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Identity, landscape, and adaptation for sustainability in Menorca.

integration for governance in complexity through Post-Normal Science (PNS)

Alejandro Marcos Valls

PhD Dissertation

directed by

Dr. Zora Kovacic | Dr. Mario Giampietro | Dr. Giorgos Kallis

and tutored by Dr. Mario Giampietro

PhD Programme in Environmental Science and Technology 2023





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Cerdanyola del Vallès

2023





Suggested citation:

Marcos-Valls, A. (2023). Identity, landscape, and adaptation for sustainability in Menorca. Advancing integration for governance in complexity through Post-Normal Science (PNS). PhD thesis. Universitat Autònoma de Barcelona.



The present doctoral thesis has been developed thanks to a project financed by the Spanish Ministry of Economy and Competitiveness (CTM2016-75772-C3-1-R) as well as a research scholarship (BES-2016-079119) awarded to Alejandro Marcos Valls from Spanish Ministry of Economy and Competitiveness (MINECO) (Resolution 01/09/2016) through the María de Maeztu program for Units of Excellence (MDM-2015-0552)



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Various minor typos corrected and new versions on:

https://www.dropbox.com/sh/6aeuz91m78svp9y/AABXAJ7WBDohhEFYXEKA77DFa?dl=0

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ABSTRACT

In this thesis, I study how islands are affected by and adapt to global changes, defined in environmental and economic terms. I argue that islands are not just another piece of land to which principles of sustainable development developed elsewhere can be applied by default. Islands have their own identity, and specific ways in which the local societal metabolism interacts with the global socio-ecological system, which creates the challenge of integrating diverse and complex information for governance for sustainability.

I focus on the Mediterranean island of Menorca (Balearic Islands, Spain) as a case study. I use the recent history of the island, linked to the declaration as a Biosphere Reserve, and offer an integrated analysis considering the context of the global changes and challenges we are facing today.

To this purpose, the thesis focuses on two main themes: i) the characterization of the societal metabolism of island systems; and ii) the assessment of the quality of local and plural governance processes vis-à-vis global pressures to adapt to the blueprints of sustainable development. Therefore, this thesis is based on a study of two different aspects. On the one hand, aspects related to the decision-making process, especially the role of science and the integration of different types of information and data considering different scales and dimensions of the decision-making process. And, on the other hand, aspects related to island studies, especially focusing on island identity and the existing narratives that coexist and inform policymaking.

The dissertation explores i) an ecological economics perspective, focusing on the concept of societal and ecological metabolism, and using the MuSIASEM approach to identify and integrate available information, ii) a political ecology perspective, aiming to analyze the current situation based on the evolution of landscape and landscape policies, discourses found in political documents, and ethnographic observations about the identity of Menorca, and, iii) the PNS perspective informs a prospective procedure to integrate diverse (non-equivalent) information in the decision-making process focusing on the quality of the process.

The results of the research conclude in the presentation of the PNS building block. A procedure to integrate non-equivalent information, that provides a structuring space for decision-making advancing in the integration of incommensurable inputs of information and focusing of the quality of the process. The political dimension represents the justification narratives that include different concerns identified in society and how they are prioritized. The scientific dimension explores the explanations narratives and how the different types of expertise, models and data are used to inform policies. And the PNS dimension is used to check the normative narratives and if there is coherence in the integration process between the framing of the problems and the suggested solutions. The goal of the PNS building block is to provide a multi-scale structuring space to check the resilience of social-ecological systems.

RESUMEN

En esta tesis, estudio cómo las islas se ven afectadas y se adaptan a los cambios globales, definidos en términos ambientales y económicos. Sostengo que las islas no son simplemente otra porción de tierra a la que se pueden aplicar por defecto los principios de desarrollo sostenible desarrollados en otros lugares. Las islas tienen su propia identidad y formas específicas en las que el metabolismo social local interactúa con el sistema socio-ecológico global, lo que crea el desafío de integrar información diversa y compleja para la gobernanza de la sostenibilidad.

Me centro en la isla mediterránea de Menorca (Islas Baleares, España) como caso de estudio. Utilizo la historia reciente de la isla, vinculada a la declaración como Reserva de la Biosfera en 1993, y ofrezco un análisis integrado considerando el contexto de los cambios y desafíos globales que enfrentamos hoy en día.

Con este propósito, la tesis se centra en dos temas principales: i) la caracterización del metabolismo social de los sistemas insulares; y ii) la evaluación de la calidad de los procesos de gobernanza local y plural en relación a las presiones globales para adaptarse a los patrones de desarrollo sostenible. Por lo tanto, esta tesis se basa en el estudio de dos aspectos diferentes. Por un lado, los relacionados con el proceso de toma de decisiones, especialmente el papel de la ciencia y la integración de diferentes tipos de información y datos considerando diferentes escalas y dimensiones del proceso de toma de decisiones. Y, por otro lado, aspectos relacionados con los estudios de islas, centrándose especialmente en la identidad de la isla y las narrativas existentes que coexisten e informan la formulación de políticas.

La disertación explora i) una perspectiva de economía ecológica, centrándose en el concepto de metabolismo social y ecológico, y utilizando el enfoque MuSIASEM para identificar e integrar información disponible; ii) una perspectiva de ecología política, con el objetivo de analizar la situación actual basada en la evolución del paisaje y las políticas de paisaje y territorio, discursos encontrados en documentos políticos y observaciones etnográficas sobre la identidad de Menorca; y iii) la perspectiva de PNS informa un procedimiento prospectivo para integrar información diversa (no equivalente) en el proceso de toma de decisiones, centrándose en la calidad del proceso.

Los resultados de la investigación concluyen en la presentación del cubo de construcción PNS (ciencia posnormal). Un procedimiento para integrar información no equivalente que proporciona un espacio estructurado para la toma de decisiones, avanzando en la integración de entradas de información incompatibles y enfocándose en la calidad del proceso.

La dimensión política representa las narrativas justificativas que incluyen diferentes preocupaciones identificadas en la sociedad y cómo se priorizan. La dimensión científica explora las narrativas explicativas y cómo se utilizan los diferentes tipos de experiencia, modelos y datos para informar políticas. Y la dimensión PNS se utiliza para verificar las narrativas normativas y si hay coherencia en el proceso de integración entre la formulación de los problemas y las soluciones sugeridas. El objetivo del cubo de construcción PNS es proporcionar un espacio de estructuración a múltiples escalas para verificar la resiliencia de los sistemas socio-ecológicos.

RESUM

En aquesta tesi, estudio com les illes es veuen afectades i s'adapten als canvis globals, definits en termes ambientals i econòmics. Sostinc que les illes no són simplement una altra porció de terra a la qual es poden aplicar per defecte els principis de desenvolupament sostenible desenvolupats en altres llocs. Les illes tenen la seva pròpia identitat i formes específiques en les quals el metabolisme social local interactua amb el sistema socioecològic global, el que crea el desafiament d'integrar informació diversa i complexa per a la governança de la sostenibilitat.

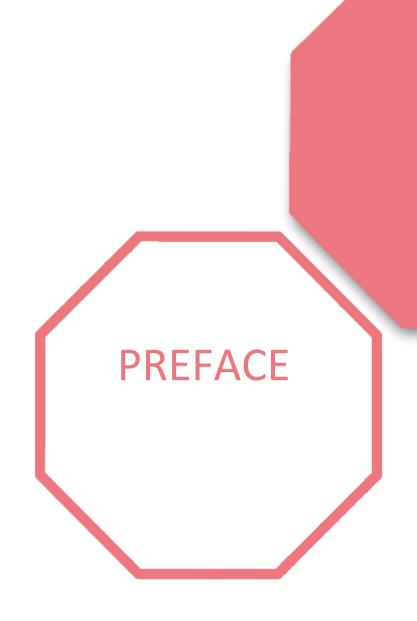
Em centro a l'illa mediterrània de Menorca (Illes Balears, Espanya) com a cas d'estudi. Utilitzo la història recent de l'illa, vinculada a la declaració com a Reserva de la Biosfera el 1993, i ofereixo una anàlisi integrada considerant el context dels canvis i desafiaments globals que enfrontem avui en dia.

Amb aquest propòsit, la tesi se centra en dos temes principals: i) la caracterització del metabolisme social dels sistemes insulars; i ii) l'avaluació de la qualitat dels processos de governança local i plural amb relació a les pressions globals per adaptar-se als patrons de desenvolupament sostenible. Per tant, aquesta tesi es basa en l'estudi de dos aspectes diferents. D'una banda, els relacionats amb el procés de presa de decisions, especialment el paper de la ciència i la integració de diferents tipus d'informació i dades considerant diferents escales i dimensions del procés de presa de decisions. I, d'altra banda, aspectes relacionats amb els estudis d'illes, centrant-se especialment en la identitat de l'illa i les narratives existents que coexisteixen i informen la formulació de polítiques.

La dissertació explora i) una perspectiva d'economia ecològica, centrada en el concepte de metabolisme social i ecològic, i utilitzant l'enfocament MuSIASEM per identificar i integrar informació disponible; ii) una perspectiva d'ecologia política, amb l'objectiu d'analitzar la situació actual basada en l'evolució del paisatge i les polítiques de paisatge i territori, discursos trobats en documents polítics i observacions etnogràfiques sobre la identitat de Menorca; i iii) la perspectiva de PNS informa un procediment prospectiu per integrar informació diversa (no equivalent) en el procés de presa de decisions, centrada en la qualitat del procés.

Els resultats de la investigació conclouen amb la presentació del bloc de construcció PNS (ciència postnormal). Un procediment per integrar informació no equivalent que proporciona un espai estructurat per a la presa de decisions, avançant en la integració d'entrades d'informació incompatibles i centrant-se en la qualitat del procés. La dimensió política representa les narratives justificatives que inclouen diferents preocupacions identificades en la societat i com es prioritzen. La dimensió científica explora les narratives explicatives i com s'utilitzen els diferents tipus d'experiència, models i dades per informar polítiques. I la dimensió PNS es fa servir per verificar les narratives normatives i si hi ha coherència en el procés d'integració entre la formulació dels problemes i les solucions suggerides. L'objectiu

del bloc de construcció PNS és proporcionar un espai d'estructuració a múltiples escales per verificar la resiliència dels sistemes socioecològics.'



Motivation

We know that we are living in a complex world. The technological evolution over the last two centuries has been translated into an exponential improvement of life expectancy and living conditions for a lot of people, but also have brought more inequalities and an exponential requirement and use of resources, with its increasing pressures and impacts over social and ecological systems.

These facts are clearly shown in the famous graphs that represent the trajectory of the Anthropocene (Steffen et al., 2015)1. Figure 1 illustrates the evolution and trends of some of these socio-economic and Earth system indicators. The awareness about this evolution implies the necessity to find new ways for humans to relate to the environment and face the appearance of global challenges with no clear consequences nor solutions.

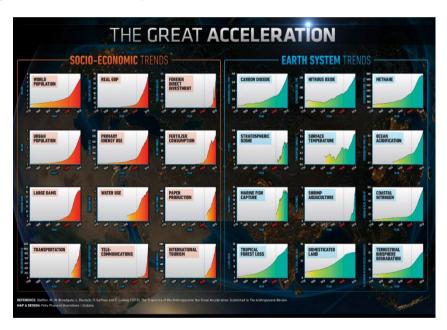


Figure 1. The Great Accelartion¹. Trends of socio-economic and earth system indicators since 1750. Image from https://futureearth.org/2015/01/16/thegreat-acceleration/

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¹ Steffen, W., Broadgate, W., Deutsch, L., Gaffney, O., & Ludwig, C. (2015). The trajectory of the Anthropocene: The great acceleration. Anthropocene Review, 2(1), 81–98. https://doi.org/10.1177/2053019614564785

Science and technology are advancing also exponentially, creating 'solutions' for existing 'problems' and, at the same time, creating new 'problems'. The rapid advance of science and technology creates an imaginary that 'anything is possible' and that science and technology will provide these solutions to save people and the planet. However, the decision-making process to adjust these technologies to the existing knowledge about the consequences is often slow and full of crossed-interests and uncertainty that makes the process complex and necessary actions are delayed to, sometimes, irreversible situations.

The global consequences of our everyday lives and the existing tensions between social structures and individual agency have always interested me. I always think about how societies can practice the tagline 'act local, think global' to stay within the planetary boundaries when the inputs of information to decide are complex, often contradicting and/or requires big scale changes that are far from individual decisions.

Reflecting and working about these issues at CEMUS (Uppsala University and SLU) I bumped into a PhD offer, back in my hometown, to study the social-ecological metabolism of Mediterranean islands focusing on Menorca and Ikaria from an interdisciplinary perspective. It seemed a perfect match: going back to Barcelona, research about topics that I'm interested in, and focus on islands, one that I knew from past experiences, Menorca, and an unknown one, Ikaria, that seemed to offer some secrets to life well, and long, within certain limits.

I was not sure about what societal metabolism was back then (2016), but it resonated with the issues I was thinking about, and it seemed a great project and opportunity to dig deeper. I applied to the PhD position with not a lot of hope, and I got the position!

My story with Menorca started back in 2004. After a first-time visiting Menorca to learn about the management of Protected Natural Areas, I went back a few years participating in the census of Mediterranean turtles, *Testudo hermanni*. I literally walked all over the island looking for turtles and it was a great surprise to be able to return 10 years later, and zoom out from looking at the floor, to focus on the landscape, human activities and study the 'metabolism' of the island.

The initial plan was to compare Ikaria and Menorca, but due to COVID pandemic, this dissertation is monographic about Menorca.

Once I finished the diagnosis of the metabolism of Menorca and losing the opportunity of doing a comparative diagnosis of Ikaria, I focused on the political dimension. Initially, the political dimension was part of the 'future work' that I considered to do after the PhD, but COVID-19 forced a change in the planning, and I started considering how I could illustrate this dimension in Menorca. The main idea was to identify the narratives from the political parties in Menorca around landscape and the territory and explore ways to integrate diverse types of information to justify and explain certain policies on the island.

How does the decision-making process on the island work? What scales are considered? What types of information are used? Is information from different scales and dimensions integrated in the policy-making process? How is the understanding of the relation between the whole and the parts of the system?

Who has the power to generate agendas and how? Is there any control mechanism? Who decides? How is this process mediated? What control mechanisms exist to check if solutions suggested address the problems identified? How does the consideration of scale and power relations shape the impacts and consequences of the decisions?

I was interested in knowing about the interface between science and policy, the role of simplification, the problems of this simplification and reductionism, and all the issues connected to uncertainty and the complexity mentioned before. All the questions expressed above have been crossing my thoughts during these years with no clear answers. Post-Normal Science (PNS) appears as an approach to offer procedures or artifacts that can incorporate transdisciplinary elements in the discussion and deliberation for decision-making that I wanted to explore.

Focusing on Menorca, I have a case study of an island where some of these questions and discussions have been addressed in the past. The declaration of Menorca as a Biosphere Reserve (1993) was the result of social movements and the realization of certain 'risks' associated to touristic development identified in neighboring islands and touristic territories. The declaration was linked to a goal of becoming a lab-territory where balance between (hu)Man and the biosphere was possible. The island of Menorca was declared as a model of sustainable practices to be identified and upscaled. However, this model is not free from threats, environmental pressures, and sustainability issues. The promotion of certain land uses, i.e. tourism vs agriculture and other

traditional practices, create tensions that need to be acknowledged and addressed.

In this thesis I have had the opportunity to explore, from a PNS perspective, the consequences in the political narratives and quantitative storytelling of more than thirty years since the declaration. And I have focused my research on the idea that, beyond unique technological solutions, societies need to integrate diverse knowledge and focus on the quality of the decision-making process. Including diverse scales and dimensions in deliberations to adapt to changes in a sustainable way.

The dissertation that you are reading is a transdisciplinary attempt to understand how the complexity connected to decision-making for sustainability happens in social-ecological systems. Transdisciplinary because it aims to connect different types of knowledge that normally stand in disciplinary silos without engaging with each other. Attempt because as a complex issue and with limited time one must draw some boundaries and focus on certain aspects and leave others for the future.

Acknowledgements

¡Llegó el momento!

No siempre pensé que fuera posible, pero aquí está. Ha sido un proceso intenso. Con algunos momentos muy duros, pero también con espacio para la alegría, las risas, aprendizajes y acompañamiento de personas que siempre estarán en mi memoria y que le dan todo el sentido a esta página de agradecimientos.

Primero de todo quiero agradecer su tiempo y esfuerzo a las personas que han dirigido esta tesis 'trans'-(disciplinar).

A Zora Kovacic, gracias por estar siempre ahí, por darme apoyo, calma y tanta claridad intelectual en momentos en los que no tenía nada claro. Gracias por contribuir a dar espacio a mis inquietudes y por colaborar para convertirlas en aprendizaje. Gracias por entenderme y ayudarme a hacerme entender, aunque no siempre fue fácil. Y, gracias por tu amistad y empatía. No sé si podré agradecerte todo lo que has hecho durante estos años, pero aquí estoy para lo que traiga el futuro.

A Mario Giampietro, gracias por ser una guía durante este proceso. Gracias por estar siempre disponible y dispuesto. Gracias por tener siempre la puerta abierta a dudas, preguntas, ideas. Gracias por las conversaciones y la 'FORZA'. Y gracias por el apoyo en los momentos difíciles. ¡Hasta la victoria final! Una batalla menos...

A Giorgos Kallis, gracias por tus contribuciones y por el apoyo en los momentos complicados. Nos queda pendiente Ikaria, y con ella una parte muy importante de lo que tenía que ser esta tesis, pero así son las cosas. Hay que adaptarse a los cambios y esperar que haya momentos en el futuro en los que poder explorar las preguntas pendientes.

Quiero dar las gracias, también, a Sandra Bukkens por su apoyo, su ayuda en varios momentos clave, y por ser una pieza clave para que las cosas funcionen.

Cristina, gràcies per tot! Han estat uns anys molt intensos a tots els nivells. Han passat moltes coses, però, aquí estem! Tots dos a punt d'acabar una etapa de la nostra vida, i espero que la nova ens porti coses encara millors. Et desitjo molt de gaudi, i que puguis aprofitar molt del temps sense tenir desenes de doctorandxs demanant coses!

Isabel, ha estat genial tenir la teva energia positiva i el teu somriure per l'edifici (i entrant a meitat dels seminaris a fer la foto de rigor! jeje). Pere, que et dic...

Gràcies per tota l'ajuda i predisposició a solucionar problemes, vas fer molt fàcil l'entrada a l'ICTA.

Gràcies a totes les persones que treballeu des del PAS per fer possible la nostra feina. Marta, Lola, Valentina, Oriol, Maica, Vanesa, Laura, Cristina, Montse, Núria, Gemma, Olga, Sonia, Gloria, Susana, Juan... i segur que em deixo noms! MOLTES GRÀCIES!

Espero no hacerme muy pesado en esta sección, pero sois muchas las personas que habéis contribuido a que estés leyendo estas líneas en este momento.

Han sido más de 6 años conectado a ICTA-UAB. Me llevo amistades que sé que estarán siempre ahí, aunque pase el tiempo y no nos veamos demasiado. Sois muchas las personas que me habéis acompañado en esta aventura. Si estás en alguno de estos grupos, es que hemos compartido momentos que llevaré siempre conmigo: la 333, Poliamor, Redecita, Food Buddies, Grupo de Soporte, Oroscopo Negro, Gin&tonics, Soluciones Chipi, TdO Climate, Team Colombia, Alexxxxxx, Ñoñis, Former Friends, MuSIASEMists Comando, Rollitos, Voley, Can cubo, Calçotadas, Playeos, Ñoñis, Colonist, En fin...

Empezamos por un lugar que define muchas de las cosas que por las que he pasado: la 333. David, Gorka, Bekah, Matt, Jose, Ksenija, Luís, y, fugazmente, Santi y Adrien. ¿Qué puedo decir de vosotrxs? Habéis sido una parte esencial de mi proceso. Lo mejor, diría. La 333 fue el lugar en el que más interdisciplinariedad he visto en estos años. Poder compartir con vosotrxs muchas conversaciones. Sobre la ciencia que hacemos, sobre dudas, problemas existenciales, conflictos internos y externos, muchos momentos de risas, de café (con galletitas y chocolate), de sofá,... Y esta parte se hace extensiva a todas las personas que pasaron tiempo en ese sofá-diván compartiendo momentos.

David, ese primer verano con Diana en el que el ICTA era casi nuestro... Las charlas sobre connect-e, las encuestas a expertos sobre cambio climático y entrevistas en Sierra Nevada. Gorka, totes les nostres converses i tertúlies en moments crítics tant per al pais com a les nostres vides. Has estat un gran suport! Mis chipis, Jose y Ksenija. Sólo Soluciones, jeje. Cuántas horas de conversaciones y apoyo mutuo. Bekah, espero haberte acompañado en los momentos menos fáciles. Matt, siempre recordaré tu peculiar manera de hacer pizza (y muy rica!) Chiquilín, ¡tú qué lo sabes todo! A ver si me puedes decir...jaja. De cada persona me llevo recuerdos que espero podamos ir rememorando en el futuro.

Después de la 333, pasamos a la persona con la que entré a este Instituto, Diana. Qué te puedo decir. Han sido unos años muy intensos y me alegro de haber podido tenerte cerca. Hemos pasado por momentos de todo tipo, y siempre he podido contar contigo para buscar apoyo y comprensión (y espero que tú conmigo también). Algunos procesos administrativos han sido árduos (por decirlo suave) y poder hablar con alguien que te entiende ayuda (y mucho). La piscina, Nápoles, preparar las estancias y el trabajo de campo en paralelo, Cerdanyola, las barbacoas y comiditas con Lucas, tus peques,... Cuántas cosas han pasado, ¿eh? Espero que sigamos sumando.

Aljoša, te incorporaste a la oficina de Diana y Elvira. Y pronto te convertiste en una pieza clave para mi (y diría que para una gran parte de ICTA). Estás en muchos de los grupos arriba mencionados y hemos compartido mucho tiempo durante estos años. ¡Gracias por estar ahí! El 'Food Buddy Programa', que gran aportación, Joshi. Y qué bien haber compartido tanta comidita rica y mejor compañía con Vero, Sonia, Sole y Finn.

Sole, gracias por tus cuidados, tus memes, y por estar ahí! Fuli, gracias por tu energía y por la lluvia (que falta hace!). Mari, gracias por ayudarme a darme cuenta. Borja, Finn, Ksenija me habéis ayudado mucho en los momentos más bajos, y, por supuesto tú, Ana Aupi. Habéis formado parte de esa Redecita de soporte tan necesaria a la que se añaden Santi, Anna, Raúl, Joshi y Diana. ¡Muchas gracias a todas por el apoyo y el acompañamiento!

Juanix, gracias por la terapia! Siempre una risa, un 'oroscopo', unas cartitas, ijy esos desayunos y comiditas ricas!! Filippos, gracias por tu buena energía y por cuidar(me/nos) tanto. Vero, gracias por acompañarme en tantos momentos. Albert, em va agradar molt coneixe't més i passar tants moments que no oblidaré (mudança inclosa!). Franzi, me alegro mucho de haber coincidido en Barcelona después de cruzarnos en Suecia. Théo, tenemos que repetir nuestros desayunos con empanadas caseras. Olga y Joshi, gracias por tantos momentos! El verano pandémico no se explica sin vosotrxs y 'la burbuja' que formamos junto a Josito y Finn. Aquellos fines de semana están llenos de momentos: el 'buenos días, princesa', cenar 'chis' o pazpacho, los comentarios en las cenas a oscuras, las caminatas, los baños 'als gorgs' y en la playa, aquel Sant Joan en l'Escala, la coca casera, el kayak... En fin, una buena colección de recuerdos!

No dejo de pensar en nombres de personas que han formado parte de la aventura en ICTA... Laura Pérez, Laura Simón, Louisa, Ansel, Juan, JuanJe, Michele, Rafa, Violeta, Brototi, Maria y Su (aka Las 'braguis'), Felipe, Ramiro, Miki,

Alexandra, Rafa, Cristina, Ola, Stephen, Amalia, Petra, Roberta, Kim, Joel, Camila, Vincent, Xiao, André, Ana, Ramin, Julian, Adrien, Pietro, Joan, Roger, Ana V. Anh Thu, Marina, Marula,... gracias por alegrar el camino, y mucha suerte a las nuevas incorporaciones

A few words in English: Thank you! Is the expression that comes to my mind when I think about this more than 6 years' journey. Thank you to everyone that has been part of this process. Thank you for all the support that I have received in so many different ways from every individual that has crossed my way during this time. It hasn't been easy but here we are! It has been an intense learning process that leaves more questions than answers, but this realization is an important aspect of becoming a 'scientist'.

I want to thank my friends and colleagues I met in Uppsala. I'm really glad about all the friends I made. The first two years with all my master's friends and classmates, and then working at CEMUS. In total, five incredible years. It was a great experience that contributed a lot to my personal and professional development.

Quiero agradecer a Cristián Alarcón-Ferrari y a Margarita Cuadra, de SLU (Swedish University of Agricultural Sciences) por facilitarme la estancia en su departamento para esta tesis. Gracias por vuestro apoyo.

Ilias Gianniris and Ilektra Strovolidou, thank you for hosting me in Athens and Ikaria! It was great to spend time, long conversations, walks, cooking. I bring with me your hospitality and kindness and I hope we can see each other soon. Thanks also to Marina, Wim, Lefteris, Giorgos, Penny and everyone in the schools and municipalities that offered time to contribute to the original plan.

De les meves estades a Menorca, tinc a moltes persones en ment. Primer de tot, a les persones de l'Agència Menorca Reserva de Biosfera del Departament de Medi Ambient i Reserva de Biosfera del Consell Insular de Menorca (CIMe), i de l'Observatori Socioambiental de Menorca - Institut Menorquí d'Estudis (OBSAM-IME). Irene Estaún, Miquel Truyol, Félix de Pablo, Josefina Salord, Marta Jordi, David Carreras, gràcies per la vostra feina i per recolzar la recerca a i sobre Menorca.

Al Joan Rieradevall per la seva hospitalitat i guia durant l'estada a Menorca. I per algunes de les seves contribucions en aquest projecte.

David, gràcies per fer les coses fàcils i per recolzar-me en moments complicats!

Vull fer un agraïment molt especial a les persones amb qui he estat compartint moments els darrers dos anys: al club de BaSo! Jeje. No sabeu el que m'heu ajudat durant aquests mesos que hem compartit... Vau aconseguit aturar una inèrcia complicada que portava quan vaig arribar a Menorca, i m'heu ajudat a reconciliar-me amb el projecte i a arribar a on som avui. Eva Cardona, Aina, Borja, Esteve, Ana, Maria, Rober, Rosa, Pau, Joana, Àlex, Eva Marsi, David, Sònia, Marta, Marina, Lali,... De debò, moltes gràcies! Ara comença una nova etapa que, esper, estiqui plena de nous projectes, i de cafès a les 11h!

Faig extensiu aquest agraïment a les persones que han format part d'aquesta aventura menorquina des de l'administració, en l'organització de congressos i jornades, i a les meves 'zumberas': Txus, Maria Fuertes, Enrica, Jose Maria, Aram, Conchi, Sonia, Clemen, Marina, Eva, Isabel, Maite, etc., etc.

A mis amistades de Ciencias Ambientales: Carol y Víctor, gracias por estar ahí junto con Maiol y Marcos! Gracias por las excursions, comidas, ferias y, sobretodo por ayudarme a desconcectar y a reconectar.

A Eva, Xavi, Dani, Irene, Jessi, Ceci y familias, gracias por estar ahí. Cada vez más complicado el encuentro en persona, pero me alegro de mantener el contacto con vosotrxs.

A mis amistades de toda la vida: Marta, Lidia, Fani, Davi, Raquel, Diana, Susana, Cris, Jordi, Tifi, Noe y familias. Me alegro mucho de que sigáis estando ahí para trasladarme a un lugar seguro. También se hace complicado vernos con tanta frecuencia, pero me alegro de mantener el contacto y de seguir compartiendo momentos con todas. Espero que no nos falten cafés, comidas, cenas y huertings en los años que vienen.

Gracias Carla, Joana, Mama, Sole, Carol, Estefanía, Marina y Marta por vuestro tiempo ayudarme con la portada.

Para cerrar este apartado, quiero agradecer a mi familia todo su apoyo y acompañamiento en este proceso y durante toda mi vida. A mi familia 'de Calaceite', representada en mi tía Tere, y a la familia 'de Castelldefels'. Con un recuerdo especial a todxs lxs que ya no están.

A mis padres Juan Antonio y Paquita por todo lo que han hecho para hacerme la persona que soy hoy. Y las palabras finales para las tres personas más importantes en mi vida: mi madre, Paquita, mi hermana, Estefanía, y mi sobrina, Marina. GRACIAS por estar siempre ahí, por vuestros cuidados, por apoyarme, por aguantarme, y por estar en los buenos momentos y en los no tan buenos. ¡Os quiero mucho! Y este trabajo os lo dedico a vosotras.

Chapter 1. Introduction

Islands, identity, and policymaking for sustainability in the context of global changes.

The case of a Mediterranean island: Menorca

The finite geography of an island belies a more complex identity that confronts attempts at definition. The mere rendition of an island as "a piece of land surrounded by water" is academically imprecise. Where does "land" become too large or too small? Does anything happen to an island if it is physically linked to a mainland?

(Baldacchino, 2007, p. 4)

1. Introduction

In this thesis, I study how islands are affected by and adapt to global changes, defined in environmental and economic terms. I argue that islands are not just another piece of land to which principles of sustainable development developed elsewhere can be applied by default. Islands have their own identity, and specific ways in which the local societal metabolism interacts with the global socio-ecological system, which creates the challenge of integrating diverse and complex information for governance for sustainability.

To this purpose, the thesis focuses on two main themes: i) the characterization of the societal metabolism of island systems; and ii) the assessment of the quality of local and plural governance processes vis-à-vis global pressures to adapt to the blueprints of sustainable development.

Therefore, this thesis is based on a study of two different aspects. On the one hand, aspects related to the decision-making process, especially the role of science and the integration of different types of information and data considering different scales and dimensions of the decision-making process. And, on the other hand, aspects related to island studies, especially focusing on island identity and the existing narratives that coexist and inform policymaking.

I focus on the Mediterranean island of Menorca (Balearic Islands, Spain) as a case study. In the following subsections I will describe the specific characteristics of Menorca considering the context of the global changes and challenges we are facing today. This research has required considering information and perspectives across different disciplines from the beginning. The emergence of the covid pandemic in 2020 forced this work to adapt and move to an even more transdisciplinary approach (see. 1.4). This high level of transdisciplinarity generated tensions and difficulties, some connected to the practice of problem-oriented research (Kovacic & Marcos-Valls, 2023).

In this introductory chapter, I want to offer an overview of the background and problem formulation addressed in this dissertation. First, I will describe the general situation to frame this research, then I will focus on the case of Menorca to define the problem I'm addressing, and my contribution to the debate and the research questions. I will end the chapter with some reflections about my positionality during this research process.

1.1. Background

In the following subsections I introduce the background to contextualize this research.

Some parts of Chapter 1 are from:

Marcos-Valls et al., (2020), and Marcos-Valls (2023)

Marcos-Valls, A., Kovacic, Z., Giampietro, M., Kallis, G., & Rieradevall, J. (2020). Isolated yet open: A metabolic analysis of Menorca. Science of the Total Environment, 738, 139221. https://doi.org/10.1016/j.scitotenv.2020.1392

Marcos-Valls, A. (2023). Chapitre 5. Choix entre biodiversité, industrie et tourisme: une approche métabolique à Minorque. In Romagny, C. Cibien, & Barthes (Eds.). Réserves biosphère et objectifs développement durable 2 (Vol. 3, pp. 91-114). (Développement des territoires)

The first element of my framework is related to islands and island identity, and "islandness". In this subsection I summarize some general characteristics of islands, and elements that have made islands relevant study cases, in scientific research and beyond. This focus on the peculiarity of islands is essential to better understand how different societies and communities have adapted to different circumstances to arrive at the current situation.

The second element I focus on is about the challenge of reconciling different perspectives about how to deal with complexity connected to sustainability and global changes, and how governance, at different scales, is addressing those challenges. I aim at contextualizing the general situation with these questions in mind: How are global changes and the climate emergency shaping policies and social behavior? Does the political arena include all the relevant information in the decision-making process? How are time and geographical scales included in these processes?

The last part of this section presents the case of Menorca. I want to explain, shortly, the situation of Menorca to justify the choice of this island for the study; and give general information to understand the following sections and chapters.

1.1.1. Isolated yet open. Islandness, identities, land, and adapted social practices

According to Special Issue about *The Metabolism of islands* (Singh et al., 2020a) there are around 465.000 islands in the world, 80.000 of them inhabited with approximately 8,5% of the global population, 600 million people.

Islands are well known and studied for their diversity in size, population, geographic, biological and geological characteristics, administrative organization, and development paths (Baldacchino, 2007). Islands are recognized as biodiversity hotspots and home of endemism and rare biodiverse systems (Singh et al., 2020a). And, similarly, islands have been conceptualized as human laboratories or microcosms (Kallis et al., 2022) where scale and specific properties have allowed to concentrate efforts to study the adaptation to changing circumstances all over the planet through History.

Islands share a 'largely common *experiential identity* (Baldacchino, 2006; Conkling, 2007; Stratford, 2008), widely felt, yet conspicuously hard to pin down' (in Kallis et al., 2022, p. 3). There is a quote from Quammen (1996) that express that characteristic condition of islands as places that have attracted interest from diverse fields:

Islands resemble one another in that each is unique. Huh? Islands are distinct from mainlands in that they represent simplified, exaggerated versions of... of exactly those evolutionary processes that occur on mainland. (Quammen, 1996, p. 120)

This tension between similarities and differences among islands make them an appreciated object [of study] beyond a place where it is possible 'to reproduce on a manageable scale' processes and dynamics existing somewhere else. Islandness appears 'as an intervening variable that does not determine, but contours and conditions physical and social events in distinct, and distinctly relevant, ways' (Baldacchino, 2004, p. 278).

For this reason, the emergence of Island studies -or Nissology- attempt to create a transdisciplinary body of knowledge connected to islandness beyond 'looking at islands *because they are islands'* (Baldacchino, 2007, p. 7, emphasis in the original) but as a response to the phenomenon of globalization and its consequences on islands, with a key mandate of: 'sharing, advancing and challenging existing theorization on islands and island studies; while avoiding, delimiting or debunking false or partial interpretations of the island condition' (Baldacchino, 2007, p. 16)

Research on different disciplines has described and explained the implications of human-environment interactions on landscape (Ruiz & Sanz-Sánchez, 2020) and on evolution of human societies and ecosystems (Singh et al., 2013). For instance, cases of social collapse due to overuse and/or lack of key resources, defined as an example of 'ecocide' (Baldacchino, 2007, p. 125), colonization and wars to occupy islands from different civilizations, introduction of plagues and illnesses, extinctions, biodiversity loss and extinctions (Singh et al., 2020b), pirate attacks, religious retirements, and forced exile places or prisons (Baldacchino, 2007; Papalas, 2005) are some examples of this knowledge connected to islands. Moreover, islands have been an infinite source of cultural and artistic inspiration represented in films, books, series, pictures and so on.

Insularity plays a relevant role in the definition of the community and its identity, since it makes it easier to establish boundaries and define what is in and out of the system. However, these supposedly *easy to establish* boundaries, defined by water around a piece of land, are not always that clear. Isolation is often paired with the existence of different degrees of openness that connect islands with people and resources elsewhere. Insularity, then, is key to define characteristics beyond boundaries and identity. These characteristics are connected to the availability of resources, the management strategies of these

resources, and the specific social practices that are connected to these circumstances. A Menorcan researcher wondered whether insularity is a 'limitation' or an 'incentive' (Casasnovas Camps, 2005, p. 28), and he concludes that the historical conditions are key to see how insularity affects islanders. In the case of island identity, the geographical condition of being a piece of land surrounded by water has shaped a common idiosyncrasy, a way of being, acting and becoming of the inhabitants of these territories. And this idiosyncrasy swings between two extreme situations: isolation, defined by the use of internal resources; and connectivity, defined by different degrees of relations to external resources. Identity is defined by the surrounding land, and the created landscape, but both identity and landscape are dynamic. Identities responding to change, mobile and constantly open to formulation and reformulations. And landscape is contested, always in process, being and becoming (Tilley, 2006)

On the one hand, island societies are groups of people that are characterized by being directly linked to land, territory, and the available resources. They are used to knowing and managing the resources within the limits of the island. This knowledge has led to the development of practices of self-sufficiency and the control and awareness of the options and vulnerabilities and risks towards changes in the availability or lack of resources. On the other hand, the increasing possibilities to move around the globe have put islands in a position of openness to external inputs and influences. Position that brings new opportunities, and also new vulnerabilities and risks. The specific combinations of material flows and stocks can become socio-metabolic risk (Singh et al., 2020b) depending on how reliable are the relations between inputs and social practices.

Long-term interaction of humans with their social and physical environment – that leads to the stabilization of given state-pressure relations (a specific biophysical structural coupling) – usually tends to create a strong identity in isolated communities. On the contrary, globalization tends to generate common pressures determined by a progressive homogenization of functional and structural elements. This trend translates into a pressure towards a continuous (re)definition of the identity of the societal metabolism of small touristic islands.

The tension expressed in previous paragraphs between isolation and connectivity makes islands special cases to study social practices that have been, both, used to adapt to limited resources and conditions, and open to trade and exchange of external resources.

The position and strategic situation of islands on trading routes, traditionally, or touristic attractors, in more recent times, are key to shape part of the identity of the islands, and this tension between openness and closure is also trademark of islandic identity. On the one hand, providing examples of self-sufficiency, and adaptation to limits, and, on the other hand, with the exchange, incorporation, and use of external resources from different civilizations that have created dependency, vulnerabilities, and risks, but also opportunities, diversity, and emergence of innovative practices to deal with the different conditions.

1.1.2. The complex challenge of sustainability

Sustainable development and sustainability have become familiar concepts since their emergence in the 1980s with the so-called Brundtland report. The 60's are considered the decade in which environmental movements started with the publication of the influential book Silent Spring (Carson, 1962). The 70's brought an increase of environmental social movements that were reacting to the impacts of pollution on public health, an increasing world's population and the peak in the prices of oil in 1973 (Gómez-Baggethun & Naredo, 2015). In 1972, the Club of Rome published the landmark report "The limits to growth" which argued that unlimited economic growth is not possible on a finite planet. And the 80's, was when the concept of sustainable development was included in the report *Our Common Future* (WCED, 1987), also known as the Brundtland report, as an initial milestone for this concept to be included in political and scientific agendas worldwide.

The popular definition from *Our Common Future* (WCED, 1987), says that 'sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs', focusing the attention in the key concepts of 'needs', 'the idea of limitations' and an intergenerational component. In general terms, the concept is easy to understand and relate to, however it gets more difficult to pin down because it is *by its nature complex, normative, subjective, and ambiguous* (Martens, 2006) generating critics from the social and scientific point of view.

The concept of sustainability or sustainable development epitomize the question of science for governance (Cabello Villarejo, 2015), since it tries to use scientific evidence to solve a diversity of legitimate concerns identified in society. Sustainability science emerged as a response to the debates and environmental problems identified during the last quarter of the 20th century (Kovacic, 2015). Governmental institutions, from global to local, have started

to incorporate sustainability as a requirement in policy documents and policy-making processes.

In the 1990s, an increasing number of scholar started arguing for the need to produce scientific transdisciplinary knowledge to inform policies in times of uncertainty (Funtowicz & Ravetz, 1990, 1993; Gibbons et al., 1994). Societies in transformation require new modes of knowledge production where contextualization influences the traditional world of science (Nowotny et al., 2001, p. 54).

Higher education institutions reflect a momentum in relation to sustainability studies (Lozano García et al., 2006). These institutions responded with the increase and consolidation of an offer of environmental and sustainability science degrees that include system thinking, complexity, context dependency and transdisciplinary competences in their programs (Evans, 2019).

At the same time, new international organizations, institutions, summits, and conferences emerged as meeting points for policymakers, economic sectors, civil society, and scientific institutions to discuss and deliberate about these issues with the aim to provide solutions.

During the last 60 years, sustainability issues have increased their influence on the international agenda. Six 'Earth Summits' – Stockholm 1972 and 2022, Nairobi 1982, Rio de Janeiro 1992 and 2012, and Johannesburg 2002 –, the Millennium Development Goals (2000), the Sustainable Development Goals and the 2030 Agenda (UN, 2015) and other global and regional initiatives prove this interest and increasing relevance of sustainability. However, is the world more sustainable today than it was 60 years ago?

While these initiatives and goals provide a valuable contribution and guidelines for several regions to include sustainability in their agendas, some issues arise: What are the limits of regional decision-making? Can a region be sustainable without considering the impacts it generates somewhere else? What types of scientific information is used to justify and define policies? Are targetoriented initiatives the best governance tool to approach sustainability issues? To what extent can different voices be included in the debate, deliberation and decision-making when there are contradicting goals, interests, and outcomes?

These questions entail the challenge of dealing with complex issues when it is nearly impossible to control everything. In this situation, uncertainty is high, and decisions still need to be taken. Part of the challenge is designing governance tools that can deal with complexity.

There are different frameworks and tools to inform decision-making that incorporate strategic analysis representing specific elements in a given situation. SWOT analysis (strengths, weaknesses, opportunities and threats) or PESTEL analysis (Political, Economic, Social, Technological, Legal and Environmental) are useful to represent environmental performance applied to different cases (Islam & Mamun, 2017; Loizia et al., 2021) and fields (Benzaghta et al., 2021).

The development of the DPSIR framework (Driver-Pressure-State-Impact-Response) for social-ecological systems (SES) has been one of the responses to the need to create adaptative management tool to address environmental problems (Gari et al., 2015) and also as a didactic way to communicate. However, this framework presents limitations when it comes to incorporate the complexity of environmental and social-economic systems (Maxim et al., 2009).

The complexity around sustainability and governance requires addressing the issue of how to prioritize indicators and targets referring to non-equivalent policy concerns, which is a normative decision and not a scientific one (Giampietro, 2019b). This entails that this decision depends on who controls the process. As Martinez-Alier puts is, who has the power to simplify complexity? (Martinez-Alier, 2010)

The monitoring of specific indicators and targets in isolation can bring hypocognition (Lakoff, 2010) in the decision making process. That is, it can convey a wrong idea of success creating new sustainability problems. In fact, the interactions among targets and indicators are complex, impossible to predict. A systemic approach is needed to identify and address potential side effects and trade-offs (Weitz et al., 2018).

The use of indicators for governance to justify decisions is often based on the existence of an uncontested belief that *'science speaks truth to power"*-(Benessia et al., 2016) in Modern science. However, this is a problematic assumption in complex adaptive systems where there is a plurality of non-equivalent perspectives and legitimate values that cannot be measured and compared (Kovacic & Giampietro, 2015).

The need for integrated analysis and reflexivity is connected to the fact that in complex adaptive systems there is not a single truth but several truths that need to be acknowledged. That is, different stakeholders will carry different perspectives and representations about the issues at stake. In this situation, integrated and reflexive ways of framing, discussing, and deciding about the

issues are key to creating a trustworthy and transparent process capable of including different voices and concerns.

1.1.3. The role of science for governance in complexity

Diagnosis, management, and decision-making in complex times

Simplification is essential to produce scientific knowledge that can be used for governance, by allowing the identification of relevant narratives and pertinent models. However, as it is mentioned in a classic quote 'essentially all models are wrong but some are useful' (Box & Draper, 1987) there is a tension between the completeness of the model and the usefulness of the information. Reductionism is problematic when simplification produces useless (or even worse, misleading) information to address the issues at stake, or if it is too complicated.

Finally, there is another key aspect to be considered in relation to governance, science, and sustainability. Different social actors have legitimate but contrasting concerns and perspectives about what should be considered as a "solution" and, to be engaged in a process of deliberation, they must receive different inputs of information tailored on their specific perceptions. Dealing with complexity entails either the risk of missing relevant information (if we simplify too much the analysis) or the risk of paralysis in the decisional process for excess of information (if we complicate too much the analysis).

Complexity poses the epistemic challenge of irreducible pluralism, as complex systems cannot be modeled without losing relevant information. In fact, complexity can be defined as the existence of multiple non-reducible representations of a system. Sustainability issues are complex and characterized by involving multiple scales, urgency, and pluralism (Kates et al., 2001). And, governance, in a wide sense, is about the policy and decision-making processes that take place in this context of high uncertainty and complexity (Kovacic, 2015).

Multi-scale governance alternatives: the case of islands and their vulnerability

There is an uneven distribution of the causes and consequences of global changes and the environmental and social emergencies happening nowadays. Countries or regions that are more vulnerable to climate emergencies and other changes have usually contributed much less and are more affected than

the countries and regions that are responsible for the causes of these changes and emergencies.

International organizations are always confronting these two situations and that can be traced on the negotiations of several international agreements, such as the Paris Agreements (UNFCCC, 2015). Equity and justice are central to the discussion about climate policy making. However, the results of these agreements are often not binding and/or a mere list of 'good' intentions with little accountability. The voluntary scheme of the Paris agreement, for instance, lead to potential tension between decreasing emissions inequality and lower global emission (Zimm & Nakicenovic, 2020). The tension between so called 'developed countries' that have developed using fossil fuels for decades, and 'developing countries' and remote regions that 'claim their share' of pollution or alternative resources to improve their situation.

The Man and the Biosphere program (MAB) (UNESCO, 2020; U. N. E. S. and C. O. UNESCO, 2017), initiated in 1971; the 2015 Sustainable Development Goals and the 2030 Agenda (UN, 2015), or the Paris Agreement (UNFCCC, 2015), mentioned before, are examples of international responses to use the available scientific knowledge to make a decent human life and development compatible with the biosphere and the use of resources. These initiatives address inequality and aim to compensate the existing tension between regions responsible for the global changes and the more vulnerable regions. However, the tension and inequalities remain.

Small islands are particularly vulnerable to climate change (IPCC, 2014, 2022). At the same time structural changes in their economies, especially those determined by the growth of tourism, mean that their resource, energy, and emissions profiles are changing, not only due to decisions of the residents but also because of the effect of external drivers. The improvement of mobility and communication technologies in the last decades, for example, has increased the number of permanent and temporary residents, tourists, and seasonal workers in many islands resulting in an overall increase in the consumption of food, energy, water, and other material flows. The changes on a global scale, environmental and social, are affecting small islands that have little maneuvering capacity and power to address global issues. They are simply affected by the consequences of these changes and need to adapt.

1.1.4. The case of Menorca: A Mediterranean Biosphere Reserve and its landscapes policies: A lab for Sustainability?

General information and administrative organization

Menorca is the more oriental island in the Balearic Islands region, located in the north-west of the Mediterranean Sea (Figure 1.1). Menorca is the second biggest island in size in the Balearic archipelago, after Mallorca, and the third in population after Mallorca and Eivissa (Ibestat, 2022). Menorca covers an area of around 700 km², and declares a population of 96.467 registered inhabitants in 2022, that goes up to more than 110.000 actual people if we consider all the people on the island due to tourism and visitors that can more than double the population during summer (OBSAM, 2023).





The capital of Menorca is Maó and, in total, there are eight municipalities in the island: Alaior, Ciutadella de Menorca, Ferreries, Es Castell, Es Mercadal, Es Migjorn Gran, and Sant Lluís. The regional constitution, the *Estatut d'Autonomia de les Illes Balears* (*Llei Orgànica 01/2007, de 28 de Febrer, de Reforma de l'Estatut d'autonomia de Les Illes Balears*, 2007) created in 1983 and modified in 2007, regulated the existence of insular specific institutions, the insular councils (CI from the Catalan abbreviation of *Consell Insular*), to manage certain aspects at the island level. These councils were an *ad hoc* organization to manage island issues besides other institutions, and administrative organizations related to the municipalities, the Autonomous Community of Balearic Islands, and the Spanish state.

The first *Consell Insular de Menorca* (CIMe from now on), after the end of Franco's dictatorship, was established in 1979. Four years later, it was

Figure 1. 1. Map of Menorca and situation in the west of the Mediterranean.

From Google Earth

included in the regional legislation with the *Estatut d'Autonomia* (1983), and it has been modified by different laws during these decades to adapt the structure and policy-making possibilities to the circumstances.

The first four years' period of CIMe, 1979-1983, was led by the center party (UCD for the Spanish abbreviation of Union of the Democratic Centre) that was dominant in Spain during the so called *Transición*, the transition from the dictatorship to the democratic organization of Spain. In the following forty years since 1983, twenty-eight years have been dominated by center-left parties, mainly PSIB-PSOE, with some periods of governments leaded by the center-right party, PP (CIME, 2023).

In chapter 4.2, I present 'A short tale about the History of Menorca' where I contextualize in more detail the recent history of Menorca in relation to its past as strategic location in the Mediterranean Sea, and how, in recent times, Menorca has moved from an agrarian to a touristic island aiming to sustainability in the present.

After this brief background about the general organization and basic information about Menorca, in the following paragraphs I explain the situation of Menorca as a Biosphere Reserve and in the Mediterranean region and the current regulatory framework.

Menorca, a Mediterranean Biosphere Reserve, and its landscapes policies: A lab for Sustainability?

The Balearic island of Menorca (Spain) has been a biosphere reserve since 1993 (UNESCO, 1993), extended in 2004 and 2019. During this period, Menorca, through CIMe (Menorca's Island Council), IME-OBSAM (Menorcan Studies Institute – Socio-Environmental Observatory) and the participation of civil society and other entities have performed different functions related to the biosphere reserve. On the one hand it has presented several initiatives and plans for its sustainable development such as an initial Sustainability Plan (IDS & IME, 1996), an update of the 2003 Territorial Plan of the Island, PTI, (CIME, 2019b) or the Menorca Biosphere Reserve Law (Llei 3/2023, de 17 de Febrer, de Menorca Reserva de Biosfera, 2023). On the other hand, it is continuously monitoring and reporting about social, economic and environmental indicators (Canals Bassedas et al., 2013; IME & CIME, 2019; OBSAM, 2020) to evaluate the progress of the island and inform society and policy-makers. Moreover, Menorca has developed an action plan for 2025 based on the Agenda 2030 in order to reach the targets and indicators defined by the SDG (CIME, 2019a).

The Mediterranean region concentrates an important number of biosphere reserves and involves the participation of several countries. For decades, biosphere reserves across the Mediterranean have been designing, testing, and establishing different management practices to balance human development with environmental protection (UNESCOMED, 2014). These experiences offer many lessons to learn from and new questions to deal with. And the same can be applied, in general, to coastal areas and to islands. As it is introduced previously, islands are *conservation frontiers* (Singh et al., 2020a) including biological and ecosystemic diversity, and human heritage and cultural practices.

The World Network of Island and Coastal Biosphere Reserves includes more than eighty reserves from all over the world (Murcia Diaz & Cardona Pons, 2023). Menorca is recognized in this network as responsible for one of the two technical secretariats since 2012. One secretariat focuses on climate change issues, Jeju, in South Korea, and Menorca (Spain) is dedicated to sustainable development (UNESCO, 2023). The network is in charge of periodically meet and share experiences and establishes priorities, and desired actions to be performed in the biosphere reserves of the network (UNESCO & MAB, 2017).

Menorca has undergone a unique process of land protection that started as a reaction of an urbanization plan in the 70s, the PPOB (Spanish abbreviation of Regional Territorial Plan of Baleares) (DPB, 1970) (see 4.2. for more detail). This plan suggested a similar development pathway as the one of the neighboring islands of Mallorca and Eivissa, where important touristic infrastructures were already developed, and where Franco's dictatorship promoted an economic monoculture based on tourism earlier than in Menorca.

This delay, called by some authors *el retard virtuós* (the virtuous delay, in English) (Marí Pons, 2010), was initially promoted by the Spanish dictatorship after the Civil war as a punishment for Menorca's *loyalty to the Republican government* (Murray Mas, 2012, p. 1385). However, this delay in the 'development' of Menorca based on touristic infrastructures that was planned in the PPOB from people in government, ended up having positive consequences in the maintenance of the territory and landscape, that contributes to explain the current situation in Menorca.

The proposal of this urbanization plan, prioritizing the development of residential and touristic infrastructures created a strong opposition among Menorca's inhabitants and civil organizations. This opposition from civil society and the alliances with different stakeholders led to the declaration of Menorca as a biosphere reserve in 1993 and to the beginning of a different development pathway where a balance between (hu)man and the biosphere was

established as desirable and used as an example of sustainability (UNESCO, 1993).

The case of Menorca is presented as a relatively 'successful' case when it comes to the application of sustainable development principles and of land-scape protection. The progression of events during the second half of the 20th century summarized before, and more detailed in chapter 4, converged in the declaration of the Biosphere Reserve (1993) as an appreciation of the efforts for this sustainable development.

As it is embodied in the declaration as a Biosphere Reserve and the MAB Program, the main goal of these areas is to serve as human labs of sustainable development. Therefore, experiences to balance human development and environmental protection are practiced, monitored, evaluated, and, potentially, applied to other parts of the world. But what type of information is used to evaluate this 'success'? Who has control of these decision-making processes?

In the following subsection, I introduce the problem formulation that has guided this thesis connected to the complexity of integrating diverse information for governance.

1.2. Problem formulation. The complexity of integrating diverse information for governance. An interdisciplinary challenge, a PNS approach

After I introduced the background for the case of Menorca, the challenges connected to complexity, the use of science for governance, and the specific characteristics of island territories, I want to formulate, briefly, the problem I am addressing in this thesis.

The main problem I'm addressing in this dissertation is how to integrate a diverse and complex set of inputs of information to be used for the governance of sustainability in socio-ecological systems using a Mediterranean island, Menorca, as a case study.

In fact, in spite of a considerable amount of available information decision-makers often do not have an adequate access to the existing knowledge that would be required for selecting proper action (Cramer et al., 2018). Moreover, the complexity of the information space to be handled in a process of decision making has often led to either 'paralysis by analysis' (Maxim & van der Sluijs, 2007; J. Van Der Sluijs & Turkenburg, 2006), 'paralysis by precaution' (Cooney, 2006) or 'democratic paralysis' (Nath, 1969 in Kovacic, 2015;). The problem can be formulated as either (perceived) lack of information, an excessive level

of uncertainty about consequences, or the inability to reach an agreement on what actions are needed.

In the case of islands the problem gets worse because, regardless of the specific characteristics of the socio-ecological systems – i.e. meteorological, geographic, geological, and socio-economic, among others – globalization is producing common pressures on islands forcing changes that are modifying their functional and structural organization. (Connell, 2018).

To face the impasse created by the diversity of weakly integrated relevant ways of knowing, this thesis suggests adopting a flexible and adaptive approach to contextualize information and critically frame debates to improve deliberations.

An integrated structuring of the analysis of the metabolic pattern of socialecological systems must recognize the impossibility of achieving a unique or optimal solution, thus shifting decision making from a puzzle solving exercise to a deliberative effort.

The thesis offers a transparent framework to share relevant information about the concerns and problems to be solved.

To achieve this result the proposed approach addresses two issues (Munda, 2008): (1) How to deal with the challenge of integrating diverse information coming from non-equivalent descriptive domains (technical incommensurability), and (2) How to guarantee the quality of the process of decision making in presence of legitimate but contrasting views found among the social actors and large doses of uncertainty requiring flexibility and adaptability of the chosen solutions (social incommensurability).

These two issues characterize the systemic existence of a communication problem experienced inside the decision-making process. This problem requires the existence of a translation tool that can make 'emitted information' identified and understood by the recipients of the process (in a direction) and feedback on this input that can be sent back and 'understood' by the original emitters. Therefore, the identification and translation of this problem is a first scientific and social challenge.

Of course, this problem of communication becomes a philosophical one that may be understood with inspiration from philosophy of science. How to integrate different types of information in a way that reflects the perspectives and the concerns associated with a specific policy issue and allows an effective communication among decisionmakers, stakeholders and those providing relevant knowledge claims?

1.3. Objectives and research questions

This thesis has three main objectives:

- (i) identify the diversity of relevant information that can be used to describe Menorca as a socio-environmental system,
- (ii) assess how issues are prioritized and who has the power to simplify complexity; and
- (iii) suggest an approach to assess the quality of decision- making processes that integrate diverse and complex information.

These objectives are also expressed as research questions, that will guide the following chapters of the thesis:

- 1) What information is pertinent to the characterization of islands understood as complex socio-ecological systems?
- 2) How do the political discourses reflect the 'simplification of explanations' and 'prioritization of concerns' that took place within the process used to inform policy?
- 3) How can diverse and complex information spaces be integrated in deliberative decision- making processes?

1.3.1. Methodological contributions of the thesis

To address the objectives of the thesis I contribute to advancing methodologically to integrate incommensurable types of information for decision-making in two ways:

Dealing with the challenge of integrating diverse information coming from non-equivalent descriptive domains (technical incommensurability)

The study presented in Chapter 3 has two specific objectives. The first objective is to expand the use of the MuSIASEM approach with the aim of integrating information about the metabolism of households and economic sectors in a Mediterranean island as a social-ecological system. The second objective is to explore how the application of MuSIASEM can be used to study the factors associated with the definition of the identity of the system, its resilience and adaptive capacity.

By societal metabolism, we refer to the pattern of conversion of resource and energy inflows by structural and functional components of a society with the goal of maintaining and reproducing the identity of a given society (Giampietro & Sorman, 2012), in this case Menorca. This process entails the gathering of primary flows from the environment and the generation of waste outflows to be discarded into the environment. An effective characterization of the relations between structural and functional elements of social-ecological systems allows: (i) a non-reductionist identification and characterization of concerns; (ii) the identification of indicators that take complexity into account; and (iii) some anticipatory power about possible troubles in the future (increase in the understanding of adaptation).

Several studies have focused on the metabolism of the Balearic Islands giving a comprehensive and holistic picture of the evolution of the general socioeconomic metabolism (Ginard & Murray, 2015; Murray Mas, 2012) and energy metabolism (J. Ginard-Bosch et al., 2015; F. J. Ginard-Bosch & Ramos-Martín, 2016) of the whole region. In this dissertation, I focus on the island of Menorca to perform a metabolic analysis that can integrate information that comes from non-equivalent descriptive domains. I want to contribute methodologically enabling the use of metabolic analysis to explain the different development pattern, compared to the other Balearic Islands, and can contribute to deliberation and decision-making.

Improving the assessment of the quality of the process of decision making in presence of legitimate but contrasting views found among the social actors and large doses of uncertainty requiring flexibility and adaptability of the chosen solutions (social incommensurability)

The specific aim of chapter 5 is to evaluate the quality of the discussion and the decision-making process for sustainability and landscape policies in Menorca. In order to do this, the PNS approach is presented and used to explore and study the dimensions that participate in the discussion to adapt to global changes and achieve a sustainable future in specific social-ecosystem systems.

To achieve this aim, I will provide a framework to evaluate the quality of the discussion, using a PNS approach and I will illustrate the use of this framework in the specific socio-ecological system of Menorca, using a metabolic approach.

Based on the theoretical contribution of Giampietro & Bukkens (2022), I characterize the dimensions of the decision-making process used to develop

sustainability policies connected to landscape in Menorca to understand and to find procedures for integrating quality checks in this process.

This thesis, using the study case of Menorca, wants to develop a comprehensive framework that can be applied to different social-ecological systems, and that can be applied to different scales and dimensions in an integrative manner.

1.4. Positionality

1.4.1. Doing research in pandemic times: Dealing with uncertainty, precariousness, and the administrative trap

The present subsection is a reflection of my personal experience carrying out research in the context of the COVID-19 pandemic and how it has affected my research management and plans. Besides the effects of the political conflict in Catalonia and the exceptional times we went through in Autumn 2017, which were intense and shocking at times.

It is obvious that COVID was an unexpected global situation for all, and it was hard to take decisions. Institutions were adapting to the circumstances and that created a moment of impasse. At the beginning, the messages from the university and the Spanish Ministry were to do not worry about work and focus on health care and protect each other. However, as the months, and years, passed the lack of information, misleading information, and the one-size-fits-all solution from the different administrations started generating worries and anxiety.

Αντίο Ελλάδα (Good bye, Greece)

On the 12th of March 2020 I landed on Greece, four days before the beginning of my international stay. On the 14th, the 'Emergency state' was declared in Spain and in the 15th, I received a call from the Spanish Embassy in Greece 'you have to return to Spain, or you are by your own'. Four or five days later, I arrived back to Spain after several flight cancellations. The situation was extreme. Everyone was locked at home for 15 days, 15 days that became more than a year of different restrictions.

At the beginning of 2021 after seeing that it was not going to be possible to retake the international stay and the data collection in Ikaria afterwards, I decided together with my supervisors to cancel that part of the research. During this time, I analyzed possible alternatives. However, an important part of the

work, such as the fieldwork in Ikaria, was not going to happen. No more comparative study. New situation, new plan.

During the first half of 2021, owing to the circumstances, I planned a new research approach focusing on Menorca. A part of the 'future research', the analysis of the political dimension in Menorca, was going to be real. Even though I was interested, I missed part of the theoretical and methodological framework to do it. Thus, I planned another international stay in Sweden, in a group with expertise in Environmental communication, to explore the new possibilities and then go back to Menorca.

Hejdå Sverige (Good bye, Sweden)

In July 2021, when the situation with COVID was more stable, I went to Uppsala, Sweden. I thought I could restart my research and have some extra time to finish, but it didn't happen. Apparently, it was impossible to extend the final date to submit my thesis. When COVID started, I was finishing my second year of the PhD, with almost two years of time ahead. However, when the pandemic situation started to normalize, I had six months left. No more.

The public university system gave a general administrative extension of a few months to everyone registered, and the Spanish government gave, also, a general contract extension for everyone with an active contract funded by them during a period of COVID. No matter if you were writing your dissertation or if you had to cancel an important international stay or fieldwork to gather data for your project. I had six months left to finish research that I didn't do and that was a source of anxiety. I didn't know how to handle it, and I had to stop.

After the disappointment of Uppsala, I decided to go to Menorca. I needed to stop and think about what to do. I stopped the official research, but I started another experience living in Menorca. In the beginning, it was a plan for three months, but I have been in Menorca for almost two years now. It was not easy on the personal side, but living there helped me a lot. Moreover, after more than a year, I could retake the research, and this dissertation is the result.

In conclusion, this dissertation has been an obstacles race: at first full of joy and happiness, and at the end with suffering and some pain. As someone told me, a 'PhD is a test of tenacity'. It is about resisting and being there. This is how I perceive Academia after these years.

Academia is a prove of resistance to endless administrative processes, from trying to book a trip to a conference -through monopolistic practices that didn't consider train, bus, or ferry -mainly plane- and that forces you to spend

your budget through them - to going through never-ending review processes that take months or even years for some people to publish. It is proof of either power submission and resistance to Malayan drops and other types of modern tortures that 'for your own good' want to extract as much as possible; or ignorance if no profit can be extracted from you.

Even though it might appear to have a negative connotation, to analyze and to reflect on these challenges and contradictions is an important exercise of honesty towards better working conditions, and hopefully, more respect, care, and coherence. Research is wonderful. And being able to have time to investigate and critically question issues that happen around us has a great value that society needs to claim and maintain, in opposition to being farms of publications.

Chapter 2.

Theoretical and Methodological framework

A transdisciplinary framework for decision-making

Nature consists only of what can be perceived; beyond, there are only hypothesized abstractions. His ideas about the relation between nature and human perception of nature led to a particular epistemology concerned mainly with valid analytical representations of relations among facts.

For Georgescu-Roegen, any worthwhile economic theory must be a logically ordered description of how reality functions.

Kozo Mayumi about Nicholas Georgescu-Roegen (2001)

2. Theoretical and methodological framework

2.1. Chapter overview

In this chapter I introduce the theoretical and methodological frameworks I have explored and used in my research. As explained in the introductory section, the complexity and uncertainty of the problems I addressed in this dissertation motivate the use of the ideas proposed by Post-Normal Science (PNS). Part of its basic philosophy is the observation that in contexts of high uncertainty and complexity, the participation of an extended peer community helps provide a frame for deliberation and decision-making (Funtowicz & Ravetz, 1993). This extended peer community is key because issues connected to sustainability, land use management, and also island studies, require the representation of diverse disciplinary knowledge, beyond-discipline perspectives and the addressing of concepts like moral responsibility, fairness and solidarity.

According to this idea I aimed to be inclusive in the representation of perspectives and imaginaries in this research. I use theories and practices from different disciplines to provide diversity, from both the scientific arena and the political and social arena. However, as it is stated in the introduction, I am addressing a transdisciplinary issue that goes beyond scientific disciplines and embodies the complexity and the uncertainty explained above. In relation to this point I am totally aware of the limitations of an individual researcher, or a small team, to approach such an transdisciplinary endeavor.

There are limitations inherent to the decision-making process for sustainability, limitations in the research design and practices of interdisciplinarity, and there are limitations, also, to manage the emergence of problem-oriented researchers (Kovacic & Marcos-Valls, 2023) in academic institutions.

In this chapter, I explain the theoretical references that I have used to develop my work, and I link each theoretical concept with the methodological framework that I applied to obtain the data I analyzed in each chapter. The adaptation of the methodology to the case of Menorca will be noted here and explained in more detail in each chapter.

The theoretical and methodological frameworks are divided in three subsections, which correspond to the research questions defined in chapter 1:

 An ecological economics perspective, focusing on the concept of societal and ecological metabolism, and using the MuSIASEM Some parts of Chapter 2 are from:

Marcos-Valls et al., (2020), and Marcos-Valls (2023)

Marcos-Valls, A., Kovacic, Z., Giampietro, M., Kallis, G., & Rieradevall, J. (2020). Isolated yet open: A metabolic analysis of Menorca. Science of the Total Environment, 738, 139221. https://doi.org/10.1016/j.scitotenv.2020.1392

Marcos-Valls, A. (2023). Chapitre 5. Choix entre biodiversité. industrie et tourisme: une approche métabolique Minorque. In B. Romagny, C. Cibien, & Barthes (Eds.), Réserves biosphère et objectifs développement durable 2 (Vol. 3, pp. 91-114). (Développement des territoires)

- approach to identify and integrate available information, responding to RQ1 (Section 2.2.).
- 2) A political ecology perspective, aiming to analyze the current situation based on the evolution of landscape and landscape policies, discourses found in political documents, and ethnographic observations about the identity of Menorca, responding to RQ2 (Section 2.3)
- 3) And, finally, the PNS perspective informs a prospective procedure to integrate diverse (non-equivalent) information in the decision-making process focusing on the quality* of the process, responding to RQ3 (section 2.4).

Firstly, I provide a theoretical framework (section 2.2) to introduce the concept of societal metabolism from an ecological economics perspective, and the MuSIASEM approach that I used as a methodological approach for Chapter 3.

Secondly, I focus on concepts from political ecology and methods from environmental communication, grounded theory and ethnography (section 2.3) that I used in Chapter 4 to analyze the political discourses about landscape and the territory, and the idea of identity applied to Menorca.

And, finally, I present an application of the ideas of PNS that have been used to develop a framework that the schools of Bergen and Barcelona have been developing during the last decades (section 2.4). This application is described as a novel procedure to integrate information for governance (Chapter 5). Based on this framework I create a building blocks structure to integrate information from the political and scientific dimensions in a defined system for the deliberative and democratic processes and be able to check the quality of the decision-making process.

2.2. Societal metabolism: an ecological economics perspective to integrate information.

Ecological economics (EE) has emerged as a transdisciplinary field, to comprehensively understand and deal with the interconnections between the economy, ecosystems, and the social structures that support and maintain human well-being (Zografos & Howarth, 2010).

As Hanaček et al. (2019) states, EE can be described as a pre-analytic perspective that views the economy as a physical system integrated within the *finite* and complex planetary ecosystem. And, in contrast to neoclassical economics,

emphasizes the need to recognize explicitly the fundamental objective values of ecological sustainability and social justice (Daly, 2007).

One key aspect of EE is the integration of ecological and ecosystemic principles to study the dynamic interaction between the environment and the economy, and it poses the challenge to understand the ecological constraints, the limits to growth, and suggest alternative approaches to sustainability.

Another key feature, introduced by Martinez-Alier et al. (1998), is the incommensurability *-the absence of a common unit of measurement-*, that implies the need of a plurality of values to characterize a social-ecological interaction. This incommensurability imposes the necessity of multi-scale and multi-criteria tools to evaluate a situation considering that different options of representations are *weakly comparable* among different valuation types and criteria.

EE also deals with the different hierarchical levels of analysis that take place in a specific situation (Giampietro & Pimentel, 1991). Each level carries its own plurality of values and aims, but these decisions are affecting the other levels, and, therefore, it is important to assess the effects of the compatibility of goals and impacts on the rest of the levels.

One of the methodologies put forward by EE for the biophysical accounting of economic activity is the societal metabolism approach. The concept of metabolism is usually associated with the activity of a living organism and the processes taking place in order to maintain life. However, the basic rationale of systems that require energy and matter to achieve its internal order and (re)produce themselves has also been applied to socio-ecological systems (Cottrell, 1955; Lotka, 1922, 1956; Ostwald, 1907, 1911; Soddy, 1926; White, 1943; Zipf, 1941). This application has generated an emerging field of study, 'societal' (or social) metabolism, that characterizes socio-ecological systems regarding the use of energy and matter and the production of wastes and emissions (Daniels & Moore, 2002; Fischer-Kowalski, 1998; Fischer-Kowalski & Hüttler, 1998; Giampietro et al., 2008, 2014; Martinez-Alier, 1987, 2010).

The use of socio-ecological metabolism approaches integrates the relation of social and economic activities to the material and energy flows that are needed to maintain and reproduce the system, and, at the same time, it provides a hierarchical organization of the systems with other systems (super- and sub- systems).

By societal metabolism, I refer to the existence of a pattern of resource and energy inflows, and waste outflows, exchanged by a society and its context, that must be stabilized in time in order to maintain and reproduce its internal

functions and structures. The sustainability of this class of complex adaptive systems requires an effective control and monitoring of the changes experienced by the system both on the interaction with its environment (primary flows) and on the interaction of its internal parts (secondary flows exchanged between the parts). This fact implies that to get a better understanding of causes and the consequences of changes in the structure of the metabolism of social-ecological systems we need better informed policies and new analytical tools. That is, to deal with ever-increasing complexity, we need analytical tools and institutions that can handle such complexity.

Several researchers have presented metabolic approaches to understand and explain what happens in diverse socio-ecological systems and to assist policy-making ((Fischer-Kowalski, 1998; Fraňková et al., 2017; Giampietro & Mayumi, 2000; González de Molina & Toledo, 2014)). From urban metabolism (Broto et al., 2012; Pérez-Sánchez et al., 2019; Swyngedouw, 2006; Wolman, 1965) to the metabolism of islands (Bogadóttir, 2020; Ginard & Murray, 2015; Martínez-Iglesias et al., 2014; Singh et al., 2001), including regions and states (Carpintero, 2005; Ginard & Murray, 2015; Velasco-Fernández et al., 2015) there are examples of the application of the concept.

The application of the concept of societal metabolism to an island, allows studying not only the input/output flows of energy and materials but also how these flows determine the state of the system in a specific period and its relationships with other external and internal subsystems.

As presented in Fraňková et al. (p:10, 2017), there are different variants within societal metabolism studies which are based on the analysis of input/output flows with special focus such as substance flow analysis (SFA), physical input-output (PIOT), life cycle analysis (LCA), or material and energy flow analysis (MEFA). The Multi-Scale Integrated Analysis of Societal and Ecosystem Metabolism (MuSIASEM) together with these other methods represents a significant contribution towards the development of socio-metabolic research in sustainability science (Haberl et al., 2019). The peculiarity of MuSIASEM is that its accounting system allows to integrate different indicators defined across different levels and dimensions (Giampietro, et al. 2014).

Gerber and Scheidel have compared MEFA and MuSIASEM as 'today's most powerful methods for analyzing the metabolism of social systems' (Gerber & Scheidel, 2018). They concluded that while MEFA provides a strong and standardized method, compatible with national statistics and able to perform long-term studies, MuSIASEM contributes to more integrative and comprehensive study analyzing processes and functions, linking scales of analysis and different

dimensions (ibid). More specifically MuSIASEM links the quantity and the quality of input and output flows of food, water, energy, and materials to the functional and structural elements of the system under study. This integrated analysis of qualitative aspects (the profile of inputs and outputs per unit and fund elements) and quantitative aspects (the overall size of both fund and flow elements) is based on the flow-fund model (Georgescu-Roegen, 1975). The analysis is carried out at multiple levels of analysis.

The main difference between MuSIASEM and other analytical tools belonging to the family of conventional input/output analysis (Daly, 1968; Duchin, 1992; Lenzen, 2011; Leontief, 1968; Leontief & Ford, 1970; Stone, 1936; Stone et al., 1959) is simple. Conventional input/output assessments are based on the analysis of how inputs and outputs change in time (for example, from year to year) reflecting changes in prices determining their use in the various production processes. This analysis does not address the specific characteristics of biophysical processes determining the various (specific) biophysical inputs and outputs and how inputs and outputs co-evolve or co-determine the size of each other. This is also the epistemological stand of the analytical tools used to calculate LCA, eco-efficiency, MEFA, and in general the family of footprints tools (Giljum et al., 2013; Hoekstra & Wiedmann, 2014). The robustness of these studies is based on the use of large databases and statistical processing. The resulting assessment does not make a distinction between an input/output ratio determined by the technical characteristics of a given structural element performing a given task (e.g. a tanker or a truck transporting oil) or a functional element performing the same task, but at a larger scale (e.g. the oil transportation sector) using a mix of tank, trucks, pipelines with different technical characteristics.

In this research, I focus on the application of Multi-Scale Integrated Analysis of Societal and Ecosystem Metabolism (MuSIASEM), explained in the following subsection, and applied in Chapter 3.

2.2.1. MuSIASEM: Integrating information from multiple scales to improve participation and stakeholder engagement

The MuSIASEM approach is an accounting methodology that makes it possible to establish a bridge across different indicators defined across different levels and dimensions (Giampietro, 2014).

The analysis of the metabolic pattern of social-ecological system entails the use of several indicators observable at different levels and in relation to

chosen dimensions of analysis. The ability of preserving this multi-dimensionality and complexity in the representation avoids the hypocognition generated by the use of indicators one scale and dimension at the time (excessive simplification). More specifically, MuSIASEM provides a set of tools to identify the factors determining the quantity and the quality of input and output flows of energy and materials by establishing a relation between the analyzed flows and the functional and structural elements of the system under study, based on Georgescu-Roegen's (1975) flow-fund model. Flows refer to elements that appear or leave the system over the duration of the representation —e.g. fossil energy, food, water-, and funds refer to elements that remain over the duration of the representation and transform input flows into output flows — e.g. labor and land (Giampietro et al., 2008).

MuSIASEM studies the metabolic elements in terms of "expected" characteristics, whose robustness is given by the entanglement of metabolic relations over its functional and structural elements. When analyzing a metabolized flow of food – i.e. the required amount of kcal of food/year for food security - we have to specify: (i) a fund element that is consuming it (e.g. number of days of people on the island x kcal/day p.c.); (ii) a fund element that is producing it (e.g. number of hectares x yield of food per hectare); and (iii) their expected relation in the metabolic pattern. In this way, assuming no imports, we can explore the forced relations of congruence (i.e. the amount of food determined by the demand of food of the "human funds/population" must be compatible with the supply of food of the "agricultural land uses/frop production). Put it in another way, the relative size of the funds (pace and density of production and consumption of specific flows) inside a given metabolic pattern can be used to identify the role (importance) played by the imports and exports in balancing the requirement and supply of metabolized flows. That is, this type of relational analysis is not based on deterministic predictions based on the "ceteris paribus hypothesis" but on contingent definitions of the option space. In a relation of congruence, we can change the factors determining the requirement (i.e. number of people or their diets) and the factors determining the supply (i.e. land in production, the mix of land uses, the technologies used for each production).

One of the key aspects of MuSIASEM is that it is based on the hierarchical idea of a holon (Koestler, 1967, 1979). A holon as a system that can be understood as a whole, as a part of bigger systems (the functional part) and containing other (sub)systems (the structural parts), that in MuSIASEM are defined as hierarchical levels of analysis. The existence of different levels of analysis enables to understand and visualize integrated information bearing in mind the

relation to the reference system. The usefulness of having a multi-scale perspective is that allows contextualizing information and ease stakeholders from different levels of analysis to participate adding data and understanding the relation of these data with bigger or smaller systems. The possibility of defining the size of the system and the scale of analysis is an important feature of MuSIASEM and it provides a flexible and adaptive approach to sustainability issues.

The approach includes three stages: 1) the definition of the system in terms of constituent components; 2) the diagnosis and characterization of the societal metabolism, looking at the implications of the metabolic characteristics of the functional and structural elements operating in the constituent components; and 3) the anticipation and simulation of different scenarios (Marcos-Valls et al., 2020). The definition stage implies to decide about what is the system that we want to analyze - constituent components, hierarchical organization of the relations over functional and structural elements across the different levels, and the metabolic characteristics (flow/fund ratios) - and what kind of data are available and how to obtain it. The diagnosis stage allows understanding who uses certain types of resources for what activities in order to maintain and reproduce the system. This stage includes an overview of the degree of dependency or self-sufficiency in relation to other systems, and the potential environmental pressures and impacts associated with the use of primary flows (oil, coal, agricultural primary sources) connected to the secondary flows (electricity, fuels, blue water, grains, poultry). Finally, the anticipation stage allows developing scenarios to discuss and deliberate about the implications of alternative policies in terms of the metabolic performance, dependency of external resources or environmental impacts linked to maintaining and reproducing the system as it is or modifying it.

The three stages reflect three critical questions introduced to operationalize how to deal with sustainability: sustainability of what? (Stage 1. defining the system); sustainability for whom? And why? (Stage 2. Diagnosis) (Frame & O'Connor, 2011; O'Connor, 2006) and sustainability for how long? (Stage 3. Anticipation).

The MuSIASEM approach includes the complexity faced when dealing with feasibility and viability, in biophysical terms, and desirability, in social and cultural terms, of alternative scenarios. Feasibility, regards the availability of resources depending on processes outside human control (external biophysical constraints). Viability, regards the possibility to implement alternatives of use and transformation of resources (use of different technologies, carriers, etc.)

in processes under human control (internal economic or technical constraints). And, desirability of alternative policies considers the consequences at different scales on the quality of life, expectations and normative values of a society (constraints determined by the need of keeping together the social fabric). Hence, the use of integrated approaches, such as MuSIASEM, can support participation and stakeholders' engagement to contrast scenarios and analyze how viable and feasible are desirable/sustainable alternatives suggested by stakeholders with different perceptions and interests.

In Chapter 3, I present the results of the application of the MuSIASEM approach to the case of Menorca for the year 2015. For more information about MuSIASEM and how to apply the stages to any social-ecological system, there are supplementary materials on *Annex 1: Stages of MuSIASEM application*.

2.3. The political ecology of landscape. The importance of landscape to define identity and policies.

As presented by Robbins (2012), political ecology (PE) is a *generous* term that includes a range of definitions depending on the focus of each research. Political ecology is about studying the continued interactions between the political organization of human societies and the effects on the environment. The political organization of human societies includes power relations, economic, and social factors, and the effects on the environment are both causes and consequences of human actions. As it is summarized in this paragraph by Otero and colleagues (2011, p:1307):

Political ecology sees society and nature as intertwined, the one conditioning the other and in the process co-producing new natures and new social arrangements. In return, ecological economics offer to political ecology the important insight that there are multiple, irreducible visions of progress (Norgaard, 1994) and multiple languages of valuing progress (Martinez-Alier, 2002).

In this dissertation I focus on the political ecology of landscape. I conceive the landscape of Menorca as a dynamic result of the *application or expression of power* with significant consequences for people (Neumann, 2011). My analysis is based on the study of discourses in historical and present documents. As explained by Neumann, the application or expression of power is not static but the result of a process that has effects, in material terms, for the people in the territory. These effects determine, or condition, where and how people deal with individual and collective livelihoods, generating potential

contestation and competing representations (Fairhead & Leach, 1996; Robbins & Sharp, 2003; Walker & Fortmann, 2003 in Neumann, 2011).

The material reality of landscape has been a strong theme in PE research, grounded on the analysis of biophysical conditions across space and time. This research focus on how those conditions are interpreted and understood by diverse stakeholders, and conditioned by local knowledge and practice that produce material landscapes (Neumann, 2011). However, there is also an "emotional turn" in PE that wants to address questions about subjectivities that include broader debates about the subject, agency and power (González Hidalgo, 2017).

"Landscape" means an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors (Council of Europe, 2000, p:2). As pin pointed by Rędzińska and colleagues (2022), the use of the word 'perceived' in the definition of landscape from the European Landscape Convention (ELC) is essential. These different perceptions comprise diverse representations and meaning making of landscape. Landscape emerges from a struggle to give meaning to the territory, as contested nature, that is the result of simultaneous struggles over social identity, belonging or exclusion, and land uses vs land covers and rights (Neumann, 2011) . Landscape management and planning are, then, a reflection of what society and social powers preview and consider as desirable for a specific territory on the basis of existing aspirations and past experiences.

The pressures over the territory and the creation of landscape are connected to people's livelihood in the space at each moment, and therefore independently on the type of pressure, the struggle is about maintaining, adapting, or losing the identity of the social-ecological system.

Identity is a dynamic process that is evolving, shaping, and reshaping itself with the influence of several conditions and phenomenon happening at different scales and time frames. There are a lot of factors that contribute to define the identity of a system such as the geography, the availability of resources, or the social, economic, and political organization. As Castells mentions in his book *The power of Identity* (Castells, 2010), he understands identity as 'the process of construction of meaning' based on related cultural attributes that are given priority over other sources of meaning. And other definitions complement this idea referring to identity as a 'process of sense-making' based on a set of social and cultural traits that include values, symbols, beliefs, customs, traditions, behaviors and other elements that define an individual or community as different from 'others' (Prieto, 2020).

Landscape and territory are key concepts to be considered when analyzing how policies are suggested and operationalized. On the one hand, landscape is the result of the previous decisions and actions that took place in the territory (Nogué & Vicente, 2003). This provides material information accumulated on the territory that contributes to explaining the present and understanding potential future paths. On the other hand, landscape also embeds a cultural process that contributes to contextualizing multiple functions of the territory that give significance to the landscape by mixing economic, political and the physical systems with the social order. Biophysical reality and cultural rules shape three aspects defining landscape: form, function and meaning, also expressed as the trilogy of visual/material, experiential/functional, and symbolic/cognitive that are highly interconnected and interactive (Terkenli, 2002).

As Terkenli states, this cultural or landscape identity is not established *once* and for all (my emphasis). It is articulated and revealed depending on variables and counter positions to other place identities that are also changing and constructed based on dynamic variables in terms of inclusion or exclusion, functional distinctiveness, unique symbolic values (ibid) or geographical difference (Saussure, 1974, in Terkenli, 2001).

Landscape identity is not established once and for all, nor does it remain constant in place; it may be articulated and manifested at a variable geographical scale, spatial entity or unit of analysis. It requires, as any production or reproduction of place or other identity, the juxtaposition of other place identities, also continuously reorganizing, in order to be constructed on the basis of geographical difference (de Saussure, 1974) whether in terms of inclusion and exclusion, in terms of functional distinctiveness, or simply in terms of unique symbolic value (Terkenli, 2001, p. 202)

In this dissertation, I analyze how landscape in Menorca has evolved during the last decades, and I explore what are some explanations and views of this landscape according to different stakeholders. I also identify political discourses that can represent competing interest over landscape. To do it, I investigate what representations are behind the idea of Menorca, what type of concerns are hidden and how they connect to landscape, and, finally, how these elements are included in the discourses to create narratives that justify policies about and beyond landscape.

From the perspective of political ecology applied to the case of Menorca, I want to contextualize what are the historical elements that have allowed

Menorca to be where it is today, and, then, make an analysis of the current situation. I want to understand the dialogue that exists between the ideas of landscape in the policies that are suggested, supported, and contested in the island, and the elements that are in discussion when society debates about identity, preservation, and the maintenance of Menorca.

The need to study the interactions between the current environmental situation, and the historical and political distribution of power and social struggles connected to landscape in Menorca justifies the use of a political ecology perspective. As presented above, this part of the research is devoted to present relevant aspects to represent the political sphere that will be integrated in chapter 5 with the suggested PNS procedure, explained in the next subsection, 2.4.

The political ecology informed analysis of identity is closely linked to the societal metabolism analysis described above. The analysis of metabolism recasts the discussion of resilience and adaptation to climate change and other global pressures in terms of how to deal with the process of "becoming" of human societies. This process is associated with the tension between maintaining the original identity by coming back to the original states of equilibrium after absorbing and responding to perturbations (resilience) and be able to accommodate the effect of long-term incremental pressures (adaptation) pushing for changes. Changes in the existing state will have a different impact on different stakeholders.

Tourism, for instance, is a generator of this tension: it requires the ability to offer modern services that tourists expect – e. g. standard accommodation, food services, or guided tours – that may clash with the goal of maintaining and promoting activities that *keep the original identity* of islands. That is, tourist services may compete with traditional activities. Their expansion tends to modify, relocate or remove aspects of the identity and create new pressures and impacts, both inside and outside the island, that requires adaptation capacity for renewal, re-organization and development of the social system without causing dramatic consequences, essential for sustainability (Folke, 2006).

The qualitative information and data that I use is a representation and an interpretation of different documents, events, and experiences that I have explored during my research using a mix of methodologies. In the following subsection, I explain the methodological approaches connected to environmental communication that I conducted to obtain data regarding the political dimension.

2.3.1. Mixed methods from situated analysis to environmental communication.

In this subsection I introduce the methodologies used to obtain data connected to the political situation that is analyzed in Chapter 4, and partially in Chapter 5 based on i) Situated analysis (SA), and ii) environmental communication methodologies.

From situated analysis and grounded theory, I focus on the idea from Clarke and colleagues of situational mapping, mainly during the research design phase, to help organize contextual information that contributes to explain a specific situation. In the case of Menorca I use these maps to 'capture the messy complexities of the situation' (Clarke et al., 2015) and to see patterns, rethink and plan the research. I consider information that I obtained from different sources and using different methodological tools, and I take into account that there is no one 'right' map but you can include or ignore elements depending on the relative importance along the research (ibid). Due to the changes in my research plan because of the covid pandemic, I had to reconsider what to do and how to do it, especially regarding the analysis of political documents, and this methodological approach helped me to expose all the available information I had, and reconsider what to include or ignore for the analysis.

From environmental communication I use concrete methods to obtain ideas and concepts that are useful to frame the existing discourses (Ferrari, 2015; Mempel, 2022) about landscape in Menorca. Framing discourses, I want to identify influential elements from documents to connect perceptions about environmental issues with the political debate in this case.

The information that I analyze in this dissertation comes from different sources including grey literature, electoral programs, legal documents, and formal and informal interactions with people living in Menorca. Each type of document or source required a different approach, from discourse analysis to ethnographical research based on participatory processes, attendance to seminars and everyday life observations.

I have been using material connected to a historical analysis, grey literature and documents about Menorca to show the evolution of land uses in the island and relevant milestones affecting the landscape. But at the same time, I obtained data from a participatory process, held in 2019, and observations detected thanks to living intermittently in the island for more than a year, between 2021 to 2023. These observations and data have been key to identifying

relevant elements to characterize the identity of Menorca. These elements include relevant information recognized by participants in a process to define essential elements of Menorca.

The goal was to identify the elements considered relevant by the participants as they embody concerns that are present in society. These elements include the biophysical reality of Menorca, cultural, economic, ecological, social, and environmental characteristic and contribute to create imaginaries of what is Menorca (as a system to maintain and reproduce). Getting more in detail, first, I performed prospective analysis from different documents and formal and informal interactions with people in Menorca based on a participatory process and the analysis of different types of documents.

The main goal of this prospective information was to 'create the situational map'. According to Clarke and colleagues (2015) this *situational map* is useful to lay out everything that would require some data to be gathered to gain a sense of potential relations among data. I obtained information from different sources and tried to make sense in relation to new and previous information I analyzed. This initial map allowed me to move across that map, zooming in on specific topics, and zooming out more general ones, and contributed to guide the next steps of the research.

Second, I performed specific analysis on selected documents. The goal of this analysis is to code and obtain concrete information to name and categorize (Moghaddam, 2006) topics and discourses from stakeholders that I identified in the prospective analysis. Based on different rounds of coding political documents I selected the topics that I found relevant to analyze in depth. Following the jargon used by Clarke and colleagues, this phase in my research has been connected to the two next mapping categories: *social worlds/arena maps* and *positional maps* (2015). Defining *social worlds and arena maps* offer interpretations of the broader situation from different actors that are engaged in ongoing discourses and negotiations. The *positional maps* lay out the main perspectives and positions taken or not by the actors in particular axes. This mapping explains the positions that contribute to characterizing the existing range of discursive positions and how actors place themselves allowing multiple positions and even contradictions to be articulated (ibid).

In the remainder of this section, I introduce the methodological tools I use over the different types of documents or sources to gather the data analyzed in this dissertation. I make an overview of the methodologies, that I explain in depth in each chapter with the application to the case of Menorca.

2.4. Post-Normal Science (PNS) for governance to address uncertain, complex, and global changes.

The complexity of the interactions between societies and the environment described earlier requires approaches that include diverse types of knowledge, expertise, and decision-making mechanisms.

During the first half of 20th century, modern science emerged as a provider of simplified solutions based on reductive explanations of the complexities of nature (Mitchell, 2009). Policymaking required quantitative information and 'the' scientific method applied to different cases is equipped with tools to simply these problems and provide 'solutions'. However, as it is explained by Mitchell, even though there are *arguments for reductionism* to support the use of science to describe and explain nature, the *traditional notion* of scientific experimentation *can fail to accommodate non-linear, robust, dynamic behaviors* and there is a need to more pragmatic and pluralistic approaches of scientific practices (ibid).

For a long time, science has been organized around a paradigm of the Cartesian dream of prediction and control (Guimarães Pereira & Funtowicz, 2015), that has created the imaginary that science can explain what is 'out there' and offer solutions once the information is decoded. As Kovacic writes (2018):

The use of numbers gives an illusion of certainty and precision that is often at odds with the uncertainty that characterizes many complex and multidimensional policy issues, such as sustainability, poverty alleviation, and the regulation of global finance, to name but a few examples. A flourishing literature denounces a variety of issues associated with excessive faith in numbers (Porter, 1995; Saltelli & Funtowicz, 2014), failures in making predictions about the future (Pilkey & Pilkey-Jarvis, 2007; Savage, 2009; Taleb, 2007), the limited usefulness of idealized mathematical models in dealing with complexity and uncertainty(Chu, 2013; Fine & Milonakis, 2011), and the misuse and misinterpretation of quantitative information in policymaking (Funtowicz & Ravetz, 1990; Reinert, 2009).

Porter (1995) points out that the ideal of objectivity associated with numbers has created the perception that quantitative science can be trusted. Saltelli et al. (2013) argue that the authority of science is associated with the rhetorical use of quantitative information, which is used as Latin

was used in the Middle Ages to confuse rather than to clarify.

The complexity of environmental and social issues described above, emerging especially from the last decades of the 20th century, introduced new challenges in governance. Environmental issues are evolving to incorporate social research methods and also institutional analysis (Corral-Quintana et al., 2016; Guimarães Pereira & Corral Quintana, 2002; Paneque Salgado et al., 2009). These new policy issues, universal in their scale and long-term in their impacts, are characterized by irreducible uncertainty and require quality to become central (Funtowicz & Ravetz, 1993) rather than 'truth' as the concept guiding the scientific analysis to inform decision-making.

Post-Normal Science (PNS) appears as a response of these new challenges to address complexity in the governance of environmental issues where, typically, facts are uncertain, values in dispute, stakes high, and decisions urgent (Ravetz, 1999). As it is pointed out by Mayumi & Giampietro (2006), a typical PNS situation should be based on scientist learning the best way to perceive and represent sustainability issues rather that indicating the right thing to do, and acknowledging that science has limited information and communication systems to transmit this information.

PNS distinguishes between different problem-solving strategies that may be applied depending on the level of uncertainty and systems stakes (Funtowicz & Ravetz, 1993; Giampietro, 2004; Giampietro et al., 2006) represented in Figure. 2.1.

There are problems in the lower spectrum of uncertainty and stakes, that may be suitable to the application of 'normal' science (ANS), based on reductionist model and protocols. In contrast, other issues, in the higher spectrum, that present social and technical incommensurability, require professional consultancy (PC) or PNS approaches, that demand negotiations about how to deal with changes on a systemic level.

I engage with the idea, here, that governance and decision-making are processes that use meaningful information to adapt to changes. In this sense, I understand the decision-making process as a biosemiotic one (Giampietro, 2019b) The decision-making process performed by any system is a communication process based on the existence of an interpretant with purposes, meanings and provisional beliefs to be validated (or discarded) through action (Giampietro & Kovacic, 2019). Even though in a more philosophical dimension the decision-making process for all living systems may end up in the same

point: survival or not, the more complex a system is, the more diversity in outcomes exists, considering different levels and scales of analysis.

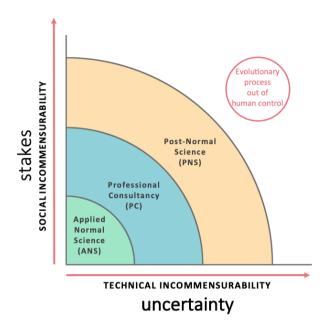


Figure 2.1. The PNS graph.

Adapted from Giampietro et al. 2006.

In a social-ecological system the implementation of this process is complexified by social incommensurability result of the interaction of consciousness, passions, power relations and reflexivity at different levels - individual, collective, regional, national, or international. Moreover, this process includes several stages that are happening simultaneously at different scales and with different impacts associated with a high degree of uncertainty and complexity that are difficult to integrate as they come from non-equivalent descriptive domains (technical incommensurability).

As it is explained before, this combination of complexity and uncertainty poses barriers to a full understanding of how the decision-making process works, and how and why actions and policies are implemented or not. Information, scientific and otherwise, is used during the decision-making process to validate, contrast, deny or reject ideas in a dynamic process affecting different stakeholders depending on circumstances and conditions. Therefore, each decision-making process is crossed by several variables that are hard, if at all possible, to replicate.

Actions in certain systems happen as a result of an entanglement of inputs in different contexts that create new situations and expectations that force the system to anticipate new actions. These actions determine the present, based on past actions driven by *because-motives* (reflections upon already taken decisions), and condition how the system anticipates the future, based on inorder-to-motives that are components of the actions itself (Poli, 2010; Rosen, 1985).

The diversity of motives and actors provides a variety of potential leverage points for adaptation to global changes. These may include individuals' perceptions, values, ideas, and visions to collective actions and policies, considering power asymmetries, and also unexpected events out of human control that can cause sudden paradigm shifts. This potential for adaptation includes a component of the agency-structure debate about the role of individuals that 'construct' the social world, in opposition to the social world, that many consider the 'structure', that 'constructs' the individuals (Sibeon, 1999). This impredicative relation opens the door to several questions: is agency or structure the key factor for systemic change? how does this relation operate? and how does it contribute to the complexity that characterizes decision-making in general, and about sustainability issues, in particular? (Avelino & Rotmans, 2011).

Power emerges as a sensitive factor. The political power is to "make visible and explicit" what is implicit, "to make groups, to manipulate the objective structure of society" (Bourdieu, 1989, p. 23). Power connects to how knowledge about society is developed and communicated (Avelino & Rotmans, 2011), in Foucault words 'power and knowledge directly imply one another' (Foucault, [1977] 1995, p. 27). The boundaries between decision-making and science are also determined by power. The study of the science-policy interface thus benefits from a political ecological perspective to understand how certain 'knowledge' has been evolving and established through time as the "truth" that is to be spoken to power.

The complexity, uncertainty and high stakes described above justify the suggestion of adopting the ideas of PNS to address these issues. In fact, the decision-making process related to the sustainability of social-ecological systems requiring the consideration of multiple perspectives, scales and dimensions poses a great challenge to the process of governance.

In order to address the challenge and operationalize the handling of relevant knowledge claims coming from different disciplines and areas of expertise existing at different levels (to handle technical and social incommensurability present in the information space used in the process of decision making) I adapt a conceptual map proposed to frame and structure the analysis (Figure. 2.2.). This methodological and conceptual frameworks is based on the ideas of PNS and developed in the MAGIC project, short for *Moving Towards Adaptive Governance in Complexity: Informing Nexus Security* (Consortium, 2020; Giampietro, 2019b; Giampietro & Funtowicz, 2020).

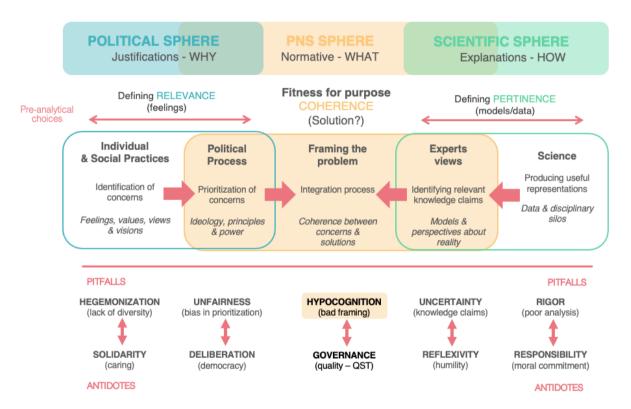


Figure 2.2. presents the relations among the exiting options in the decision-making process. With this map, I want to recognize and represent the existence of different types of narratives that contribute to consider information that justify (why?), explains (how?) or suggest actions (what?) coming from the political sphere and from the scientific sphere (Giampietro & Bukkens, 2022).

Quality is defined within the PNS framework as fitness for purpose. Therefore, in this thesis, the main criterion I use to assess the narratives used in the

Figure 2. 2. Conceptual map. Integration of information, choices and relations involved in the decision-making process about complex problems.

Adapted from Giampietro & Bukkens (2022).

decision-making process is the fitness for purpose. Purpose is defined by the goal of achieving semantic closure over the three different spheres analyzed: WHY, WHAT and HOW, both in the biophysical realm (social metabolism) and in the political process. *Semantic closure*, has been defined by Pattee, as the ability of symbolic controls to impose material constraints on a process in order to achieve a given purpose (Rocha, 2001). Information and descriptions, then, encode the initial conditions for self-organizing processes, creating an interdependence between symbols and material constraints (ibid).

Quantitative storytelling' (QST) (Giampietro & Bukkens, 2022; Saltelli & Giampietro, 2017), represented in the center of Figure 2.2., is an approach that explores the quality of the process and if there is consonance among the narratives that are used to describe the concerns (why) and existing knowledge (how) with the suggested actions and policies (what) (ibid).

The existence of different types of narratives facilitates the understanding of complex issues to simplify messages and be able to deal with them. However, these narratives are selective (and therefore partial) and they always carry out several 'unknows' that are important to consider in/for policy-making.

In the following subsection, I explain how I adapt the spheres that I used to create the PNS building block suggested on Chapter 5.

2.4.1. From spheres to dimensions. Focusing on the quality of the narratives for the problem structuring in decision-making process.

In this subsection, the goal is to present a tool to mobilize the expertise of an extended peer community and focus on the quality of the deliberative process to discuss about desired goals in the system, and assess and prioritize potential leverage points, opportunities, and barriers to achieve these goals, for instance sustainability, considering different scales.

Adapted from the map presented above, Figure 2.2, I integrate the three spheres defined in previous studies, political, scientific, and PNS, into a three-dimensional block, in Figure 2.3. The block represents the continuous exchange of different types of information, representations, and actions that happen in different layers of social-ecological systems and are connected to each other.

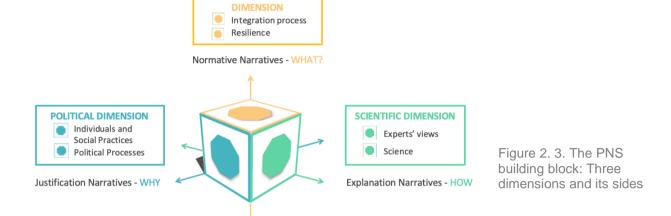


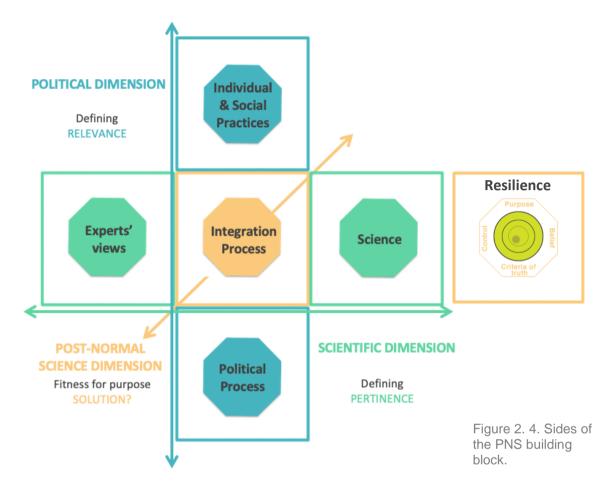
Figure 2.3. shows the integration of the *scientific dimension* -the types of information, data, models, representations, analysis, and conclusions that happen in the scientific-technical sphere-, with the *Political dimension* -the types of individual and social values, feelings, views, visions, concerns, and priorities that happen in the socio-political sphere. Both dimensions converge with a PNS dimension, that focus on the quality of the governance mechanisms to integrate the information about concerns and solutions existing in the system. Figure 2.4. expands this representation to show each side of the block.

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In short, the political dimension contributes to negotiating the relevance of the problems at stake. The scientific dimension refers to the pertinence of the narratives used to understand and explain the defined problems and anticipate the result of performed (or planned) actions. The PNS dimension aims at determining if there is 'fitness for purpose' in the system, that means if there is a correspondence between the problems/concerns identified and framed, and the solutions that are proposed and decided. To what extent do the solutions solve the problems identified?

The PNS dimension, then, is useful to evaluate to what extent the governance processes contribute to check if the coherence between the purpose, beliefs, controls and the existing explanations and criteria to address certain issues in social-ecological systems are coherent. This consistency, represented in the base of the block (see Figure 2.4.), shows if the information used to frame the problems is adequate to offer solutions. The coherence responds to the *semantic closure*, that is if the system will be able to maintain and reproduce its

identity or not, based on the analysis of the narratives used to frame the problem and solutions and implement actions to address them.



It is important to notice that the block represents a social-ecological system, and the structure as a cube allows to conceptualize them as building blocks that can create bigger or smaller systems (super/sub systems) to perform the analysis. The definition of the system, the size of the block, allows to stablish relations and dependencies among other blocks that can be used to represent the Sudoku-effect dependencies among systems (Giampietro & Bukkens, 2015; Renner, 2020).

In Table 2.1. I characterize each side of the block. I summarize the main goals, the focus, and what elements constitute the quality checks, -the pitfall (adapted as vulnerability) and the antidote, in jargon introduced in previous figures adapted from Giampietro & Bukkens (2022). Quality is represented

here as a key check to control each side of the block and to frame the components of the deliberations.

The description of every side of the block introduces a high degree of complexity and diversity of elements to consider. However, this characterization contributes to being aware of what we are including in the deliberation (also to define who is 'we' in each discussion) and what 'we' are leaving 'out of the box' (further detail in the following sections).

In Chapter 5 I explain in detail, and adapt to the case of Menorca, these sides and elements, of each dimension, that are briefly introduced next.

2.4.1.1. Political dimension

The political dimension defines relevance and the justification narratives that exist in societies. Justification narratives answer the question of 'why' something is important and needs to be addressed in a system.

Justification narratives are useful to understand and explain why certain issues are considered problematic, and also why these concerns are prioritized over others. This dimension represents why society is performing certain practices (the final causes² in the Aristotelian view that generate actions) and how they are prioritized.

The characterization of the political dimension in the block focuses on two sides: Individual and social practices, and the Political process (see Table 2.1).

2.4.1.2. Scientific dimension

The scientific dimension focuses on the pertinence and plausibility of the models and data used to offer explanation narratives. Explanation narratives answer the question 'how', how the existing information and scientific evidence explains the mechanism of identified concerns, problems, and solutions; and how is the process that allows to provide these explanations.

The sides of this dimension represent the types of expertise, and science that is used to provide information for decision-making (see Table 2.1.).

²Each of the four causes of Aristotle may be considered as an irreducible explanatory resource, essential to answer an inquiry of "Why?".

- Material cause is the material or "matter" out of which something is constituted.
- Formal cause is the form or "shape" into which the material enters, or the "account of what it is to be".
- Efficient cause is the primary agent or source of change realizing or initiating something which is done.
- Final cause is the sake for which something is done. It addresses: To what end?

These four causes are our explanatory building blocks, from which we can derive many things. Typical examples of using the four causes to explain include "Why a table?" (wood, design, carpenter, dining) and "Why a statue?" (bronze or marble, figure, sculptor, decoration), but we need not limit ourselves to such mundane phenomena. (Renner, 2020, p: 33)

² See Note in the margin

Table 2. 1. Characterization of the sides of the PNS Building block.

Dimension	Political		Post-Normal Science		Scientific	
Side	Individual & so- cial practices	Political pro- cess	Integration process	Resilience	Experts' views	Science
Goals	Identification of concerns	Prioritization of concerns	Framing the problem	'Fitness for purpose'	Identification of relevant knowledge claims	Producing use- ful representa- tions
Focus	Feelings, val- ues, views, vi- sions and be- havior	Ideology, principles and power	Coherence be- tween con- cerns and so- lutions	Pre-analytical choices. As- sessment cri- teria	Models and perspectives about reality	Data and disci- plinarity
Vulnerabilities	Lack of Diver- sity	Bias in priori- tization	Hypocognition	Lack of coher- ence	Uncertainty - Inadequate knowledge claims	Lack of rigor - Poor analysis
Antidote	Care and soli- darity	Democracy - Deliberation	Quantitative Storytelling (QST) - Quality of framings	Iteration	Humility	Responsibility
Quality Check	Degree of di- versity	Degree of fairness	Governance	Adaptation	Reflexivity	Integrity

2.4.1.3. PNS dimension

The focus of the PNS dimension is on the normative narratives. Normative narratives are answering the question 'what', in this case it affects to what are the problems? What are the solutions? And what are the mechanisms to discuss these issues?

This dimension is key to integrate the different types of information inputs and check the coherence, 'fitness for purpose', between the concerns identified, the solutions suggested and the governance process to exchange all this non-equivalent information.

The two sides of this dimension, see Table 2.1., represent the adequacy of the integration process, if the information used is adequate to frame the problems, and, at the base of the block, an equilibrium platform that represents to what extent the epistemic perspective about the problems discussed, the criteria developed, and the governance structures address the existing threats to the maintenance of the system.

The application to Menorca, presented in Chapter 5, is an illustration of how the integration could be done, based on the analysis of the metabolic information (Chapter 3), and the political situation (Chapter 4). Due to the time limitations, I haven't been able to complete parts of the analysis that I would find relevant and pertinent for this discussion, but probably this is also a lesson to learn. Nonetheless, this dissertation offers an attempt to integrate these narratives and see if the policymaking in the system is 'fit' for achieving sustainability.

Chapter 3.

The Scientific dimension

Isolated yet open. A metabolic analysis of Menorca

3. Isolated yet open: A metabolic analysis of Menorca

3.1. Chapter overview

Self-Sufficiency

DEPENDENCE

DEGREE of IMPORT

CONCERNS

between sustainability concern.

This chapter focuses on the Mediterranean island of Menorca (Balearic Islands, Spain) and illustrates how an analysis of the sustainability of societal metabolic patterns can be implemented using the Multi-Scale Integrated Analysis of Societal and Ecosystem Metabolism (MuSIASEM) approach. The MuSIASEM approach allows integrating information across dimensions and scales in order to inform deliberation about the adaptability and sustainability of small islands to global challenges, rather than closing the debate by focusing on only one scale or dimension at the time. An overview of the analysis carried out by the MuSIASEM approach is illustrated in Figure 3. 1.

Chapter 3 reproduces parts of:

Marcos-Valls et al.. (2020)

Marcos-Valls, A., Kovacic, Z., Giampietro, M., Kallis. G.. Rieradevall, (2020). Isolated yet open: A metabolic analysis of Menorca. Science of the Total Environment. 738. 139221. https://doi.org/10.10

Self-Sufficiency

GOVERNMENTS SOCIETY at LARGE

Self-Sufficiency

RISK for SOCIETY

16/j.scitotenv.2020.1 Labor, Technology, Electricity, Fuels 39221 **EXTERNALIZED ENVIRONMENTAL PRESSURES** Land (\rightarrow loss of habitat), Green water, Blue water, Fertilizers, Soil, Pesticides, GHG emissions **IMPORTS Performance** Relevant **Indicators** Stakeholders Dietary intake Dietary intake SUPPLY of ANIMAL and CONSUMERS LOCAL USE OF PRODUCTION FACTORS PLAN PRODUCTS Labor, Technology, Electricity, Fuels **Economic Viability** Economic Viability TOURISTS PRIMARY PRIMARY PRICES and COSTS LOCAL ENVIRONMENTAL PRESSURES **ECONOMIC AGENTS** SOURCES SINKS Land (→ loss of habitat), Green water, **Environmental Security Environmental Security** Blue water, Fertilizers, Soil, Pesticides, **ENVIRNOMENTAL** GOVERNMENTS **GHG** emissions **PRESSURES TOURISTS** SOCIETY at LARGE

LOCAL ECOSYSTEM

EXTERNALIZED USE OF PRODUCTION FACTORS

Figure 3. 1. How the analytical toolkit can generate a set of indicators studying the entanglement

HEALTH of PEOPLE HEALTH of ECONOMY

Economic Viability

Environmental Security

HEALTH of ECOSYSTEMS

This overview provides the semantic picture of how the approach can establish an effective integration over a selected set of concerns, and indicators. A more detailed analysis of the conceptual and practical details on how to establish a set of quantitative relations using the proposed approach is available in Cadillo-Benalcazar, Giampietro, et al., 2020; Cadillo-Benalcazar, Renner, et al., 2020; Di Felice et al., 2019; Giampietro, 2018; Renner et al., 2020; Serrano-Tovar et al., 2019.

The application of the MuSIASEM accounting framework responds to different stages that I introduce in the next Table 3. 1 and explain in the following subsections. The stages and the requirements of each stage are described in detail in Appendix A.

Stages of MuSIASEM

T able 3. 1. Stages of MuSIASEM

A. Definition of the system

- Constituent components defining the system
- Hierarchical organization of the relations over functional and structural elements (sectors and subsectors) across levels
- Definition of the metabolic characteristics (flow/fund ratios) needed to maintain and reproduce the elements

B. Data gathering

- Top-down approach
- Bottom-up approach

2. DIAGNOSIS

1. DEFINITION

- C. Characterization of the system (Tools)
- Level of Openness (O)
- End-Use Matrix (EUM)
- Environmental Pressure Matrix (EPM).
- Impact Matrix (IM)

D. Scenario development

3. ANTICIPATION

- Explore the feasibility, viability and desirability of alternative "state-pressure-openness" combinations (starting from the assessment done in stage C) to test the sustainability of different scenarios with the available information
- Explore the possibility of changing the relation between state, pressures and impacts associated with changes in both social practices or technology

3.2. The stages of MuSIASEM applied to Menorca. Methodology

The following subsections describe the application of MuSIASEM to the case of Menorca including the pre-analytical choices, the data used in the analysis (Table 3. 2) and some limitations.

3.2.1. Stage 1: Definition

A. Definition of the system

Pre-analytical definition of Menorca as a system

The first step consists in defining the size of the constituent components and selecting the metabolic characteristics to analyze. In this study, we analyze Human Activity (HA) and Land Use (LU) as constituent components. The size of the fund Human Activity is measured in hours per year, and include the hours of activity of residents, tourists, seasonal residents (workers and second-residence owners), and when considering the fund Land Uses (LU) and Non-Managed Land (NML) is measured in hectares per year. Both categories, represented in Figure 3. 2, are used to measure the size of the functional and the structural elements of the system defined across different hierarchical levels of organization (defined below).

The size of the funds (i.e. quantity of hours and quantity of hectares) can be multiplied by the specific flow-fund ratio (i.e. energy per hours of human activity or energy per hectare) to obtain the relative quantity of metabolized flows (i.e. the total flow of energy metabolized by land or humans) to assess consumption of resources or generation of waste and/or emissions).

Data about land uses for this study has been extracted from the latest digital cartography of land uses in Menorca (OBSAM, 2018a) linking land cover with the main use, if more than one use can be attributed. The data about the total human activity, expressed in hours, has been calculated by summing: (i) the activity of the permanent residents; and (ii) the activity of the temporary residents (seasonal workers, seasonal residents, tourists). Both data have been the result of multiplying the average human pressure of 2015 and the monthly minimum human pressure times 365 days per year times 24 hours per day (OBSAM, 2016)). The data about paid work is based on the official statistical database on contracts registered on each sector (IBESTAT, 2017). The calculation considers all contracts as full-time contracts, 40 hours of work per 48 weeks per year (four weeks of holiday). This calculation overestimates the number of hours worked because some contracts are part-time, others seasonal, and there are sick leaves that we do not take into account. On the other

hand, it is reasonable to expect a certain amount of informal work also not taken into account (Iglesias-Pérez et al., 2018), particularly common in islands like Menorca with a sizeable tourist industry.

Hierarchical organization

The second step is to define the hierarchical organization between structural and functional elements in Menorca. The sum of both fund elements and flows at lower levels of analysis has to add up to the total of the higher level – see Figure 3. 2.

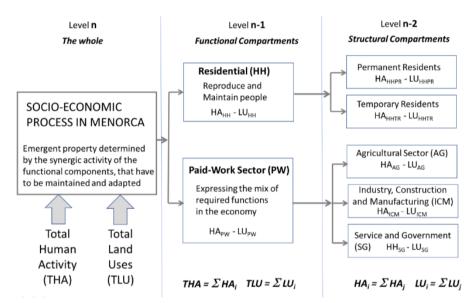


Figure 3. 2. Hierarchical organization of the levels in the system

Level n identifies the set of functional compartments to which we allocate the total amount of the funds of human activity (HA) and land uses (LU). At level n-1, we split the total between (i) household activities (HH) that include activities, such as sleeping, eating, hygiene, leisure time, etc., contributing to human maintenance and reproduction; and (ii) activities in the Paid Work sector (PW), that is work in industry, services or agriculture, where human activity, secondary flows and other fund elements (land use, technology infrastructures) are used to generate (and also consume) goods and services within the market. Level n-2 corresponds to functional elements whose characteristics depend on the mix of time and land uses found in their structural elements. Within the residential sector, we may distinguish between the activity and land-use of permanent residents (PR) and temporary residents (TR), the latter including seasonal or temporary workers, tourists, and people with a second residence in Menorca. Within the paid work compartment (PW), we define the three economic sectors: agricultural sector (AG), including agriculture and

livestock; industrial sector (ICM), including industry, construction and manufacturing; and the services sector (SG), including services and government activities/public sector (and in our case transport).

The categories defined in Figure 3. 2. refer only to funds related to socio-economic processes in Menorca. However, as we noted there are ecological funds (e.g. aquifers, soils, terrestrial and marine ecosystems) whose activities of self-organization are outside human control, that provide services and therefore have to be considered. The analysis of these funds is important to assess environmental impact. They allow studying how much is too much when coming to the extraction of inputs from ecological funds and the dumping of wastes or emissions. In this study, the size of ecological structural and functional components is mapped in terms of the land fund type "non-managed land" (NML). This category includes all type of land-covers that provide contributions that people in Menorca may use, such as beaches, forests, rivers, rocky areas, etc. but whose characteristics do not depend directly on human intervention (even though they may be affected by it). The activity of these ecological funds may have a significant effect on the quality of life of the people on the island or may affect economic sectors, such as tourism.

Transportation is another functional sector that needs to be properly defined looking at its structural elements. As functional compartment, it includes human activity belonging both to the household sector (the use of private cars) and paid work (in the public transportation sector in services sector and in other economic activities in paid work). In this study, given the characteristics of Menorca, in first approximation all the activities referring to transportation have been allocated to the services sector.

B. Data gathering

MuSIASEM allows for the combination of top-down and bottom-up strategies to gather data. Top-down strategies use statistical data to characterize the metabolic characteristics of the components of the system, for instance, total blue water accounted for agricultural land in Menorca divided by the hours of human activity provides a benchmark about the metabolic rate of blue water per hour of human activity. Bottom-up strategies use benchmarks for specific structural or functional elements that can be "scaled up" to explain the metabolic characteristics of the components. For instance, if we know the requirement of water of different crops, and the number of hectares of each crop, one can estimate the total amount of blue water used in the agriculture sector in Menorca in a certain period. The combination of top-down and bottom-up information applied to a set of forced relations of congruence of metabolic

characteristics, generates mutual information: the same phenomenon experienced in crossword puzzles or the mathematical game "sudoku" (Giampietro & Bukkens, 2015). This phenomenon allows to double check and verify the coherence, errors, and inconsistencies in the data, or find unexpected information. Even more important is the possibility of anticipating changes when using these relations in an "anticipation mode" – "what if" the size of the human activity changes? - e.g. more tourists, more temporary residents; or "what if" the existing social practices change? Extensive variables – the size of human activity – can affect intensive variables/benchmarks (more human activity means less land available per capita). Intensive variables/benchmarks (less consumption of gasoline per tourists) can affect extensive variables (the total amount of gasoline imported by Menorca).

3.2.2. Stage 2: Diagnosis

C. Characterization of the system

The third step is to define the metabolic characteristics to analyze in Menorca: flows, use of these flows in relation to funds, represented in the End-Use Matrix (EUM) for resource use and in the Environmental Pressure Matrix (EPM) for emissions or wastes.

In the present study the analysis of end-uses focuses on: (i) two fund elements - hours of human activity and hectares of land uses; and (ii) on four flows of elements - MJ of electricity, MJ of thermal energy of fuels, MJ of process heat, and cubic meters of blue water. In order to establish a bridge with economic variables we added to the end use matrix also the accounting of flows of gross value added of economic sectors (EUROSTAT, 2018).

In relation to the environmental pressure matrix, we use a simplified assessment based on the direct emissions of CO_2 associated to final consumption of the energy system in Menorca, with the purpose of testing the methodology. In the future, we plan to carry out a more detailed assessment related to other types of environmental pressure (e.g. Nitrogen-Phosphorus leakages in the water table, pesticides residues, emission of particulate in the air, pollutants from industrial processes).

Calculations consider a one-year period, taking 2015 as a reference (or closest year with available data for all funds and flows considered). Data for blue water were obtained by comparing top-down data on the total consumption of water (DGRH, 2017) with bottom-up information. For the agricultural sector, we estimated the water extracted and used for crop types and cattle (OBSAM, 2008) updating the information to 2015. For services sector and households,

we used the average water per capita per day for household activities in Spain (Eurostat, 2017) to estimate the amount of water on households with top-down information, and the difference with urban water is assigned to services sector. This study focuses only on "blue water" (water extracted and controlled by humans), it does not considered "green water" – i.e. water available in the soil coming from rain or condensation (Falkenmark & Rockström, 2006; Mekonnen & Hoekstra, 2010). This preliminary study adopts a generic definition of "blue water" due to limited data availability, even though this category can result too generic for informing policy (Madrid-Lopez & Giampietro, 2014)

Table 3. 2 contains a brief definition and source of the data used to characterize the End-Use and Environmental Pressure Matrix (EUM and EPM) of the system: constituent components, extensive variables, and intensive variables, and presented in the following section.

Table 3. 2. Extensive and intensive variables considered on the End Use Matrix (EUM) and sources.

	Abbı	reviation	Source							
	Constituent Components									
	НА	Human Activ- ity	tiv- Time, in hours (h), devoted to each level of analysis (OBSA (IBEST							
	LU	Land uses	Area, in hectares (ha), devoted to each level of analysis	(OBSAM, 2018a)						
	Flow	'S								
S	GV A	Gross Value Added	Value, in millions of euros (M \in), of goods and services produced in each level of analysis	(EUROSTAT, 2018)						
Extensive variables	ETi	Energy Throughput	Amount of every type of energy, i, used in each level of analysis (kWh for electricity and MJ for thermal energy and liquid fuels).	•						
Extens			Types of energy considered (i): electricity (E), (ii) fossil fuels used as Fuel (F) and fossil fuels used for Heating (H).							
	CEi	Carbon Emissions	Amount of CO_2 emissions for type of energy, i, used in each level of analysis (t).	(DEM et al., 2018)						
			Types of energy considered (i): electricity (E), fossil fuels used as Fuel (F) and fossil fuels used for Heating (H).							
	WT	Water Throughput	Amount of blue water used in each level of analysis (m ³).	(DGRH, 2017) (OBSAM, 2008) (Eurostat, 2017)						
	Meta	abolic Relations								
	MR	Metabolic Rate	Flow/HA: Amount of flow (ETi or WT) per unit of human action to each level of analysis (unit/h).	ivity (HA) devoted						
Intensive variables	MD	Metabolic Density	Flow/LU: Amount of flow (ETi or WT) per unit of land use each level of analysis (unit/ha).	e (LU) devoted to						
ısive ı	Prod	uctivity Relatio	ns							
Inte	JP	Job Productivity	GVA/HA: Gross value added per hours of human activity in our ysis (€/h)	each level of anal-						
	LU P	Land Use Productivity	GVA/LU: Gross value added per hectare of land use in each (ϵ /ha)	h level of analysis						

3.3. Results

This section presents and discusses the diagnostic results of the metabolism of Menorca applying MuSIASEM. In the tables, the columns, in grey scale, show the hierarchy of levels of analysis n, n-1 and n-2. The colored patterns in level n-2 indicate the higher (dark color) and lower values (light color). Note that the rounding of significant digits might modify the sum among columns in some cases.

3.3.1. Constituent components

Table 3. 3 shows the available information about human activity (HA) and land uses (LU) of Menorca during a year period. This information is the reference to calculate the metabolic and economic relations in Tables 3. 4 to 3. 7, represented in Figures 3.3 and 3. 4.

Data about human activity (HA), Table 3. 3, shows that around 95% of the total hours in Menorca are devoted to non-paid activities categorized as households (HH), and just 5% is dedicated to paid work (PW) activities. PW hours are usually low, note that we count as paid work only 1/3 (8 hours) of the daily time of the registered working part of the population. However, the 5% of paid work in Menorca is especially low compared to the 12% of Barcelona (Pérez-Sánchez et al., 2019), the 10% in Catalonia (D'Alisa & Cattaneo, 2013; Giampietro et al., 2013) or the average 7% in the European Union (EU27 + Norway) (Velasco-Fernández 2017, p:145). This value indicates that a larger share of the population is economically inactive, most likely due to seasonality of tourism and the temporary pattern of residents in the island, and this has implications to understand the metabolism and how and why resources are used in Menorca. The low proportion of PW time indicates that this metabolic system is highly dependent on imports and externalization of productive activities. The distribution of working time also reflects the influence of tourism and services. The services sector (SG) accounts for 76% of the working hours, 11% higher than in the case of Catalonia (Giampietro et al., 2013), but similar to the 81% of Barcelona (Pérez-Sánchez et al., 2019) showing the influence of tourism. The metabolic system of Menorca is typical of a tourism-driven system.

Table 3. 3 also displays information about **land uses (LU).** From the total land area of Menorca, 3% is devoted to urban and residential areas, that is HH activities, and this figure includes rural and disperse settlements. Economic activities, PW, use almost 44% of the land, most of which goes to agriculture, the 88%, 10% to services and less than 2% to industry. Non-managed land (NML)

accounts for more than 53% of the land in the island. Compared to data about Spain 2018 (IGN-CNIG & AEMA, 2019) residential activities (HH) use 1% of the land, one third less than Menorca. Economic activities and non-managed land account for a similar share, 47% (PW) and 52% (NML), but agriculture uses more than 97% of the land in Spain while in Menorca drops to 88% increasing the percentage devoted to services in the island due to the importance of tourism. Once again, the metabolic pattern shows a system that is geared towards tourism and is less land-intensive than other metabolic system

Table 3. 3. Characterization of the constituent components of Menorca at different levels of analysis.

(OBSAM, 2016), (OBSAM 2016a) and (OBSAM, 2018).

Levels of analysis

		n	Menorca (whole system)							
			n-1 I	n-1 Household		n-1	Paid W	ork		n-1
				n-2				n-2		Non- Man- aged Land
CONSTITUENT COMPONENTS			нн	PR ^c	TR ^d	PW	AG ^e	ICM ^f	SG ^g	NML
Human Activ-	HA (Mh ^a)	974	919	753	165	56	1	12	42	
Land Uses	LU (hab)	69.480	1.920			30.380	26.900	540	2.940	37.180

^a Mh: Millions of hours, ^b ha: hectares, ^c PR: Permanent Residents, ^d TR: Temporary Residents, ^e AG: Agriculture, ^f ICM: Industry, Construction and Manufacturing, ^g SG: Service and Government

3.3.2. Economic Variables

Table 3. 4 presents economic data relative to paid work activities in the island. In absolute terms, the services sector (SG) accounts for the higher share of the gross value added (GVA) of Menorca, 78%, dominated by tourism activities, followed by industry (ICM), 21%, and 1% in the case of agriculture (AG). These values follow a similar pattern compared to Spanish data where services and government include the main economic activities, 74% of the value added, followed by industry, 23%, and agriculture, 3% (Eurostat, 2019).

In terms of economic productivity, results show different trends. Regarding Economic Job Productivity (EJP), there is a balance between the euros generated per hour of work in the industrial sector and in the services and

government, with agriculture doing much worse, being almost one-third of the value added compared to industry and services sector. In terms of land use, the economic land use productivity, ELUP, shows that the industrial sector produces more than 1100 times more euros per hectare of land than agriculture and almost 150% more than services. As we will see, this productivity is the result of a high reliance on fossil fuels, with the consequent dependence on external resources. These results indicate that Menorca is metabolically an open system, whose economic activities are not defined by the physical boundaries of the island.

Table 3. 4. Gross Value Added for the different economic activities in Menorca and economic productivity per unit of hour of labour, EJP, and per unit of area devoted to each sector, ELUP.

(EUROSTAT, 2018)

Level of analysis

	n	Menorca (whole system)						
			n-1	n-1				
						n-2		
ECONOMIC VARIABLES			HH ^d	PW ^e	AG ^f	ICM ^g	SG ^h	
Gross Value Added	GVA (Mۻ)	1.590		1.590	15	340	1.230	
Economic Job Productivity	EJP (€/h ^b)	1,6		28,6	10,4	28,2	29,4	
Economic Land Use Productivity	ELUP (€/ha ^c)	22.880		52.320	560	628.560	419.760	

^a M€: Millions of euros, ^bh: hours, ^cha: hectares, ^d HH: Households, ^e PW: Paid Work, ^f AG: Agriculture, ^g ICM: Industry, Construction and Manufacturing, ^h SG: Service and Government

3.3.3. End-Use Matrix for energy and water

Tables 3. 5 and 3. 6 presents the values of total energy and water throughput used in Menorca in different levels of analysis and also the metabolic relations of how much resource is used for each hour and hectare dedicated to each activity.

3.3.3.1. Profile of energy types used in Menorca and metabolic relations

The analysis of the total energy throughput (TET) at the level of the whole island, n, considering equivalent thermal units for the three energy types: electricity (E), fuels for heating (H), and fossil fuels (F), show a predominant use of electricity, 50% - measured in its Gross Energy Requirement Thermal (GERT),

and fuels, 47%. The use of fuel for thermal energy, categorized as heat, is 3% of the total (Table 3. 5).

At lower levels of analysis, *n-1* and *n-2*, services (SG) use 68% of the total energy followed by residences (HH) 26%. The remaining 4% and 2% belong to industry (ICM) and agriculture (AG), respectively. The analysis of the different energy types for households (HH) and paid work (PW) reflect the dominance of electricity for households (in GERT), with 88% of the total; while paid work is dominated by fuels, 61%, followed by electricity (in GERT) with 37%.

The higher energy metabolic rates, EMR, in Menorca are those of agriculture and services. These two economic sectors not only use more energy per hour of work, but also more than 90% of the energy used in Menorca per year (remember that transportation is included in services). The lower intensity in the use of energy, 9%, is for industry, possibly connected with the fact that the industrial sector in Menorca includes very labor-intensive manufacturing such as small-scale agroindustry, footwear, or jewellery.

This result presents an anomaly compared to other metabolic studies using MuSIASEM where industry presents higher values and agriculture lower values. It could be worth studying what is the influence of non-registered, informal work on agriculture to see if the EMR of agriculture is overestimated for this reason.

The comparison of energy metabolic density profiles, EMD, for each economic sector shows that services are more than three times more intense in the use of energy per hectare than industry, and more than 240 times more than agriculture. This is probably because services include transportation and because agriculture requires a lot of land and, while having the lowest total energy throughput. The high share of energy consumption by the transport sector is due to the high dependence on imports, and contribute to defining Menorca as an open metabolic system, whose metabolic rates are determined partially by the activities carried out within the system and partially by the externalization of its economic activities and metabolic requirements.

Table 3. 5. End-Use Matrix of energy uses in Menorca. (DEM et al., 2018)

Level of analysis

			/							
			n	Menorca (whole system)						
				n-1	n-1					
							n-2			
				HHe	PW ^f	AG ^g	ICM ^h	SG ⁱ		
ENERGY THRO	UGHPUT (ET)									
	Electricity (mechanic)	E (MWh ^a)	440.600	198.270	242.330	7.690	24.270	210.370		
Electricity	Thermal equivalent –	CED (CIP)	4.424.020	4 055 000	2 260 240	72.000	227.440	1.000.070		
	Gross Energy Requirement	GER (GJ ^b)	4.124.020	1.855.800	2.268.210	72.000	227.140	1.969.070		
Heat		H (GJ)	271.320	125.740	145.580	20	42.670	102.890		
Fuel		F (GJ)	3.809.700	121.580	3.688.120	138.800	69.480	3.479.840		
TOTAL ET	(in thermal equivalent)	TET (GJ)	8.205.040	2.103.130	6.101.910	210.820	339.290	5.551.800		
Electricity	Electricity (mechanic)	E (KWh ^a /h ^c)	0,5	0,2	4,4	5,4	2,0	5,0		
	Thermal equivalent –	GER (MJb/h)	4,2	2,0	40,8	50,1	18,8	46,9		
	Gross Energy Requirement	OLK (IVIJ /II)	4,2	2,0	40,8	30,1	10,0	40,9		
Heat		H (MJ/h)	0,3	0,1	2,6	0,02	3,5	2,5		
Fuel		F (MJ/h)	4,0	0,1	66,4	96,7	5,8	82,9		
Total EMR	(in thermal equivalent)	TEMR (MJ/h)	8,4	2,3	109,9	146,8	28,0	132,2		
Energy Metabo	olic Density (EMD)									
Electricity	Electricity (mechanic)	E (MWh ^a /ha ^d)	6,3	103,4	8,0	0,3	44,7	71,6		
	Thermal equivalent –	GER (MJ/ha)	59.360	967.730	74.660	2.680	418.560	670.190		
	Gross Energy Requirement	OLIV (IVIS/IIIA)	33.300	307.730	74.000	2.000	410.500	070.130		
Heat		H (MJ/ha)	3.900	65.570	4.790	0,8	78.630	35.020		
Fuel		F (MJ/ha)	54.830	63.400	121.400	5.160	128.030	1.184.390		
Total EMD	(in thermal equivalent)	TEMD (MJ/ha)	118.090	1.096.700	200.850	7.840	625.220	1.889.600		

^aM/kWh: Mega/kilowatts hour, ^bG/MJ: Giga/Megajoules, ^ch: hours, ^dha: hectares, ^eHH: Households, ^fPW: Paid Work, ^gAG: Agriculture, ^h ICM: Industry, Construction and Manufacturing, ¹SG: Service and Government.

3.3.3.2. Profile of water used in Menorca and metabolic relations

The distribution of the water throughput (WT) used in Menorca at level n-1 shows that economic activities (PW) take 77% of the total, while residential activities (HH) use 23%. Within the economic activities, level n-2, agriculture represents 45% of the water, followed by services, 27%, and industry, with 5% (Table 3. 6). A similar study on Catalonia shows a different profile where agriculture accounts for the 70% of the total while household uses are marginal (Madrid et al., 2013).

The distribution of the percentages of water withdrawal for urban (including household and services), agricultural, and industrial uses is diverse across countries according to data from AQUASTAT (FAO, 2019). The profile for Spain, for instance, is 14%, 67%, and 19%, with agriculture having the main use, similar to Catalonia, while the profile of Germany is 78%, 2%, and 20%, clearly dominated by urban uses (ibid). In Menorca, the amount of water used in households accounts for almost a quarter of the total, and goes up to 50% if we include activities in services sector that use urban water. Agriculture has an important share, 45%, but the pressure on water for urban uses is high, influenced by seasonality, including temporary residents and touristic activities. The pattern of water use shows also in this case that the metabolic system is dominated by tourism.

Households are very intense in the use of water per hectare (WMD), 3.030 m³/ha, but very low if we study the amount of water per unit of time (WMR), 0,006 m³/h. This is because household activities include most of the total time used in Menorca, 95% of the hours, and are concentrated in the territory, occupying just 3% of the land. On the contrary, agriculture is highly intensive in the use of water per hour of work (WMR), using almost 8 m³/h, but is the lowest when it comes in the use per hectare (WMD), with 420 m³/ha. This is not surprising since agriculture is the higher water user but also spreads over the land and it requires low human activity when machinery is performing most of the tasks.

Services and industry behave similarly to households in the analysis of the metabolic rates compared to agriculture because they require much less water per each hour of work, 0,16 m³/h and 0,10 m³/h. However, these values are more than 10 times higher than households' values indicating that activities with high value added are more intense water users per hour than residential activities.

Comparing the three economic sectors (level *n-2*), industry is the most intense. Industry consumes more than two times more water for each hectare than services, and more than three times that of agriculture. Even though in absolute terms industry has the lower water consumption, an increase of the land devoted to industry without additional changes will increase the use of water in Menorca

Level of analysis

		n	Menor					
			n-1	n-:	1			
							n-2	
			HH ^d	PV	V ^e	AG ^f	ICM g	SG ^h
WATER THROUGHPUT (WT)							
Water Throughput	WT (Mm³ a)	26,6	5,8	19),2	11,2	1,2	6,8
Water Metabolic Rate	WMR (m³/h ^b)	0,03	0,01	0,3	35	7,79	0,10	0,16
Water Metabolic Density	WMD (m³/ha ^c)	380	3.030	63	80	420	2.29	2.310

Table 3. 6. End-Use Matrix of water use in Menorca (DGRH, 2017) and (OBSAM, 2008)

3.3.4. Environmental Pressure Matrix (EPM). Emissions of CO₂

Table 3. 7 illustrates the environmental pressure connected to the energy flows in Menorca. In this study, the environmental pressure matrix represents what the emissions of CO_2 connected to what the final uses of energy in Menorca are. It is a local EPM that does not assess the emissions that are externalized through imports (associated with the production and transport of the imported commodities and the generation of the added value spent by the tourists in the island).

^a Mm³: Mega cubic meters, ^b h: hours, ^c ha: hectares, ^d HH: Households, ^e PW: Paid Work, ^f AG: Agriculture, ^g ICM: Industry, Construction and Manufacturing, ^h SG: Service and Government

The analysis considering level n, the whole island, and energy types shows that most of the emissions come from the use of electricity (E), 56%, and fuels (F), 42%, and the 2% left for heat (H). At the lower levels, n-1 and n-2, present services sector as the higher net contributor to CO₂ emissions, with 66% of the total, followed by households with 27%, and industry and agriculture with 4% and 3%. A deeper analysis of the services sector reveals that the energy types associated with more emissions are fuels, with 58% mainly due to transportation, and electricity, with 40%. In the case of households, 92% of the emissions are due to the use of electricity, which is the third source of emissions after fuel and electricity in the services sector. The environmental pressure matrix is thus dominated by the high dependence on transport for imports of both primary and processed goods. This analysis is also indicative of a trade-off between local environmental pressure (generated by agriculture and industry) and the externalization of environmental pressure elsewhere (which then reguires transportation of outsourced production).

In this preliminary study we did not calculate other types of environmental pressures to be related to potential ecological impact, because this analysis requires the geo-localization of the various environmental pressures considered. A more detailed analysis will be done in the second iteration of this study to check the scenarios associated with the chosen policy alternatives to be considered.

Level of analysis

		n	Menorca ((whole system)					
			n-1		n-1				
						n-2			
			HH c		PW ^d	AG ^e	ICM ^f	SG ^g	
CARBON EMISSIONS (CE)									
CE ^a for Electricity	CEE (t ^b)	369.670	166.420		203.250	6.460	20.370	176.420	
CE for Heat	CEH (t)	15.140	6.190		8.950	0	2.470	6.490	
CE for Fuel	CEF (t)	278.120	9.020		269.100	10.290	5.150	253.650	
Total CE	TCE	662.930	181.630		481.300	16.750	27.990	436.560	

^a CE: Carbon Emissions, ^bt: tones, ^cHH: Households, ^dPW: Paid Work, ^eAG: Agriculture, ^f ICM: Industry, Construction and Manufacturing, ^g SG: Service and Government

Table 3.7. Environmental Pressure Matrix for emissions of CO₂ linked to energy use inside Menorca

(DEM et al., 2018)

3.3.5. Economic productivity in relation to energy and water use, and CO2 emissions

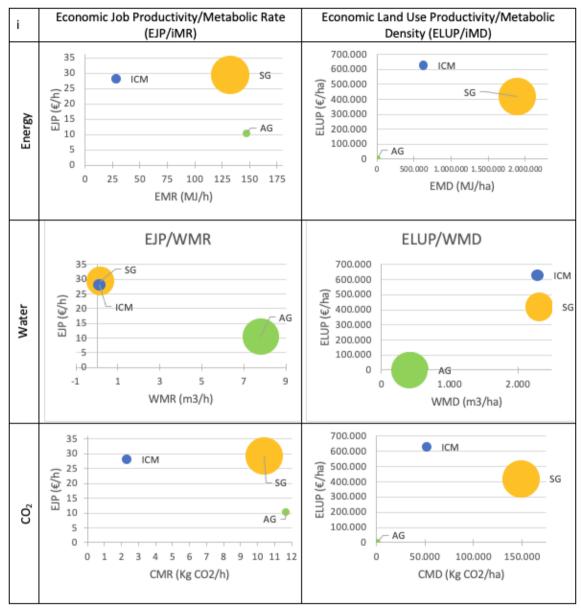
Figure 3. 3 summarizes the relations between how much value added each economic sector generates per hour, Economic Job Productivity (EJP), or per hectare, Economic Land Use Productivity (ELUP), in the columns, and how much energy, water, and emissions, in the rows, are needed or produced in the same hour or hectare, iMR or iMD. The three economic sectors, agriculture (AG), industry (ICM), and services (SG) are represented in colored bubbles showing proportionally the weight of their use of resources and total emissions (the bigger bubble represents the higher energy use, the higher water use, and the higher emissions).

The analysis of the **vector of energy end-uses per unit of time** shows that industry presents the best situation when it comes to the creation of value added per use of energy in contrast with services and agriculture. While services provide high value added with high-energy use, agriculture contributes less to value added with a high-energy intensity per hour. Industry creates value added with lower use of energy while services and agriculture are more intense in the use of energy, in the case of the services sector mainly due to transportation, which makes these two economic sectors potentially more vulnerable to rising prices of fossil fuels and or changes in the energy sector. Given the dependence of Menorca on imports, vulnerability to fluctuations in oil prices translates into vulnerability to the sustainability and resilience of the metabolic pattern of the island as a whole.

The analysis **per unit of land use** shows a similar scenario. Industry provides the higher value added per hectare, followed by services and both far from agriculture, which has low value added per hectare but also low energy use. At the same time, the services sector presents the highest use of resources per hectare being also the sector with more total emissions, in part due to transportation. In the case of industry, the high value of energy use per hectare is due to the high spatial concentration of industry.

The analysis of water gives a different picture. There is a considerable difference between the generation of economic resources and the consumption of local endogenous resources such as water per unit of time, between industry and services, and agriculture. Agriculture requires a quantity of water more than 100 times higher for a value added almost three times lower. The value added per cubic meter of water used for agriculture is 1.34 euros, while it rises to more than 275 €/m3 in industry and nearly 180 €/ m3 in services. This contrast shows that the externalization of economic activities brings considerable

economic advantages, pointing to a potential trade-off between environmental and economic sustainability.



€: euro, h: hour, ha: hectare, MJ: Mega joule, m³: cubic meter, kg: kilogram, AG: Agriculture, ICM: Industry, Construction and Manufacturing, SG: Service and Government.

Figure 3. 3. Economic Job Productivity (EJP) and Economic Land Use Productivity (ELUP). EJP (left column) and ELUP (right column) in relation to use of energy (first row), water (middle row) and emissions of CO₂ associated to energy use (lower row) in Menorca per hour and hectare.

The analysis of the metabolic densities, MD, shows a different situation. Industry and services present higher use of water per each hectare, more than five times the use in agriculture, but they also generate the highest value added far from what agriculture generates directly.

The situation regarding the **emissions of CO₂** is the same as the one described for the vector of energy. Industry generates fewer emissions per each euro compared to services and agriculture, and these two sectors are big emitters per each hour of activity even though services provides higher value added compared to agriculture. Comparing the hectares devoted to each activity, industry has less intensity of emissions and produces more value added per hectare compared to services, while agriculture has lower emissions intensity than industry and services, but also produces marginal direct economic benefit per each hectare.

3.3.6. Performance of economic sectors in Menorca

The metabolic performance complements the idea of eco-efficiency (Ehrenfeld, 2005) adding relevant information such as the dependency on local resources needed to perform an economic activity that are often not included in the analysis, due to lack of data or appropriate level of disaggregation. Figure 3.4 compares the resource requirement (energy, water, and land), emissions of CO₂ and value added of each sector i) to generate one euro of value added (upper row), ii) for each square meter that is devoted to each sector (middle row), and iii) for an hour of human activity in each economic sector (lower row). The representation takes the higher value of each row as a reference and the others are proportional to it.

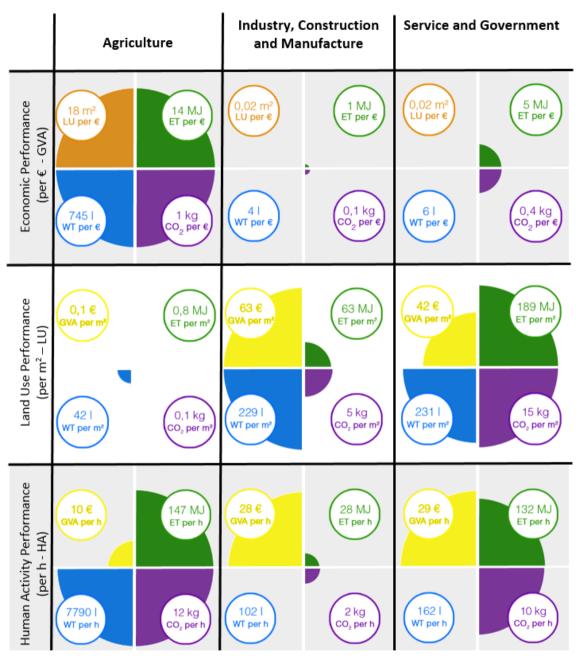
While agriculture has a large dependency on local resources to generate wealth, the first row of Figure 3.4, industry and services present a greater outsourcing of the use of resources, reducing the environmental pressures on the island and externalizing part of the impact to create wealth associated with both sectors. The combination of metabolic rates with the analysis of openness shows that "efficiency" may not improve the sustainability of a system, but merely shift unsustainable and resource-intensive activities elsewhere.

The analysis of the spatial dimension in the use of resources and the generation of wealth and emissions, represented in the middle row of Figure 3.4, shows the opposite situation. Industry has a much higher density in the use of water compared to both services and agriculture, and the services sector has a higher density of energy use. When promoting the expansion of services and industry because of their higher economic productivity, it is important to take

into consideration the higher resource use per unit of land they entail, and what are the trade-offs related to promote one sector over others. The higher economic productivity per square meter of industry and services implies a more intense use of resources and therefore an expansion of both sectors, without other changes, will increase the total energy and water throughputs and emissions. Moreover, the inclusion of the transport sector in services complicates the analysis of the performance of these two sectors as separated. In fact, all the material processed and produced by the industry has to be transported by services and this fact will imply a synergy in terms of increase of consumptions and emissions.

The third row summarizes the values presented in previous sections in relation to the total use of energy and water, CO₂ emissions and euros of gross value added per hour of human activity dedicated to each economic sector. In this case, industry and services provide more than three times more value added than agriculture with very limited use of resources per hour, except for energy and emissions in services.

Agriculture presents a high dependence on local resources and a low direct contribution to the value added for its main function, which is food provision. However, this analysis does not consider other functions provided by agriculture, such as the preservation of traditional landscape and traditional identities. As has been proved for the case of Mallorca, a neighbor Balearic island, traditional farming plays 'a crucial role in shaping and maintaining a complex set of land-use mosaics' and associates it to the existing biodiversity in Mallorca (Marull et al., 2015). Some Payment for Ecosystem Services schemes have already put in place in Balearic islands, with a touristic eco-tax (Llei 2/2016, de 30 de Març, de l'impost Sobre Estades Turístiques a Les Illes Balears i de Mesures d'impuls Del Turisme Sostenible, 2016) partially funding the creation of new agro-ecological territories (Murray et al., 2019) that contribute to maintain agriculture and traditional farming. Still, it is important to understand how this multifunctionality contributes to the generation of wealth in other sectors --for instance, how agricultural land management contributes for example through the provision of cultural or ecosystem services to tourism in Menorca - in order to be able to decide about policies and management options in the island.



€: euro, h: hour, m²: squared meter, MJ: Mega joule, l: litre, kg: kilogram, GVA: Gross Value Added, LU: Land Use, HA: Human Activity, ET: Energy Throughput, WT: Water Throughput, CO₂: CO₂ emissions, AG: Agriculture, ICM: Industry, Construction and Manufacturing, SG: Service and Government.

Agriculture, ICM: Industry, Construction and Manufacturing, SG: Service and Government.

Figure 3. 4. Metabolic Performance in Menorca by economic sector (columns).

Each row indicates the use of energy (ET), water (WT), land (LU) and production of CO₂ emissions and value added (VA) 1) to produce one euro of Gross Value Added (GVA), Economic Performance

(first row); 2) per each square meter of Land Use (LU), Land Use Performance (middle row); and 3) per each hour of Human Activity (HA), Human Activity Performance (lower row).

3.4. Discussion of the results

In order to discuss the results, we are going to introduce two examples to illustrate the relation between the end-use of resources, environmental impacts and openness. It is important to note that the examples are used as a mean to understand how the methodology contributes to the debates in relation to decision making for sustainability considering adaptation to new situations and a resilient system that keeps certain identity.

3.4.1. The agriculture/industry/services interface: The case of Mahón-Menorca Cheese

The case of Mahón-Menorca cheese and cattle is a paradigmatic case of Menorca that we can use to link the biophysical needs of this activity, to the identity of the island, the level of openness, and to tourism and other economic sectors. Mahón-Menorca cheese is a product with D.O.P. (Spanish abbreviation for Protected Guarantee of Origin and Quality), intimately tied to its geographical area, Menorca, and the human element that has traditionally produced it (Consejo Regulador Denominación de Origen Queso Mahón-Menorca, 2019).

In the year 2015, the production of milk and cheese was around 53.000 tons and 3.000 tons, of which more than 2.000 tons are D.O.P. Mahón-Menorca Cheese (García García-Roldán, 2018). The size of the cattle in Menorca was over 18.000 heads, and more than 44% of the land in Menorca is used either as pastures or to grow fodder for the cows (S. GOIB, 2016). These numbers should be considered extremely high when compared with the neighboring island on Mallorca, three times bigger in area and having only 11.000 heads of cattle. During the same period, more than 41.000 tons of concentrated fodder was imported to feed the cattle (ibid), which means that a certain area of land and resources needed to produce the milk is already externalized (this virtual area and resources are embodied in the imported feed) in order to maintain 'a traditional and local' practice in Menorca.

If people in Menorca want to further increase cheese production, there are different options to consider. An increase in the number of cows would require more agricultural land for pastures, competing with other land uses, and more feed production; an increase in imports of feed for cows would externalize environmental pressures and impacts; or an increase in the amount of imported milk would reduce the requirement of cows and allow sparing land for other uses in Menorca - for tourism or industry. But, would this solution

jeopardize the identity of the Mahon cheese? Would Mahón-Menorca cheese still be a product 'from' Menorca?

This example illustrates how important is to integrate information about the factors determining the metabolic pattern of a social-ecological system, especially in the case of islands where the endowment of land and other natural resources is limited. In this way, it is possible to explore the option space looking at the possible combination of economic productivity, environmental pressures and impacts, biophysical limits and the dependence on imports (externalization of environmental pressures to other social-ecological systems).

3.4.2. Local sustainability, external impacts: The case of tourism

Another interesting analysis of trade-offs can be found when analyzing the case of tourism. Tourism is an activity belonging to the services sector (SG) with a high value added. It might seem desirable for society to promote this activity because it is an economic activity with high economic benefits. However, it is heavily dependent on external resources and on the decisions of external social actors (such as travel agencies, airlines, hotel chains). The innate openness of the tourist industry has dual implications: it reduces the ability of Menorca to decide about the activities carried out in its own territory, and it increases the externalization of the environmental impacts. The first, because it entails the inflow of many non-resident social actors in the system that locals do not control, and the second, for instance, because the economic activities that generate the added value spent by the tourists on the island and the biophysical processes needed to produce the imported products used by the tourist are outside the island. Put in another way, more tourism would modify the pattern of human activity, bringing more tourists and temporary workers, and it would increase the use of fuels for transportation (and therefore more CO₂ emissions). In this example, the trade-off in the short terms is between the increase of economic benefits and the increase the environmental pressure. In the long-term tourism can imply a change in the structure of the society: who will benefit from this increase of tourism? Which proportion of the economic benefit will remain in Menorca and which part will leave Menorca either in the form of wages for temporary workers or profits for international corporations? How would society manage and decide about these trade-offs?

3.5. Limitations in the application of the approach.

The MuSIASEM approach provides a critical assessment of potential trade-offs within the option space of possible solutions that decision-makers and other

actors may perceive as 'optimal' or 'win-win'. The variety of assessments shown in Figure 3. 4 clearly show, that there are no optimal solutions and each alternative entails trade-offs that society should identify and consider to decide. The type of integrated analysis presented here provides the possibility of exploring options and discussing how feasible and viable the considered alternatives are in a transparent way. This approach has the potential to co-produce a common understanding of the situation if social actors are involved, based on the diagnosis and exploring potential consequences of changes in different scenarios. This approach is potentially more inclusive and transparent, but it may generate a phenomenon of "too much of a good thing". The wealth of information generated in this way may cause a slower decision-making process, as all alternatives will have pros and cons.

The examples provided show that a characterization of the metabolic performance, metabolic rates and densities, in the use of energy, water, and CO_2 emissions, and the economic productivity of human activities and land uses in Menorca provides a useful approach to understand how the socio-ecologic system of a small island economy based on tourism operates. However, it is important to acknowledge that the results presented here just show trends in the studied scale of analysis -whole island and economic sectors - in order to become useful for informing policy they have to be tailored on more detailed level of analysis to know what happens in different activities within the economic sectors and household types.

The consideration of potential trade-offs among alternatives, as presented in the case of the Mahón-Menorca cheese, illustrates the potentiality of the approach for informing the deliberation over alternative scenarios, however, as mentioned earlier a better framing of environmental pressure and impact (geo-localizing the changes in the scenarios) is required to enrich this diagnosis. This can be only done while applying the method together with local social actors (co-production).

Chapter 4.

The political dimension

Behind [and beyond] landscape policies in Menorca

4. Behind [and beyond] landscape policies in Menorca

4.1. Chapter overview

This chapter studies the implications of the co-existence of different perspectives about landscape and landscape management on the island of Menorca. I want to examine how these different perspectives contribute to the creation of local narratives and the role of these narratives when prioritizing concerns and informing policies according to different political groups.

A brief introduction to the recent history of Menorca, section 4.2., helps to contextualize the importance of landscape and landscape management in the perception and representation of the current situation on the island. At the same time, this historical analysis allows to introduce a political ecological analysis, in line with Greenberg and Park (1994) that see political ecology as a historical result of central questions from social sciences about the relations between human society, viewed in its bio-cultural-political complexity, and a significantly humanized nature.

To characterize the current debate about the choice of concerns to be addressed and their prioritization, after the historical summary, I present the analysis of the electoral programs for the elections to the Council of the Island of Menorca (CIME) in 2019. I also use information gathered from my experience living in the island and observations from the organization of a participatory workshop and participating in different seminars (as explained in chapter 2.3.).

After recalling the goals and research questions (in section 4.3.), I explain in detail how I applied the concepts and methodological frameworks referring to: political ecology, situated analysis, environmental communication, and ethnographic research (introduced in chapter 2). There are different scales that can be useful to understand visions about the identity of Menorca. However, I focus on the importance of the landscape to contribute to define the imaginary of the Menorcan identity based on how political parties in the island use the words connected to 'landscape' and 'territory'.

The results show how political parties in Menorca frame their discourses about landscape, and what type of policies they suggest maintaining and reproduce the system when forced to adapt to existing pressures and potential challenges.

Following the goals and main research questions, I describe how the methodology explained in chapter 2, has been adapted to conduct this study. Then, I

present and discuss the results (section 4.5). And, finally, I express the conclusions and ideas to further study the connections between the elements that are essential to explain the identity of Menorca, and the narratives that the political parties use to justify and prioritize their agendas.

4.2. A short tale about the History of Menorca: A strategic location in the Mediterranean, the agrarian Menorca, a (hu)man lab for sustainability and the risk of 'morir d'exit'

Menorca, as the more oriental island in the Balearic archipelago, has been historically a strategic point, a feature that has determined the idiosyncrasy of the island. The location of the island and the characteristics of its main port, in Maó, has been the entry to different cultures and societies that had left their trace in the territory of the island. The Maó port, as one of the biggest natural ports in Europe, has provided relevance to the village of Maó offering a possibility to obtain incomes through trade, military, pirates or handcraft activities among others (Murray Mas, 2012).

The case of Menorca embodies the evolution of a place that has shaped its identity, switching from an isolated system to a more open one, depending on the historical context. Menorca maintained certain population with local resources and was able to develop several concentrations of pre-historical populations (Casasnovas Camps, 2005; CIME & GOIB, 2023; Martí Camps, 1979; Pla i Casadevall, 1950).

Then, the domination of the seas by different empires and societies put Menorca on spot to be a desired strategic point. Phoenicians and other pre-Roman empires, Romans, first, and Muslims, English, French, and Spanish, later, have fought to colonize and occupy Menorca in different moments of time (Casasnovas Camps, 2005). The occupation by existing cultures was mixed with periods of 'abandonment' from these external powers, and also its resources. These periods forced islanders to adapt to existing resources and develop self-sufficient practices (i.e. in relation to water). The heritage that exists in the island and its landscape certifies a lot of memories of these periods and it is a part of the current identity of Menorca.

Focusing on the first half of the 20th century, I use the work of Bisson (1967) to understand and illustrate some characteristics of Menorca during this period. In his work 'La tierra y el hombre en Menorca' (ibid), Bisson illustrates the essence of the rural/agrarian Menorca, the existing industry until the 60s, and he already presents some hints about the coming touristic pressures. His work clarifies how important land and the landscape are to explain the identity

of Menorca and, simultaneously, it shows how the analysis of land uses brings relevant information about social structures. Bisson explains how the property of the land and labor was distributed. This distribution of land property influenced the evolution of agrarian activities and the rural exodus of farmers to industry and services. The changes in land productivity, due to new technologies and practices, forced the landowners of the 'worst part of the inherited land', especially small plots in the south of the island, to find new uses or sell it to a real estate company (Bisson, 1967, p. 60) that promoted urbanization. The work of Bisson is key to understand how Menorcan people adapted to specific circumstances and changes, such as the Spanish Civil War, and postwar, that affected the availability of certain resources.

According to existing literature and the historical analysis of what happened during the second half of 20th century, Menorca followed a different 'development' path compared to its neighbor islands in the Balearic archipelago Mallorca and Ibiza (Pons & Rullan, 2014). While Mallorca and Eivissa developed touristic infrastructures earlier during the second half of the 20th century that allowed a mass tourism model to raise, Menorca had a delay of around ten years that contributed to an alternative model coined as 'the Menorcan way of Growth' (la via Menorquina del Creixement, in Catalan) (Andreu & Erbina, 2015; Farré-Escofet et al., 1977; Murray Mas, 2012). Industry and agriculture maintained a more prominent position, that contributed to a diverse economic system in opposition to the touristic monoculture that was growing on other islands and coastal areas.

This delay, called by some authors 'el retard virtuós de Menorca' (Marí Pons, 2010), the virtuous delay, was the result of a confluence of factors. The Spanish dictatorship after the Spanish Civil war 'punished' or abandoned Menorca for its loyal resistance against Franco's movement and in favor of the Republic until almost the end of the Civil war, in 1939. (Murray Mas, 2012, p. 1385; Rullan, 2023). This punishment without 'development' of touristic infrastructures and governmental aid during the post-war, contributed to stimulate alternative economic endeavors that lead to the flagship industries of Menorca connected to jewelry, shoes industry, cheese industry, among others (Murray Mas, 2012, p. 1433). Paradoxically, this lack of 'development' as understood by people in institutional power, ended up having positive consequences in the maintenance of the landscape that contributes to explaining the current situation.

One of the documents that better reflects this situation is the 'Plan Provincial de Ordenación de Baleares', PPOB, for Spanish abbreviation of 'Regional

Development Plan of Balearic Islands' (DPB, 1970). The PPOB treats Menorca differently, compared to its neighboring islands. Menorca was considered more rural and 'lagging behind' in the touristic process (DPB, 1970, p. 268) compared to Mallorca and Eivissa where tourism was already taking place and space. The narrative about tourism as an opportunity to develop, modernize and represent a successful society is clear in this document, in contrast to agriculture that represents 'old' traditions that are considered positive 'but' need to open somehow.

The context of the Franco's dictatorship in Spain around the 60s was an important factor for the development of tourism in the coastal areas of the country including, of course, the Balearic Islands. The regime was moving from an autarchy to a regime that was looking forward to receiving international aid and money. The promotion of tourism, based on the 'sun and beach' model, was seen as an opportunity to show modernity, and attract international investments and people, and as to change the mindset about the dictatorship regime (Pons & Rullan, 2014).

Beyond the geopolitical implications of these strategic developments, and the national consequences of the contradictions, in terms of social justice, between the openness for international tourists and the restrictive regime to Spanish civil society, at the regional scale, touristic areas started appearing all over the country. The transformation of the territory is unquestionable, especially in coastal areas, and an intense development and construction of infrastructures started to emerge in several regions of Spain, such as Benidorm, Malaga-Costa del Sol, Salou, Costa Brava, and Balearic Islands among others (DPB, 1970; Ginard-Bosch et al., 2015; Murray Mas, 2012; Pons & Rullan, 2014). The emergence of these touristic areas was coordinated through Regional Development Plans, PPO, from the Spanish abbreviation of *Planes Provinciales de Ordenación*.

In Menorca, the PPOB (DPB, 1970) introduced earlier, pursued a similar model as the developed ten years before in other islands and touristic areas. Figure 4.1. represents the distribution of infrastructures and land-uses planned for Menorca. The goal of the plan was to promote the creation of urban developments all around the coast of Menorca, represented as black areas, with a perimetral road connecting all these places, the red lines. The yellow areas represent agricultural land uses, and the green shows the areas dedicated to forestry.



The ten years delay in the development of the plan in Menorca, the 'virtuous delay' mentioned before, and the fact that some negative consequences of the model were already identified in the neighboring islands, pushed some citizens and organizations in Menorca to fight against this model (GOB, 2023). These social movements aligned with other factors, such as the oil crisis in the seventies, or the decay of the dictatorship, and stopped the development of the plan.

Islands. Menorca (1970).From PPOB (1970)

Figure 4. 1. Territorial Plan of

the Balearic

The struggle of civil society against the development of touristic areas in Menorca during the seventies, the end of the dictatorship after the death of Franco (1975) and the transition to democratic institutions promoted the adoption of an alternative touristic model that lead to the declaration of Menorca as a Biosphere Reserve in 1993 (UNESCO, 1993).

The last decade of the 20th century initiated, then, a new touristic paradigm in Menorca based on a model that promoted the preservation of the natural resources in balance with human activities according to the (Hu)Man and the Biosphere Program of the UNESCO (UNESCO, 2020; U. N. E. S. and C. O. UNESCO, 1996, 2017).

This model created a new imaginary in the history of Menorca. A model endorsed by international organizations with the 'mission' for Menorca to become a *human lab* to try experiences and alternatives for sustainability. Since the declaration, thirty years ago, this model has promoted the idea of a 'sustainable Menorca' that has been progressively assumed, mainly, by civil society, economic sectors, organizations, and institutions (OBSAM, 2018b). Touristic promotion, political discourses of the main parties in Menorca, and the legislation have incorporated the principles of the Biosphere Reserve and of sustainable development.

The current situation, based on the 'sustainable' model described above, and internationally certified by the declaration of the biosphere reserve, have consolidated this imaginary of Menorca as a touristic island with high priority in developing a sustainable model. This model has generated a source of 'differentiation' with respect to other islands and touristic areas where mass-tourism infrastructures were developed in previous decades. The 'Menorcan model' promoted as 'different', 'relaxed', 'quiet', more 'connected to the environment', a 'paradise' to find (Méndez Vidal, 2017) presents a model of success and offers examples of balance between human activities and environmental protection.

However, this model is also contested, and different movements, claim that the touristic pressures exist in Menorca and the situation is as negative as it is in the other islands and touristic areas (GOB, 2023; Mao, 2023; Posidònia , 2023b; StopCiment, 2012; TempusFugit, 2014). The main difference is 'just a delay' (virtuous but a delay after all). These movements argue that the protection of the territory connected to the Biosphere Reserve is creating different types of pressures that need to be addressed if society, in general, and institutions, in particular want to prevent Menorca of 'morir d'èxit' (dying due to success) (Rullan, 2023).

The abandonment of rural activities, the increasing of tourism, and, in the case of Menorca, the protection of the island, create new pressures on the territory. The evolution of tourism and the creation of the biosphere reserve which puts the whole island under protection, with restrictions on new housing, are generating scarcity and situations of gentrification. Usually connected to urban areas (Lees & Phillips, 2018), gentrification has been studied in other islands (Clark et al., 2007; Hines, 2010; Jackson, 2006; Marjavaara, 2007) and in rural-to-touristic areas (Randelli & Martellozzo, 2019; Solana-Solana, 2010). In short, the consequences of these changes lead national and international visitors with more purchasing power to appropriate part of the island. This fact

forces locals and permanent residents to abandon the island or move to less 'privileged' locations (Pol Nuevo, 2018; Valdivielso & Moranta, 2019; Yrigoy, 2017). This gentrification is combined with an 'elitization' of the island (Valdivielso & Moranta, 2019, p. 1883)that is transforming the island towards a privileged and 'deluxe' asset that cannot be found in other touristic areas...

The tension between availability of natural resources and how humans decide to appropriate or not these resources, has been studied before in different contexts, for example the perturbation on the regular functioning of the Dutch economy determined by the sudden exploitation of fossil reserves. A phenomenon known as "the Dutch disease") Capó and colleagues illustrate the 'Dutch disease' in touristic economies with the cases of Balearic and Canary islands (Capó et al., 2007). In the case of Menorca, this general tension swings between establishing different degrees of land protection and defining what types of human activities should be promoted or restricted. This tension is mediated through different institutions, organizations, lobbies, citizens, etc. In this chapter, I use documents from the political parties with representation in the regional council, CIMe, to analyze how they frame the concepts territory and landscape.

In the following subsections, I present with more detail the research goals of this chapter and I explain the application of the methodology I used to analyze the discourses and narratives presented in the electoral programs (2019) of the political parties with representation in the regional council, CIMe, in relation to landscape and territory.

4.3. Goals and research questions

This chapter responds to the second Research Question of the thesis: How do political discourses influence the "simplification of explanations" and "prioritization of concerns" that took place within the process used to inform policy?

This main research question is broken down into 4 more specific research questions:

- (1) How do the political parties with representation in the island council of Menorca, CIMe, frame their discourses about territory and land-scape?
- (2) What types of policies are they prioritizing connected to landscape and the territory?
- (3) What type of concerns and identity elements identified in society are mobilized by the political parties?

(4) How do the representations used by the political parties contribute to the simplification of the analysis of the concerns?

The first goal of this chapter is to identify and categorize the narratives connected to landscape and territory according to the political parties with representation in the regional council of Menorca, (CIMe). I use the electoral programs of the parties for the regional election (in 2019), and then I explain how they framed messages about landscape. Whenever possible, I tried to identify what priorities were established when suggesting policies and actions from each party. Finally, I discuss to what extent the narratives identified have commonalities or contradict each other, commenting on missing narratives and contested prioritizations.

The second goal is to contextualize the specific discourses from the political parties with general concerns present in the Menorcan society that have been collected and mapped using different methodologies (see 2.3.). In this way it becomes possible to assess to what extent political discourses contribute to the work of simplification.

Finally, I discuss how prioritization and simplification are interconnected. The way something is simplified and prioritized is a matter of power. Framing is a way to both prioritize and simplify. However, 'who has the power to simplify complexity, imposing a particular standard and procedure of valuation? (Martinez-Alier, 2010, p. 87).

There is a need to simplify *reality*, but this reduction has to important side effects: (i) simplification promotes one perspective among several (hegemonization); (ii) simplification is directly related to the issue of power. The prioritization of economic concerns, for instance, invites the use of indicators about economic growth, employment, trade, all of which contribute to a simplification of the problem which is framed within an economic narrative. Therefore, the choice of this framing has consequences in social and environmental terms that need to be acknowledged and analyzed.

The following section explains the application of the methodological framework used to gather, manage, and analyze the data.

4.4. Application of the methodology. Mapping identity elements, concerns, and priorities in the *political discourses*

This subsection presents how I applied the theoretical and methodological frameworks to the case of Menorca. As introduced in chapter 2, I analyze the

political ecology of landscape in the island of Menorca, and I use mixed methodologies from ethnographic research, situated analysis and grounded theory, and environmental communication to gather data.

As presented in Chapter 2, the political dimension describes the relevance of an issue, and it is dynamic and context dependent. Its analysis provides partial explanations based on information that is available and considered pertinent in a specific moment for a specific group of social actors. There are different levels to analyze the political dimension. The level of individual ideas and daily social practices generates visions about the system and identifies concerns, whereas the level of the political process prioritizes the identified shared concerns by defining collective imaginaries, regulations, and norms.

These regulations and norms adopted by society are the result of deliberations and decision-making processes having the purpose to achieve solutions to the problems identified by society and to reach desirable situations. Both the social practices carried out by individuals, and the political process used to define regulations and policies are mediated through the interaction of diverse *political* organizations – political in the broad sense - that embody different power capacities and decision-making potential. These interactions happen at different levels, and are used to negotiate prioritizations, select, and organize the ideas to debate and to achieve consensus (or engage in political conflicts).

To characterize the political dimension, I focus on i) individual and social perceptions of identity elements to define Menorca, and ii) political prioritization of concerns, explanations and solutions connected to landscape and suggested by political parties.

To characterize the political dimension in Menorca I borrow the concept of 'political community' from (Easton, 1957). When implementing this concept, I assume that the participants in the workshop (chapter 2.3), the documents and events; and the electoral programs from the political parties described in the following subsections, are representative, at different scales, of 'political communities". This idea of 'political community' can be associated to the idea of 'imagined community' (Kaina & Karolewski, 2013, p. 22) that represents large collectives of members (Anderson, 2006) that share 'precious' commonalities that unite 'them' in contrast to outsiders (Estel, 1997, p. 79 in Kaina & Pawee Karolewski, 2009, p: 14). In the case of Menorca, I assume that the different materials I used to gather data share diverse imaginaries and views of 'Menorca' and contribute to the procedural definition of its identity.

The study relies on two main primary data sources, explained in the following subsections. First, a characterization of the perceptions about the identity of Menorca and its relation to landscape. This is obtained by applying Situated analysis (presented in 4.4.1).

- 1. Situated analysis (based on individual and social inputs).
 - a. Reading different materials
 - b. Participatory process.
 - c. Participant observation and ethnographical research.

Second, the text analysis over the electoral programs used to identify the discourses of the political parties in Menorca. This is presented in 4.4.2.

- 2. Discourse analysis (based on text analysis)
 - a. Selection of documents: electoral programs
 - b. First coding of topics and narratives. Inductive
 - c. Mapping the information from the first round of coding with data obtained through 1.
 - d. Decision on the key words to focus on: *Territory* and *land-scape*.
 - e. Selection of segments (paragraphs) and second round of coding.
 - f. Analyze topics and see patterns.
 - g. Operationalization of criteria, topics and categories.
 - h. Categorization of the paragraphs.
 - i. Analysis of the results

4.4.1. Situated analysis: Mapping the situation through observational data and participation.

The first elements to characterize and map the situation regarding the identity elements of Menorca is to recognize what elements are important for people living in Menorca. At the individual level, it is challenging to know what Menorca is for every citizen of Menorca and what are the elements that are key to define the identity of the island. I am not engaging with the discussion about what defines one's idea of the 'Menorcan identity' and what does it mean to

be Menorcan, the individual notions of 'belonging together' and 'belonging to' discussed in Kaina & Karolewski (2013).

I have used a participatory process as a qualitative method to collect data about relevant elements found in Menorcan society. I tried to explore what are the elements that the participants consider essential to describe the identity of the system 'Menorca' according to their vision, independently of what is their relation to the system or how they would identify themselves.

Besides the participatory process, I collected qualitative data through the analysis of grey literature, newspapers, regional plans, and reports about Menorca. As explained in Chapter 2, I have been living in Menorca for more than a year, and I have participated in seminars and events that I used to triangulate and contextualize the data obtained. My own experience in Menorca since 2004 has been useful to contrast the information and contextualize the data obtained through different sources.

For this study I use the outcomes of a participatory process about identity elements and the future of Menorca that I organized and facilitated in Maó, in October 2019 (Marcos-Valls, 2019). I planned the workshop to be developed in two days and included different activities. The activities of the first day covered general ideas about the notion of change, the identity of Menorca and how the participants think about a sustainable future in the island. The second day focused on more concrete actions connected to energy and water management.

For this chapter, I use the outcomes of a World Café Methodology (Brown & Isaacs, 2005) that took place during the first day of the workshop. There were eleven participants (out of twenty-five registered) that were distributed in groups. Each group discuss in a table with a specific topic switching from time to time. All the groups discussed and contributed to describing, and voting, the essential elements of the identity of Menorca. To boost the discussion, I presented three extreme scenarios, one per table, to be able to detect what elements were common and what were specific or circumstantial. The three scenarios are indicated as *Touristic, Conservation*, and 100% *Renewables*.

I categorized the participants in three types of stakeholders: a) part of local entities and NGOs (six participants), b) Civil servants or working for the public administration (four participants), and c) part of the business sector (one participant). Initially, I had registered at least four representatives of each type of stakeholder. However, only half of the registered participants attended the meeting. As a result, the views of the business sector stakeholders are not

representative of the sector, and the representativeness of the other groups is limited as well. This workshop is used to complement the analysis of identity, knowing that the participatory process can be improved.

The participants were grouped in the three tables, prioritizing diversity of stakeholders in the discussion. Each table had a permanent facilitator that remained during the three rounds to moderate the discussion, and all the participants discussed the three scenarios.

The participants discussed and wrote the elements that they considered essential, and the other participants decided if they agreed (adding a vote) or not. The outcome of this activity was a list of identity elements that were considered essential to define the identity of Menorca.

Obviously, the level of participation of the Menorcan society to this seminar was not elevated. This point together with other shortcomings of the participatory processes that have been carried out in this study will be discussed in the discussion.

In the results section, I present the outcome of this activity, showing a qualitative picture of elements that were discussed in this session. I contrast the list of elements obtained in this activity with the reading of reports, news, and documents; the attendance of events; the participation on seminars; and daily life in Menorca.

The activities and documents that are included in this analysis to map and comment the results about the perception of the identity of Menorca are diverse: from seminars and congresses to informal conversations, legislation, planning documents, strategies, news and even an artistic exhibition about the identity of Menorca.

4.4.2. Discourse analysis about landscape and territory in electoral programs.

The second element to characterize the political dimension in this research focuses on the review of the discourses found when reading the electoral programs, from the political parties with representation in the Island's Council, CIME, during the 2019's elections.

Discourse analysis is a generic tag to define a vast amount of empirical methods to study a broad spectrum of topics (Conde Gutierrez del Álamo, 2009). The notion of Political Discourse Analysis (PDA) is ambiguous since it can be difficult to interpret when a discourse is *political* (van Dijk, 1998). However, electoral programs are a genre of political discourse themselves together with

propaganda, political advertising, speeches, media interviews, ballots, and so on (van Dijk, 1998, p. 18). Therefore, using these documents to characterize the content is an example of political discourse analysis. There is a more critical reading of discourse analysis, CDA (Critical Discourse Analysis). According to Fairclough, beyond the analysis of discourses per se, CDA is an "analysis of the relations between discourse and non-discoursal elements of the social, in order to reach a better understanding of these complex relations (including how changes in discourse can cause changes in other elements)" (Fairclough, 2005, p. 924).

In this chapter, I focus in the approach of Van Dijk, who argues that 'PDA is both about political discourse, and it is also a critical enterprise' (van Dijk, 1998, p. 11). I offer an analysis of political discourses that includes the narrative configurations and semantic spaces from the political parties in line to the 'analysis of system of discourses' from Conde (2009) presented in Requena-i-Mora (2023).

In the following subsection I describe the operationalization to define categories that I use to organize the coded segments based on specific words. Then I use this analysis to critically integrate with other types of narratives and storytelling using PNS in chapter 5.

The electoral programs analyzed are the political suggestions of each party that achieved representation in the Menorcan Council, CIMe. These documents reflect the needs and power capacities of this institution regarding concerns that the parties identify in their community. The electoral programs select and prioritize what they consider more relevant for the voters.

For this part of the research, I mix different concepts and methodologies to characterize the political discourses about landscape and territory in Menorca. I use as a reference the work of Ruiz-Jiménez and colleagues (2014) and I adapt their approach to analyze electoral programs. In their work, they use the concept of a 'political community', introduced earlier, and I apply this concept to Menorca as a political system where its members, the population of Menorca, can support the existence of a community that wants to 'settle differences or promote decision through peaceful actions in common' (Easton, 1957).

Following their methodological design, I assume that political parties are part of the political community in Menorca and segments of the population on the island are, to some extent, represented by these parties (at least their voters). The electoral programs are the documents that offer the messages that each party considers relevant for the people of Menorca.

These messages are key to offer a membership criteria in the political system to avoid ambiguity about who is 'us' (Easton, 1965, found in Ruiz-Jiménez et al., 2014, p. 117). In the case of Menorca, Menorcan people and territory *versus* other islands or *versus* the state, or 'my' party members *versus* 'other' party members. According to the authors, naming each political community, 'us', highlights the political bonds over social or cultural differences, 'them'. This difference helps simplify some messages by assuming certain common understanding and the participation in common political processes (Ruiz-Jiménez et al., 2014), such an election process.

There are different studies from political sciences and sociology to research about how the preferences of the political parties are established based on analyzing election results, polls, surveys to experts, interviews, or political documents, such as electoral programs. I don't address how the political parties establish their preferences (Debus, 2009; Laver, 2001; Volkens, 2007), alliances for government (Debus, 2008), nor how represented the citizens are with the political parties or with their electoral programs. Rather, I focus on analyzing the messages and discourses that the parties with representation in the council have included in their programs connected to specific words.

In conclusion, the analysis presented in this chapter is the result of an iterative process of reading and selecting information. I performed the content analysis of the electoral programs through different rounds of reading, coding and inductively organizing the content in themes and categories that helped me to map the situation that can be messy (Clarke et al., 2015, p. 78). This mapping of the general content from the electoral programs runs parallel to the situational mapping explained in the previous subsection. The analysis of the outcomes of the workshop and other materials described above, and the first round of coding converged in the selection of *landscape and territory* related words as key words to conduct the second round for the analysis.

For the first round of coding of the electoral programs, I used NVIVO and MAXQDA software. I pre-defined certain categories of analysis and I included new codes and categories as they emerged. With this information, I drafted different maps and organized topics and narratives. Then, I applied the second round of coding to the paragraphs that contained the root of the words *land-scape or territory* in the language of the document (Spanish or Catalan) using Excel.

To categorize the content of the selected segments, I used as a bases the operationalization strategy presented in Ruiz-Jiménez et al. (2014) and defined the different categories to present and explain the results.

In the following paragraphs I explain and describe the adaptation of this operationalization to classify the segments about landscape and territory.

4.4.2.1. Operationalization of the categories

Tables 4.1 and 4.2 summarize the operationalization of the criteria I used to define the categories to code the segments. In this research, the segments correspond to paragraphs from the electoral programs that contain the words *territory*, or *landscape*, and derived words (including abbreviations, i.e., PTI, for Insular Territorial Plan).

In table 4.1 I adapt the components, levels and orientation described on Ruiz-Jiménez and colleagues (2014) to operationalize the coding of the segments. To complement this operationalization, I include two new columns that help me to frame the discourses from the parties: Narratives and Typology.

I adapted these two new criteria from inputs that different scholars have done in relation to Quantitative storytelling (QST) (Di Felice et al., 2021) and biosemiotics (Giampietro & Kovacic, 2019). Narratives are connected to what is the main function of the paragraph I was categorizing. *Justification narratives* expose the *why*, if the segment defines why an action, goal, discussion, etc. needs to be performed. *Normative narratives* state *wha*t is to be done. And *explanation narratives* describe the *how*, expressing how something needs to be developed.

The choice of narratives relates to the typology of messages. I identify different types of messages as pertaining to a gradient that moves from a more intangible characterization, linked to emotions and feelings, to a more biophysical characterization, linked to actions that can be monitored.

I combine these narratives and typologies with the components, levels and orientation of the categories as explained in Ruiz-Jiménez et al., (2014). They systematize concepts and ideas from Easton (1965), (Kaina & Karolewski, 2009, 2013). On the one hand, I categorize components that go from more affective, to more structural, or considering a mix of both. On the other hand, the level of the text that I analyzed, going from the lower level, that represents a declarative statement naming the group, issue or characteristic, to a behavioral level that is focused on practices. And finally, I categorize if the segment is oriented to a cognitive statement, that stablishes knowledge; conative or pragmatic, if intends to influence change of behaviors or show useful or 'valued' behaviors; and evaluative orientation; or neutral (see Ruiz-Jiménez et al.(2014) for more details).

The result of the operationalization with the criteria explained in the previous paragraphs and summarized in Table 4.1 is the five categories that help me to frame the types of discourses that each party links to the words *landscape* and *territory*.

Table 4. 1.
Operationalization of the categories for the political discourses related to landscape and territory in the electoral programs.
Adapted from Ruiz-Jiménez et al and colleagues (2014)

Component	Level	Orientation	Narrative	Typology	Categories
Affective	Declarative	Cognitive	Justification (WHY?)	INTANGIBLE	C1 - Legitimacy
Affective	Behavioral	Conative/ Pragmatic	Normative (WHAT?)	Mixed	C2 - Economic development
Affective	Behavioral	Conative/ Pragmatic	Normative (WHAT?)	Mixed	C3 – Sustainable develop- ment
Structural	Behavioral	Evaluative	Normative (WHAT?)	Mixed	C4 - Land protection and land uses preservation
Mixed	Mixed	Neutral	Explanation (HOW?)	BIOPHYSICAL	C5 – Management and legal instruments

In this study, the categories are:

C1: Legitimacy,

C2: Economic development,

C3: Sustainable development,

C4: Land protection and land use preservation, and

C5: Management and legal instruments.

The categorization of the segments was the result of an inductive process in two steps. First, I coded the topics that I found in the paragraphs, and then, I grouped the topics according to trends combined with the criteria defined to operationalize the categories (Table 4.1). As the reader can see in Table 4.2, some of the topic belong to more than one category, and I classify the segments into more than one category if necessary.

C1 - Legitimacy				
Identity	Concerns			
Menorcan Identity Culture* Heritage Menorcan model Language**	Migration Hunting** Fishing** Urban development* Coast*			
Sovereignty/Power	Climate change*			
Self-determination Coordination among ad- ministrations	Abandonment (rural activities and people)* Stop economic development affecting the territory* Compatible activities* Resilience*			

Table 4. 2. Classification of the topics coded in the electoral programs within the defined category.

*Topics that appear in more than one category and/or just had one segment coded with this topic.

C2 - Economic development				
Industry, Transport and Infrastructures	Primary sector	Tourism		
Industry	Hunting	Differentiation		
Housing	Fishing	Marketing		
Infrastructures	Urban development	Cruises		
Transport	Coast	Golf		
Roads	Food system	Balance between Agrarian		
	Rural	and Touristic activities		
	Balance between Agrar-			
	ian and Touristic activi-			
	ties			

C3 - Sustainable development Social issues **Alternative models Biosphere Reserve** Balance Human and Na-Culture Sustainable growth Education Compatible activities ture Health Care Local economy Balance between Agrarian Leisure Land stewardship and Touristic activities Wellbeing and quality of life Food system Self-sufficiency Resilience

C4 - Land protection and land uses preservation

Protection of land uses

Alternative models

Degrowth

Conservation

Preservation

C5 - Management and legal instruments

Legal instruments and processes

Resources management

Taxes
Technologies (Smart/ICT)
Participation
Legal instruments

NEXUS+waste Energy Water Competences

Coordination among administrations

The first and the last categories, C1: Legitimacy, and C5: Management and Legal instruments are two extremes in the classification. The first one includes all the affective considerations that the parties use to justify their policies: identity elements, concerns or issues connected to sovereignty or to who has power, or the right, to decide about certain issues. The latter indicates the mechanisms that they suggest, explaining how they are going to address an issue: the legal instruments to manage resources or activities, or the way each party suggest collaborating with other administrations and entities.

In the middle of the classification, I define three categories that relate to what are the models or goals that the parties suggested in the different segments. Under these categories I coded segments depending on whether they were focusing on C2: Economic development, C3: Sustainable development, or Land protection and land uses preservation.

The first category describes elements related to ideas and visions about the development of economic sectors: agriculture, farming, industry, construction and infrastructures or tourism. The second, C3: Sustainable development, when there is a component of balance between economic development and other social issues, and environmental preservation. The concept of sustainability entails addressing the tragedy of change (Funtowicz & Ravetz, 1994), i.e. the need of re-adjusting the identity of the social system while considering non-equivalent and incommensurable representations of performance referring to different dimensions and levels of analysis. I include in this category the references to the biosphere reserve and alternative models that shift the focus

from economic development to well-being, quality of life. land stewardship or self-sufficiency and consider other social elements beyond the economic component. The last category is connected to the models or goals that prioritize C4: Land protection and land uses preservation. I use this category when the segment is focused on the protection of the land, or the traditional land uses beyond a utilitarian or economic value. I am aware that it is hard, if not impossible, to separate human activities, and the impacts, from land, however, I considered it relevant to have a category to specifically code when the discourses about landscape and territory have this connotation.

4.5. Results

In this section I present the results of the characterization of an aspect of the political dimension in Menorca connected to landscape and the territory, based on the methodology explained above.

4.5.1. Situating the debate: Landscape at the center of the Menorcan identity

The short history of Menorca presented in this chapter (4.2.) and the last decades of the island as a biosphere reserve show a high importance of the perception of landscape as a key element to describe the identity of Menorca.

First, I want to start with an art piece that I discover during a walk in Maó, the capital of Menorca, during June 2022 (Figure 4.2).



Figure 4. 2. A Menorcan still life. (Gomila et al., 2022)

With the title 'A Menorcan still life' (Gomila et al., 2022), the authors created a mural with an image of elements that they consider relevant to represent an idea of Menorca (Figure 4.2.). They included thirteen elements with a small critical text full of irony. Beyond the food, plants, animals, traditional practices, and products, I was positively surprised that they included the PTI, Catalan abbreviation to the Island Territorial Plan, with the following text:

Sacred book from Menorcan lands (...). Like any sacred text, it remains open to different interpretations, depending on the religious denomination. The most heterodox — who usually have links to enormous fortunes of French origins — have the scriptures read by lawyers and notaries. In doing so, divine powers help them to transform treated water tanks into swimming pool and to build concrete promenades, like an agora where the gods of agroturistic monoculture are invoked.

Mutant el Myotragus (Mutating the Myotragus). (Gomila et al., 2022)

This short text reflects the importance of landscape in the debate about Menorca and includes sarcastic references to the PTI as something 'sacred', 'open to interpretations', with 'divine powers to transform' since it generates political tensions and is ambiguous enough to be used in different directions. These reflections are useful to introduce some of the outcomes from a workshop about 'The future of Menorca' (Marcos-Valls, 2019).

The outcomes of the World café were three posters (Figure 4.3.), one per table that represented each scenario - Touristic, Conservation and 100% Renewables — and the participants wrote and voted for the elements that were considered essential to define Menorca. I'm presenting part of the results to discuss an overview of the perceptions about territory and landscape that appeared during the activity.

In general, participants agree on similar elements that define Menorca's identity. While there are variations in the agreement depending on the scenario, key trends emerge and there are four types of elements that are consistent: directly connected to landscape, related to the environment or biodiversity, connected to heritage and cultural elements, and, finally, other social elements, including economy, demography, or lifestyles.







Landscape elements were clearly used to define Menorca's identity. The mosaic pattern, that includes agroforestry patches, rural and populated areas, crossed by old paths, such as the 'Camí de Cavalls', the widespread 'paret seca' or dry-stone wall, and new infrastructures are common elements in the imaginary of Menorca. Environmental elements like beaches, biodiversity, climate, and stargazing opportunities are also common. The traditions and past actions intertwined with landscape make heritage and cultural factors, such as language, architecture, archaeology and historical heritage (i.e. Talaiotic Menorca), traditional gastronomy, products and celebrations (i.e. Horses celebrations), essential to define Menorca's identity. From this selection we can clearly see how, according to the participants, the social practices from the past and the testimonies of those practices have shaped the environment and is part of the landscape and identity of Menorca today.

Figure 4. 3. Outcomes of the World Café during the workshop about 'The future of Menorca'. October 2019

Participants also recognize as a crucial aspect to maintain a diversified economy centered around the agrarian sector, the preservation of rural activities and populations with environmental consciousness. Quality of life, tranquility, and self-controlled urban development supporting the locals are highly valued.

Some elements didn't achieve consensus but were deemed important by certain participants. For instance, some said that the promotion of tourism as an economic 'monoculture' will bring as identity elements the commodification of Menorca as a brand, loss of economic diversity and weakened community relations. In contrast, the promotion of conservation activities was identified as compatible with rural activities, diversified tourism and practices to support and maintain local population, agrarian activities, and quality of life.

The results of the workshops reflect that a current perception of the identity of Menorca is highly connected to the landscape that embodies both the natural and historical heritage, and the existence and preservation of economic activities that maintains a local population stable. The results of the workshop

also reflect the tension that exists between economic activities, and the difficulties in establishing compatibilities that maintain agrarian and industrial activities with tourism.

Besides the results of the workshop, the historical context of Menorca that led to the declaration of the biosphere reserve (see 4.2.), and the artistic piece I use at the beginning of this section to illustrate the importance of landscape there are other indicators of this relevance. Local media, NGOs and institutions in Menorca are active in explaining issues, and organize debates, seminars, and congresses to raise awareness about landscape, territory and connected environmental issues.

When considering local media, the traditional newspaper 'Diari de Menorca' includes the words 'landscape' or 'territory' in more than 15.000 news since 2009 (Menorca, 2023). New initiatives such as 'Revista Posidònia' with a specific section for news about landscape, territory and environmental issues (Posidònia, 2023b), offer spaces to share information and create critical debates in the local society. Moreover, there is an active civil society organized around NGOs and movements that put territorial issues at the center. For instance, GOB, short for Balearic Group of Ornithology and Defense of Nature, with more than 1500 members in Menorca (GOB, 2023), has organized activities and actions to protect the territory and raise awareness and debate since its origins, in the 70s. And, there is a long history of an ecologist movement, initially focused on 'saving' specific toponymics, i.e. 'Save S'Albufera', 'Save Trebalúguer', and recently focusing more in systemic or metabolic issues, i.e. water, energy, or waste, as mentioned by the scholar Ivan Murray in Posidònia (2023a).

Last, but not least, I want to mention the tasks of the local and regional administrations, and public institutions that have a relevant role in Menorca to promote scientific research, through publications and outreach activities often connected to landscape and environmental issues. IME, the *Institut Menorquí d'Estudis (Institute of Menorcan Studies)*, OBSAM (Catalan abbreviation of Social-Environmental Observatory), and the Ateneu de Maó, with the collaboration of municipalities and the Menorcan Council (CIME) are some of these institutions (Canals Bassedas & Carreras Martí, 2013; Consell Insular de Menorca, 2020; IME & CIME, 2019; Maó, 2023; OBSAM, 2019). I attended several activities, seminars, debates, round tables, and congresses organized by these institutions (CIME & MAB, 2018; Consell Insular de Menorca, 2019; DEM et al., 2018; IME & DEM, 2022; IME et al., 2023; IME & CIME, 2019; Muñoz & Vernet, 2017) and landscape and the territory are always a noticeable issue.

There is a sentence that I think represents and summarizes the importance of landscape for part of the Menorcan community.

'What in Catalonia are language and culture, in Menorca are the landscape and the territory'.

'Our landscape is our identity'

Verbal communications during XII Escola de Primavera (IME et al., 2023)

A similar sentence was mentioned by different people during the event, and shows the importance and relevance of landscape, beyond anecdotal. Landscape is a key characteristic that is considered essential to describe the identity of the island. And landscape is not used as a general term, as proves the analysis of the documents, seminars, and observations in aforementioned events.

As I explain in the methodology I use the electoral programs of the political parties with representation in the regional council, CIME, to know how they are framing the discourses about landscape. The following subsection aims to connect the individual perspectives and discussions to another level of socializing and prioritizing concerns and elements that are considered important for society.

4.5.2. Political discourses about landscape and territory.

In this subsection I draw an image of the framing that the political parties with representation on the Islands' Council of Menorca, CIME (Consell Insular de Menorca) for the 2019 elections have related to landscape and the territory.

In the following paragraphs, I introduce the results of the elections, that took place the 26th of May 2019, and then I discuss the discourses that each political party relates to territory and landscape, based on the operationalization and categories explained in the methodological section (4.4.2.) based on the content analysis of their electoral programs.

4.5.2.1. Political representation in CIME 2019-2023.

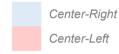
Table 4.3 shows the results of the election of 2019 (G. I. B. GOIB, 2019). Nine political parties, coalitions or platforms were candidates to win one of the thirteen seats on the council, and five of these political parties obtained representation. More than nine out of ten voters chose one of these five parties, and there was a participation of 58% of the census with the right to vote.

Political Parties - Candidates (Acronym - Name)	Votes	% Seats Coalitions		
PP – Partido Popular	11176	28,64	4	
PSIB-PSOE - Partit Sociallista de les Illes Balears	10410	26,68	4	
MxMe - Més per Menorca	6953	17,82	3	
Podemos-EM.EUIB - Podemos-Esquerra de Menorca. Esquerra Unida de les Illes Balears	4307	11,04	1	
Cs - Ciudadanos - Partido de la Ciudadanía	3357	8,6	1	
Other	2822	7,23		
Total voters	39432	58,02		
Abstention	28525	41,98		
CENSUS	67957		<u>.</u>	

Table 4. 3. Election results. 26th of May, 2019. Consell Insular de Menorca (CIMe).

(GOIB, 2019).

Legend for coalitions:



The winner of the elections was PP with more votes but the same number of seats as PSIB-PSOE, four each. But, extending the incumbent government in the council 2015-2019, the center-left coalition formed by PSIB-PSOE, MxMe and Podemos, made an agreement to continue in power for four years more, 2019-2023.

Even though PP has won some elections and has been able to form government in three occasions, four with the recent election in 2023 (BOIB, 2023), Menorca has had mostly center-left governments led by PSIB-PSOE since the end of the dictatorship and the beginning of modern democratic processes in 1979.

To organize the results from the electoral programs, I group the parties depending on the coalition they are part of. The parties in government (2019-2023), the center left-coalition formed by Podemos-EM.EUIB (Podemos), Més per Menorca (MxMe), Partit Sociallista de les Illes Balears (PSIB-PSOE), and the parties in the opposition, Ciudadanos- Partido de la Ciudadanía (Cs) and Partido Popular (PP), representing the center-right. I mainly use acronyms, in brackets, from now on.

4.5.2.2. An overview of the results: The domain of Management and legal instruments.

Figure 4.4. is a summary of the results of the categorization of all the paragraphs that contain the words landscape, territory or its derivates. Based on the methodology explained above, I describe the five categories that go from a more structural or administrative *Management and legal instruments (C5)*, to a more affective one linked to identity and legitimacy (C1).

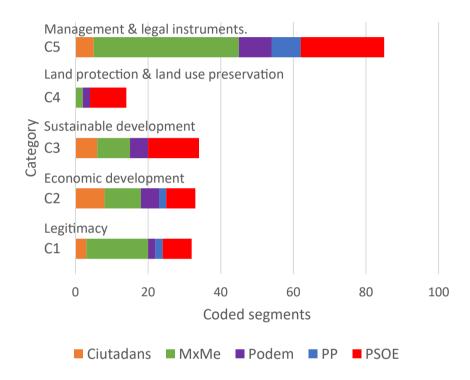


Figure 4. 4.
Categorization of electoral programs:
Landscape and territory.

Coded segments with 'landscape' or 'territory' related words.

The more represented category for all the parties, except for Cs, is Management and legal instruments (C5). In this category, I coded all the paragraphs that suggest a legal instrument, process, technical solution, or a way to coordinate among different levels of public administration (local, island, region, state, or other).

Electoral programs are documents where each party presents their ideas and solutions to the challenges, they consider that Menorca is facing. Therefore, it is not surprising that this category is highly represented. The suggestion of plans and programs to manage resources and human activities connected to the territory is essential in most of the programs. This presentation of management strategies is connected to the work of simplification of challenges done by each political party. Regulatory measures play an important role in

how issues are simplified by providing specific solutions to the identified problems. However, it is sometimes hard to extract more information if this category is not combined with another one. Ambiguity appears here also to offer a generic and simpler solution, 'approve a 'Plan' for X', to a complex problem. In words of Kovacic and di Felice, ambiguity 'suggests that uncertainty may be mobilized to pursue different goals, not because of a lack of information, but because a plurality of representations can be accommodated' (Kovacic & Di Felice, 2019, p. 161). In the case of the electoral programs analyzed, ambiguity is used to claim that the party is addressing a concern without specifying how, thus maintaining some leverage for action.

I want to mention the references to the PTI, the Insular Territorial Plan. As one of the more powerful regulatory frameworks in Menorca, when it comes to landscape uses, the parties also present their position about the PTI in their electoral programs. PSOE-PSIB, prioritize the need to approve the text during the electoral period, (2019-2023) and focuses on maintaining the frame of the previous PTI (2003). They claim that the potential of the PTI is key to plan and limit certain activities to specific areas - such as Tourism, renewable energies, or define uses in coastal areas – in line with the other parties of the center-left coalition. In contrast, the parties in the opposition focus on the need for consensus with the plan (PP) and claim that they will reduce and make more flexible and easier the administrative procedures to promote transparent and shorter processes (PP), and to prioritize sustainable growth (Cs).

4.6. Discussion

The main research question I aim to answer in this chapter is: How do political discourses reflect the "simplifications of explanations" and "prioritizations of concerns" that took place within the process used to inform policy?

Simplifications and prioritizations are key to frame the discourses that are used to inform policy. Landscape and territory are recognized in the analysis as relevant elements for policy making, but there are tensions among the discourses from different stakeholders.

First, in subsection 4.6.1., I comment on a discursive tension between the use of the words "territory" and "landscape" as embodying identitarian discourses that are used to legitimize and justify policies *versus* a more instrumental approach, presented in the results.

Then, in subsection 4.6.2, I will discuss the discursive tensions connected to the normative narrative I coded for each party – i.e., what are the goals, imaginaries and ideas suggested by each party connected to the landscape. The

categories in this case swing between discourses that stress the economic development *versus* the protection and preservation of land uses and the landscape. In the middle of these extremes, appears the discourse about sustainability or sustainable development that promotes economic development in balance with the environment.

4.6.1. Landscape and territory I: A discursive key to explain Menorca from identity to management.

In opposition to the structural component represented for C5, the category Legitimization (C1) includes the affective component justifying both the maintenance of certain aspects and the adaptation to changes that could be threatening some practices or structures in the island (dealing with the tragedy of change). I coded all the segments linked to an affective component and I included the references to the 'Menorcan model' that were mentioned by different parties.

This category contains references to self-determination and/or the establishment of specific decision-making options for Menorca. These references were linked to the consideration of the political community defined by islandness and the specific characteristics of the Menorcan territory as a source of power.

This category is more represented by two of the center-left parties in power, MxMe and PSIB, which links to a national sovereignty and self-determination ideology, the first one, and to a federal tradition linked to the territory, for the second party.

In opposition, PP also assigns relative importance to this category that connects landscape and territory with identitarian justification and source of legitimacy. This is mainly because PP aims at creating consensus to pass laws and make policies that have long-term effects connected to landscape, such as the PTI, or the Action Plan for the Biosphere Reserve.

The minoritarian forces at CIME, Podemos and Cs, give relatively less importance of landscape and territory as a source of legitimacy, and always linked to other categories. Podemos mentions preservation as key to define the identity and it links this preservation with a fundamental value to maintain this identity and promote economic activities. The frame of Cs of landscape and territory as a source of legitimacy is fundamentally giving value to the Menorcan landscape to differentiate from other places and presents rural abandonment as a concern that needs 'new alternatives economically viable' pointing to tourism.

In these results I see this tension between a discourse that embraces a view of the territory as a source of legitimacy to decide how to manage and what to do, because it contributes to define the identity of Menorca, and a discourse with a more utilitarian view of landscape, that sees the territory and existing landscape as a source of differentiation that Menorcan people can use as a comparative advantage to develop economic activities (without considering the implications on the landscape of promoting this 'development').

This tension is also present in the following analysis of the three categories that reflect what types of society are desirable for each party. The context of Menorca creates a shared frame and understanding of the biosphere reserve as a human laboratory for sustainability, however the approaches from the different parties show differences that are in line with the tension already introduced. While, mainly, the parties of the center-left coalition advocate for sustainability as principles to reproduce the system maintaining the landscape and adapting social practices, the parties from the center-right coalition advocate to use the landscape and the territory as a potential touristic resource.

4.6.2. Landscape and territory II: Aiming for sustainability?

The three categories in the middle of the spectrum, that mix components and orientations, are very much connected to the development pathway that is defended and justified by each party.

In this respect, I coded the different paragraphs according to their connection to a more utilitarian view of the territory and landscape that needs to be used for economic development (C2), or protected and preserved by its intrinsic value, Land protection and land uses preservation (C4). I created a third category, Sustainable development (C3), to code discourses that suggest a balance between both.

As figure 4.4 shows, discourses about economic development and sustainability are dominant over land protection for all the parties. The influence of the biosphere reserve declaration is present. The goal to balance human development and the biosphere making possible livelihoods with the maintenance of the environment is very much included in all electoral programs.

Just the three parties from the center-left coalition in power make some reference to the preservation of territorial or landscape elements, as I explain in detail below. While the two parties from the center-right focus on economic development and, to some extent, sustainable development.

In the following paragraphs I present the discussion about the discourses of the electoral programs introducing similarities and differences within the coalitions. I focus, first, on the parties in government, center-left, and then the opposition, center-right.

The parties in the coalition in power, Podemos, MxMe, and PSIB-PSOE share common ground in their emphasis on preserving Menorca's landscape, environment, and agrarian sector, when mentioning the words territory and landscape. They focus on the importance of balancing economic development with environmental protection. The three parties highlight the need to maintain the characteristic landscape of Menorca and view the agrarian sector as a vital component in preserving it. Additionally, there is a consensus among the parties regarding the importance of sustainable tourism, promoting alternative models that respect the environment and local communities.

While the parties share similarities, there are also noticeable differences in their frames and approaches. Podemos stresses the need to complement agrarian activities with new economic endeavors, avoiding the replacement of traditional practices. MxMe puts a strong emphasis on land stewardship initiatives, involving civil society in balancing development, agriculture, ecology, and land protection. They advocate for an alternative tourism model based on niche-specific attractions. And, finally, PSIB-PSOE focuses on achieving a sustainable and resilient development model, prioritizing energy management, and attracting international talent in connection to other European urban and industrial areas.

The three parties recognize the significance of Menorca's landscape in their discourses. They promote sustainable practices, respect for the territory, and the preservation of natural and cultural heritage. While they share these common views, they differ in their specific approaches, about what they prioritize including promoting complementary economic activities (Podemos), emphasizing land stewardship (MxMe), or prioritizing sustainability, resilience, and attracting talent (PSIB-PSOE).

The parties in the opposition, Ciutadans (Cs) and Partido Popular (PP), share a common focus on the economic development of Menorca and the preservation of the rural landscape to support the tourism sector. Both parties talk about environmental preservation but put an emphasis on promoting sustainable growth, and alternatives such as agrotourism or rural tourism. However, Cs positions itself as an alternative model to PP and PSOE emphasizing marketing Menorca's uniqueness, quality tourism, and reducing all-inclusive tourism dominance. In contrast, PP highlights the importance of transport

infrastructure mobility, and connectivity for economic development, aiming to generate demand and improve external connectivity to Spain and international destinations.

Both Cs and PP focus on the economic development of Menorca and recognize the significance of preserving the rural landscape. They promote sustainability, environmental preservation, and propose alternatives for tourism diversification. However, Cs sets itself apart by highlighting its unique model and quality tourism, while PP emphasizes the importance of mobility and transport infrastructure for economic growth.

In summary, while both the center-left coalition and the opposition parties acknowledge the importance of Menorca's landscape, they diverge in their specific approaches and priorities for economic development, with the former emphasizing sustainability and the latter placing greater emphasis on economic factors.

4.6.3. From social identity to political narratives: Discourses of landscape protection vs touristic development and the joker of sustainability.

In this chapter I aimed at understanding how the political discourses found in Menorca are associated with the simplification and prioritization of specific narratives. After identifying landscape and the territory as relevant issues in Menorcan society with different perspectives and political takes on the topic, I analyzed i) how the political parties frame their discourses about landscape and what types of policies they prioritize, and ii) how the political parties mobilize and simplify the concerns identified in society.

Along the chapter I show how the concepts and ideas behind landscape and territory are present in Menorcan society. Landscape emerges as a significant element to define the identity of Menorca, and therefore, is a politicized concept that is reflected in the suggested policies. The analysis of the discourses about landscape in the territory in the electoral programs show this importance. However, depending on the party, the dominance of different categories illustrates which narratives are preferred.

The instrumental use of the PTI, for instance, shows that is a central regulatory mechanism in Menorca that serves most political parties to simplify and hide the complexity of landscape management, while sending a strong and ambiguous message to voters: 'this is important', 'we care', 'we care better than them [even though we are not clear about how]'.

These aspects are useful to partially characterize the political dimension about landscape and landscape management in Menorca. With this case I illustrate part of the dialogue that exists among narratives in a social-ecological system, specifically, how an element that is considered important - the landscape - is used in political discourses to justify policies. While the justification (why) appears clearly, the electoral programs are more ambiguous explaining how and what they are suggesting (explanation and normative narratives). In general, the parties present simplifications that might be appealing for most.

A political ecology perspective is useful to explain how the past and the present perception of landscape and territory in Menorca conditions the narratives existing on the island. What is considered important? By whom? What are the priorities? What simplifications are framed by the parties?

The geographic and historical context of Menorca summarized in this thesis, especially focusing on the last decades of 20th century, show that the current situation is the result of a long-term social struggle to protect the landscape, and the consequence of certain contextual situations at different scales that delayed the touristic development and made possible the biosphere reserve.

The declaration of the biosphere reserve and the promotion of a sustainable development that balances human activities preserving the environment are appealing and have been incorporated in individual and political discourses.

The documents and sources used in this research show that landscape and territory are essential to define Menorca, and therefore to maintain and reproduce the system 'Menorca'. However, different narratives emerge, to justify why is necessary to act — what are the threats, and concerns-, to frame what are desirable situations, and to explain how the solutions proposed solve, or not the issues identified.

Political parties with institutional representation select, prioritize, and translate ideas and visions related to Menorca's identity into policies based on their political agendas and electoral strategies. They analyze and interpret the preferences and the needs of their constituencies, considering the diverse viewpoints and interests within society. Through this process, parties simplify complex information and prioritize certain aspects of Menorca's identity that align with their party platforms and resonate with their supporters. The chosen ideas and visions are then translated into policy proposals that are used to justify their actions and gain public support.

Parties that represent center-left coalition express the need to preserve landscape uses and control or limit human activities, through the PTI and other instruments, and promote economic activities that are compatible. The parties from the center-right suggest looking for new ways of developing economic activities that can benefit from this situation.

Overall, political discourses reflect the simplifications and prioritizations of information used to inform policy. In this way, they shape the perception of Menorca's identity among different groups and translate shared ideas and visions into policy justifications. The interplay between political ideologies, societal interests, and electoral considerations guides the decision-making process of political parties with institutional representation.

Chapter 5.

The PNS dimension

Integrating multidimensional inputs of information in the regional discussion, deliberation, and decision-making for a sustainable Menorca.

5. PNS building blocks: integrating multidimensional inputs of information in the regional discussion, deliberation, and decision-making for a sustainable Menorca

5.1. Chapter overview

This chapter explains in detail a procedure I have developed (presented in Chapter 2) based on the ideas of PNS. It can be used to integrate diverse inputs of information in processes of deliberation and decision-making.

I use the case of Menorca to show how the "PNS building blocks" procedure can be applied to improve the quality of a process of deliberation about the governance of a specific social-ecological system. This procedure should not be considered as a blueprint to be replicated, as such, in other cases. Rather, the proposed procedure should be adapted to other systems after a proper contextualization. This procedure can offer a structuring space to integrate diverse and complex inputs of information by focusing on the quality of the deliberative process rather than on the individuation of optimal solutions.

The situation of the island, described in the Introduction, in Chapter 4, and through the whole thesis, makes Menorca a clear case in which a plurality of framings and legitimate perspectives intersect. The island has gone through a specific process of land protection, as a biosphere reserve, but it is also under the threats of global changes that include the climate crisis, and social pressures related to tourism, gentrification, and abandonment of rural areas, to mention a few of them.

In this chapter I show how the integration of diverse inputs of information in the deliberative process can offer a nuanced view of the complex relationship between policies and the narratives used to reach those policies. Moreover, I illustrate how this integration can provide useful spaces to critically question those policies that are based on reductionist knowledge claims.

I analyze the limitation of certain regulations existing in Menorca, and how deliberation and policy making would greatly benefit from integrating in the analysis narratives referring to societal metabolism. The example used here refers to the adaptation to Menorca of the 2030 strategy and the Sustainable Development Goals (SDGs) using the results obtained after applying the MuSIASEM framework to Menorca (Chapter 3).

Some parts of Chapter 5 are from:

Marcos-Valls et al., (2020), and Marcos-Valls (2023)

Marcos-Valls, A., Kovacic, Z., Giampietro, M., Kallis, G., & Rieradevall, J. (2020). Isolated yet open: A metabolic analysis of Menorca. Science of the Total Environment, 738, 139221. https://doi.org/10.1016/j.scitotenv.2020.1392

Marcos-Valls, A. (2023).Chapitre 5. Choix entre biodiversité. industrie et tourisme: une approche métabolique à Minorque. In B. Romagny, C. Cibien, & Barthes (Eds.), Réserves biosphère et objectifs de développement durable 2 (Vol. 3, pp. 91-114). (Développement des territoires)

This exercise illustrates the need to address the implications of the incommensurability of different types of information in the deliberation process.

The "PNS building blocks" are used as a pedagogical device to explain how the results from previous chapters can be integrated to generate a better-informed discussion capable of contrasting non-equivalent information, from the political and scientific dimensions, according to a PNS philosophy.

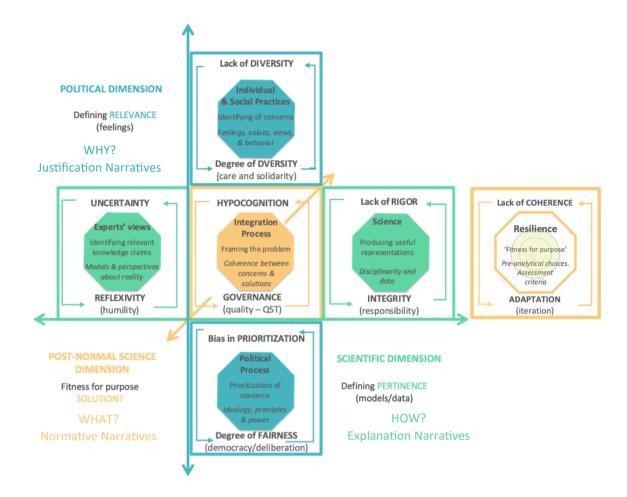
This chapter thus develops one of the main contributions of the thesis. It proposes a conceptual tool for advancing the integration of (i) different types of inputs of information, from scientific evidence to political concerns, and (ii) scientific, political, and participatory processes.

5.2. Conceptual framework of the PNS Building Block

As I explained in Chapter 2, the governance of sustainability in social-ecological systems, and its global implications, entails high levels of uncertainty. When the stakes handled in policymaking are high it is essential to adopt a post-normal science (PNS) approach to inform this process. This requires integrating inputs of information coming from the adoption of non-equivalent narratives and non-reducible models: a severe theoretical and methodological challenge.

In this chapter, I focus on describing the procedure I developed to handle the challenge associated with the integration of diverse types of inputs of information (presented in Chapter 2.4). The PNS building blocks are illustrated in Figure 5.1.

This building block is based on the conceptual map of Giampietro & Bukkens that uses the Quantitative Story-Telling (QST) heuristic approach to check 'the quality of the process of selecting narratives in the framing of a given policy problem (WHY-WHAT) while double checking the relevance and the robustness of the models and indicators used in the analysis (WHAT-HOW)' (Giampietro & Bukkens, 2022, p. 3). This suggested procedure is a way of establishing deliberations about complex issues and face the changes that affect social and ecological systems (Giampietro & Kovacic, 2019). The building block considers the existence of non-equivalent representations that need to be communicated and dealt with in the deliberation for sustainability (Zografos & Howarth, 2010).



The **political dimension** contributes to defining the relevance of the problems at stake and negotiating their prioritization. This dimension collects the justification narratives. Why are (those) things important (and not others)?

The **scientific dimension** refers to the pertinence of the narratives used to understand and explain the defined problems and anticipate the result of performed (or planned) actions. This dimension focuses on the explanation narratives: how plausible is the scientific knowledge used to inform the issue at stake.

Figure 5. 1.
Description of characteristics of the sides of the PNS Building block.

The **PNS** dimension aims at determining if the framing of the deliberation about problems-concerns identified and solutions proposed and decided in a system is adequate. The PNS dimension allows to check if the deliberative process is fit for purpose (see 2.4.), that means if there is a correspondence between what is identified and framed as problems and concerns-in society, and the solutions that are informed, suggested, and decided.

Figure 5.1 includes the characterization of each side based on the elements I explained in Table 2.1. The summary of the description presented on each side is illustrated in Figure 5.2., that I use as a model to the characterization to each side in the following subsections.

The procedure considers three dimensions: Political, Scientific and PNS dimensions. Each dimension is broken down in two "sides" of the block. The representation of the building block serves as a guide to characterize the sides of each dimension, and the associated quality checks (Figure 5.1). Moreover, the block helps convey the relational interdependence between dimensions that, at the final stage, detail to what extent there is consonance among the narratives (WHY-WHAT-HOW).

Before describing the application of the PNS blocks to Menorca, below I present, briefly, how to characterize each dimension and I explain the quality checks associated to each side of the block. For each quality check, I suggest a series of guiding questions to emphasize that quality should not be checked through indicators, but rather through a reflexive evaluation of the three processes: (i) political, (ii) scientific, and (iii) the integration of the two.

5.2.1. The political dimension:

The political dimension is the one that defines the relevance of the issues to be discussed and it is organized around justification narratives about problems and solutions identified within societies. Justification narratives are useful to understand and explain why certain issues are considered problematic, and why some concerns are prioritized over others.

Within the political dimension, there are 2 sides of the block. The first refers to the Individual and social practices as a means of identifying concerns, and the second refers to the political process as a means to assess how concerns are negotiated and prioritized.

Checking the diversity of concerns

The goal of this side is to identify the concerns present in society. The chosen set of concerns allows the definition and discussion of the identity of the system. Identity elements represent what needs to be maintained and reproduced according to the members of society for the system 'to be (remain) that particular system'.

Concerns are expressed through feelings, values, visions, and behavior. Visions may be elicited from stakeholders, for example through interviews, focus

COLOR = DIMENSION Pre-analytical choices

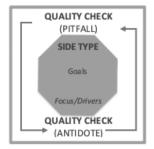


Figure 5. 2.

Description of the characterization of each side.



Figure 5. 3. Individual and Social Practices

groups, workshops. Social practices are considered as a way of observing feelings, values and behaviors.

The challenge in the identification of concerns might be that some concerns are more easily identified while others are more elusive and then tend to be underrepresented. This fact may lead to a lack of diversity in the representation of existing concerns. To respond to this challenge, care and solidarity are useful perspectives to improve the quality of the participatory processes used to elicit concerns and of the broader deliberative process.

The quality check proposed for this side is to assess the degree of diversity of issues considered in the problem and solution structuring.

To operationalize this quality check, the following questions may be asked:

- 1) How diverse are the concerns expressed? Is a dimension (e.g., economic interests, identity elements, environmental concerns) overrepresented? Is a dimension underrepresented?
- 2) How diverse are the stakeholders whose concerns are identified? Whose concerns are represented? Whose are missing?
- 3) Are different concerns expressed differently? Are values, feelings, visions and behaviors accounted for?

Checking the fairness of political representations.

The goal of this side is to understand how different concerns are prioritized.

The elements that determine the prioritization of concerns are ideologies, which may be political and/or economic, principles, which may be issue oriented (such as sustainability) or process oriented (such as fairness), and power, which alerts to the contingent character of political processes as power relations may subvert the prioritizations based on principles and ideologies.

The challenge in the prioritization of concerns may be that power asymmetries may make some concerns hegemonic, creating biases in the choices of prioritization. To respond to this challenge, inclusive and deliberative procedures can be promoted that create the conditions for democratic values to be upheld. Democracy itself is, of course, subject to prioritization biases. However, recurrent elections and public consultations are mechanisms that offer possibilities to correct or counteract these biases when they appear.

The quality check proposed for this side of the block is to assess the degree of fairness. This quality check considers: (i) who participates in the discussion,



Figure 5. 4. Political Process

and (ii) who is represented when addressing the diversity of concerns in the discussion.

Questions that guide this quality check are:

- 1) Is the prioritization fair? Are the procedures and the outcomes of the prioritization accepted or contested? By whom?
- 2) How are different the voices represented? Which voices are included in the debate? Does the political process include future generations and concerns affecting systems outside the system?
- 3) How can the participants show their concerns and participate in the prioritization? Do power structures allow for all participants to express their concerns and participate in the prioritization?
- 4) Are there systematic biases in the prioritization? Are there hegemonic views, power asymmetries, ideological distortions?

Deliberation can be seen as an antidote to the lack of fairness based on the idea that deliberative processes 'are likely to generate decisions that are more acceptable, hence effective, due to their value-inclusive nature' (Zografos & Howarth, 2010, p. 3406). Following the Habermasian school of thought, providing a structure that can offer spaces for deliberation among different interests through communication can improve the fairness of the political process. Communicative rationality, defended by Habermas, appears as 'better placed' to advance the democratic development of society through discussion and quest for consensus, in opposition to instrumental action that looks for achieving individual ends (Zografos & Howarth, 2010).

In the PNS literature, deliberation is not necessarily aimed at creating consensus, rather, it is a way of improving the quality of decision-making processes in a context of irreducible uncertainty, in which no optimal solutions can be defined. Van der Sluijs (2012) speaks of "working deliberatively within imperfection" to signal that the purpose of deliberation is to improve the quality of the process, irrespective of whether consensus is reached about the outcome. Similarly, Haraway's (2016) call to "stay with the trouble" focuses more on the importance of procedural aspects like care, than on the need to resolve problems.

5.2.2. The scientific dimension

The scientific dimension focuses on the pertinence of the models and data used to offer explanation narratives. Explanation narratives describe how concerns can be addressed and how specific solutions can be achieved.

In this framework, the scientific dimension is based on these two sides, with their associated quality checks. The first side refers to experts' views and aims at identifying the knowledge claims that are used to define which models of *reality* should be used. The second side refers to the scientific process by which data and scientific evidence are produced, peer-reviewed and come to be regarded as truthful.

Fostering reflexivity in the production and use of knowledge claims

The first side of the scientific dimension refers to experts' views. The goal of this side is to identify the validated knowledge claims that are used when creating models that explain how problems and solutions operate.

To characterize this side of the box, we need to know, first, what are the scientific principles and narratives used to understand the mechanisms that explain the problem, and then, identify the anticipatory models used to explain how the suggested solutions work.

The main pitfall of this side is that expertise is limited by uncertainty. Especially when studying complex challenges such as sustainability challenges, many uncertainties are present, which may be technical (pertaining to data gaps and bad measurements), methodological (regarding the inadequacy or insufficiency of the models used to represent reality) and epistemic (referring to the limits of knowledge determining the presence of unknown unknowns). Unrecognized uncertainties can lead to inadequate knowledge claims, which do not recognize the limits of Knowledge usefulness. The antidote to the challenge represented by uncertainty is humility, that is, the recognition of the limits of expertise and science as providers of knowledge and as problem-solvers (Jasanoff, 2007).

Humility and reflexivity are necessary to recognize and be transparent about the limitation of the models chosen to frame both problems and solutions. If we accept that 'all models are wrong, but some are useful' (Box, 1979), then quality refers to the usefulness of expert knowledge not to its truth. The key here is to be humble and open enough to reflect upon the limits of the models



Figure 5. 5. Experts' views

used to represent the complex issues to be dealt with. The guiding questions for this quality check are:

- 1) What type of uncertainties should we expect in relation to the data, models and theories used?
- 2) How reliable is scientific expertise in this field? Is there a high degree of scientific consensus about the pre-analytical choice of narratives or is the field characterized by controversies?
- 3) How ignorant are we about our ignorance?
- 4) What do we know about the factors that will make our models no longer valid in the future?

Upholding integrity in the production of scientific information

The goal of this side is to produce pertinent representations of the external world. The focus is on the data used to measure and describe perceived events and on the choice of the discipline that gives meaning to the data. The scientific analysis is connected to the types of data and representations that are developed and used to create explanatory narratives.

The role of science for governance envisioned in the linear model of "science speaking truth to power" is to provide such information -evidence- that can be used to solve specific issues. However, as is introduced with the parable of the *Blind Men and the Elephant* (2023), science is limited to 'the methods of questioning' decided in a pre-analytical phase and therefore cannot speak with one voice.

Scientific activity has developed its own quality checks to acknowledge these limitations. Science has provided rigorous methodologies for gaining knowledge about the external world. However, it is not sure that the "scientific method" provides the best approach to address complex issues connected to all social and individual areas of life (SAPEA, 2019; Stueber, 2012). The term 'scientism' (Haack, 2007) is used in a derogatory sense to describe the favouring of scientific knowledge while disregarding local traditions and insights from other fields of study and culture (SAPEA, 2019) that may be pertinent to address certain issues, including sustainability challenges.



Figure 5. 6. Science

Science for governance and sustainability has played a privileged role in dealing with all human problems through technological progress. However, this role based on the old business of prediction and control - i.e. "the Cartesian Dream" (Guimarães Pereira & Funtowicz, 2015) that many institutions use to justify plans, is often based on poor scientific results (Saltelli & Giampietro, 2016, p. 60).

The main pitfall of the production of representations of events in the external world is thus determined by either lack of rigor (the scientific process does not satisfy its own quality checks) and/or poor analytical choices (the chosen scientific method cannot characterize the issue at hand).

The antidote to lack of rigor and poor analysis is the responsible use of scientific data. Responsible scientific practice requires an openness to citizenship and society to critic and be creators in the knowledge production as part of an extended peer community (Guimarães Pereira & Saltelli, 2016, p. 121).

The quality check proposed for this side is integrity, which may be operationalized through the following questions:

- 1) How are we sure that the proposed scientific analysis is robust and relevant to society?
- 2) Did we try to integrate the proposed scientific information with other types of knowledge?
- 3) Is scientific data used to silence other voices and forms of knowledge?

As presented in the book 'The rightful place of science' (Benessia et al., 2016) the integrity of science has become an increasing concern, among scientists and the media. Even though science is still a trusted public institution, the crisis of quality within science is a threat to this trust (Saltelli et al., 2016) and could lead to the delegitimation of the social role of science.

5.2.3. PNS dimension

The PNS dimension of the block relates to the need of having an adequate capability for checking the quality of the problem structuring. The complexity of the problems at stake requires the integration of incommensurable inputs of information. Therefore, the deliberation process needs to check if the integration of the political and the scientific dimensions has been effective in relation to the need to analyze the plausibility, effectiveness, and fairness of suggested solutions.

In terms of narratives, the PNS dimension assesses the normative narratives (what to do) that integrate the explanation narratives that address the problems and solutions (how) with the concerns (justification narratives) identified by the system (why).

Addressing the adequacy of the problem framing

The first side of the PNS dimension is aimed at checking the quality of the framing of the problem. The problem structuring faces several challenges related to the complexity of wicked problems of many environmental and sustainability issues (Ney & Verweij, 2015). The existence of diverse framings for a given issue makes it impossible to find *the correct* problem structuring, as the perceptions and representations will be always contested.

Therefore, the focus of this side is the coherence between concerns (identified and prioritized in the political dimension) and solutions (provided by the scientific dimension). The challenge to be overcome is how to avoid the bad framing of a challenge.

That is, the existence of multiple framings of narratives and concerns pose challenges to decision-making. The selection of a specific framing for governance entails the simplification of the complex mix of scientific representations. This simplification entails the generation of hypocognition in relation to the discarded frames and information. Hypocognition, as described by Lakoff, is 'the lack of frames that capture the reality of the situation' (2010), and it leads to 'socially constructed ignorance' (Ravetz, 1987; Rayner, 2012).

The antidote to hypocognition is QST (Quantitative Storytelling, see section 2.4). In brief, QST is an approach that provides multiple storytelling about the issues at hand, whose plausibility is checked using basic quantitate data. The diversity of co-existing framings indicates that there are no 'right' solutions. QST is particularly useful in excluding implausible narratives. In this context, it is important to consider the pressures that may come from different stakeholders and check the consistency between the political and scientific dimensions when evaluating the quality of policies.

The quality check of this side pinpoints the importance for the governance system to be flexible enough to readjust to changing situations. The system requires mechanisms to adapt when the outcomes of the quality check result to be not as expected or when new inputs of information show that the proposed policy is not contributing to improve the situation.

Some guiding questions for the quality check are:



Figure 5. 7. Integration Process

- 1) How do we know that the chosen policies will respond to the problems defined according to available information?
- 2) Is it plausible to assume that the proposed regulation will address the concerns prioritized?
- 3) What are potential side effects that could be determined by the desired outcomes looked by the regulation?

'Fitness for purpose': Considering the resilience of the system

The resilience side represents the base of the block. The basement of the block contributes to defining if the system is in "semantic closure" or not after integrating the narratives from the different sides of the block. Accordingly, I use the basement of the block to assess if there is closure between i) the justification narratives that come from society defining what are the worries and wishes from the system, ii) the explanations narratives that illustrate the known mechanisms about how the systems works and the possible changes determined by suggested policies, and iii) the normative narratives that define what are the actions that should be taken to solve the identified problems.

This side takes a long-term perspective on coherence. According to this dimension, if there is coherence between concerns, solutions and biophysical constraints, the system will keep reproducing and adapting – i.e., its sustainability will be improved. Thus, the aim of this side is adaptability.

I have illustrated earlier this equilibrium with the metaphor of a bubble level, like the ones used to check if a shelf is straight or twisted (Figure 5.9). In the case of the building block, the inclination shows if one narrative dominates or if there is equilibrium - fitness for purpose. Lack of equilibrium shows mismatches among the quality checks for policymaking.

The equilibrium of the block, representing fitness for purpose, builds on the relationship between desirability, feasibility and viability described in previous chapters (see Chapters 2 and 3). Desirability - what society in a system wants to be or to become - needs to be contrasted to the feasibility and viability in relation to what is possible in biophysical terms and in technical terms in the system.

The focus of the analysis are pre-analytical choices within the scientific dimension, which determine viability and feasibility, and the assessment criteria of



Figure 5. 8. Resilience



Figure 5. 9. Representation of equilibrium level.

(see Fig 2.4)

the political dimension, which prioritize what is to be maintained and reproduced (desirability).

Lack of coherence is the main challenge of this side, and it implies that the system is unable to reproduce itself. Lack of coherence signals a lack of balance in the block as a whole.

The remedy to the lack of balance is the iteration of quality checks looking for an overall coherence of the problem framing. When dealing with complex systems, solutions may not be easily identifiable. For instance, If I want to check 'sustainability' in "system A", first I need to define the boundaries and certain sustainability criteria. A possible definition of sustainability in "system A" can define as desirable to 'reduce CO2 emissions in "system A". But then, if all fossil fuel devices in that system are removed or substituted for new technologies, then "system A" will become "system A". The system achieved the goal to reduce emissions (a purpose reflecting the original definition of sustainability problem), but how do we know that "system A" is more sustainable? Because of the unavoidable presence of hypocognition we really cannot know. We cannot know the side effects of the changes on other systems. May be activities with high CO₂ emissions may have been simply relocated to other systems, or the solution of the problem with CO₂ may have generated a different problem in a different field, leaving overall sustainability predicament the same.

The quality check suggested for this side of the block is to assess the factors determining the adaptation of the system. This quality check can be operationalized using the following questions:

- 1) According to the chosen representation, what are the factors to be considered for assessing the capability of the system to reproduce and adapt in the long run?
- 2) What are the factors determining unbalances in the system? Are the solutions proposed feasible, viable and desirable or is one of the three criteria more/less present?
- 3) Are political and scientific processes integrated democratically and deliberatively or does the system tend towards authoritarianism and/or scientism (i.e. hegemonization of a reduced set of narratives)?

In the following section I summarize the results of the application of the analysis based on the PNS building block.

5.3. Application of the PNS building block to Menorca.

I warn the reader that what presented below is just a procedural illustration of the approach aimed at advancing integration of the diverse information I collected to characterize each dimension. A full application of the PNS building block is a transdisciplinary endeavor that would require a large-scale process involving different types of expertise. The challenge of carrying out participatory processes is tough, in general, and specifically in the timeframe of a doctoral research (Kovacic & Marcos-Valls, 2023). My doctoral research, in this case, has been affected, also, by the COVID pandemic. Nonetheless, I hope that the diversity of proposed methodologies and their integration in the PNS approach represent a preliminary, tentative integrated framework that can be used for deliberation.

5.3.1. Summary of the methodological approach applied to Menorca.

To achieve the goals of the research I applied a combination of qualitative and quantitative methods. In previous chapters I characterize each dimension -scientific and political- separately. In this chapter, I apply the rationale of the PNS building block and I integrate the results of the situational analysis, Chapter 4, with the metabolic one, presented in Chapter 3. I refer to the adaptation of the SDG to Menorca and the targets about biodiversity and landscape to illustrate how integrated tools can help make sense of diverse inputs of information.

Due to limitations of the research, I couldn't include an extended peer community in this research about Menorca. Therefore, in this section, I present some preliminary reflections about the potential of a transdisciplinary approach based on the insights gained through my collaboration with different researchers and stakeholders during my research.

First, I use situated analysis (SA) to map and understand the general situation. I apply SA as a starting point to organize the *messy* information about the identity of Menorca. I want to understand what elements are important for *people* of Menorca. SA allows to employ diverse tools to obtain information and data to explain part of the political dimension. The analysis of documents and ethnographical research provided this information. I present a glimpse of the perceptions about what is important in Menorca receiving inputs from individual and groups discussions, events, media, the analysis of different documents and everyday life on the island.

Once the situation is mapped, I used environmental communication methodologies to find specific discourses of representative stakeholders. I focused on landscape and the territory as a relevant element that embodies part of the identity of the island according to the mapping. I selected political actors, the political parties with representation in the island council, CIME, to understand their discourses about the topic. I categorized their discourses and identified how each party prioritizes landscape messages in their electoral programs.

To characterize the scientific dimension, I applied two types of analysis. As presented in chapter 3 – i.e., the MuSIASEM approach shows an integrated view of the societal metabolism in Menorca in a set moment. Moreover, I contrast this integrated view with the analysis of existing indicators and scientific reports about Menorca. These indicators show how Menorca is perceived, and which quantitative storytellings (QST) are dominant in the available framing of perceived problems and solutions. This way I contribute to show what information is considered pertinent to characterize the complexity of the problems identified in Menorca.

Finally, in relation to the PNS dimension I consider the integration of the inputs of information collected from the four connected sides of the block. The goal is to check if there is coherence -fitness for purpose- between the information that is perceived and prioritized as relevant -political-, and the explanations that are provided as pertinent to solve the identified issues -scientific -.

In the following section I present an integration of the information about the political and scientific dimensions explained along the chapters of the thesis. Moreover, I complement the analysis by introducing new elements that contribute to contextualizing the situation in Menorca. I include regulatory frameworks approved in Menorca during the electoral period to provide perspectives that add relevant elements from institutions in the discussion. Among these new elements, I highlight the Action Plan for the Biosphere Reserve of Menorca, an adaptation of the Agenda 2030 and the SDGs to Menorca.

5.4. Preliminary results and discussion. The case of Menorca

5.4.1 The political dimension (WHY): A common imaginary with biased prioritization

A Biosphere reserve to promote balance between human activities and landscape protection

The mapping of the results I present in Chapter 4 show the importance of landscape as an identity element. Landscape has a relatively dominant importance in the justification narratives found in Menorca. Here, I focus on one specific component of the Menorcan landscape, namely biodiversity.

The declaration of Menorca as a biosphere reserve with consensus among most political parties with representation in the institutions of Menorca is an indicator of a common imaginary of Menorca. Beyond the political parties, civil society represented by organizations, entities and media adds to this consensus. Landscape emerges as a trademark of the island that is mostly accepted. There are also critical discourses and movements against the biosphere reserve, such as the movement 'Reserva de la billetera^{3*}, but in general there are certain consensus with this narrative as I present in the previous chapter.

Even though there is this common imaginary of landscape as a key component in Menorca, different prioritizations emerge depending on the political spectrum.

I use the case of the 'Menorca 2025. An Action Plan for the Biosphere Reserve' approved by the parties in government (center-left coalition, see Chapter 4) to illustrate the existing and contested prioritizations.

Menorca 2025. An Action Plan for the Biosphere Reserve

In 2019, the Action Plan for the Menorca Biosphere Reserve was approved (CIME, 2019a). The document develops a complete strategy to promote a sustainable development based on the conceptual framework of the Sustainable Development Goals (SDGs) and the requirements of the MAB strategy 2015-2025 (U. N. E. S. and C. O. UNESCO, 2017) the Lima Action Plan 2016-2025 (UNESCO, 2016), and the Ordesa-Viñamala Action Plan 2017-2025 (MaB España & OAPN, 2017) under the guidelines of the Seville strategy (U. N. E. S. and C. O. UNESCO, 1996). In its Summary Document (C. I. de M.-A. M. R. de B. CIME & GOIB, 2019), the Plan recognizes that the development of the economy was incompatible with the conservation of nature (ibid) and therefore new actions are needed to promote sustainability.

The Action Plan presents four lines of action, six main objectives with several operational objectives organized in different Action Programs. I contrast two main objectives from the plan that are connected to different SDGs: main

³ Reserva de la billetera translates as 'Wallet reserve', in English. Biosphere and wallet are similar in Catalan and Spanish, 'biosfera' *versus* 'billetera'. This movement claims that the protection of Menorca is bringing benefits for speculative economic interest more than environmental protection (StopCiment, 2012)

objective 1 and main objective 3 (Figure 5.10). I focus on the reference to the word 'biodiversity' in the operational objectives and actions. If the word doesn't appear, as is the case of the main objective 3 or any of its operational objectives, I discuss the potential impacts of these actions and objectives towards biodiversity.

Main objective 1 responds to the 'Program for the conservation and sustainable use of natural heritage, biodiversity and landscape', which is related to SDGs 3, 6, 11, 14 and 15 (3. Good health and well-being, 6. Clean water and sanitation, 11. Sustainable Cities and communities, 14. Life below water and 15. Life on land). Main objective 3 is included in the 'Sustainable economy promotion program', related to SDGs 1, 2, 8, 9, 10, 12 (1. No poverty, 2. Zero Hunger, 8. Decent work and economic growth, 9. Industry, innovation and infrastructure, 10. Reduced inequalities, and 12. Responsible consumption and production).

OPERATIONAL OBJECTIVES • 1.1. To conserve, restore and promote the sustainable use of the terrestrial ecosystems and stem the decline in biodiversity through adequate resource **OBJECTIVE 1** management. • 1.2. To ensure a well-conserved, productive sea through the responsible collective use and sustainable management of resources and by strengthening their capacity for To successfully conserve the Menorca Biosphere Reserve's intrinsic natural and cultural 1.3. To ensure the conservation, improvement, restoration and good use of the architectural, archaeological, sociocultural and ethnological heritage through appropriate tools and by respecting and safeguarding the intangible. 1.4. To work to ensure the rational use of the territory and avoid geographical values, promoting the sustainable use of the Reserve in a manner Compatible with its dispersion, encourage social cohesion, guarantee the right to decent housing, attend t the preservation and improvement of livelihoods traditionally practised in rural areas and consolidate a territorial model that is efficient in all aspects conservation **Connection with SDGs OPERATIONAL OBJECTIVES** 3.1. To achieve higher levels of economic sustainability and circularity through the efficient use of resources, diversification, cooperation, low-carbon production and distribution chains, technological updating, feedback and innovation. **OBJECTIVE 3** distribution chains, technological updating, feedback and innovation. 3.2. To reinforce the primary production system and optimise the use of resources and productivity, promoting sustainable agriculture and fishing. 3.3. To develop sustainable, inclusive, resilient, secure and diversified food systems, making sure the whole society has access to healthy and affordable food. 3.4. To foster a more conscious model of tourism that is jointly responsible for maintaining the values of the Menorca Biosphere Reserve. 3.5. To foster sustainability in the industrial sector, using resources more effectively and promoting the adoption of clean and environmentally rational industrial technologies and processes To achieve sustainable economic and social development. promoting a circular, green, blue and social economy

The 'Program for the conservation and sustainable use of natural heritage, biodiversity and landscape' focuses its attention on one of the three pillars of the Biosphere Reserve declaration: how to make the use of resources compatible with its conservation. On the other hand, the 'Sustainable economy promotion program' centers the attention on 'develop activities that are environmentally and socially responsible, as well as financially viable and profitable' ((C. I. de M.-A. M. R. de B. CIME & GOIB, 2019) using circular economy as a main conceptual tool. The questions raised by the scientific quality check are: Is it possible? To what extent can a society do the same economic activities,

Figure 5. 10. Selected Main objectives, Operational objectives and Connection to the SDG from the Action Plan for the Menorca Biosphere Reserve)

(adapted from (C. I. de M.-A. M. R. de B. CIME & GOIB, 2019)

or even more, with less resources? What role does biodiversity management have in this case? The following subsection will introduce the metabolic performance of the economic sectors in Menorca to illustrate the reflexivity and integrity checks of scientific information.

Checking the quality of the political dimension:

The degree of diversity, as pertaining to the political priorities of the Action Plan for Menorca, is limited. The Action Plan for the Menorca Biosphere Reserve 2025 introduces a few main objectives that the island is following to meet the SDGs. The limited degree of diversity, however, is to be understood as having a political function. The objectives and specific actions aim at being concrete and relatively easy to measure but they are often too open and defined in a manner that the action can be formally accomplished without evaluating its impact on biodiversity or its contribution to sustainability in a bigger scale.

With regard to the prioritization of concerns and policy goals, it should be noted that prioritization is not just a matter of ordering options. In the presence of trade-offs, prioritization may require choosing some goals over others. Considering biodiversity in policymaking implies to be aware of what are the interactions and trade-offs among different human activities that take place in a society and the environmental impacts that it generates. Knowledge about these interactions and impacts is often partial (or neglected – i.e. avoidance of uncomfortable knowledge) and implies the use of non-equivalent narratives and epistemologies that do not necessarily recognize or understand each other. Therefore, managers and policymakers are often walking within a fine line that implies promoting actions that they might find desirable in relation to given areas of expertise, interest, or the region where they work at but that can create undesirable effects at different scales when considering other areas of expertise.

Because of the clear existence of trade-offs, the policy measures prioritized are in tension with each other. The Action Plan for the Menorca Biosphere Reserve shows an ambitious set of actions to protect biodiversity with a program that includes objectives aiming to 'conserve, restore and promote a sustainable use of terrestrial ecosystems' (1.1), to 'ensure a well-conserved coastline and productive sea' (1.2) and work 'to ensure the rational use of the territory' (1.4). At the same time, the action plan includes a program to promote a sustainable economy with objectives aiming at 'achieving economic sustainability and circularity' (3.1.), 'developing sustainable, inclusive, resilient, secure, and diversified food systems' (3.3) or fostering 'a more conscious model

of tourism' (3.4) or 'sustainability in the industrial sector through more effective resources (...) and clean and environmentally rational technologies' (3.5). As a result, the multiple goals prioritized — a classic example of win-win-win solution - may be interpreted as having a high degree of fairness, but when it comes to policy implementation and the incompatibility between different goals comes to a head, this fairness may be lost. In the presence of trade-offs the main concern of the process of decision-making should be analyzing and understanding the implications of them.

Unfortunately, as mentioned before, the specific actions to fulfil these objectives are often open – i.e. 'Application of good practices in all activities organized in the Reserve' (A.1.1.9) or 'Promotion of a form of ecotourism that will help shift the paradigm towards a sustainable tourism model' (A.3.4.3). It is difficult, then, to draw any line about if the accomplishment of the action will protect biodiversity or promote sustainability even though they are designed to achieve this goal. No reference to the attributes to be considered to deal with the consequences of these trade-offs is given.

The adaptation of the SDG to the Menorca biosphere is a strategic exercise to evaluate the situation and adopt actions and goals to aim for a more sustainable society. However, the complexity of sustainability issues and the interconnection between actions and consequences all around the globe make it difficult to achieve sustainability based on these actions and goals. The sustainability of a social-ecological system requires being aware of relations between resources, use, and disposal at different stages, different scales, and different places.

5.4.2. The scientific dimension (HOW). Selecting the lenses to see the world and monitoring indicators. Reductionism vs integrated knowledge for decision making

The amount of scientific information available in Menorca is prolific and covers a relatively high number of disciplines and indicators, from different organizations and institutions, such as 'Ateneu' of Maó (Ateneu Maó, 2002), OBSAM (Catalan abbreviation for Socio-Environmental Observatory) (*L'OBSAM | OBSAM*, n.d.) and the work of universities and independent researchers from all over the world that have contributed to scientific knowledge about Menorca.

I obtained a significant amount of data for the MuSIASEM applied in my research from OBSAM, together with official statistical institutes of Spain (INE), and Balearic Islands (IBESTAT). In the following subsections I show some

implications of the use of the metabolic approach in contrast to focus on specific indicators.

Metabolic performance of economic sectors in Menorca. Application of the MuSIASEM approach

In this subsection, I recall part of the diagnosis of the societal metabolism of Menorca mainly based on the performance of the three economic sectors in the island for the year 2015 (Chapter 3, Marcos-Valls et al., 2020) represented in Figure 5.11..

The metabolic performance of Menorca can be characterized by three indicators: (i) the quantity of resources and emissions needed to produce a euro of gross value added (GVA), (ii) the resources, emissions and value added attached to a square meter of land use (LU), and (iii) to an hour of human activity (HA) in each economic sector. In this case, we focus on the use of energy, considering the thermal equivalent of different energy types (ET, including electricity, fuels and heat), blue water (WT), and on direct CO_2 emissions. This qualitative information based on intensive variables is complemented by the quantitative information based on extensive variables defining how the total amount of hours of human activities (THA), hectares of land (TLU) and gross value-added (TGVA) are distributed among economic sectors (see Figure 5.11). The size of the sections in the figure is proportional to the higher value per each row and color.

For the illustrative purposes of this chapter, I show just one scale: the one used to analyze the economic sectors.

Results show an important divide between industry and services sectors on the one hand, and agricultural activities on the other. While Industry, Construction and Manufacture (ICM) and Services and Government (SG) can generate more value-added with less resources per each euro generated, the volume of the value-added in both activities, especially Services and Governance, that include transportation, imply that in absolute terms both activities use much more energetic resources than Agriculture. Agriculture has a higher dependency on local resources, especially water and land, while industry and services outsource the use of resources, externalizing part of the environmental pressure and impact.

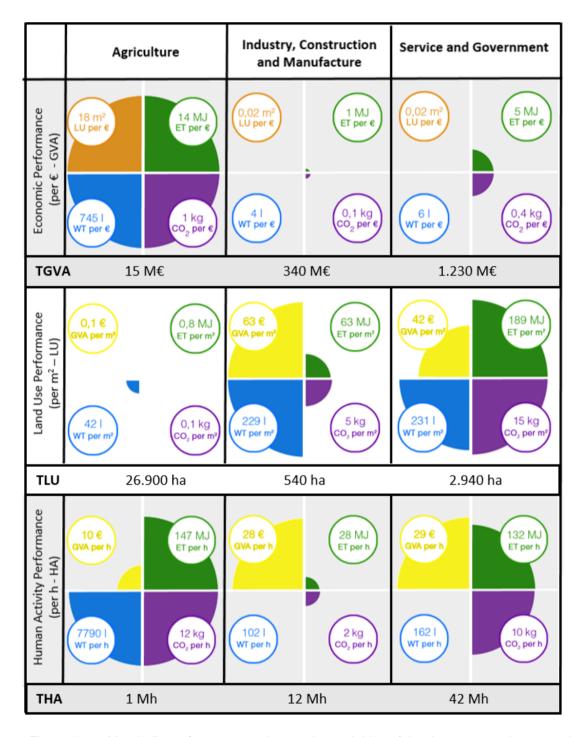


Figure 5. 11. Metabolic performance and extensive variables of the three economic sectors in Menorca 2015 (adapted from (Marcos-Valls et al., 2020)

Looking at the Land Use performance - euros generated, resources used or emissions produced per unit of land (m^2) – I show a similar divide. While agricultural activities have little impact per unit of land, the fact that agriculture occupies a big share of the land in Menorca amplifies the need of resources, especially water, while it still keeps a low economic value-added. Industry and services present a high resource use and emissions per each squared meter and high value-added, due to the fact that both activities occupy less land in the island. The amount of energy (ET) needed for squared meter of services and governments is especially high because it includes transportation and a direct use of fuels for this activity.

The analysis of – (i) euros generated, (ii) resources and emissions linked to an hour in each economic activity, (iii) the Human Activity performance - reproduces a similar pattern. Agriculture, even representing a small share of the total hours of human activity, requires a significantly high amount of water per each hour of work, more than seventy times bigger than industry and almost fifty times bigger than services, while produces a third of value-added. The total energy and emissions show also higher relative values but the difference of hours devoted to industry and especially to services reduces the absolute impact.

Checking the quality of the scientific dimension:

The use of a metabolic perspective suggests a different logic and introduces reflexivity about the methods and models used. The understanding of the metabolic pattern and the performance in the use of resources of the system allows considering relevant information related to what it means to promote certain human activities over others in terms of requirement of human time, land and economic values in a system. As the results show, high economic benefit is often linked to an open economic system (not a circular one) in terms of energy sources (Giampietro, 2019a), and high pressure on water resources, such is the case of industry (ICM). Therefore, promoting industry can increase the pressure over resources and/or the dependence on external resources. The integrated analysis of the use of resources and production of emissions in relation to human activity, land use and the value added provides a more complete vision of the system. That way, it is possible to study tradeoffs among alternatives once they are decided – it is not the same to promote the yachting sector than footwear, and therefore we will need to study and compare the metabolic indicators of both industries before deciding. This way, reflexivity about the models used also promotes integrity and responsibility in the use of indicators and in the treatment of data.

Agriculture depends on local resources, and it has a low contribution to the value added directly for its main function, which is food provision. However, this analysis does not consider other functions provided by agriculture, such as keeping traditional landscape management practices and other traditions. Therefore, it is important to understand how this multi-functionality contributes to the generation of wealth in other sectors, for instance, how agricultural land management contributes, for example, through the provision of cultural services to tourism, or to increase biodiversity by promoting traditional agricultural land patches in Menorca.

The same applies in the opposite direction. The promotion of sustainable tourism can be seen as a desirable activity since the services sector has a higher economic performance and it promotes a sustainable and respectful behavior towards nature and the environment of Menorca. However, it is important to know how many resources are externalized for this tourist to arrive to the island, or to know how many tourists are going to do one route because it is popular this year, the other routes are closed or any other reason, affecting the biodiversity in this area.

The externalization of the demand of resources and the environmental pressures and impacts associated to this externalization implies that the promotion of these kind of economic activities generate a more sustainable development locally, shifting the environmental and social pressure to other places, which should be considered when discussing policies and implementing actions for a sustainable development. Sustainable development for whom?

As we see in the results of the study, we can have information about how the economic activities perform in a system. We can also define goals and targets that we believe are desirable and beneficial for society, but decision-making implies also to prioritize one alternative over another with the participation of different stakeholders and considering incommensurable information that might come from different sources. Just considering one part of the information can lead to decisions that may be desirable for some and undesirable for others. Therefore, reflexivity is needed to check whether there are blind spots and missing knowledge claims in the scientific models used. In relation to this point, integrity relates to the acknowledgment and analysis of uncertainty in indicators, scientific information and evidence for policy is a must. The use of crisp numbers and scientific evidence should not be confused with (or presented as) the ultimate truth.

5.4.3. The PNS dimension to inform decision-making (WHAT): Do we need to choose between biodiversity, industry, and tourism?

Is there coherence/fitness for purpose between problems, solutions, and the current situation?

Since its declaration as a biosphere reserve in 1993, Menorca has developed several initiatives to promote sustainable development and balance human activity with nature. The island has approved its Action Plan for the Menorca Biosphere Reserve to meet the SDGs and is planning to implement its actions until 2025. The document presents ambitious actions with a calendar and required budget to achieve the defined objectives. Conservation of natural heritage, biodiversity, and landscape; efficient resources management; environmental education; and monitoring of the acceptable impacts are the four lines of action included in the plan. The operational objectives and actions are designed to be connected to the SDGs and every program connects with some of the seventeen goals.

The difficulties and limitations of considering biodiversity and sustainability issues in a goal-oriented manner in biosphere reserves, such as the presented Action Plan for the Menorca Biosphere Reserve, lie in the fact that achieving a goal allow for different solutions that normally are not integrated or cohesive with solutions for other goals that can interact among themselves. The use of MuSIASEM shows an example of how integrated approaches enable to deal with complexity and contextualize statistical and numerical data in a transparent way. The approach requires to be open about exploring alternative scenarios and tries to minimize problems related to reductionism and the use of partial scientific data that can lead to decisions against the general interest if the complexity of the system is not considered (Giampietro & Mayumi, 2018).

Menorca is an open socio-ecological system, with a high dependency on external resources. This analysis shows that services (SG) and industry (ICM) contribute directly to the economy in Menorca more than agriculture (AG), far behind in terms of economic relevance. Both services and industry depend on external resources (with high levels of embodied energy) and use more resources per unit of area, while agriculture depends on local resources, such as water. These results can inform policymaking, to decide which economic models are to be promoted or how economic sectors need to transform to adapt to changing biophysical and social constraints.

The high dependency on external resources of Menorca shows that most of the environmental pressures and impacts are externalized out of the biosphere reserve. Therefore, any strategy or action for sustainability should also balance its impact out of the boundaries of the biosphere reserve. Dealing with biodiversity, directly linked to the territory, makes it an extra degree of complexity since managers and policymakers need to take concrete and localized actions to preserve biodiversity on-site while, at the same time, should care about reducing the side effects of these actions to global changes, such as climate change, that could affect biodiversity locally and elsewhere in the long run.

This case study thus shows how achieving coherence between the political and the scientific dimension is not a straightforward exercise of speaking truth to power. No matter how integrated the models are, how complete is the information and how reflexive and responsible are the scientists the intrinsic complexity of the issue of sustainability cannot be simplified. Socio-ecological systems are best understood as multi-level systems and decision-making processes are best understood as happening at multiple levels of governance. The biosphere reserve is affected by and affects the societal metabolism of Menorca together with its trading partners. Political decisions about the biosphere reserve should respond to local concerns and Menorcan identities, as well as the wish to comply with global level policies and political interests related to the SDGs. For this reason, the PNS dimensions comprises two quality checks: coherence in the strict sense of checking the quality of problem framings in relation to local scale perceptions, and in the broader sense of checking the sustainability of social, political, economic and ecological systems at a larger scale.

Biosphere reserves are already at the forefront of implementing policies for sustainable development and maintaining a balance between human development and nature. After years of experiences, with a lot of shared knowledge about this class of initiatives, biosphere reserves are in position to explore the way to new strategies and approaches to integrate systemic information to understand what happens within the reserve but also what are the implications of these actions for global sustainability.

An integrated analysis provides transparency about trade-offs, and it provides a structure to show how changes can modify the metabolic performance across the system. This in combination with the participation of different stakeholders makes it possible to create a democratic and deliberative process

to contrast and share non-equivalent data, alternative perceptions, and the implications of implementing certain actions over others.

Chapter 6.

Conclusions and future developments

Complexity...

... is not beyond our understanding; it requires new ways of understanding. It requires, in many cases, a more explicit and detailed analysis of the many roles context plays in shaping natural phenomena

Sandra Mitchel

(Mitchell, 2009)

6. Conclusions and future developments

In this last chapter I present the main conclusions and contributions of this research.

First, I answer the research questions presented at the beginning of the dissertation. Then, I summarize the contributions and concluding remarks for each chapter. And, finally, I suggest future developments beyond research to expand the findings of this project and overcome the limitations.

6.1. Answering the research questions

The three main objectives of this thesis are, i) identify the diversity of relevant information that can be used to describe Menorca as a socio-environmental system; ii) assess how, in the process of decision making, issues are prioritized and who has the power to simplify complexity; and iii) suggest an approach allowing to assess the quality of decision-making processes integrating diverse and complex inputs of information.

The following subsections answer the three main questions:

- RQ1. What information is pertinent to the characterization of islands understood as complex socio-ecological systems?
- RQ2. How do the political discourses reflect the 'simplification of explanations' and 'prioritization of concerns' that took place within the process used to inform policy?
- RQ3. How can diverse and complex information spaces be integrated in deliberative decision- making processes?
 - 6.1.1. RQ1: What information is pertinent to the characterization of islands understood as complex socio-ecological systems?

Coming to practical results characterizing the metabolism of Menorca, our results show that we are dealing with an open social-ecological system, with a high dependency on external resources. The two sectors thriving on externalization - services (SG) and industry (ICM) - are the main direct contributors to the economy in Menorca, while agriculture (AG), far behind, is starting the process of progressive opening expanding the sector of animal products (where feed can be imported) and moving to agribusiness (importing directly milk to produce cheese). Both services and industry rely on external resources and are intense resources users per unit of area, with high – but often outsourced – metabolic densities, while agriculture has a high dependence on

Some parts of Chapter 6 are from:

Marcos-Valls et al., (2020)

Marcos-Valls, A., Kovacic, Z., Giampietro, M., Kallis, G., & Rieradevall, J. (2020). Isolated yet open: A metabolic analysis of Menorca. Science of the Total Environment, 738, 139221. https://doi.org/10.1016 /j.scitotenv.2020.1392

Marcos-Valls, A. (2023).
Chapitre 5. Choix entre biodiversité, industrie et tourisme: une approche métabolique à Minorque. In B. Romagny, C. Cibien, & A. Barthes (Eds.), Réserves de biosphère et objectifs de développement durable 2 (Vol. 3, pp. 91-114). (Développement des territoires)

local natural resources, such as water. At the same time, how people use land and time defines the identity of Menorca. Therefore, changes in the existing performance of the metabolic pattern of Menorca are directly related to changes in all aspects of its identity – landscape, traditions, food, language.

Based on the MuSIASEM accounting framework, I identified and characterized in quantitative terms the factors determining feasibility, viability, desirability and the level of openness of the system. The pertinence of this information depends on the problem framing. For instance, if the purpose is to study economic sustainability, the characterization of viability and the level of openness will provide pertinent information; if the purpose is to study environmental sustainability, the characterization of feasibility and level of openness will provide pertinent information. In relation to the ability to integrate these different inputs of information, we have still to learn how to establish an effective interface with the social actors that have to be involved in an informed deliberation about their future. This point leads to the next research question I aim to answer:

6.1.2. RQ2. How do the political discourses reflect the 'simplification of explanations' and 'prioritization of concerns' that took place within the process used to inform policy?

Chapter 4 delved into the presence of landscape and territory concepts in Menorcan society and explored the discourses promoted by political parties with representation in the regional council of Menorca, CIMe.

The findings shed light on the politization of landscape and territory, highlighting their significance in discussions surrounding Menorca's identity and policymaking processes. A political ecology perspective proved useful in understanding how historical perceptions and present contexts shape narratives about landscape and territory, including what is considered important, who determines priorities, and the simplifications framed by political parties.

The geographic and historical context of Menorca revealed that the current landscape situation is the outcome of long-term social struggles to protect it, as well as specific contextual factors that delayed tourism development and facilitated the establishment of the biosphere reserve. The declaration of the biosphere reserve and the promotion of sustainable development that balances human activities with environmental preservation have become appealing concepts integrated into individual and political discourses. However, the

existence of this common ground or idea is not eliminating the existence of diverse perceptions and narratives about potential challenges and solutions.

Political parties with institutional representation play a pivotal role in selecting, prioritizing, and translating relevant issues and visions related to Menorca's identity into policies. They simplify complex information and emphasize specific aspects of Menorca's identity that resonate with their supporters, using these issues and visions to justify their actions and gain public support, aligning with their political agendas and electoral strategies.

In conclusion, this research showcased the essential role of landscape and territory in defining Menorca in the political discourse, while acknowledging the emergence of diverse narratives that identify different threats and concerns, justifying different actions, and framing diverse desirable situations, and solutions.

There are a lot of types of information and inputs needed to represent a complex reality and inform policy making. Any political discourse tends to simplify and be ambiguous. Still decision-making is required and political choices entail specific actions and consequences. This point leads to the next question flagging the need of developing approaches effective in the structuring and integration of information for the governance *in* complexity.

6.1.3. RQ3. How can diverse and complex information spaces be integrated in deliberative decision- making processes?

Based on the research carried out in this PhD, to answer this question I start by claiming that addressing complex issues requires using a PNS approach. Complicated issues can be handled by disciplinary expertise and rigorous work, but complex issues require going beyond the existing knowledge and consider incommensurable types of information that include ethical, social, technical, or scientific inputs, including the implications of unknown unknowns.

In this thesis, I suggest adopting a flexible and adaptive approach — what I called "the PNS building block" - to contextualize information and critically frame debates to improve deliberations. I illustrate how the PNS building block can be applied to the case of Menorca by focusing on the discussion of the biosphere reserve, and I use it to integrate the characterization of the scientific and political dimension. At the end, in this way it becomes possible to analyze specific policies in relation to the available information.

Different social actors have legitimate but contrasting concerns and perspectives about what should be considered as an "improvement". The political discourses about landscape in Menorca present certain diversity in the approaches depending on the preferred economic model of the different parties reflecting their instrumental or identitarian views. However, the simplification and ambiguity found in the narratives of the various political parties embody a certain degree of agreement: a contextual analysis of the future of Menorcan society should start from the landscape and that actions are required. In addition to this analysis of the political dimension, the openness of the system poses other challenges in relation to the evaluation of the appropriateness of the knowledge provided by experts and scientific studies in relation to decision making.

The conclusion is that checking the quality of the process of production and use of scientific information in decision making is an essential step to guarantee a proper integration and prioritization of the non-equivalent but legitimate perspectives found in society. The quality check should control that the discussion about problems and solutions is framed adequately to guarantee adaptation, resilience, and fairness allowing new inputs to be included in the deliberation.

6.2. Contributions and concluding remarks

6.2.1. Organizing complexity. Advancing integration of information about complex systems.

The characterization of complex socio-ecological systems requires the integration of information about: (i) the system under analysis and its interdependencies with other systems, (ii) key attributes described using a combination of intensive (qualitative) and extensive (quantitative) variables allowing a discussion of trade-offs and nuance the characterization of different economic and social activities.

When discussing sustainability issues, that are complex by definition, it is key to consider and be aware of the diversity of existing information and find ways of integrating it. A system can be described in many ways. It is the purpose of the analysis that defines the usefulness of the characterization – i.e. achieving sustainability. However, we still need to answer other questions – sustainability of what, for whom, for how long, and at which cost before being able to identify the inputs of information that are pertinent.

Moreover, when coming to a biophysical characterization of the metabolic pattern of social-ecological systems, the factors determining biophysical flows can only be observed across different levels of analysis and considering the complication associated with the extreme openness of the economic processed operating in a globalized world. When dealing with the analysis of the metabolism of islands where tourism is a relevant economic activity, such as Menorca, the characterization of metabolic patterns is an essential starting point to assess the openness and environmental impacts of the system.

A narrative based on an integrated analysis of the island's metabolism (inward looking) and of the openness of the system (outward looking) can contribute to provide pertinent information to characterize the system and to improve the quality of the debate about resilience and adaptation.

In the case of climate change, for instance, it is pertinent to show how responses to climate change may depend on both local factors and global trends. This interdependence means that the location and boundaries of governance are blurred: local government initiatives to improve the sustainability and resilience of Menorca may be weakened by the dependence on imports and tourism.

6.2.2. Identity, landscape, and governance for sustainability. How to decide about what matters?

Political discourses affect and are affected by the simplifications and prioritizations of the inputs of information used to inform policy in three ways: (i) including or excluding the relevant elements detected in society, (ii) shaping their discourses and simplification to their ideological agenda, and (iii) using ambiguity to allow different interpretations that can increase their representiveness.

The political parties aim at simplifying the explanations and prioritizing the concerns to offer narratives that are appealing to the community they are part of, and reflect the issues that society finds relevant. Each political party has its own agenda and guiding ideology that contributes to explaining how each party frames certain issues.

Beyond the political parties, the political discourses that exist in society are shaped by the context. The history and characteristics of a system define, in part, these discourses and are represented by the existence of organizations, institutions, and the way social practices are organized.

The interplay between political ideologies, societal interests, and electoral considerations guides the decision-making processes of political parties with institutional representation. Ambiguity appears to be a key characteristic to amplify the potential of the representativeness of their discourses. That way, political parties can claim that i) they have identified important elements in their discourse, ii) they are ready to act – e.g. by declaring the "we are going to approve the PTI", however iii) it is often not clear what 'the plan' is about, and what are the actions, implications and consequences.

The narratives that justify why something needs to be addressed in a system is tightly connected to threads that can modify the perceived identity of that system. This recognition of the identity of the system is key to establishing priorities and, more importantly, to check how the existing problem-solutions frames do affect the system.

6.2.3. Methodological contribution. The PNS building block

Addressing the objectives and the research questions in this research, I contribute methodologically advancing in the integration of incommensurable types of information for governance.

Each chapter explores in detail one aspect of the integration of diverse information. Chapter 3, dealing with the challenge of integrating information coming for non-equivalent descriptive domains (technical incommensurability). Chapter 4, addressing the existence of legitimate but contrasting views among social actors (social incommensurability). And, finally, chapter 5, propose a PNS approach to integrate this incommensurable social and technical information. The proposed approach focuses on the problem of how to guarantee the quality of the process of decision making by checking the coherence or fitness for purpose of the different inputs of information processed in it.

Technical incommensurability

The application of MuSIASEM in chapter 3, provides a valuable example of an approach that can contribute to avoiding the use of sets of incoherent indicators (valid indicators, that, however, do not change in relation to each other). In relation to this point, the MuSIASEM provides a multi-scale integration of the quantitative analysis establishing a link between the values taken by the different indicators used to characterize the societal and ecosystem metabolism across different scales and dimensions.

In the case of Menorca, the use of this methodology presents an integrated analysis that explains the relation between the use of local resources and interaction with other social systems in the functioning of Menorcan society. The energy and material flows (characterized in intensive and extensive terms) are connected to the profile of human activities. The openness of the island-system is described, and that way illustrates concrete dependencies that explain the performance of the economic sectors on the island.

Social incommensurability

In relation to social incommensurability, the thesis shows how political discourses engage with different types of narratives. Justification narratives (why) appear clearly and are often shared and connected to recognized identity elements. However, the identification and representation of these common elements don't translate into the same implications for action for everyone. Social incommensurability can be seen in the fact that to deal with this problem electoral programs are ambiguous when explaining what they are suggesting and how they plan to reach their goals (when providing details on explanation and normative narratives).

The contribution of this research is to provide a procedure to contrast these different narratives and enable a more informed and open deliberation about complex issues. The recognition of complexity (uncertainty in the issue definition) and lack of concrete or unique solutions is key to approach deliberation and decision-making. This approach provides a structuring space for discussion and a space for questioning the chosen frames of discussion. The use of quality checks allows us to go beyond the current frames by including considerations that could question the plausibility of existing policies for sustainability.

The PNS building block: Quality as a guiding principle

The last contribution of this dissertation is connected to the procedure developed in chapter 5: the PNS building block. As it is defined by the name, this innovative procedure, based on the ideas of PNS, allows to handle non-equivalent inputs of information across dimensions that are characterized by a high degree of uncertainty and high stakes.

The application of the PNS building block to Menorca presented in this dissertation is a small step (just a proof of concept) in the direction of building a structured procedure to integrate diverse information in a decision-making

process. As it is explained previously, this quality check would require the participation of an extended peer community to enrich the information and the analysis. This extended community should provide both missing relevant and pertinent information to represent the situation, and perspectives about problems and solutions that can be shared at the moment of deliberation (see Future developments).

With this thesis I tried to contribute on advancing in the direction of providing a structuring space to organize this diverse information in order to focus on the quality of the discussion.

To summarize the contribution of this thesis, in the following table (Table 6.1) I present a collection of guiding questions that can contribute to the description of the quality checks to improve governance in complexity.

Quality check	Guiding questions		
Political dimension			
•	How diverse are the concerns expressed? Is a dimension (e.g., economic interests, identity elements, environmental concerns) overrepresented? Is a dimension underrepresented?		
Degree of diversity	How diverse are the stakeholders whose concernare identified? Whose concerns are represented Whose are missing?		
•	Are different concerns expressed differently? Are values, feelings, visions, and behaviors accounted for?		
•	Is the prioritization fair? Are the procedures and the outcomes of the prioritization accepted or contested? By whom?		
Degree of fairness	How are different the voices represented? Which voices are included in the debate? Does the political process include future generations and concerns affecting systems outside the system?		

Table 6. 1. Guiding question for the quality checks to improve governance in complexity

- How can the participants show their concerns and participate in the prioritization? Do power structures allow for all participants to express their concerns and participate in the prioritization?
- Are there systematic biases in prioritization? Are there hegemonic views, power asymmetries, ideological distortions?

Scientific dimension

• What type of uncertainties should we expect in relation to the data, models and theories used?

Reflexivity

- How reliable is scientific expertise in this field? Is there a high degree of scientific consensus about the pre-analytical choice of narratives or is the field characterized by controversies?
- How ignorant are we about our ignorance?
- What do we know about the factors that will make our models no longer valid in the future?

Integrity

- How are we sure that the proposed scientific analysis is robust and relevant to society?
- Did we try to integrate the proposed scientific information with other types of knowledge?
- Is scientific data used to silence other voices and forms of knowledge?

Post-Normal Science (PNS) dimension

 How do we know that the chosen policies will respond to the problems defined according to available information?

Governance

- QST

- Is it plausible to assume that the proposed regulation will address the concerns prioritized?
- What are potential side effects that could be determined by the desired outcomes looked by the regulation?

 According to the chosen representation, what are the factors to be considered for assessing the capability of the system to reproduce and adapt in the long run?

Adaptation

- What are the factors determining unbalances in the system? Are the solutions proposed feasible, viable and desirable or is one of the three criteria more/less present?
- Are political and scientific processes integrated democratically and deliberatively or does the system tend towards authoritarianism and/or scientism (i.e. hegemonization of a reduced set of narratives)?

6.3. Future developments

The future developments that I imagine after this project are diverse and transdisciplinary. I'll organize this section in a multi-scale manner, addressing what issues would be relevant for me to consider in the future beyond academia.

Communication, Participation and Science for Governance.

As a graduate in Media and communication I tend to filter everything I do through communication lenses. Communication crosses everything and, as Luhmann says 'society is pure communication' (1998, p. 20).

'All communication is societal communication; all societal communication implies communication about the society itself and the society as such is inaccessible to communication' (Luhmann, 1984, p. 60).

In relation to complexity theory (and practice) in societal systems, I think that one of the main challenges is to communicate this complexity. Beyond claiming about the existing complexity, information needs to be contextualized to reshape the narratives about problems and solutions. If there are complex issues and science cannot provide answers, it should provide useful structures and ways to organize discussions about these complex issues.

In times of social media and quick communication with a big flow of data [information?], also in academia with the constant publication of 'new' research

I would like to contribute to provide and test such spaces for discussion and deliberation in different contexts.

Would 'our' scientific production change after a PNS building block analysis?

The discussions about desirability, feasibility, and viability applied to different systems -i.e. science, an islands, a region, a state- will, for sure, bring a lot of new and relevant information for governance.

Future research efforts should assess to what extent an expansion of the diversity of the information space helps avoid the risk of missing relevant information (hypocognition) or the risk of paralysis in the decisional process for excess of information.

The role of participation in decision-making is also a field that I would like to develop further. Connected to the way discussions about complex issues are set in our societies and the roles of media, education systems, institutional policymaking at different scales, and so on, it brings plenty of possibilities for research, and for facilitating the communication among stakeholders.

From my point of view, the inclusion, representation, and participation of stakeholders in the decision-making processes is essential and one of the main challenges for governance in complexity. I tried to include participation in my research, especially in the case of Ikaria (see below), but I had to adapt to the circumstances and cancel this part due to COVID. The participatory process in Menorca was just a part of the process to compare with Ikaria and I'm aware of the limitations in this dissertation. However, I thought it was important to be included and the limitations show that there is a lot of potential that I would like to explore further in the future.

Temporary scale

The study presented in this dissertation focuses on the Mediterranean island of Menorca in recent years. This research is a picture in time and there is a lot of potential to expand the study to offer new temporal and geographical scales.

The metabolic analysis of the metabolism of Menorca in different moments in time, using MuSIASEM, will bring an interesting contribution to characterize the biophysical requirements of the social practices in Menorca along History. How was the social structure and the requirements of material and energy flows in 1950? in 1900? In 1000? After a war? Or before and after a pandemic situation?

This analysis would bring valuable information about the potential of self-sufficient practices in society, connected to life conditions. A more self-sufficient or closed system, in which most production and transformation of resources would take place within Menorca, could reduce the distance between pressures and impacts and increase the control over decisions. However, a lower degree of openness or more self-sufficiency, will have to be paid by a major reduction of the economic activities, such as industry and tourism, diversity in social activities that would require a sustained flow of external resources. These trade-offs should be discussed with local stakeholders. Our analysis cannot suggest a given course of action.

Geographical scale. More island studies

Equally to different time frames, this study could be extended to other geographical units and systems. Moreover, island studies would benefit from advancing in the use of PNS approaches to understand and explain what happens in different types of islands, even beyond islands surrounded by the sea... Mediterranean, small island states, biosphere reserves, isolated regions, etc.

One of the main disappointments of this research was having to cancel the part of the project connected to Ikaria. While the study in Menorca was focused mainly on a top-down approach to gather data, in Ikaria the planned research was to collect data for MuSIASEM using a bottom-up approach.

The research design for Ikaria involved the participation of youth from High Schools along the island to characterize the household metabolism. After data collection, the goal was to establish typologies of households that could explain the whole island metabolism following the hierarchical structure presented in chapter 3.

This bottom-up approach will enable different perspectives to emerge on the project. It would be relevant, and an intellectual challenge, to study the effects of the participation of the community in the gathering of the data, and the evolution of the discussion and deliberation of certain issues.

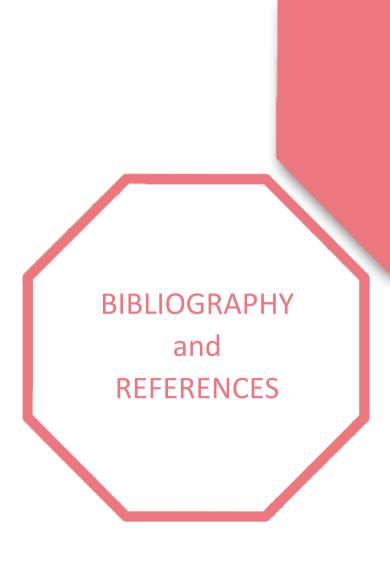
Methodological

Regarding the methodology, a whole new world of possibilities appears to be developed in the future.

One of the characteristics of MuSIASEM is that is possible to, following the same structure, tailor the approach to apply it to any system. It is a flexible and adaptive approach but there are some contrasting ideas about the possibility to standardize the application.

The advancement of PNS and quantitative story telling (QST), together with the possibilities that GIS and computing systems offer, enable new research that could be done in this direction.

In my wild imagination, research will get to a point where Gaia theory will be translated into a World Sudoku, where one can see the interdependencies among systems. And even in a further dream, the sudoku would become a 'Rubik cube' structure where beyond geographical interdependencies, also intergenerational interdependencies become essential to understand where our lifestyles and social practices come from, and how more sustainable societies can emerge.



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APPENDIX A

APPENDIX A: SUPPLEMENTARY MATERIALS

A. Stages of MuSIASEM application

MuSIASEM can be used to study the (i) feasibility, (ii) viability, (iii) desirability and (iv) level of openness of the system. This task requires checking: (i) the availability of primary resources (whose availability does not depend on the local human activity – i.e. feasibility in the external view); (ii) the ability to establish an effective set of 'end uses' (social practices) and transformation of resources (technologies) associated with local human activity – i.e. viability in the internal view; (iii) the social and cultural desirability of alternative policies considering quality of life, expectations and normative values; and (iv) the dependence of the metabolic pattern of the system on processes taking place outside its boundaries (security in metabolic terms).

The application of MuSIASEM is organized in three stages with different steps and the following sections summarize this process.

A.1. Stage 1: Definition

A.1.1. Definition of the system.

Step 1: Pre-analytical definition. Constituent components.

The first step to define the system implies deciding the reference level, n, which delimits the internal and the external view. Fund elements, such as human activities or land uses, allow to define the size of the constituent components. For human activity it is important to consider the different types of people that are in the system: permanent residents, temporary residents, seasonal workers or commuters, and

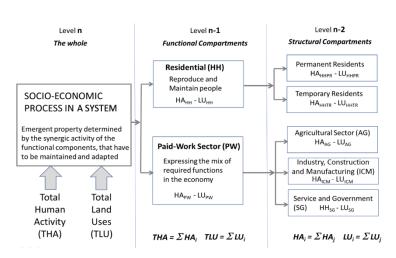
tourists need to be included in the accounting of the overall size of "human activity" (on a time scale shorter than 1 year). In addition, we can define the different land uses and land covers included in the area of the system. Starting from the size of these two funds (Step 3), it become possible to calculate flowfund ratios – the pace of flows per hour of human activity and the density of flows per hectare of land use - to establish a relation between "the state" of the system and its "environmental pressure" (Stage 2). Different quantities of human activity and land are allocated across the different functional and structural elements. This allocation defines how funds are used in doing what and how, and what are the resulting flows of primary sources and primary sinks that affect the local ecosystems (Lomas and Giampietro, 2017).

Step 2: Hierarchical organization.

The second step requires defining the hierarchical organization of the relations between structural and functional elements. The accounting of the size of both fund elements and flows has to remain congruent across the representation of constituent components across different levels of analysis – i.e. the level n (whole society), level n-1 (HH sector vs PW sector) and level n-2 (IMC sector and SG sector inside the PW sector) – an overview of these relations is given in Fig. A. 2. That is the sum of all the hours of human activity considered in the end use matrix across different levels has to remain constant in the profile of distribution (dendrogram) – see Fig. A. 1.

Fig. A 1.. Hierarchical organization of the levels in the system

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Level n-2 corresponds to functional elements whose characteristics depend on the mix of time and land uses found in their structural elements. Within the residential sector, we may distinguish between different typologies, i.e. the activity and land-use of permanent residents (PR) and temporary residents (TR) as illustrated in Fig A. 1, that could include tourist, commuters, second home owners, etc. depending on the system we want to study. Within the paid work compartment (PW), we can find the three economic sectors: agricultural sector (AG), including agriculture and livestock; industrial sector (ICM), including industry, construction and manufacturing; and the services sector (SG), including services and government activities/public sector. Deciding on the allocation of funds and flows over these compartments is a key step required in the pre-analytical phase. Transportation, for instance, is a functional sector that needs to be properly defined in terms of its required structural elements and be assigned to a level of analysis (in Fig. 1 belongs to services sector). However, this functional compartment includes human activity belonging both to the household sector (the use of private cars) and paid work (in the public transportation sector in services sector and in other economic activities in paid work). Therefore, the definition of the final dendrogram depends on the purpose of the analysis and the availability of information - e.g. in this study all the energy for transportation has been allocated to the service sector, due to the relative small importance of private car use.

Once the structure of relations between the whole, the constituent components and the

functional and structural elements are defined, it becomes possible to assess the profile of flows required to maintain the system, the level of openness and the environmental pressure that the various elements exert on the local ecological funds.

Step 3. Defining the size and the metabolic characteristics of the system.

The third step if deciding on how we are going to measure the size of the constituent components and what are the metabolic characteristics that we want to analyse. The size is measured by considering the fund elements, for instance, Human Activity (HA) and Land Uses (LU) according to Fig. A. 1. Human activity is measured in hours per year and include the hours of activity of permanent and temporary residents. Land uses is measured in hectares per year. Both categories characterize the size of both the functional and the structural elements of the system defined across the hierarchical levels of organization.

The definition of the size of constituent components and their metabolized flows is needed to characterize the metabolic pattern of the system. By dividing the quantities of metabolized flows by the size of the fund elements we can characterize the metabolic pattern of the system in terms of metabolic rates or metabolic densities. Metabolic rates - i.e. the Energy Metabolic Rate (EMR_i) averaged over the year of an element i = Energy throughput of the element i (ET_i) per year divided by the hours of human activity in the element i (HA_i) per year – i.e. $ET_i = HA_i \times EMR_i$. The same relation can be found when considering the density rates – i.e. the Energy Density Rate (EDR_i) averaged over the year of an element i = Energy throughput of the element i (ET_i) per year divided by the hectares of land use in the element i (LUi) per year $-i.e. ET_i = LU_i \times EDR_i.$).

This type of relations when combined across levels become impredicative: (i) we can calculate an intensive variables (EMR_i) – a qualitative aspect of the metabolic elements - starting from the measure of two extensive variables - ET_i and HA_i; or (ii) we can calculate an extensive variable – either ET_i or HA_i – a quantitative aspect of the metabolic element - starting from the measure by the other extensive variable and the intensive variable - EMR_i. In other words, the amount, type and distribution of metabolized flows needed to maintain and reproduce the components

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of the system relate to the information about the relative size and the metabolic characteristics of the various elements defined across levels.

A.1. 2. Data gathering.

MuSIASEM allows for the combination of topdown and bottom-up strategies to gather data. Topdown strategies use statistical data to characterize the metabolic characteristics of the components of the system, for instance, total blue water accounted for agricultural land divided by the hours of human activity provides a benchmark about the metabolic rate of blue water per hour of human activity. Bottom-up strategies use benchmarks for specific structural or functional elements that can be "scaled up" to explain the metabolic characteristics of the components. For instance, if we know the requirement of irrigation water of different crops, and the number of hectares of each crop, one can estimate the total amount of blue water used in the agriculture sector in a certain period.

The combination of top-down and bottom-up information applied to a set of forced relations of congruence of metabolic characteristics, generates mutual information: the same phenomenon experienced

in crossword puzzles or the mathematical game "sudoku" (Giampietro and Bukkens, 2015). This phenomenon allows to double check and verify the coherence, errors, and inconsistencies in the data, or find unexpected information. Even more important is the possibility of anticipating changes when using these relations in an "anticipation mode" - "what if" the size of the human activity changes? - e.g. more tourists, more temporary residents; or "what if" the existing social practices change? Extensive variables – the size of human activity - can affect intensive variables/benchmarks (more human activity means less land available per capita). Intensive variables/benchmarks (less consumption of gasoline per tourists) can affect extensive variables (the total amount of gasoline imported by Menorca).

A.2. Stage 2: Diagnosis

A.2.1. Characterization of the system

Defining the STATE-PRESSURE relation.

The internal view is described by the End Use Matrix (EUM) – a description based on data array of how internal funds (human activity and land uses) and secondary flows (electricity, fuels, water) are combined in the various constituent components to

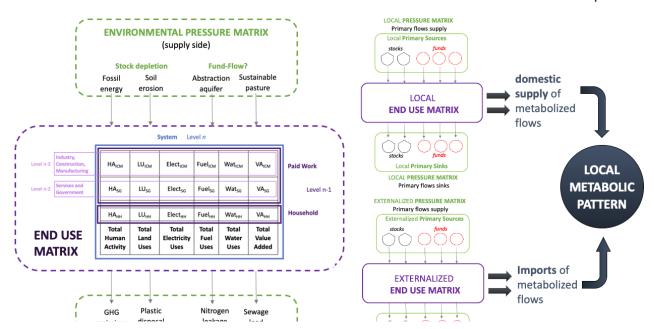


Fig. A 2. The relation End Use Matrix (EUM) ←→ Environmental Pressure Matrix (EPM) – left. The relation Local EUM/Local EPM ←→ Externalized EUM/Externalized EPM right

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express the whole set of societal functions. The resulting flows of value added can be measured using monetary variables. The external view is described by the Environmental Pressure Matrix (EPM) - what is the required from the contest in terms of supply of primary resources and sink capacity for the output flows. There are two sets of relations that can be established by the proposed approach: (i) a STATE-PRESSURE relation between the internal activity (the STATE described by End Use Matrix) and the interaction with the environment (the ENVIRONMENTAL PRESSURE described by the Environmental Pressure Matrix; and (ii) a relation determined by the level of openness of the systems (dependence on import) between the two coupled matrices - Local EUM and Local EPM - defined inside the border of the systems, and the two coupled matrices – Externalized EUM and Externalized EPM - defined outside the border of the systems. These relations are illustrated in Fig. A. 2.

Assessing the environmental impact. The categories defined in Fig. A. 1 refer only to funds related to socio-economic processes in a system included in the End Use Matrix. However, as illustrated in Fig. 2, in order to calculate the Environmental Pressure Matrix, we have to assess also the ecological funds (e.g. aquifers, soils, terrestrial and marine ecosystems) associated with the supply and sink of primary flows. These ecological funds express activities of self-organization outside human control, that are essential for the stability of the metabolic pattern. The analysis of these funds is important to assess the environmental impact of the pressures. They allow to study how much is "too much" when coming to the extraction of inputs and the dumping of wastes or emissions. In this preliminary study the size of ecological structural

1.2. References

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and functional components is mapped in terms of the land fund type "non-managed land" (NML). This category includes all types of land-covers that provide contributions that people in Menorca may use, such as beaches, forests, rivers, rocky areas, etc. but whose characteristics do not depend directly on human intervention. The activity of these ecological funds may have a significant effect on the quality of life of the people on the island not only in relation to the aesthetic aspects of the landscape and the health of the environment but also in terms of life support and on the productivity of economic sectors, such as tourism.

A.3. Stage 3: Anticipation

A.3. 1. Scenario development

After integrating the available information in the diagnostic stage, alternative scenarios can be explored to check the feasibility, viability and desirability of changes to the existing metabolic pattern. How changes in the metabolic characteristics of the various elements (in their size and metabolic benchmarks) would modify pressures and impacts? And, what is the role that changes in the openness of the system will have to play? In this way one can test the sustainability of alternative scenarios. The structure of the MuSIASEM tools allow for an exploration of different scenarios related to changing the size of the system or any of the metabolic characteristics.

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