences for the Palavas lagoons complex.

The thesis mobilizes the ordinal preference and behavioral economics theoretical frameworks. The former allows preference statements as, for any agent, "An option X is better than an option Y" instead of "An option X is worth five times an option Y". This framework forms the basis of all the chapters in the thesis. In the other hand, the behavioral economics theoretical framework assumes that depending on a number of parameters and bias, preferences may vary. These preferences may be constructed as well during an elicitation process (e.g. discussions leading to deliberation). These concern effects of information processing such as complexity,

familiarity and salience; effects associated with information presentation such as format and framing; contextual factors including anchoring, hypothetical bias, setting and reference state, as well as learning (Valatin et al., 2016). Chapters 3 and 4 of the thesis follow this framework. Chapter 2 does not take these aspects into account.

The data collection process for the empirical work involves, for Chapter 2, a total of 57 interviews with local stakeholders including 30 on the Palavas lagoons complex and 27 on Biguglia lagoon site. These interviews were carried out using a questionnaire and a serious card game. Chapters 3 and 4 concern local residents (38 individuals). The data were collected during workshops for the local residents of the municipalities close to the Palavas lagoons complex. Academic information was supplied to these individuals in the form of oral presentations with the use of a PowerPoint support prior to an individual preference elicitation session using a questionnaire. The presentations focused on ESs as well as aspects related to the ecological functioning, socio-economic dynamics and management of the Palavas lagoons and their immediate surrounding areas.

Furthermore, Chapter 4 uses data from a deliberation process involving these local residents. Chapter 3 includes an additional data set of 404 non-local residents which comprises individuals living in non-coastal municipalities in France. Two types of non-local respondents were considered according to their familiarity with the lagoons. The notion of familiarity indicates the proximity and frequency of visits of these lagoons. Non-local residents who are familiar with the lagoons reported that they visit them very regularly. Data were collected for this group through an online survey. Data were analysed using both descriptive statistics, Q method and a multinomial logit model.

2 Summary of the main findings

The main objective of the work in **Chapter 2** is **to identify levels of consensus and divergence among stakeholders on the prioritization of ESs** provided by Palavas lagoons complex and Biguglia lagoon's site. Local stakeholders are defined, in the thesis, as any group or individual that benefits (directly or indirectly) from ESs issued by the considered study sites. In general, the main results that emerged from our analysis is that there is a relatively high interest for regulation and maintenance services regardless of stakeholder types. These results were confirmed by the arguments provided by the interviewed stakeholders in order to explain their

choices for the five most and least important ESs. There are relatively very few discourses approving the hedonic vision that seemed to prevail for one group in the Palavas case study. In the case of Biguglia, the hedonic vision was not approved. However, some groups in both sites are relatively more tolerant about less impacting recreational activities (e.g. walking, nature observation), while others are strongly against all types of recreational services.

The aim of **Chapter 3** is to test the hypothesis, that is, **the impact of familiarity and academic information on preferences**. The population types in chapter 3 are local and non-local residents. The samplings were based on the criteria of living in a coastal versus a non-coastal municipality and, on a minimum frequency of visits of the coastal lagoons (i.e. familiar versus unfamiliar with the lagoons). Furthermore an additional sample was created including local residents after receiving academic information supplied during a workshop. Hence, a variable corresponding to four groups of respondents was created. The associated levels of this variable are local residents, informed local residents, familiar non-local residents and unfamiliar non-local residents.

As in Chapter 2, regulation and maintenance services were relatively highly favoured in **Chapter 3** regardless of the four population types. Thus, these services are relatively important regardless of academic information supply, familiarity or being a stakeholder or not. Accordingly, neither academic information supply nor familiarity have an impact on preferences for cognitive effects related services i.e. environmental education and research opportunity.

On the other hand, three main groupings (or clusters) were formed, among the remaining ESs which present heterogeneous individual preferences. The cluster comprising two cultural ESs (CES), i.e. historical site and local identity, is referred to as cultural heritage and was, therefore, named as ‘Heritage’. The cluster comprising the CES ‘aesthetic value of habitats or species’, ‘aesthetic value of landscapes’, ‘bird watching’ and ‘sentiment of relaxation’ relates to leisure activities based on the contemplation of the lagoon ecosystem rather on the consumption of its resources. Therefore, this cluster has been defined as ‘contemplative leisure’. The cluster with the remaining five ESs all of which imply consumption of natural resources, either for provisioning or for leisure. This cluster has been defined as ‘consumptive activities’. The results highlights that local residents strongly favoured contemplative leisure compared to the unfamiliar citizens. However, this trend decreased with academic information supply which led the local citizens to prioritize more the collective services (heritage services) at the expense of

the self-centred ESs. Accordingly, the results show that unfamiliar citizens attributed a relatively greater consideration for heritage services.

Unlike Chapter 2, the Chapters 3 and 4 address the issue of changes in preferences based on certain factors (e.g. cognitive factors, framing effects …). The first question addressed in Chapter 4 is **to know what ESs hold stable preferences using two different methods which are computed individually: elicited preferences and deliberative aggregated preferences**. The second question is **to know whether the variation in preferences for ESs result in participating in a deliberative process**. The sample analyzed in this chapter includes informed local residents living in the municipalities close to the Palavas lagoons site. After two workshops, the data related to preferences elicited individually, both, before and after the deliberation process were generated. In addition, a collective ranking of the considered ESs issued from a deliberation process was produced.

As in **Chapters 2 and 3**, the results show that the ESs for which preferences do not vary according to the outcomes of computed individually elicited preferences and deliberative aggregated preferences include all the regulation and maintenance ESs. Also, as in **Chapter 3**, these ESs include research opportunity and environmental education as well as some CES. The remaining seven ESs showed two or more changes of the preferences, which include all three provisioning ESs and four CES (see Table 1). In the other hand, the results show an overall stability of preferences among the rankings of the respondents before and after the deliberation process across both the groups of respondents and the considered ESs. The averaged differences related to the coefficient of variation is very low (cf. chapter 4). One group of respondents has the exact same level of variation of preferences before and after the deliberation.

3 Contributing to public policies

Firstly, I recommend public policies to include the concept of ESs in decision processes related to apprehend human-Nature relationships. Assessing ecological processes and resources in terms of the goods and services they provide translates the complexity of the environment into a series of functions which can be more readily understood, for example by policy makers and non-scientists (Beaumont et al., 2007). Thus, the use of the concept of ESs can be seen as a mean of establishing a common language accessible to all stakeholders in decision-making processes (Granek et al., 2010, Klain and Chan, 2012, Posner et al., 2016). This requires the

inventory of all the ESs provided by the ecosystem to local populations, and when necessary at a larger scale.

Another recommendation is to take into account the diversity of stakeholders' preferences for ESs. Indeed, such an integrative practice can prevent or contribute to reduce conflicts (Bredin et al., 2015; de Juan et al., 2017; Jacobs et al., 2016; Rauschmayer and Wittmer, 2006; Rey-Valette et al., 2017).

Monetary approaches do not take into account these heterogeneous preferences because they flatten the various values of nature by projecting them on the single monetary dimension, which are often rejected by the stakeholders. This might lead to environmental problems and conflicts which are the consequence of trade-offs between values held by different groups of stakeholders, which in many cases are not well represented in the decision making process (Jacobs et al., 2016).

On the contrary, non-monetary methods allow identifying the diversity of preferences. For instance, non-monetary methods like Q method are very instrumental for the new pluralistic approach of decision support by capturing the values expressed by the stakeholders, without triggering a rejection reflex due to the monetarization. The advantage of the Q method is that, unlike approaches where deliberation is based on open discussions, the assessment is done individually. Therefore, it creates a kind of virtual forum where the protocol is strictly controlled in order to collect all the points of view.

Understanding the diversity of preferences of stakeholders can make public decision more challenging compared to monetary approaches. However, it would also insure policy makers to anticipate which groups might be set aside by some decisions. This means that policy makers would have to include in their decisions some mechanisms in order to account for the negative effects perceived by these groups and thus prevent related conflicts. This raises the issues of the type of policy mechanism to implement for an effective, accepted and integrated management. These includes some conflicts resolution mechanisms (Ostrom, 1990) such as mediation, negotiation, etc.

4 Limitations

The main limitation of the first case study of the thesis (**chapter 2**), is that it lacks insights from social choice theory. There is a difficulty to theoretically achieve a collective ranking of different competing alternatives from a collection of individual preferences. This issue was raised by some pioneers in social choice theory since the 18th century (List, 2013) such as Condorcet (1785) and Arrow (1951). Very few studies in environmental or ecological economics explored these drawbacks (e.g. Figuières and Salles, 2012; Murphy et al., 2017).

Nevertheless, there are some limits related to the social choice approaches mobilized in **Chapters 3 and 4**. Firstly, taking into account more variables would allow to better explain (i) the impact of academic information and familiarity on individuals' preferences and, (ii) the differences in the outcomes of deliberative and non-deliberative methods. This holds for instance, for the matching method used in chapter 3 in order to correct the selection bias. Most of the literature on matching and propensity scores assumes fully observed covariates, but most studies have at least some missing data (Stuart, 2010). For the latter case these variables could be, for instance, the power asymmetry between individuals, the balance in the speaking time of each individual during the deliberation process, the impact of the arguments of the others, etc.

In addition, the results issued from **Chapter 3** might be impacted by framing effects because of the use of two different settings of preference elicitation formats. More precisely, local residents' preferences were expressed during a workshop while non-locals answered a questionnaire online.

Another main methodological drawback relates to, in **Chapter 4**, the conjoint analysis of the outcomes of deliberative and non-deliberative methods. That is, even by taking into account a full range of variables, it is difficult to explain the convergence or divergence between the corresponding outcomes. This is mainly due to the fact that the information basis between the two approaches differs. That is, during the deliberative process, information is acquired along the way and is usually constructed through the interactions between people in a more or less scientific manner. Also, contrary to other studies in the literature, the results showed very low variability in preferences even before the deliberative process. The preferences of one group were even exactly the same before and after the deliberation process. This reflects lacks of diversity in the surveyed samples due to the difficulty in gathering people to participate in the workshops.

5 Perspectives

Another research question is to identify convergent and divergent preferences through deliberative and non-deliberative methods by using Social Choice theory. Legitimating the valuation and ranking processes, through using simultaneously these two traditions, is largely documented in the literature of environmental and ecological economics. However, very few researchers explored the contribution of Social Choice theory to these disciplines. The aim could be to formalise deliberative methods in order to make it comparable to the other aggregation methods and thus, make the analysis of the evolution of preferences scientifically valid. Furthermore, a research question could be to understand the determinants behind the achievement of a deliberated preference for ESs. The idea is to identify what bring the considered individuals to reach a collective deliberated preference for these ESs. Did they adhere to deliberative results, because the arguments of others convinced them? Were there any power asymmetries between them? How much time did every individual got to talk during the deliberation session (everyone's speaking time), etc.?

As pointed out by (Salles and Figuieres, 2013), there existed relatively no comprehensive taxonomy of the services delivered by Nature unlike the classification of firm activities for instance. Nevertheless, some classification schemes such as the CICES one are regularly updated. This is even more challenging when it comes to ESs issued from complex ecosystems unfamiliar to general public. One research avenue consists of setting up a sound classification scheme based on the characterization of ESs used in other fields in Economics. The idea is to adopt a classification scheme based on the difficulty with which consumers can assess the quality or obtain the pertinent information about the considered ecosystem. Non-market goods and services and particularly ESs have never been investigated through the lens of this typology (cf. **Chapter 3**). Thus, there exist at least three categories of ESs (i) *search goods*, (ii) *experience goods* and (iii) *credence goods*. The *search goods* category (Nelson, 1970) comprises the goods for which the attributes can be ascertained by inspection and information gathering *prior* to consumption. *Experience goods* (Nelson, 1970) can be accurately evaluated only *after* they have been used or consumed (e.g. restaurant, holiday). Finally, *credence goods* (Darby and Karni, 1973) are difficult or impossible to evaluate even after consumption has occurred. That is, the consumer might lack the knowledge or the expertise, or because the information is too costly to acquire compared to its expected benefits (e.g. medical treatments).

Another research avenue concerns the need to explore more the field of Social Choice theory in environmental and ecological economics. In general, there are two hypothesis behind preference theory. Preferences are supposed to be, either stable and exogenous or unstable (i.e. they vary according to cognitive factors, context …). In general, it is assumed in social choice theory that they are given (i.e. stable). This is based on respecting democratic individual preferences i.e. in social choice theory in general, *preference sovereignty* prevails. The question could be to know, for instance, for unknown ecosystems to general public, the theoretical implications of the assumption about preference instability.

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APPENDICES

I. Chapter 2: Additional results

Identification of significant consensus and distinguishing ESs

Table I. 1: *Distinguishing and consensus ESs among identified groups of stakeholders (G).*

ES categories	#	Statement	Differences in bootstrapped z-scores					
			Palavas			Biguglia		
			G1_G2	G1_G3	G2_G3	G1_G2	G1_G3	G2_G3
Provisioning services	15	Shellfish resources	**-0.98***	0.41	**1.39***	**-1.14***	**-1.33***	-0.19
	19	Biomass for grazing	-0.18	**1.17***	**1.35***	0.56	-0.06	-0.61
	21	Crops	0.01	1.05	1.04	1.06	0.72	-0.34
	22	Shellfish farming	-0.85	0.40	**1.25***	**-1.22***	-1.22	-0.01
	23	Fish resources	-0.48	0.45	0.93	0.58	-0.13	-0.71
	30	**Pisciculture**	**-0.99***	0.52	**1.51***	-1.04	**-2.38****	-1.34
	29*	Commercial inland navigation or Hydrological regulation	-0.21	-1.11	-0.90	-0.56	0.63	1.20
	31	**Non-food products**	-0.58	0.55	1.12	0.98	-0.93	**-1.90****
Regulation and maintenance services	14	Purification capacity	-0.76	0.14	0.90	-0.19	**1.32***	**1.51***
	20	Wastes decomposition	**-1.98****	-0.69	**1.29***	-0.94	-0.69	0.25
	5	Flooding and other extreme events regulation and protection	-0.20	0.97	1.17	-0.47	0.85	1.31
	13	Banks reinforcement	-0.89	0.16	1.06	**-1.27***	-0.97	0.30
	25	Microclimate regulation	-0.95	-0.71	0.25	-0.47	0.66	1.14
	3	Nursery and biodiversity maintenance	0.26	0.65	0.40	0.40	1.03	0.63
Cultural services	2	Aesthetic value of landscapes	0.64	0.04	-0.60	1.03	**1.46***	0.43
	7	Local identity	0.04	-0.43	-0.47	0.19	-0.75	-0.94
	9	Aesthetic value of habitats or species	0.33	0.03	-0.30	1.03	0.24	-0.80
	11	Historical sites	**1.31****	0.43	-0.88	0.26	-0.16	-0.43
	4	**Recreational boat navigation**	0.91	-0.79	**-1.70****	**-1.44****	**-2.33****	-0.89
	8	**Non-motorized water sports**	**1.20***	-0.44	**-1.65****	**-1.42****	-0.94	0.48
	12	Bird watching	0.35	-0.18	-0.53	0.43	**1.35***	0.92
	16	Cycling	**1.41****	-0.11	**-1.52***	0.68	0.46	-0.22
	17	Horse riding	0.77	-0.37	-1.15	0.38	0.17	-0.21
	18	Waterfowl hunting	**-1.46****	-0.81	0.65	0.69	-1.02	**-1.71***
	24	Sentiment of relaxation	**1.90****	0.94	-0.95	-0.28	0.89	1.17
	26	Camping	0.01	-0.81	-0.83	0.72	-0.48	-1.19
	27	Recreational hiking and walking	**1.96****	0.54	**-1.42***	0.87	**1.38***	0.50
	28	**Recreational fishing**	**-1.26***	**-1.52***	-0.27	**-1.17***	-1.08	0.09
	1	Artistic inspiration	0.22	-0.85	-1.06	0.35	-0.18	-0.53
	6	Research opportunity	-0.30	-0.53	-0.23	**1.23***	**1.49***	0.27
	10	Environmental education	0.76	0.89	0.13	0.16	**1.72****	**1.55***

* ES #29 refers to: (a) water-flow regulation service for agriculture in the zone adjacent to the fringing wetlands of Biguglia and (b) commercial inland navigation linked to water provision services for uses other than human consumption (on the Rhône-to-Sète canal) for Palavas. ESs in bold are potential ESs which are forbidden in Biguglia lagoon because of Natural Reserve regulations. Likewise ESs #30 and #31 do not exist or are unused in Palavas lagoons.

Note: Significance of distinctiveness of a ES (see Brown, 1980; Zabala and Pascual, 2016) is indicated for p-values: $**p \leq 0.01$; $* p \leq 0.05$. ESs which are not distinguishing for any of the groups are consensus ESs.

Plot illustrating consensus and distinguishing ESs based on the point of views of the different stakeholder groups identified in Biguglia case study.

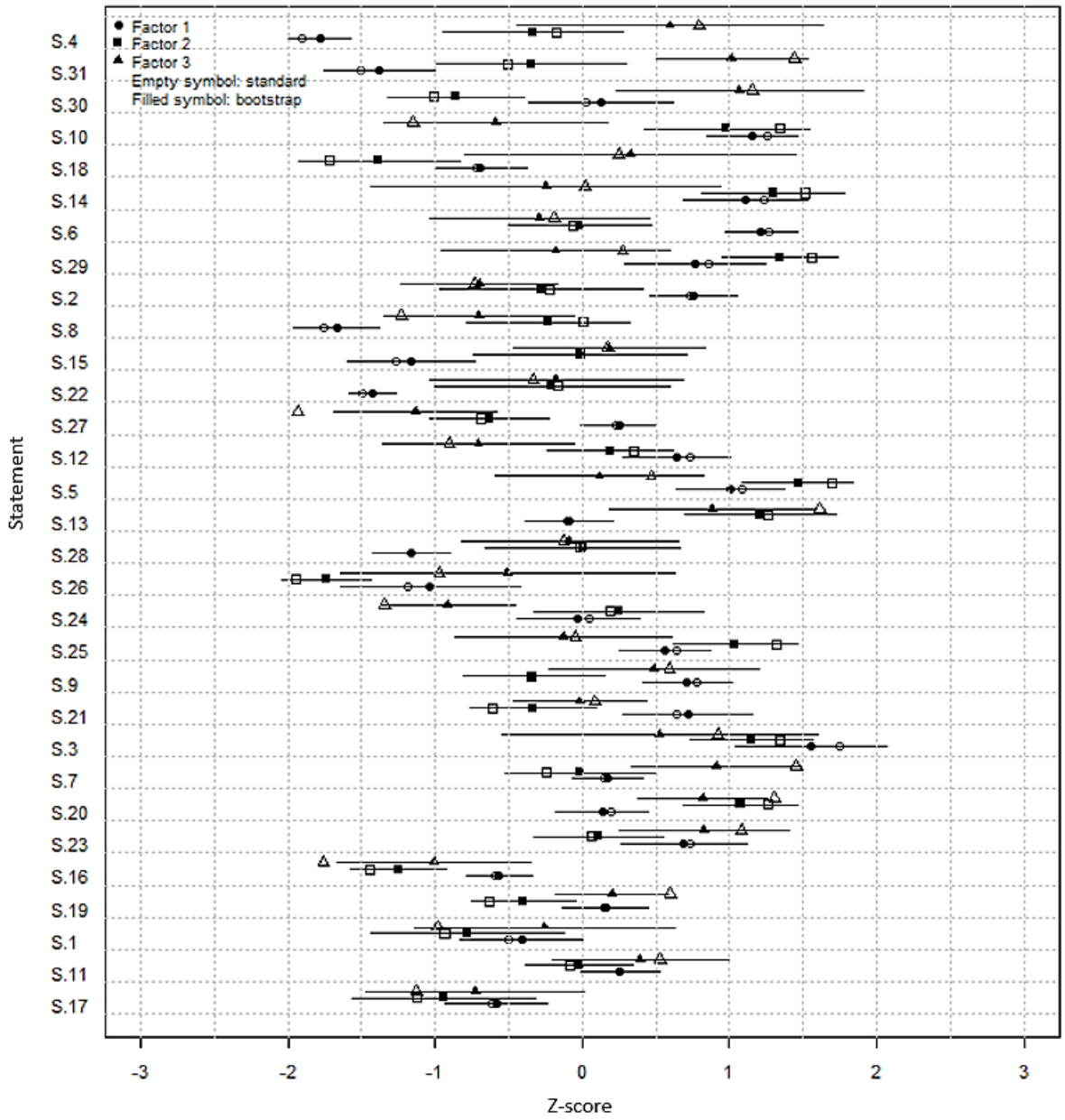


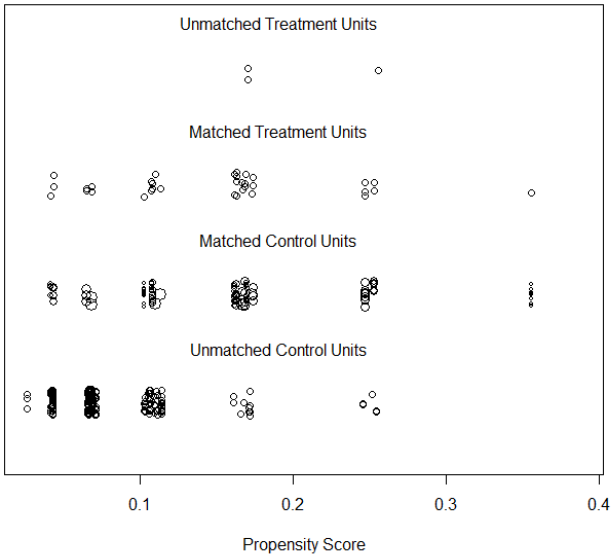
Figure I. 1. Plot illustrating consensus and distinguishing ESs based on the points of view of the different stakeholder groups identified in Biguglia case study. See Table 2 for the correspondence between the numbers used and the ESs

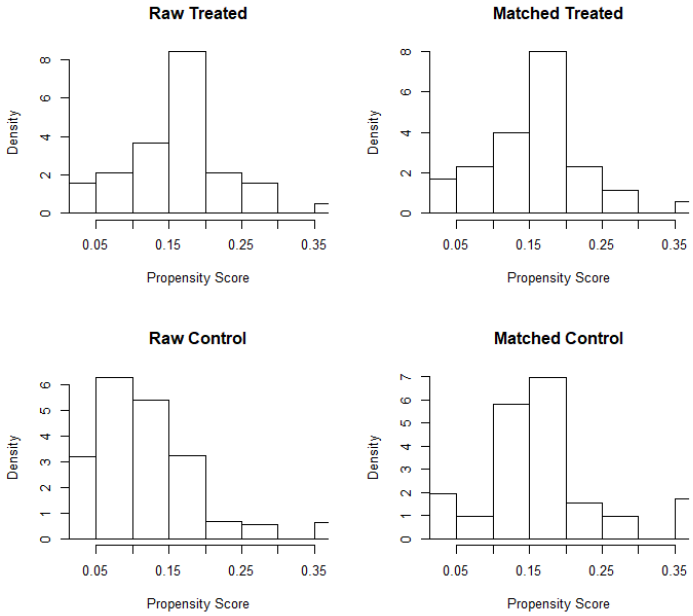
II. Chapter 3: Additional results

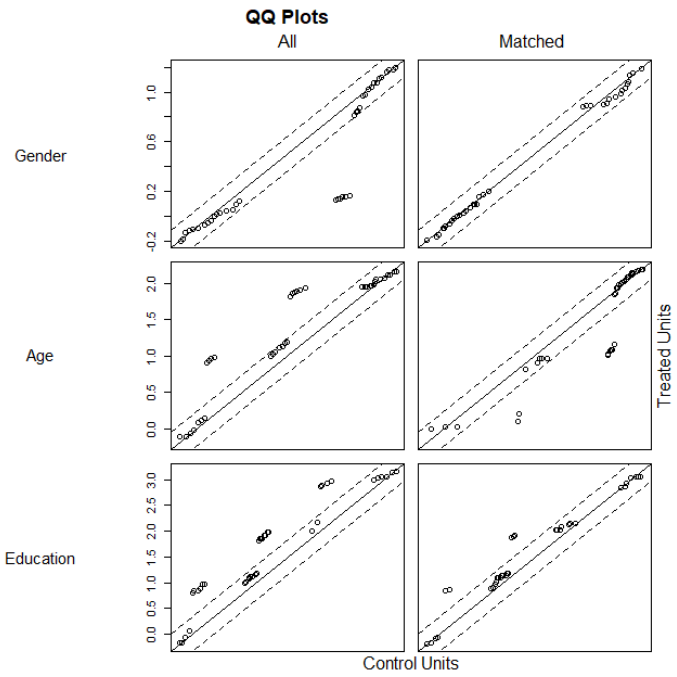
The results of the Coarsened Exact Matching (CEM)

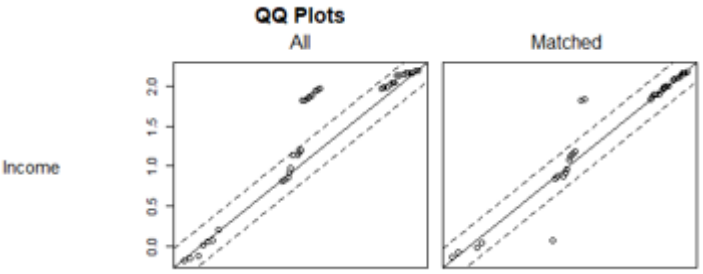
Matching unfamiliar non-local residents to local residents: results

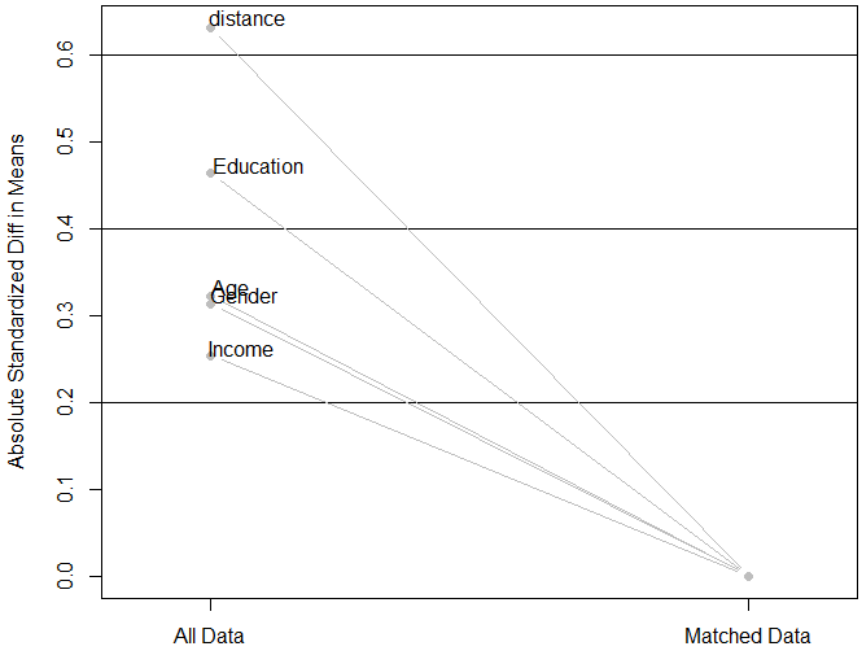
```
Summary of balance for all data:
          Means Treated Means Control SD Control Mean Diff eQQ Med eQQ Mean eQQ Max
distance         0.1562        0.1110     0.0702    0.0452  0.0506   0.0472  0.0997
Gender           0.4211        0.5779     0.4948   -0.1568  0.0000   0.1579  1.0000
Age              1.3421        1.0900     0.8115    0.2521  0.0000   0.2632  1.0000
Education        1.6842        1.2249     0.9867    0.4593  0.0000   0.4737  1.0000
Income           1.3947        1.1938     0.7148    0.2010  0.0000   0.2105  1.0000


Summary of balance for matched data:
          Means Treated Means Control SD Control Mean Diff eQQ Med eQQ Mean eQQ Max
distance         0.1525        0.1525     0.0718         0   8e-04   0.0131  0.1025
Gender           0.4286        0.4286     0.4973         0   0e+00   0.0000  0.0000
Age              1.4000        1.4000     0.7286         0   0e+00   0.2286  1.0000
Education        1.5714        1.5714     0.9392         0   0e+00   0.1429  1.0000
Income           1.4571        1.4571     0.7342         0   0e+00   0.0857  1.0000

Percent Balance Improvement:
          Mean Diff. eQQ Med eQQ Mean  eQQ Max
distance         100 98.4152  72.1529  -2.8012
Gender           100  0.0000 100.0000 100.0000
Age              100  0.0000  13.1429   0.0000
Education        100  0.0000  69.8413   0.0000
Income           100  0.0000  59.2857   0.0000

Sample sizes:
          Control Treated
All           289      38
Matched       103      35
Unmatched     186       3
Discarded       0       0
```





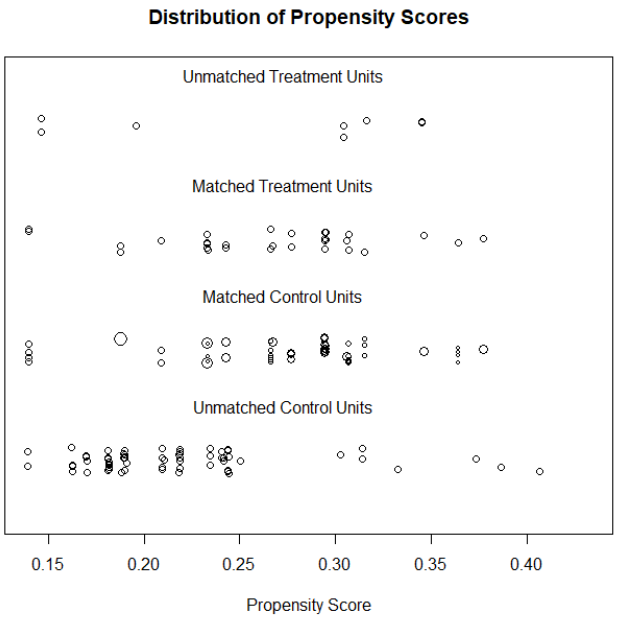

QQ Plots
All
Matched
Gender
Age
Education
Treated Units
Control Units

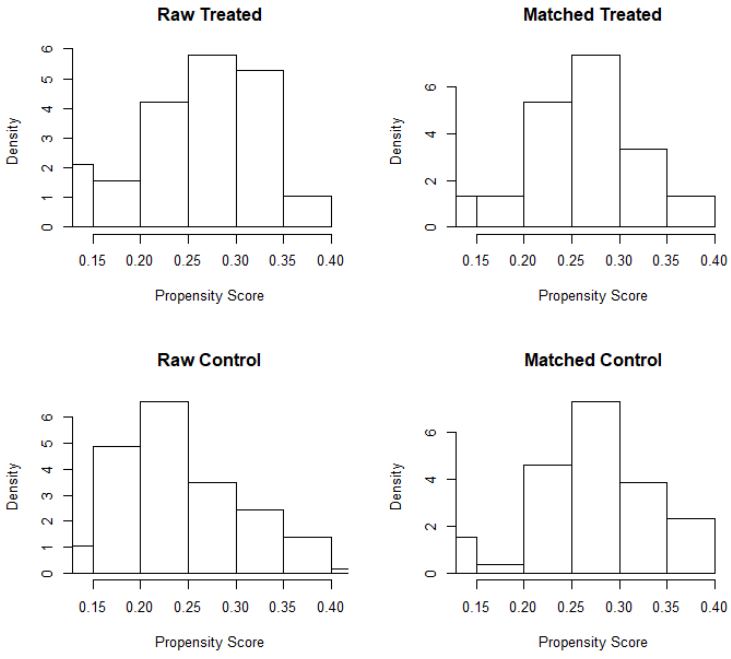

QQ Plots
All
Matched
Income

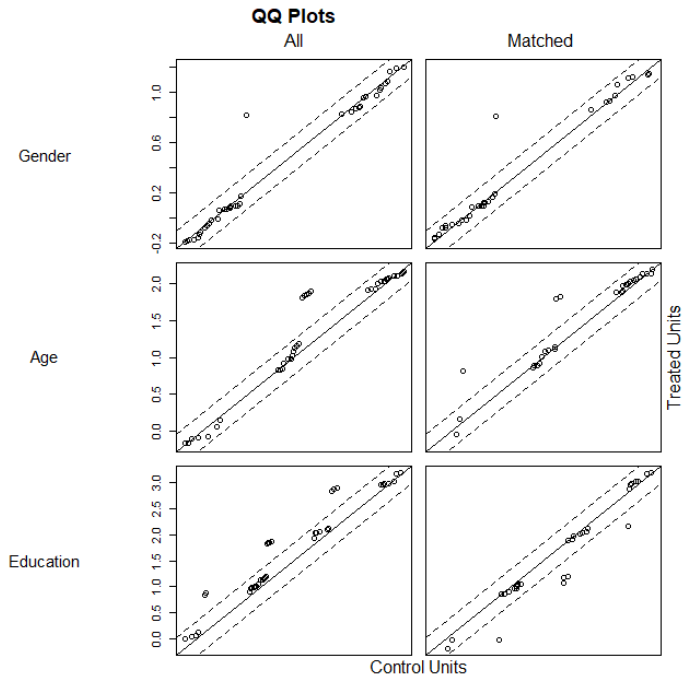

distance
Education
Age
Gender
Income
Absolute Standardized Diff in Means
All Data
Matched Data

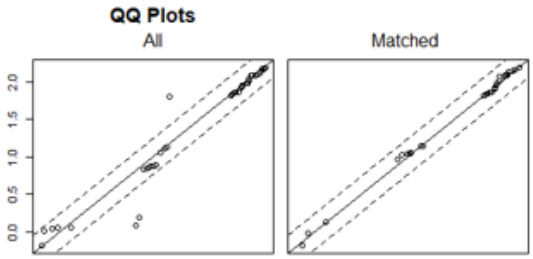
Matching familiar non-local residents to local residents: results

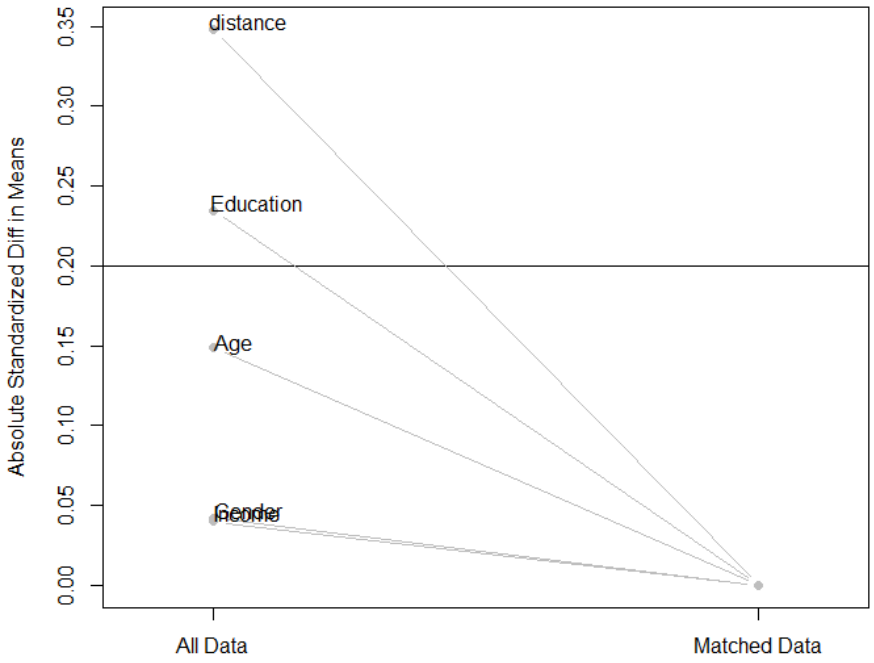
```
Summary of balance for all data:
          Means Treated Means Control SD Control Mean Diff eQQ Med eQQ Mean eQQ Max
distance         0.2648        0.2429     0.0629    0.0219  0.0272   0.0260  0.0536
Gender           0.4211        0.4000     0.4920    0.0211  0.0000   0.0263  1.0000
Age              1.3421        1.2261     0.7140    0.1160  0.0000   0.1316  1.0000
Education        1.6842        1.4522     0.9574    0.2320  0.0000   0.2368  1.0000
Income           1.3947        1.4261     0.7140   -0.0314  0.0000   0.0789  1.0000


Summary of balance for matched data:
          Means Treated Means Control SD Control Mean Diff eQQ Med eQQ Mean eQQ Max
distance         0.2653        0.2653     0.0568         0   9e-04   0.0090  0.0478
Gender           0.3333        0.3333     0.4760         0   0e+00   0.0333  1.0000
Age              1.5333        1.5333     0.6243         0   0e+00   0.1000  1.0000
Education        1.6333        1.6333     0.9573         0   0e+00   0.1667  1.0000
Income           1.5667        1.5667     0.6740         0   0e+00   0.0000  0.0000

Percent Balance Improvement:
          Mean Diff. eQQ Med eQQ Mean  eQQ Max
distance         100 96.5642  65.4390  10.8976
Gender           100  0.0000 -26.6667   0.0000
Age              100  0.0000  24.0000   0.0000
Education        100  0.0000  29.6296   0.0000
Income           100  0.0000 100.0000 100.0000

Sample sizes:
          Control Treated
All           115      38
Matched        52      30
Unmatched      63       8
Discarded       0       0
```






QQ Plots
All
Matched
Gender
Age
Education
Income
Treated Units
Control Units


QQ Plots
All
Matched


Absolute Standardized Diff in Means
distance
Education
Age
Gender
Income
All Data
Matched Data

Homogenous versus heterogeneous preferences of ESs among groups of respondents

Table II. 1. The set of the twenty ecosystem services (ESs) used in this study. The ESs have been categorized according to the classification designed for coastal and marine ESs by Liquete et al. (2013). Fisher's exact tests were performed to test for the homogeneity of preferences among the four groups of citizens (see section 2.2). Hence, ESs in italics presented homogeneous preferences among the four groups of citizens. ESs in bold presented heterogeneous preferences among the four groups.

ES category	Ecosystem service	Fisher exact test (p value)
Provisioning	**Biomass for grazing**	p < 0.001***
	Shellfish farming	p < 0.001***
	Fish resources	0.264
Regulation and maintenance	*Water purification capacity*	0.298
	Flooding and other extreme events regulation and protection	0.235
	Banks reinforcement	0.196
	Microclimate regulation	0.393
	Nursery and biodiversity maintenance	0.281
Cultural	**Aesthetic value of landscapes**	p < 0.001***
	Local identity	p < 0.001***
	Aesthetic value of habitats or species	p < 0.001***
	Historical sites	p < 0.001***
	Non-motorized water sport	p < 0.001***
	Bird watching	p < 0.001***
	Waterfowl hunting	p < 0.001***
	Sentiment of relaxation	0.002**
	Recreational hiking and walking	0.289
	Recreational fishing	p < 0.001***
	Research opportunity	0.869
	Environmental education	0.464

Levels of priority of ecosystem services presenting homogeneous preferences among the groups of respondents according to familiarity and academic information supply

Table II. 2. Levels of priority of ecosystem services presenting homogeneous preferences among the groups of respondents according to familiarity and academic information supply. The corresponding level of priorities are indicated in the table as P, N and NP which stand for "Priority", "Neutral" and "Not a priority", respectively.

Ecosystem services presenting homogeneous references	P-Value	Level of priority	Local residents		Matched observations for non-local residents		Initial observations for non-local residents	
			Local	Informed Local	Matched Familiar	Matched Unfamiliar	Familiar	Unfamiliar
Regulation and maintenance	*0.431*							
		P	93.3%	100.0%	96.2%	92.2%	95.7%	93.4%
		N	6.7%	0.0%	3.8%	7.8%	4.3%	6.6%
		NP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Fish resources	*0.264*							
		P	26.7%	26.7%	51.9%	36.9%	47.0%	25.6%
		N	50.0%	50.0%	30.8%	41.7%	30.4%	43.6%
		NP	23.3%	23.3%	17.3%	21.4%	22.6%	30.8%
Recreational hiking and walking	*0.288*							
		P	53.3%	46.7%	67.3%	62.1%	76.5%	61.6%
		N	26.7%	36.7%	19.2%	29.1%	15.7%	31.1%
		NP	20.0%	16.7%	13.5%	8.7%	7.8%	7.3%
Environmental education and research opportunity	*0.741*							
		P	93.3%	90.0%	92.3%	90.3%	96.5%	91.7%
		N	3.3%	10.0%	7.7%	8.7%	3.5%	7.6%
		NP	3.3%	0.0%	0.0%	1.0%	0.0%	0.7%

III. Questionnaires

Questionnaire 1: stakeholders' preference elicitation using Q methodology

ENQUETE SUR LES PERCEPTIONS ET PERSPECTIVES RELATIVES AUX AVANTAGES ISSUS DES LAGUNES PALAVASIENNES ET LEURS ZONES PERIPHERIQUES

Pendant plusieurs décennies la plupart des lagunes côtières de la région Occitanie ont subi des apports excessifs en éléments nutritifs (Azote et Phosphore), ce qui a engendré leur eutrophisation et la dégradation de la qualité de leurs eaux. Ce phénomène d'eutrophisation a été particulièrement important pour les Etangs Palavasiens. Ce site constitue un site Natura 2000 pour la rareté ou la fragilité de leurs espèces sauvages, animales ou végétales, et de leurs habitats. Il est également parmi des zones d'importance internationale (sites RAMSAR) depuis 2008. Ainsi, depuis 2000, les pouvoirs publics ont initié une politique de réduction des apports en Azote et Phosphore afin de réaliser une reconquête d'une bonne qualité des eaux. La qualité de l'eau et l'écologie des Etangs Palavasiens ont fait l'objet de plusieurs études scientifiques par des chercheurs de l'Université de Montpellier et d'Ifremer et de suivis réguliers, dont notamment ceux réalisés dans les cadres du Réseau de Suivi Lagunaire (RSL) et de la Directive Européenne sur l'Eau (DCE). **Cette enquête vise à identifier vos perceptions de l'importance des avantages fournis par les étangs palavasiens afin de mieux appréhender les actions de conservation et de restauration ainsi que la gestion de ces milieux.**

Cette enquête est réalisée par le CNRS et l'Université de Montpellier. Les données individuelles ou opinions recueillies sont strictement confidentielles et seront uniquement utilisées dans un but de recherche. Elles feront l'objet d'un traitement statistique. En aucun cas, elles ne pourront être utilisées par les administrations ou les collectivités territoriales.


vers Montpellier
A9
D 612
vers Sète
Massif de la Gardiole
Mireval
Villeneuve-lès-Maguelone
Réserve naturelle de l'Estagnol
Salines de Villeneuve
Etang de Vic
Marais de la Grande Palude
Canal du Rhône à Sète
Etang de Pierre Blanche
Lattes
Site protégé du Méjean
Maison de la Nature
Etang du Méjean
Pérols
Biotope du Grec
Etang de l'Arnel
Etang du Prévost
Palavas-les-flots
Cathédrale de Maguelone
Lido des Aresquiers
Bois des Aresquiers
Salins de Frontignan
Frontignan La Peyrade
Etang d'Ingril
Etang des Mouettes
Frontignan plage

A. IDENTIFICATION

Nom : Prénom

Numéro de téléphone :

Institution : Ville :

A1. Quelle est votre position/responsabilité au sein de votre institution ?

A2. Votre institution joue-t-elle un rôle par rapport aux actions de restauration, d'aménagement et/ou de conservation des étangs ?

A3. Quel est votre parcours social et professionnel sur la question de la restauration écologique, d'aménagement et/ou de conservation des étangs ?

A4. Etes-vous :

☐	Un homme	☐	Une femme

A5. Quel est votre âge ?

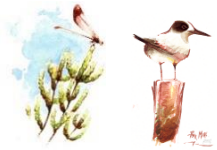
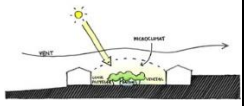
A6. Quel est votre lieu de résidence ? Depuis combien de temps y habitez-vous ?

A7. Quel type de diplôme (niveau et discipline) possédez-vous ?

B. ANALYSE DES PERCEPTIONS ET DES PERSPECTIVES RELATIVES AUX LAGUNES PALAVASIENNES ET LEURS ZONES PERIPHERIQUES

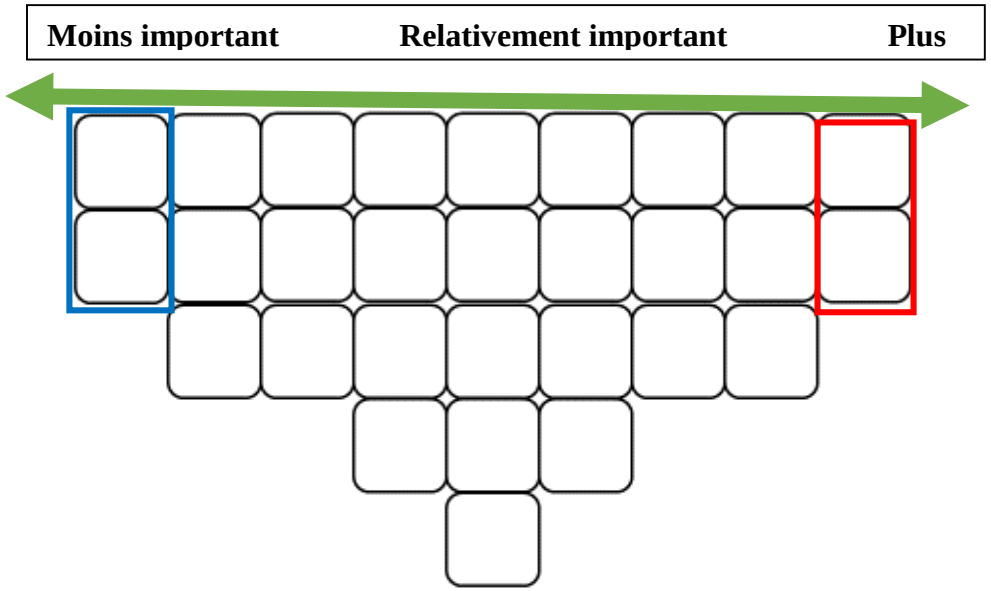
Consignes

1. lire les affirmations et les classer selon **trois classes** d'importance :
   - Plus important
   - Relativement important
   - Moins important
   -
2. Pour chaque question, poser les cartes sur la grille selon leur ordre d'importance.
   -
3. Une fois toutes les cartes posées sur la grille, c'est possible de changer l'ordre jusqu'à ce que la grille représente au mieux votre point de vue.
   -
4. Noter les numéros liés à chaque carte sur la grille correspondante dans le questionnaire.

Ressources poissons  *Pêche professionnelle (anguille, loup, …)*	**Coquillages**  *Pêche professionnelle (palourdes, …)*	**Gibiers d'eau et oiseaux**  *Chasse*	**Biomasse**  *Pâturage*	**Conchyliculture**  *Huitres, palourdes, autres mollusques, …*	**Transport fluvial commercial**  *Canal du Rhône à Sète*	**Fixation et décomposition des débris organiques accumulés** 	**Sentiment de bien-être et de tranquillité procuré aux visiteurs** 
Autoépuration et filtration de l'eau  *Améliore la qualité olfactive du milieu*	**Nurserie et habitat** 	**Fixation des berges**  *… contre l'érosion*	**Régulation du microclimat**  *Climat d'un espace géographique restreint, différent du climat général*	**Régulation des inondations et protection des terres intérieures**  *…contre les tempêtes, la salinité*	**Identité locale**  	**Support de cultures alimentaires** 	Autres produits destinés à l'usage ou à la transformation directe  *Anguille fumée, sagne, engrais, …*
Sites historiques et culturels 	**Valeur paysagère** 	**Valeur esthétique d'espèces remarquables** 	**Pêche amateur et collecte de coquillages** 	**Sports nautiques non motorisés** 	**Observation des oiseaux** 	**Promenade équestre** 	**Pisciculture** 
Balade à vélo 	**Promenade, randonnée, course à**  *…et autres activités similaires*	**Balade et excursion en bateau**  *Canal du Rhône à Sète*	**Support pour le camping** 	**Source d'inspiration artistique** 	**Education à l'environnement** 	**Opportunités pour la recherche scientifique** 	

B1. Comment classeriez-vous, en termes d'importance, les différents rôles des lagunes palavasiennes et de leurs zones périphériques que vous observez **actuellement (Automne - Hivers)?**

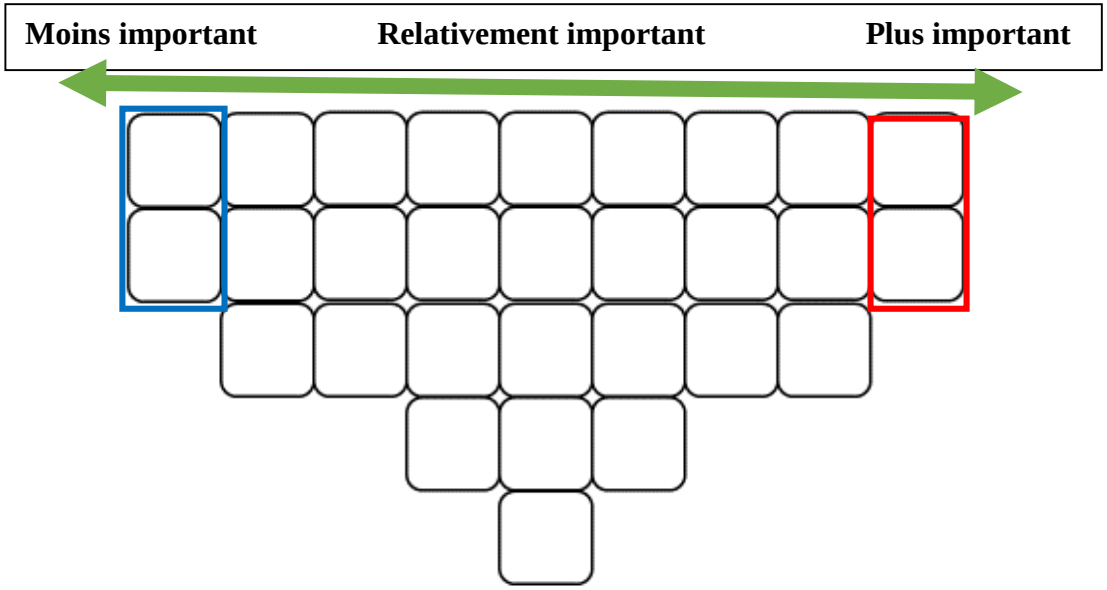
Pourquoi avez-vous choisi les deux affirmations les Moins importantes ?



Pourquoi avez-vous choisi les deux affirmations les Plus importantes ?

B2. Comment classeriez-vous, en termes d'importance, les différents rôles des lagunes palavasiennes et de leurs zones périphériques que vous observez **actuellement (Printemps – Eté)?**

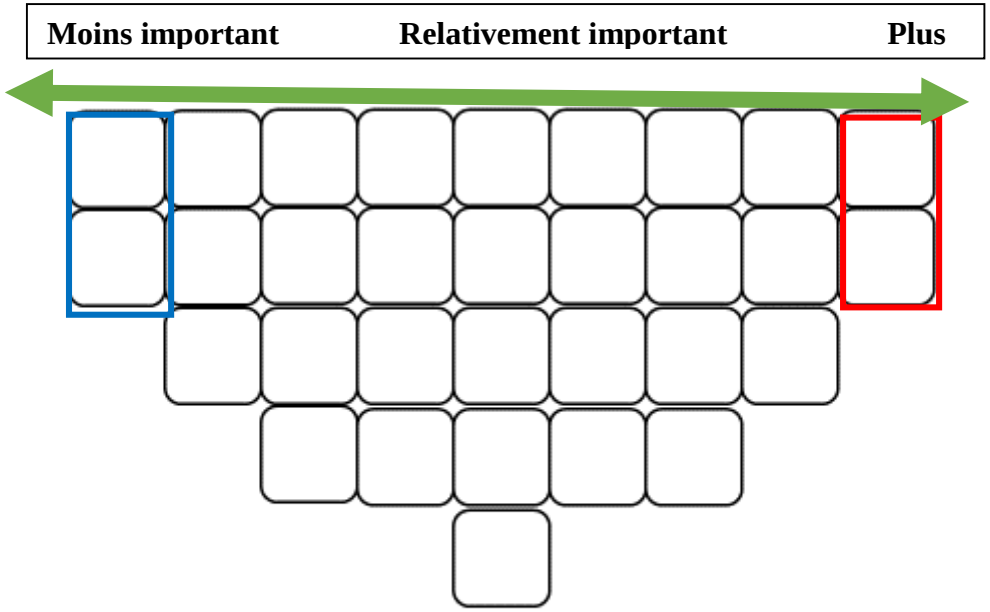
Pourquoi avez-vous choisi les deux affirmations les Moins importantes ?



Pourquoi avez-vous choisi les deux affirmations les Plus importantes ?

B3. Quels sont les rôles des lagunes palavasiennes et de leurs zones périphériques que vous voudriez prioriser **dans l'avenir** ?

Pourquoi avez-vous choisi les deux affirmations les Moins importantes ?



Pourquoi avez-vous choisi les deux affirmations les Plus importantes ?

B4. Que changeriez-vous ou ajouteriez-vous aux différent(s) service(s) présentés ci-dessus ? Pourquoi ?

B5. Quelle importance accordez-vous à ce(s) service(s) ajoutés ?

Services / *Rang*	-4	-3	-2	-1	0	1	2	3	4

C. VOUS ET LES LAGUNES PALAVASIENNES ET LEURS ZONES

C1. Êtes-vous bénévole dans une ou des association (s) ou organisation(s) en lien avec les lagunes et leurs zones périphériques ?

☐	Oui régulièrement (au moins un jour/semaine)	☐	De temps en temps (quelques jours/mois)
☐	Très ponctuellement (quelques jours dans l'année)	☐	Non

C2. Etes-vous adhérent(e)/Président(e) d'une association environnementale?

☐	Oui, laquelle ?	☐	Non

C3. Etes-vous salarié(e) de votre institution ?

☐	Oui	☐	Non

C4. Depuis combien de temps exercez-vous votre activité au sein de votre institution ?

C5. Depuis combien de temps exercez-vous votre activité sur les Etangs palavasiens ?

C6. A quelle fréquence vous rendez-vous sur les lagunes et leurs zones périphériques **en général**?

☐	1 fois/mois	☐	1 à 2 fois par/mois	☐	Plus de 2 fois/mois

C7. A quelle fréquence vous rendez-vous sur les **lagunes palavasiennes** et leurs zones périphériques ?

☐	1 fois/mois	☐	1 à 2 fois par/mois	☐	Plus de 2 fois/mois

C8. En moyenne, combien de temps restez-vous à chaque visite ?

☐	Moins d'1 h	☐	1-3 h	☐	Plus de 3h

C9. Vos visites varient-elles en fonction des saisons ?

☐	NON	☐	OUI : précisez la saison avec le maximum de visite et celle avec le minimum de visite

C10. Etes-vous consulté pour la gestion des Etangs palavasiens (comité de pilotage Natura 2000, comité consultatif du SIEL, …)?

☐	Oui, quel réseau de gestion ?pourquoi ?	☐	Non

C11. Quelle (s) opinions prioritaires voulez-vous faire entendre ?

C12. Auriez-vous des commentaires sur ce questionnaire ?

Questionnaire 2: residents' preference elicitation through majority judgement (individual task)

Crédit photo : EID Villeneuve-Lès-Maguelone

Crédit photo : Alain Dindeleux

Crédit photo : Syble

La collecte des données est réalisée par le CNRS et l'Université de Montpellier. Les données individuelles ou opinions recueillies sont strictement confidentielles et seront uniquement utilisées dans un but de recherche. Elles feront l'objet d'un traitement statistique anonyme.

A. Votre lien avec les Etangs palavasiens

A1. Quelle est votre commune de résidence ?
……

A2.Depuis combien de temps y habitez-vous ?.....

A3. Depuis combien de temps habitez-vous dans une commune proche du littoral ?

A4.Etes-vous originaire du département de l'Hérault ? ☐ OUI ☐ Non, précisez le département de naissance ……....

A5. Approximativement, combien de fois allez-vous à proximité des étangs ?

☐ Jamais ☐ 1 ou 2 fois /an ☐ 1 ou 2 fois /mois ☐ Environ 1 fois / semaine sauf l'hiver ☐ Environ 1 fois / semaine toute l'année ☐ Plus souvent

B. Analyse des priorités de conservation relatives aux Etangs palavasiens

Selon vous quels sont les rôles des étangs les plus importants en termes de priorité de conservation ?

Veuillez <u>cochez</u> la case associée à chaque rôle en fonction de sa priorité de conservation.

Rôles des étangs	Extrêmement prioritaire	Prioritaire	Neutre	Pas prioritaire	Pas du tout prioritaire
Gestion des inondations					
Epuration de l'eau					
Beauté des paysages					
Pêche professionnelle					
Conchyliculture					
Chasse gibier d'eau					
Promenades randonnée course à pied, vélo					
Pêche amateur					
Observation de la nature					
Bien être des habitants					
Nurserie et habitat					
Régulation du climat local					
Sports nautiques					
Identité locale et patrimoine					
Sites historiques et culturels					
Education à l'environnement					
Valeur esthétique des espèces remarquables					
Fixation des berges contre l'érosion					
Opportunité pour la recherche scientifique					
Zone de pâturage ou de culture					

C. Information relative aux étangs palavasiens

C1. Aviez-vous déjà entendu parler des services écosystémiques avant cette enquête ? ☐ Oui ☐ Non

C2. Lesquels des rôles présentés dans le tableau associé à la question **B1** vous ne connaissiez pas avant cette enquête ?

Veuillez indiquer les (s) numéros de ces services écosystémiques qui sont listés dans le tableau associé à la question B1 ci-dessous

C3. Comment jugeriez-vous votre niveau de connaissance concernant le fonctionnement et les services rendus par les étangs ?

☐ Très bonne ☐ Bonne ☐ Assez bonne ☐ Passable ☐ insuffisante

C4. Parmi les phrases citées ci-dessous, lesquelles sont vraies pour les Etangs palavasiens ?

	Ne sais pas	Vrai	Faux
Les Etangs palavasiens fournissent un cadre pour les activités nautiques, découverte des espaces naturels, la chasse, …			
Les Etangs palavasiens sont la propriété du Département de l'Hérault			
Les Etangs palavasiens fournissent des ressources naturelles (poissons, coquillages, fourrage etc.) nécessaires au fonctionnement de nombreuses activités économiques comme la pêche professionnelle, le pâturage, …			
La conchyliculture est l'activité économique la plus importante sur les Etangs palavasiens			
Les Etangs palavasiens bloquent l'écoulement des eaux des inondations			
Les Etangs jouent un rôle important dans le cycle des éléments nutritifs (Azote et phosphore) qui sont essentiels au maintien de la vie aquatique			
Les Etangs constituent un habitat essentiel pour la nidification des oiseaux et le cycle de vie de nombreuses espèces			
La salinité Etangs palavasiens est supérieure à celle de la mer Méditerranée			
L'eutrophisation est un phénomène écologique causé par un apport trop important des éléments nutritifs azote et phosphore			
Il n'existe aucun site historique et culturel sur le site des Etangs palavasiens			
Les Etangs palavasiens sont des sites Natura 2000 (Réseau européen pour la conservation des habitats naturels de la faune et de la flore sauvages) et Ramsar (Traité international pour la conservation et l'utilisation durable des zones humides)			
Le Syndicat mixte des étangs littoraux (SIEL) est un service technique de la commune de Frontignan			

D. Caractéristiques personnelles

D1. Sexe ☐ Homme ☐ Femme

D2. Quel est votre année de naissance ? |__||__|

D3. Êtes-vous propriétaire ou locataire de votre logement? ☐ Propriétaire ☐ Locataire

D4. Êtes-vous : ☐ Marié(e), Paxé(e), ou en concubinage ☐ Célibataire, Veuf(ve) ou Divorcé(e)

D5. Quelle est votre catégorie socio professionnelle ?

☐	Agriculteur	☐	Demandeur d'emploi
☐	Artisan, commerçant, chef d'entreprise	☐	Étudiant
☐	Cadres et professions supérieures	☐	Retraité
☐	Professions intermédiaires	☐	Femme au foyer
☐	Employé	☐	Autre : précisez …….
☐	Ouvrier	☐	

D6. De combien de personnes se compose votre ménage, y compris vous-même ? |__|

D7. Au total combien avez-vous d'enfants dans votre ménage ? |__|

D8. Dont combien d'enfants de moins de 14 ans? |__|

D9. Avez-vous des animaux ? ☐ Oui ☐ Non

D10. Quel est votre niveau d'étude le plus élevé ?

☐ Aucun ☐ BEP-CAP ☐ BAC ☐ BAC +2 ☐ BAC + 3 ou 4 ☐ BAC + 5 et plus

D11. Etes-vous membre d'une association ? ☐ Plusieurs ☐ Une ☐ Aucune

D12. <u>Si oui,</u> est-ce qu'il s'agit d'association(s) environnementale(s) ?

☐ Oui, ☐ Non

D13. Est-ce que vous mangez des produits bio ?

☐ Oui, régulièrement ☐ Oui, de temps en temps ☐ Non

D14. Avez-vous fait un ou des dons à une ou des associations au cours des 12 derniers mois ?

☐ Oui, ☐ Non

D15. <u>Si oui,</u> est-ce que certaines de ces associations ont un lien avec la protection de l'environnement ?

☐ Oui, ☐ Non

D16. Avez-vous voté aux dernières élections municipales ? ☐ Oui ☐ Non

D17. Est-ce que votre activité professionnelle est ou était liée ?

☐ Au tourisme ☐ A la gestion des risques
☐ A la mer ☐ A l'environnement
☐ Aucun de ces domaines

D18. Quelles sont les ressources **mensuelles totales de votre ménage (y compris les allocations familiales, loyers perçus...) ?**

☐	<750 €	☐	750 à 1.000 €	☐	De 1.000 à 1.500 €	☐	De 1.500 à 2.000 €
☐	De 2.000 à 3.000 €	☐	De 3.000 à 4.500 €	☐	> 4.500 € à 6000 €	☐	>6000 €

Questionnaire 2: residents' preference elicitation through majority judgement (deliberation)

Selon vous quels sont les rôles des étangs les plus importants en termes de priorité de conservation ?

Veuillez cochez la case associée à chaque rôle en fonction de sa priorité de conservation.

Rôles des étangs	Extrêmement prioritaire	Prioritaire	Neutre	Pas prioritaire	Pas du tout prioritaire
Gestion des inondations					
Epuration de l'eau					
Beauté des paysages					
Pêche professionnelle					
Conchyliculture					
Chasse gibier d'eau					
Promenades randonnée course à pied, vélo					
Pêche amateur					
Observation de la nature					
Bien être des habitants					
Nurserie et habitat					
Régulation du climat local					
Sports nautiques					
Identité locale et patrimoine					
Sites historiques et culturels					
Education à l'environnement					
Valeur esthétique des espèces remarquables					
Fixation des berges contre l'érosion					
Opportunité pour la recherche scientifique					
Zone de pâturage ou de culture					

Questionnaire 2: the workshops' quality check related questions

Sur une échelle de 1 (mauvais) à 10 (excellent), comment qualifieriez-vous :

	1	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***
1. La qualité de l'information qui vous été donnée										
2. La liberté de parole au sein du groupe (tout le monde a pu s'exprimer)										
3. La difficulté des questionnaires										
	1	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***
4. La composition du groupe (diversité des points de vue)										
	1	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***
5. Le mode d'organisation des réunions (horaires, lieux, convivialité…)										
6. Les modalités d'indemnisation des déplacements										

IV. Publications during the thesis and work in progress

Sy, M.M., Rey-Valette, H., Simier, M., Pasqualini, V., Figuières, C., De Wit, R., **2018**. Identifying Consensus on Coastal Lagoons Ecosystem Services and Conservation Priorities for an Effective Decision Making: A Q Approach. Ecol. Econ. 154, 1–13. doi:10.1016/j.ecolecon.2018.07.018.

Rey-Valette, H., Maurel, P., Miellet, P., **Sy, M.,** Pigache, L., **2017**. Mesurer les impacts des infrastructures de données géographiques (IDG) et des observatoires. Rev. Int. Géomatique 27, 375–397. doi:10.3166/rig.2017.00029.

Sy, M.M., Rey-Valette, H., Simier, M., Figuières, C., De Wit, R. **2019**. The Impact of Academic Information Supply and Familiarity on Ecosystem Services Perceptions. *Submitted.*

Sy, M.M., Figuières, C., Rey-Valette, H., De Wit, R. **2019**. Valuation of Ecosystem Services and social choice: An original protocol combining deliberative and individual Preferences. *In preparation.*

De Wit, R., Leruste, A., Le Fur, I., **Sy., M.M.**, Bec., B., Ouisse, V., Derolez, V., Rey-Valette, H. **2019**. A multidisciplinary approach for restoration ecology of shallow coastal lagoons, a case study in South France. *Submitted to Frontiers in Ecology and Evolution - section Conservation.*

Leruste, A., Bec., B., Cecchi, P., De Wit, R., Derolez, V., Fiandrino, A., Garrido, M., Laugier, T., Le Fur, I., Malet, N., Munaron, D., Ouisse, V., Souchu, P., **Sy, M.M**., Pasqualini, V. **2019**. Toward an ecological restoration of French Mediterranean coastal lagoons? *In preparation*

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Analysis

Identifying Consensus on Coastal Lagoons Ecosystem Services and Conservation Priorities for an Effective Decision Making: A Q Approach

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ABSTRACT

Coastal lagoons ecosystems, while representing benefits for the local populations, have been subjected to high anthropogenic pressures for decades. Hence, conservation measures of these ecosystems are urgently needed and should be combined with their sustainable uses. To address these issues, new research avenues for decision support systems have emphasized the role of the assessment of ecosystem services for establishing conservation priorities by avoiding monetarization approaches. These approaches, because they flatten the various values of nature by projecting them on the single monetary dimension, are often rejected by the stakeholders. We undertake a Q analysis to identify levels of consensus and divergence among stakeholders on the prioritization of ecosystem services provided by two French Mediterranean coastal lagoons areas. The results highlighted that there is a strong consensus among categories of stakeholders in the study sites about the paramount importance of regulation and maintenance services. Three groups of stakeholders, each sharing the same points of view regarding ecosystem services conservation, were identified for each study site. As a non-monetary valuation, Q methodology is very instrumental for the new pluralistic approach of decision support by capturing the values expressed by the stakeholders, without triggering a rejection reflex due to the monetarization.

1. Introduction

Natural areas in densely populated territories create a strong challenge for public policies. On one hand, conservation measures and management are needed to safeguard the ecosystems. On the other hand, it is important to consider the benefits that the local populations obtain from these ecosystems and to know their desires for ecosystem uses in the future in order to reconcile these with the conservation objectives. Therefore, the concept of ecosystem services (ESs) provides an operational analysis framework for thinking and assessing the relationships between human society and ecosystems. It facilitates the assessment of the values an ecosystem represents for humans. Traditionally, the cost-benefit approach has been considered as a central tool for decision-making for public action, involving the mobilization of economic methods to assign monetary values to environmental impacts. This involves integrating the costs or benefits of conservation measures and ecological restoration (De Groot et al., 2013; De Wit et al., 2017) into the traditional investment decision-making or planning tools. Ecological restoration is an intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity and sustainability (Society for Ecological Restoration International Science and Policy Working Group, 2004), and thus includes actions for improving water quality in aquatic ecosystems. However, whether for good or bad reasons, monetarization is often met with skepticism, when it does not trigger rejection, particularly in the area of ecological economics. Recent work emphasizes the need for other approaches for decision support systems, which focus more strongly on the values that are legitimate for individuals (Jacobs et al., 2018; Keune et al., 2015; O'Neill and Spash, 2000). These new research avenues (Guerry et al., 2015; Madrian, 2014; Rey-Valette et al., 2017)

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Frontiers in Ecology and Evolution - section Conservation.

1- Original Research (Figures inserted in text to facilitate review)

A multidisciplinary approach for restoration ecology of shallow coastal lagoons, a case study in South France

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Keywords: Restoration ecology, ecological restoration, water quality, WFD, ecosystem trajectories, DPSIR, conservation, ecological indices

A. Leruste, B. Bec, P. Cecchi, V. Derolez, R. De Wit, V. Faure, A. Fiandrino, M. Garrido, S. Ghiotti, T. Laugier, I. Le Fur, **M. Maki Sy,** N. Malet, D. Munaron, V. Ouisse, V., Pasqualini, P. Souchu, M. Troussellier. **2019**. Recovery trajectories from eutrophication of French Mediterranean coastal lagoons: lessons and perspectives. *In preparation*

Recovery trajectories from eutrophication of French Mediterranean coastal lagoons: lessons and perspectives[16].

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Keywords: eutrophication, oligotrophication, ecological restoration, recovery trajectory, coastal lagoons

Abstract:

Coastal lagoons represent huge reservoirs of biodiversity and provide many ecosystem services to the human kind. However, their intense use has led to their strong deterioration, and particularly their eutrophication. Their ecological restoration, through the reduction of nutrient loads, called oligotrophication, is increasingly studied by the scientific community, but this a relatively recent issue compared with freshwater lakes. French Mediterranean coastal lagoons

[16] *In preparation*

(FMcl) represent an interesting example for exploring the impact of lagoon oligotrophication because of the wide diversity of FMcl, and the many restoration measures that have been implemented since the 1960's.

More than thirty coastal lagoons are set along the French Mediterranean coastline. They cover with their wetlands almost 130 000 ha, and participate to a great number of ecosystem services. These transitional ecosystems have been affected by an increasing eutrophication since the mid-20th century. This has led to significant changes in the communities of primary producers, *e.g.* toward a dominance of fast growing microalgae at the expense of perennial macrophytic communities. By cascading effects, these changes have drastically altered the ecological functioning of these ecosystems. In the early 2000s, management actions have been implemented on several lagoons to reduce nutrient inputs in order to achieve their good ecological status as stated by new European regulations. Several of these lagoons have thus been involved in an oligotrophication process, while others have remained in a degraded state, or continued to deteriorate with the lack of sufficient measures.

In this study, we aimed to make an assessment of the chronology of the eutrophication state of French Mediterranean coastal lagoons over the last decades. We particularly aimed to highlight which restoration measures have allowed a significant improvement of the eutrophication state of the lagoons, which have not reached their objectives, and why. We also stated about future perspectives of this issue in the climate changes context

Communications

ETUDES ET PROJETS Publié le 10 septembre 2018

SERVICES ÉCOSYSTÉMIQUES ET PRIORITÉS DE CONSERVATION

Faciliter la prise de décision entre acteurs des milieux lagunaires

Source : Identifying Consensus on Coastal Lagoons Ecosystem Services and Conservation Priorities for an Effective Decision Making: A Q Approach [1]
Auteurs : Mariam Maki Sy[a], *Hélène Rey-Valette*[b], *Monique Simier*[c], *Vanina Pasqualini*[d], *Charles Figuières*[e], *Rutger De Wit*[a]

Une copie pdf de l'article est en accès libre jusqu'au 20 septembre en utilisant le lien suivant :
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Cyclistes sur les étangs palavasiens
©N. Barré / Pôle lagunes

Quelles valeurs les acteurs des territoires lagunaires de Biguglia et des étangs palavasiens attachent-ils à la nature ? Le laboratoire MARBEC a mené une enquête, basée sur une approche non monétaire, qui fait ressortir des niveaux de consensus et de divergence quant à la priorisation des services écosystémiques. Ces résultats peuvent aider à une prise de décision efficace en matière de conservation.

Les sites de Biguglia au nord est de la Corse, proche de la ville de Bastia et le site des étangs palavasiens proche de Montpellier en Occitanie ont été les deux territoires choisis par le laboratoire Marbec de Montpellier et ses partenaires pour mener cette étude. Ces territoires lagunaires riches de par leur biodiversité et leurs ressources naturelles, ont la particularité d'être périurbains, et d'être entourés de nombreux espaces naturels, semi-naturels et agricoles.

Ils représentent des bénéfices pour les populations locales, et de nombreuses activités humaines y sont très présentes, telles que des activités récréatives (découverte naturaliste, sports nautiques, ...) et des activités traditionnelles (pêche, chasse, ostréiculture...). Cependant depuis des décennies ces milieux sont, en raison de leur proximité des villes, fortement touchés par la fréquentation humaine et les diverses pollutions d'origine anthropique. Ils ont besoin de mesures de conservation qui doivent être combinées avec des usages durables.

L'attribution de valeurs monétaires aux services écosystémiques s'avère problématique, car un certain nombre de services s'y prêtent très mal. Par conséquence, ces méthodes, dites de monétarisation, sont souvent rejetées par les parties prenantes. Ce rejet ne se base pas uniquement sur ce biais méthodologique, mais parfois également sur des arguments de type éthique et sociétal.

Pour aborder ces questions avec les acteurs cibles de ces territoires, de nouvelles voies de recherches de systèmes d'aide à la décision ont souligné le rôle de l'évaluation des services écosystémiques pour établir des priorités de conservation en évitant des approches de monétarisation.

Étang de Biguglia © Conservatoire du littoral

Des résultats regroupant des points de vue…

Sur ces deux territoires lagunaires, 57 interviews ont été menés (30 sur les étangs palavasiens et 27 sur la réserve de Biguglia) pour une analyse « Q »[2]. Celle-ci vise à identifier les niveaux de consensus et de divergence de ces acteurs quant à la priorisation des services écosystémiques fournis par ces sites lagunaires. Les acteurs sollicités pour l'étude ont ainsi été groupés en 7 catégories : gouvernance locale, secteur privé, associations (ONG), scientifiques, public et secteurs parapublics ; gestionnaires de sites et résidents locaux. La méthode d'échantillonnage utilisée ne nécessite pas un large nombre d'enquêtés. Le but n'est pas de chercher la représentativité au niveau de l'ensemble des parties prenantes. Il s'agit plutôt d'avoir une diversité de points de vue en termes de priorités de conservation des services écosystémiques.

Les résultats ont mis en évidence qu'entre les catégories des parties prenantes, il y a un fort consensus autour des services de régulations et de maintenance de ces sites naturels. Les lagunes, de par leur localisation, permettent de réguler les phénomènes naturels et de maintenir le bon fonctionnement écologique des habitats. Ainsi, les services « Nurserie et Habitat » et « Régulation des inondations et protection des terres intérieures contre les tempêtes et la salinité » sont les services considérés comme une priorité de conservation.

Trois groupes de parties prenantes, partageant le même point de vue quant à la conservation des services écosystémiques, ont été identifiés pour chaque site d'étude. Le premier groupe de parties prenantes partage une vision environnementale et hédonique. Il privilégie principalement les services de régulation et de maintenance, ainsi que les services liés aux aspects esthétiques et symboliques des sites étudiés. Par rapport aux autres groupes, ces acteurs sont principalement des agents publics et parapublics ainsi que des résidents locaux. Le second groupe est en faveur d'une approche environnementale et territoriale, généralement axée sur une vision de l'environnement considérée comme un indicateur de qualité d'un territoire. Dans ce groupe on trouve surtout les ONG et les représentants des gouvernements locaux. Enfin, la vision de la sensibilité environnementale et patrimoniale est partagée par les parties prenantes qui privilégient principalement les services de régulation et de maintenance ainsi que l'identité locale. Il n'y a pas de tendance claire au sein de ce groupe en termes de composition.

En évitant de déclencher un réflexe de rejet par l'évocation d'une monétarisation des services écosystémiques, et en se basant seulement sur les valeurs exprimées par les parties prenantes, la méthodologie « Q » a joué un rôle important pour développer une nouvelle approche pluraliste d'aide à la décision.

Etangs palavasiens © SIEL

[1] Cette étude menée dans le cadre des travaux de thèse de Mariam Maki Sy est financée par le fonds Labex DRIIHM (Device for Interdisciplinary Research on human-environments Interactions" et par l'Observatoire Hommes-Milieux Littoral méditerranéen. Ce travail a été mené en collaboration technique avec les structures gestionnaires des deux sites étudiés, à savoir le Syndicat Mixte des Etangs Littoraux (SIEL) sur les étangs palavasiens et de la Réserve Naturelle de Biguglia.

[2] La méthode « Q » est une approche semi-qualitative permettant une analyse systématique de la subjectivité humaine à travers des procédures de collecte de données et des méthodes statistiques rigoureuses. Se rapporter à la référence ci-après pour en savoir plus sur la méthode (pages 699 – 702) : Given, L., 2008. The SAGE Encyclopedia of Qualitative Research Methods, SAGE Publications, Inc., 2455 Teller Road, Thousand Oaks California 91320 United States. doi:10.4135/9781412963909.

https://pole-lagunes.org/services-ecosystemiques-et-priorites-de-conservation/

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Attribuer une valeur aux services écosystémiques pour mieux protéger les lagunes

16 octobre 2018

RÉSULTATS SCIENTIFIQUES

Quelle valeur donner à la nature des territoires lagunaires de Biguglia et des étangs palavasiens ? Dans le cadre de l'Observatoire Homme Milieu – Littoral méditerranéen, une équipe de chercheurs[1] a mené une enquête qualitative auprès des acteurs clés de ces territoires pour réaliser une évaluation non monétaire des services écosystémiques fournis par ces lagunes. Les résultats de cette étude publiés dans la revue *Ecologial Economics* font ressortir des niveaux de consensus et de divergence quant à la priorisation des services écosystémiques, qui pourraient faciliter la prise de décisions efficaces en matière de conservation et de restauration écologique.

Photographie de l'Etang de Biguglia au lever du soleil en septembre 2014 (Rutger de Wit). Jeux de carte sérieux utilisé des 31 services écosystémiques et grille de tri utilisé pendant les interviews avec les acteurs de l'étang de Biguglia. Pendant l'interview, les acteurs sont demandés de trier les cartes et de les positionner sur la grille selon leur importance. (Conception et production des cartes réalisées par Carole Haerty, stagiaire M2 « Gestion de l'environnement et valorisation des ressources naturelles » à l'université de Corse (2017).

Les sites de Biguglia au Nord Est de la Corse, proche de la ville de Bastia et le site des étangs palavasiens proche de Montpellier en Occitanie sont des territoires lagunaires riches de par leur biodiversité et leurs ressources naturelles. Ils ont la particularité d'être périurbains et d'être entourés de nombreux espaces naturels, semi-naturels et agricoles. Ils sont ainsi la source de nombreux bénéfices pour les populations locales. De nombreuses activités humaines y sont très présentes, telles que des activités récréatives (découverte naturaliste, sports nautiques, etc.) et des activités traditionnelles (pêche, chasse, ostréiculture, etc.). Cependant depuis des décennies, ces milieux sont, en raison de leur proximité des villes, fortement touchés par les impacts de la fréquentation humaine et les diverses pollutions d'origine anthropique. Ils ont besoin de mesures de conservation qui doivent être combinées avec des usages durables.

Pour aborder ces questions avec les acteurs cibles de ces territoires, de nouvelles voies de recherches de systèmes d'aide à la décision ont souligné le rôle de l'évaluation des services écosystémiques pour établir des priorités de conservation en évitant des approches de monétarisation. L'attribution de valeurs monétaires aux services écosystémiques s'avère problématique car un certain nombre de services s'y prêtent très mal. Par conséquence, ces méthodes, dites de monétarisation, sont souvent rejetées par les parties prenantes. Ce rejet ne se base pas uniquement sur ce biais méthodologique, mais parfois également sur des arguments de type éthique et sociétal.

Sur ces deux territoires lagunaires, 57 interviews ont été menés (30 sur les étangs palavasiens et 27 sur la réserve de Biguglia) pour une analyse « Q »[2]. Celle-ci vise à identifier les niveaux de consensus et de divergence de ces acteurs quant à la priorisation des services écosystémiques fournis par ces sites lagunaires. Les acteurs sollicités pour l'étude ont ainsi été groupés en 7 catégories : gouvernance locale, secteur privé, associations (ONG), scientifiques, public et secteurs parapublics, gestionnaires de sites et résidents locaux. La méthode d'échantillonnage utilisée ne nécessite pas un large nombre d'enquêtés. Le but n'est pas de chercher la représentativité au niveau de l'ensemble des parties prenantes. Il s'agit plutôt d'avoir une diversité de points de vue en termes de priorités de conservation des services écosystémiques.

Les résultats ont mis en évidence qu'entre les catégories des parties prenantes, il y a un fort consensus autour des services de régulations et de maintenance de ces sites naturels. Les lagunes, de par leur localisation, permettent de réguler les phénomènes naturels et de maintenir le bon fonctionnement écologique des habitats. Ainsi, les services « Nurserie et Habitat » et « Régulation des inondations et protection des terres intérieures contre les tempêtes et la salinité » sont les services considérés comme une priorité de conservation.

Trois groupes de parties prenantes, partageant le même point de vue quant à la conservation des services écosystémiques, ont été identifiés pour chaque site d'étude. Le premier groupe de parties prenantes partage une vision environnementale et hédonique. Il privilégie principalement les services de régulation et de maintenance, ainsi que les services liés aux aspects esthétiques et symboliques des sites étudiés. Par rapport aux autres groupes, ces acteurs sont principalement des agents publics et parapublics ainsi que des résidents locaux. Le second groupe est en faveur d'une approche environnementale et territoriale, généralement axée sur une vision de l'environnement considérée comme un indicateur de qualité d'un territoire. Dans ce groupe on trouve surtout les ONG et les représentants des gouvernements locaux. Enfin, la vision de la sensibilité environnementale et patrimoniale est partagée par les parties prenantes qui privilégient principalement les services de régulation et de maintenance ainsi que l'identité locale. Il n'y a pas de tendance claire au sein de ce groupe en termes de composition.

En conclusion, la méthodologie « Q » a contribué à une vision plus pluraliste des services écosystémiques et joué un rôle important pour développer une nouvelle approche de leur évaluation non monétaire en se basant seulement sur les valeurs exprimées par les parties prenantes. Cette méthodologie a évité de déclencher un réflexe de rejet par l'évocation d'une monétarisation des services écosystémiques, et pourra être utilisée comme un outil d'aide à la décision pour la conservation des écosystèmes lagunaires et leur restauration écologique.

Notes :

1. Centre pour la biodiversité marine, l'exploitation et la conservation (Marbec - Univ Montpellier/CNRS/IRD/Ifremer) ; Centre d'Economie de l'Environnement (CEE-M – CNRS/Univ Montpellier/INRA) ; Sciences Pour l'Environnement, Sciences Pour l'Environnement (S P E – CNRS/Univ Corse Pasquale Paoli) ; Aix-Marseille Sciences Economiques (AMSE – Ecole centrale Marseille/CNRS/Univ Aix-Marseille/EHESS)
2. La méthode « Q » est une approche semi-qualitative permettant une analyse systématique de la subjectivité humaine à travers des procédures de collecte de données et des méthodes statistiques rigoureuses. Se rapporter à la référence ci-après pour en savoir plus sur la méthode (pages 699 – 702) : Given, L., 2008. The SAGE Encyclopedia of Qualitative Research Methods, *SAGE Publications*, Inc., 2455 Teller Road, Thousand Oaks California 91320 United States. doi:10.4135/9781412963909.

Référence :

Sy, Mariam Maki; Rey-Valette, Hélène; Simier, Monique; Pasqualini, Vanina; Figuières, Charles; De Wit, Rutger. Identifying Consensus on Coastal Lagoons Ecosystem Services and Conservation Priorities for an Effective Decision Making: A Q Approach. *Ecological Economics* 154 (December 2018), 1-13 doi.org/10.1016/j.ecolecon.2018.07.018

http://www.inee.cnrs.fr/fr/cnrsinfo/attribuer-une-valeur-aux-services-ecosystemiques-pour-mieux-proteger-les-lagunes

V. Conferences, seminars and others

Poster: 7th EUROLAG Symposium - 1-4 March, 2016 in Murcia, Spain.

P41 – presented at EUROLAG Murcia 2016

Ecosystem services assessment of lagoons systems undergoing ecological restoration

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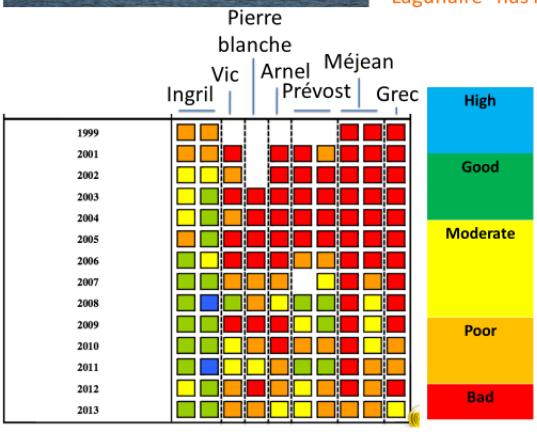
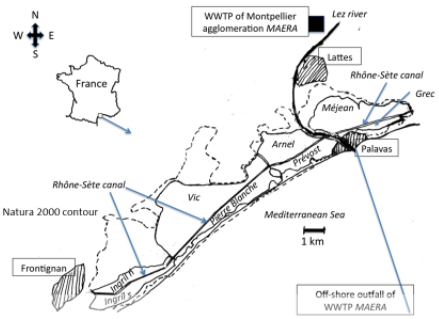
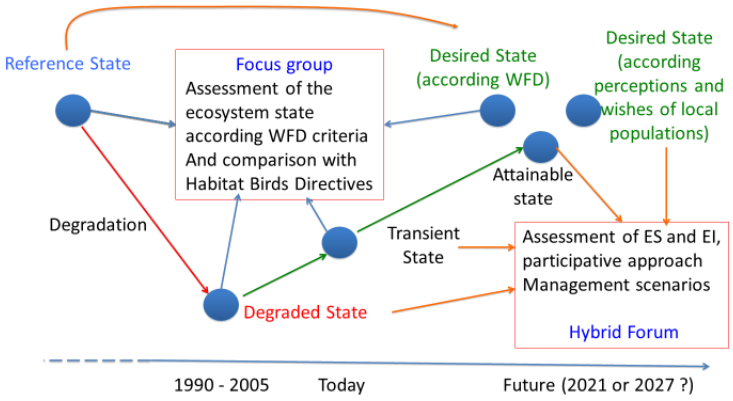
Context: The Palavas coastal lagoons have suffered from strong nutrient over-enrichment since four decades. The Monitoring programme "Réseau de Suivi Lagunaire" has monitored the eutrophication quality status from 1999-2013.





In the Montpellier metropolitan area an investment of 150 M€ was realised in 2006 to improve the WWTP and discharge the effluents of these treatments 11 km off-shore into the Mediterranean, while previously it was discharged in the Palavasian lagoons. This caused a > 70 % reduction of nutrient loadings into these lagoons.

Objectives of this PhD study that has started in November 2015: In addition to the legal framework of the WFD, the restoration of lagoons also constitutes a real benefit for society and can be expressed in terms of ecosystem services (ES), defined as the "contributions that ecosystems provide to human well-being". Hence, we will use ES to assess the gain for the society from ecological restoration of lagoon ecosystems that will be studied with a participatory approach. Therefore, we will organise a Hybrid Forum including stakeholders, scientists and managers and study their social learning.



According the WFD, the EU member States must commit to recover a "good ecological status" for degraded systems before 2021 by adopting an approach that is fully consistent with the concepts of **restoration ecology**. This involves the development of a roadmap, which specifies the objectives for the ecosystem trajectories.

References: RSL Bilans des Résultats 2013, Ifremer (http://www.pole-lagunes.org/ftp/LettreLagunes/2014/sept/Rapport_RSL_2013_VF.pdf)
De Wit et al., 2015. Aquatic Conservation, Marine and Freshwater ecosystems (doi: 10.1002/aqc.2601), Leruste et al., submitted

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- Meeting of the Natura 2000's Commission of Palavas Lagoons. November 08th, 2018. Villeneuve-Les-Maguelone, France. ***Oral communication.***
- Annual Seminar of LabEx DRIIHM, the Device for Interdisciplinary Research on Human-Environments Interactions. 08-10 October, 2018. Toulouse, France. ***Oral communication.***
- Annual Seminar of Marine Exploitation and Conservation (MARBEC). 02 – 04 October, 2018. Lattes, France. ***Oral communication.***
- Annual Seminar of OHM – Littoral méditerranéen (The human-environment observatory "Mediterranean coastline"). 20-21 March, 2017. Marseille, France. ***Oral communication.***
- Restitution of the results to the Syndicat Mixte des Etangs Littoraux (SIEL), managers of Palavas Lagoons. 15th of March, 2017. Montpellier, France. ***Oral communication.***

Sy, M.M., Rey-Valette, H., Figuières, C., De Wit, R. Ecosystem Services Assessment of Coastal Lagoons Undergoing Ecological Restoration. Delivered at:

- Advisory Committee of the Syndicat Mixte des Etangs Littoraux (SIEL). November 15th 2016. Villeneuve-Les-Maguelone, France. ***Oral communication.***
- Annual Seminar of OHM – Littoral méditerranéen (The human-environment observatory "Mediterranean coastline"). 22-23 March, 2016. Marseille, France. ***Oral communication.***
- Annual Seminar of LabEx DRIIHM, the Device for Interdisciplinary Research on Human-Environments Interactions. 23-25 May, 2016. Toulouse, France. ***Oral communication.***
- Annual Seminar of Marine Exploitation and Conservation (MARBEC). 18 – 19 May, 2016. Montpellier, France. ***Oral communication.***
- 7th EUROLAG Symposium - 1-4 March, 2016 in Murcia, Spain. ***Poster session.***

RÉSUMÉ

Dans un contexte de conservation, de gestion ou de restauration écologique des écosystèmes, l'évaluation des services écosystémiques (SEs) permet de mieux encadrer notre relation à la nature. L'objectif principal de la thèse est d'identifier la demande en termes de SEs afin de contribuer à des décisions publiques cohérentes, intégrées et acceptées. Elle comporte trois études de cas. La première identifie les niveaux de consensus et de divergence, entre les parties prenantes, sur la priorisation des SEs fournis par deux sites lagunaires méditerranéens situés au Sud de la France (le complexe lagunaire palavasien et le site de Biguglia). La seconde analyse l'impact de l'information académique et de la familiarité sur les préférences des résidents locaux et non-locaux pour les SEs fournis par le complexe lagunaire palavasien. Enfin, la troisième étude de cas explore les méthodes non monétaires d'évaluation des préférences avec une application au contexte du site lagunaire palavasien. La thèse mobilise les cadres théoriques des préférences ordinales et de l'économie comportementale. Les données ont été analysées à l'aide de statistiques descriptives, de la méthodologie Q et d'un modèle logit multinomial. Les résultats montrent l'utilité du concept des SEs et de son évaluation à l'aide de méthodes non monétaires. En effet, les approches monétaires ne montrent pas la diversité des préférences car elles les réduisent à leur seule dimension monétaire. Elles sont ainsi souvent rejetées par les parties prenantes. Aussi, les résultats montrent qu'en fonction de la méthode d'évaluation des SEs, de la typologie des parties prenantes, de l'apport de l'information académique et de la familiarité avec les écosystèmes, les préférences varient pour les services d'approvisionnement et culturels. D'autre part, il ressort un fort consensus relatif à l'intérêt pour les services de régulation et de maintenance. Les politiques publiques devraient davantage utiliser le concept des SEs dans les processus de prise de décision relatifs aux problèmes environnementaux. Les SEs traduisent la complexité d'un écosystème en une série de fonctions, dans un langage commun et compréhensible par toutes les parties prenantes. Une autre recommandation consiste à prendre en compte la diversité des méthodes d'agrégation des préférences pour les SEs. En effet, la comparaison des pratiques intégratives, notamment l'apport des méthodes délibératives permettrait d'anticiper ou contribuer à réduire les conflits entre différents groupes de parties prenantes.

Mots-clés : services écosystémiques, évaluation non monétaires des services écosystémiques, aide à la décision, lagunes côtières.

ABSTRACT

In the context of conservation, management, ecological restoration and others, ecosystem services (ESs) valuation and ranking, when meaningfully possible, allow to better frame our relationship with nature. The general objective of the thesis is to identify the demand in terms of ESs in order to achieve coherent, integrated and accepted public decisions. It is made of three case studies. The first case study identifies levels of consensus and divergence among stakeholders on the prioritization of ecosystem services provided by two French Mediterranean coastal lagoons areas. The second one investigates the impact of familiarity and academic information supply on citizens' preferences for ESs issued by the Palavas lagoons complex. Finally, the third case study explores elicitation and aggregation methods of individual preferences for the Palavas lagoons complex. The thesis mobilizes the ordinal preference and behavioral economics theoretical frameworks. Data were analyzed using descriptive statistics, Q methodology and a multinomial logit model. The results show the usefulness of the concept of ESs and its valuation using non-monetary methods. Indeed, monetary approaches do not take into account the heterogeneity of preferences because they flatten the various values of nature by projecting them on the single monetary dimension, an approach which is often rejected by stakeholders. Also, depending on the non-monetary valuation and ranking of ESs, stakeholder types, academic information supply and familiarity with the ecosystems, the results show that preferences vary especially for provisioning and cultural services. On the other hand, there is a relatively high consensus of high interest for regulation and maintenance services. I recommend that public policies should use more the concept of ESs in the decision-making process. ESs translate the complexity of the environment into a series of functions in a common language understandable to all stakeholders in decision-making processes. Another recommendation is to take into account the diversity of stakeholders' preferences for ESs. Indeed, such an integrative practice can prevent or contribute to reduce conflicts among stakeholder groups.

Keywords: ecosystem services, non-monetary preferences elicitation and aggregation methods, decision making, coastal lagoons.