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interdisciplanry background from local experiences
within the south-mediterranean environmental research
community**

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1 Some like it complex: Building a common multidisciplinary 2 background from local experiences within the South-Mediterranean 3 environmental research community 4

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19 Abstract

20 This article addresses the difficulty to introduce and settle multidisciplinary in environmental
21 researches within and among the South-Mediterranean environmental research national
22 communities. Moreover, this work attends to assess the internal and external structural factors
23 treating such complex issues in rural, urban and periurban contexts and finally the connections and
24 dependences over these components. Throughout a series of programs, projects and actions having
25 involved scientists and scholars from Algeria, France, Lebanon, Morocco and Tunisia, some common
26 patterns can be observed despite notable differences in environmental and political contexts. Thus,
27 the main common issues involve funding matters (budget reductions and less versatility),
28 administrative and social hierarchy, relatively small connection with public services and community
29 representatives and finally the reluctance shown by many researchers to make data available for the
30 community. Nevertheless, the fact that national and international (Arabic and French speaking sphere)
31 researcher's communities have progressively built mutual knowledge thanks to different
32 collaborations, is a major achievement sustaining the multidisciplinary in the environmental
33 research. Indeed, this allowed the elaboration of sustainability metrics, demarches and procedures for
34 assessing environmentally and socioeconomically complex issues.

35 Keywords

36 South Mediterranean shores; multidisciplinary research; national research communities; research
37 program history; rural-urban environmental issues

38 Introduction

39 Mediterranean shores are among the most fragile and degraded biomes on Earth, mainly due to (i) the
40 geographical situation, often at the edge of arid areas, playing a major role in the natural resources
41 distribution, and (ii) the long history of human use of local resources and occupation that has shaped
42 current ecosystems. Indeed, globally Mediterranean areas suffered an early neolithization (east
43 Mediterranean areas) as well as many great phases of landscape anthropization (especially during the
44 Bronze Age and the Roman-Byzantine periods) resulting in the diversification of agricultural activities
45 (mainly deforestation, cultivation and grazing) with therefore, major environmental consequences.
46 Many of them has led to soil transformation impacting thus the whole land cover, hydro and
47 morphosystems and therefore, all the biophysical components of socio-ecosystems (SES).
48 Consequently, this approximately 10 millennia of anthropization, especially the last two centuries, has
49 negatively impacted the resilience of the Mediterranean SES, mostly the southern areas currently
50 situated in the arid/semi-arid areas (Massuel & Riaux, 2017; Mekki et al. 2018; Ouin et al. 2021). For
51 this reason, it is essential when studying Mediterranean environment, to acknowledge the following
52 points:

- 53 • Because of the impact of long-time anthropogenic factors, every landscape is deeply anthropized
54 thus there is no “unperturbed/natural” environments present in this area.
- 55 • According to the first point and even if the SES concept is initially originated from a mostly
56 biophysical point of view and following Stojanovic et al. (2016) or Saqalli (2020), the study of
57 present-time environmental components and SES implies to consider anthropic actions and
58 motives (including demographic and socio-economic) as the most important environmental driver
59 by far;
- 60 • Even more, while quite all preindustrial farming systems were including a city where food surplus
61 and cash crops were concentrated and consumed, ancient SES from Middle East and Mediterranean
62 shores are mostly organized around and defined by dominating cities and urban fluxes and drivers,
63 with their hinterlands, although rare (inland Spain, Morocco or Turkey) are avoiding this structural
64 pattern (Grigg, 1974, Mazoyer & Roudart, 1997). Consequently, all shoreline Mediterranean SES
65 are *de facto* also urban in their nature, structure and dynamics. Research programs working on
66 them should be settled accordingly;
- 67 • Finally, applied socio-environmental research does not mean to study each environmental risk,
68 threat or nuisance separately. One may see that these lasts are often prioritized according to the
69 ease of their studies (easy-to-measure data, simple procedures...) rather than their local
70 characteristics. It shows the need of a formal methodology to evaluate and compare socio-
71 environmental issues. By that means, applied research must include socio-environmental issues in
72 order to deliver to stakeholders’ effective advice in term of environmental management and land
73 use planning in regard of sustainable development challenges.

74 Furthermore, these systems are evolving rapidly: climate change has already great impacts on
75 Mediterranean shores (Lelieveld et al. 2012; Malek et al. 2018; Lionello & Scarascia, 2020), especially
76 in very urbanized areas where the combination of extreme events, particularly droughts and extreme
77 heat waves, as well as the urban heat island phenomenon, can increase the vulnerability of the
78 concerned populations (Cartalis et al. 2001; Houet et al. 2014; Masson et al. 2014; Bartholy & Pongrácz,
79 2018; Badaro-Saliba *et al.* 2021). Coastal areas are indeed exposed to environmental pressures
80 regarding natural resources (water, soil or biodiversity) and hydro-climate fluctuations, even if some
81 trends indicate that desertification is not the sole future of the considered areas (Malek *et al.* 2018).
82 As an illustrative example, Lebanon and Algeria coastal areas have undergone over the past decades
83 an uncontrolled positive urban sprawl rate (Faour, 2014; Rabehi *et al.* 2019) resulting in high
84 environmental pressures threatening valuable natural habitats such as coastal wetlands (Aitali *et al.*

85 2022), and the quantity and quality of available natural resources as coastal water aquifers
86 (MOE/UNDP/ECODIT, 2011). Altogether, geopolitical instability, demographic growth and urban
87 expansion are undeniable vulnerability-enhancing factors threatening and pressuring natural
88 resources, letting a very thin buffer to withstand future shocks and threats to come. Because of this
89 ancient environmental anthropization and the geographical position of the Mediterranean region (at
90 the margin of various climatic systems (Alpert *et al.* 2005), the related habitats are extremely
91 vulnerable to both human pressures and hydro-climatic fluctuations. For instance, despite being a
92 natural phenomenon of the Mediterranean dry season, the combination of human pressures and
93 extreme meteorological events as summer droughts has made the Méditerranée the most impacted
94 region worldwide by forest fire hazards (Mhawej *et al.* 2016). In France, about 4040 forest fire episodes
95 have been recorded over the Mediterranean coastline between 2017 and 2018 (BDIFF). In Greece,
96 following the 2021 events, most of the burned areas have been classified as vulnerable to water runoff
97 (Evelpidou *et al.* 2021) hence exposing the neighboring urbanized areas to floods and debris flows
98 hazards during winter storms events. However, one of the main environmental and economic
99 consequences of forest fire is the reduction of crop potential of impacted areas, which leads to serious
100 societal crisis, including diplomatic incidents (Greece and Turkey in 2020 or Algeria and Morocco in
101 2021¹). Hence, by the direct impact of drought events over natural resources (water and soils mainly),
102 it is safe to consider a tangible influence on food prices in the future if the frequency and intensity
103 were to increase. Major social instabilities are therefore to be expected as the Arab spring insurgencies
104 in 2010 directly linked to a food price inflation related to a severe drought episode (Maystadt *et al.*
105 2014).

106 This drought / fire example illustrates both the imbrication of dynamics where human and
107 environmental dynamics are intertwined and the legitimate and genuine difficulty to manage such
108 issues as a public institution. Indeed, SES and especially some very anthropized such as the
109 Mediterranean ones are difficult to characterize because of the systems complexity involving many
110 components all interacting with one another. To understand and study such complex systems it
111 requires to take into consideration both biophysical and social indicators in a well-organized
112 multidisciplinary scientific approach, yet to be built (Rouchier & Requier-Desjardins, 2000; Schmidt-
113 Lainé & Pavé, 2002; Metzger & d'Ercole, 2009; Hamel, 2010; Marignani *et al.* 2017). There is a
114 tremendous amount of literature regarding the inherent multidisciplinary to be considered for
115 assessing research programs on such socio-environments. However, formalizing the demarche have
116 been facing the obstacle of formal definition among the various terms of pluri or multidisciplinary,
117 interdisciplinarity or transdisciplinarity) until these “endless” typologies, classifications and hierarchies
118 (Graff, 2015) collapses on itself, especially regarding the relation to sustainability. Indeed, several
119 attempts to systemize the definitions of this series of world did face contradictions as nuances are
120 difficult to estimate¹ (Brewer, 1999; Lélé & Norgaard 2005; Chettiparamb, 2007; Jacobs & Frickel, 2009;
121 Klein, 2010, 2017; Alvargonzález, 2011; Lam *et al.* 2014; Nicolescu, 2014; Brown *et al.* 2015; Frodeman
122 *et al.* 2017). As a result, we will use as a common minimal ground the word “multidisciplinary” better
123 than other worlds that implies more criteria but on which no consensus has been established yet.

124 But the challenge is definitively not only epistemological: development stakeholders and public
125 administrations have to establish and defend integrated environmental policies, implying a politically
126 risky prioritization of issues and objectives. These are undoubtedly, especially in these Mediterranean
127 shore environments, singularly challenging. Apart from influences from various economic operators,

¹ Even more, we clearly state against the use of “Indisciplinarity”, as it is more of a slogan referring to both the “I’m so-much-of-a-rebel-myself” teenage ambiance and the “when-you-want, you-can” corporate start-up verbiage than a real concept

128 which do exist and should be acknowledged as having a major influence over public choices,
129 collaborative scientific approaches for untangling the complexity of environmental issues are therefore
130 essential to provide decision makers advice and data and at least promote virtuous practices and
131 combat *de facto* easy-going policies. However, researchers still avoid to propose and assume such
132 prioritization procedures as they are firstly diagnostic and doubt providers. Environmental public
133 policies need response-providers, orientating them towards the consulting expert communities.
134 Indeed, these lasts provide quick and direct-to-action results since they usually detach themselves with
135 the constraints of a robust scientific approach and propose turnkey policies.

136 The question is therefore: is it only an epistemological and conceptual issue opposing different schools
137 of methodology and practice? Is it primarily an institutional and political issue within research
138 communities, even before considering the political aspect of policies? Why is it extremely difficult to
139 build a structured multidisciplinary research community?

140 In order to answer these questions, we suggest in this paper to explore how previously evaluated
141 public research programs on environmental issues have addressed such challenges. Therefore, by
142 reporting an apparent disparate series of research programs (in which the authors have been directly
143 involved), this article aims to characterize the development of the combination of procedures and
144 indicators on socio-ecological issues.

145 The objective of this article comes from a series of social experiences within the environmental
146 academic and public service communities and to be precise, the pursue of several research programs
147 that build communities of research around sustainability in three Arab countries along the
148 Mediterranean shores, namely Lebanon, Morocco and Tunisia. Assessing these research programs has
149 been promoted as both improving environment research, multidisciplinary and cooperation both
150 between North and South and between southern countries. The questions we raise after these *de*
151 *facto* social experiments: were they so positive? If No, what were the obstacles and constraints to such
152 objectives? If yes, how was it possible and what experience can we gain from them?

153 This paper focuses therefore on a reflection on practices aiming a multidisciplinary approach on
154 research thematic, where it can help setting-up objectives and being accepted by all scientific
155 communities. Moreover, the need to work on inclusive indicators will be assessed from the growing
156 necessity in research projects to link their results with socio-economic and health situation.
157 Consequently, for the study and understanding of SES, the focus will be on the development of new
158 methodologies for establishing environmental indicators rather than simple technical note provided
159 on each environmental component separately. Discussing these common trends and obstacles and
160 formalizing the sociological and institutional encountered barriers during these experiences may then
161 provide some conclusions and implementation suggestions regarding not-so-obvious integrated and
162 multidisciplinary researches.

163 These questions are not only management issues as they reveal both political, socio-economical and
164 geopolitical issues of these countries but also on the epistemological obstacles one may face in such
165 socioenvironmental issues

166 Materials & Methods

167 Several case studies are here explored and results are obtained as *a posteriori* analyses of these cases.
168 Following the participatory observation demarche as formalized by Olivier de Sardan (Olivier de
169 Sardan, 1995; 2000; 2001) and also questioned by Van Asselt & Rijkens-Klomp (2002), one may
170 consider that field qualitative observation methodologies do vary to adapt to special configurations of

171 strategic group dynamics, institutional contexts and connections. Consequently, the various case
172 studies do have various methodologies:

173 SICMED Multidisciplinary Seminar analysis

174 Context and purposes

175 MISTRALS was a 10-years multidisciplinary research program supported by the most important French
176 public research institution (CNRS) to sustain an integrative approach for the study of the
177 Mediterranean socio-ecological systems (Voltz et al. 2018). The program included seven research
178 components including SICMED². The scope of the research was on the interactions between
179 environmental components (water, soil, sea and atmosphere) with societies. The study area concerned
180 four French-speaking Mediterranean countries (Algeria, Lebanon, Morocco and Tunisia) and thus
181 opened great collaborations between French laboratories and local research centers and universities.
182 Moreover, thanks to a series of 8 years funded actions within MISTRALS program, the SICMED research
183 community was able to develop solid multidisciplinary approaches involving members of every
184 concerned countries (50 members, mostly from France, Lebanon, Morocco, Tunisia and Algeria as a
185 guest country). During this workshop, many exchanges and collaborations including scientific
186 proposals, field missions, student supervisions and scientific publications has allowed SICMED
187 researchers from different fields to learn how to work with each other and thereby, SICMED projects
188 were able to benefit of a true and solid base for scientific multidisciplinary collaboration. The scientific
189 background of the 50 workshop participants (41% Tunisian, 22% French, 15% Moroccan, 11%
190 Lebanese, and the rest Algerian, Armenian, Spanish or Italian) were from social, water, agriculture,
191 environment and geo-sciences.

192 Following the prospects of the SICMED2 meeting in Marrakech, Morocco (11/2017), the objective of
193 the 11/2018 workshop on “Governance and Indicators” in Hammamet (Tunisia) were to bring out
194 scientific perspectives exploring thematic, disciplinary, spatial and temporal boundaries in order to
195 emphasize the research towards a multidisciplinary and multiscale scientific approach. Following this
196 perspective, the purpose of the seminar was to assess complex issues about environmental risks and
197 threats on country and local spatial scales. All the researchers were divided in four groups following
198 their disciplines and nationalities in order to emphasize an objective and distanced point of view.

199 To each of these four working groups (WG), the following were included:

- 200 1. One country representative, i.e. – an academic qualified enough to be able to describe and
201 synthesize all environmental issues (risks and treats) of the country. However, because of some
202 logistic problems, only three countries were represented: Lebanon, Morocco and Tunisia;
- 203 2. A “club of Interviewers” composed by all the nationalities at the exception of the concerned country
204 was included in each WG as investigators. Following this perspective, only Moroccan, French,
205 Algerian and Tunisian scholars were interviewing the Lebanese representative for instance.
206 Furthermore, the investigators have been distributed to cover the maximum number of disciplines
207 – including one social scientist for each session;
- 208 3. One observer was designated in each session to take notes on the asked questions, the debate and
209 the provided answers by the country representatives.

210 The questions to be addressed during these sessions were open and related on scientific or socio-
211 economic issues which require a multidisciplinary approach and/or a change of spatial scale in order
212 to establish scientific approaches which go beyond thematic boundaries. The assessed problematic
213 was: “could we consider that grouping non-national experts for interviewing local ones can ease the
214 diagnosis over socio-environmental issues”? The workshop was conducted in two phases:

² Surfaces et Interfaces Continentales en Méditerranée: Continental Surfaces and Interfaces along the Mediterranean Sea

215 Working Group Phase

216 According to the Hammamet workshop thematic, researchers/workers were asked to
217 think/design/build indicators which had to (1) illustrate aspects of at least two disciplines and to (2)
218 allow researchers, evaluators and stakeholders to make sense of the representations/models they
219 adopt for analyzing, describing and evaluating research sites they investigate in their countries. Hence
220 the following recommendations were given to workgroups for creating multidisciplinary indicators:

- 221 1- Settling criteria for evaluating the quality of the then-built indicators
 - 222 a. Usefulness: Practicality, Measurability, Coverage, Accuracy, Synthetic
 - 223 b. Social relevance: Understandable, Practical, Generic, Illustrative
 - 224 c. Sensitivity/Robustness
 - 225 d. Multiplicity of target groups: Public Services, Associations, Foundations, NGOs, Agencies
226 Specific Programs, General public
- 227 2- Targeting the right groups and stakeholders: Public Services, Associations, Foundations, NGOs,
228 Agencies, Programs, large public

229 In order to make the indicators formulation approach generic across different countries, it was
230 recommended to the participants to identify for each investigated site and within each relevant
231 discipline the following components:

- 232 • Type of data: surveys, in situ data, images, maps, etc.
- 233 • Spatial scale & resolution: experimental plots, farm, watershed, etc.
- 234 • Temporal scale & resolution: intra-annual, inter-annual, decades, etc.
- 235 • Social scale & resolution: city, village, families, etc.
- 236 • Analysis methodologies: type, calibration, validation, etc.

237 Project SICMED Indicators

238 Following the 2018 Hammamet seminar, a call for funding for small projects concerning the
239 construction of combined qualitative and quantitative, socio-economic and biophysical indicators has
240 been launched. This call was named PSI program (Project SICMED Indicators) with a twofold objective:

- 241 • To pursue the dynamics of constructing an international research community following the above-
242 described 2018 Hammamet conference;
- 243 • To develop but also to investigate whether this approach of multidisciplinary combination of
244 parameters into meaningful and efficiency-driven indicators has been imbued and percolated
245 within the community;

246 This call was settled with several conditions with all been settled in order to encourage
247 multidisciplinary works and also to reduce structural and recurring biases:

- 248 • The total amounts of funding were low, between 2.5 and 3k € and the project was restricted to a
249 one-year action, mostly because of administrative reasons. However, the applicants were helped
250 because it alleviates the administrative costs and management time for such actions;
- 251 • The proposed actions may support/accompany ongoing projects or actions, in order to facilitate
252 the submission of projects and not to focus on innovative/new/disruptive research actions;
- 253 • Partnerships between researchers and public or parapublic operators were encouraged in order to
254 foster empirical and public service-oriented projects;
- 255 • All disciplines and actions regarding socio-environmental risks, hazards, threats and nuisances can
256 be considered but the more disciplines in the project, the better. However, the inclusion of
257 biophysical and social sciences topic research was mandatory.

258 The Bouregreg River and dam program

259 Issue

260 During the last decade, several research programs in Maghreb try to contribute to increase the state
261 of knowledge on the relationships between human activities and sediment transport modifications
262 from upstream to downstream, including the sedimentation in the reservoir of dams on several of the
263 larger rivers. This issue is vital and strategic in this region because of the direct links with the reduction
264 of the volume of water stored in dams and therefore of the socio-economic value of these facilities.
265 The large number of dams built in Maghreb (Remini et al. 2009) is linked to the very high stress on
266 potable and irrigated water in this area under Mediterranean and semiarid climate (Mahé et al. 2013).
267 Understanding and documenting the morphodynamical characteristics of the territories in order to
268 develop mitigation measures to prevent land erosion and sediment accumulation is therefore one of
269 the main environmental challenge in the Mediterranean countries. In addition, the accumulation of
270 sediments in dams consistent with the diminution of riverine charges and material deposition
271 downstream may contribute to increase the vulnerability of coastal areas to erosion and coastline
272 retreat in a climate change and sea level rise context, as the quantity of sediments reaching the
273 coastline is no longer sufficient (Amrouni & Mahé, 2021; Hzami et al. 2021) due to the siltation in dams
274 (Vorosmarty et al. 1997, 2003; Syvitsky et al. 2005).

275 However, in most Mediterranean countries, river sediment fluxes are not measured on a regular basis,
276 no dedicated international observatory has been established to conduct regular data collection and
277 there is a lack in spatial data to support these actions. Rare database establishment attempts are based
278 on individual data collections (Meybeck & Ragu, 2012; Peucker-Ehrenbrink, 2018) with important gaps.
279 How the real impact of dams on sediment transports from the watershed to the coastal areas can
280 therefore be assessed?

281 In 1974, the Sidi Mohammed Ben Abdallah dam has been built about 20 km from the coastal area on
282 the Bouregreg River, one of the five largest rivers of Morocco, exclusively for providing potable water
283 for the largest conurbation of the country extending over approximately 150 km on the Atlantic
284 coastline. In 2005 the facility was upgraded to increase its water capacity to more than 1 billion cubic
285 meters. The river exposes a very modest mean annual discharge of $23\text{m}^3\cdot\text{s}^{-1}$ and the important storage
286 capacity of the dam has a direct impact downstream on water flux. The dam has contributed to a
287 significant reduction in the amount of water and sediment delivered downstream for nearly 50 years
288 but however to an extent which has not been quantified/measured (El Aoula et al. 2021). Is it therefore
289 possible to understand and foresee the impacts on the amount of sediments reaching the sea at the
290 river mouth of Bouregreg River?

291 Step-by-step methodology

292 In Maghreb, several research programs were dedicated to understand sediments fluxes (erosion,
293 transport and deposition) in watersheds since 2010, in a multidisciplinary research framework. All
294 these programs were supported by the same French/Mediterranean 2010-2020 MISTRALS SICMED
295 program funded by the French CNRS Institute of Universe Sciences. The first phase concerned among
296 other rivers the Bouregreg River (Mahé et al. 2013b).

297 1. The first step was to raise and better define the focus on which the SICMED 20-persons scientific
298 community would gather. This was based on a preliminary assessment to verify whether the level
299 and distribution of required data was sufficient. Every expert, in his/her specific field, was
300 questioned by other specialists on the requirements (main gaps) of his field, first on the data needs,
301 then on the scientific priorities and finally even on the vocabulary used, until a final set of databases
302 was considered mandatory to implement. In practice, this task was achieved through a common
303 meeting and field trip on the basin, breaking the social glass.

- 304 2. Multidisciplinary exchanges were an important asset in the second step in the formalization of the
 305 scale and resolution of the common study in order to find a compromise between resolution
 306 thresholds (the resolution of data coverage) and the variables to be selected as sufficient to
 307 characterize a problem (Tra Bi et al. 2013; 2014).
- 308 3. In a third and final step, a parallel and more systematic measurement campaign was assessed by
 309 the Bouregreg river basin agency and the research project teams on sediments fluxes and surface
 310 erosion in the watershed surface.

311 [The Franco-Lebanese multidisciplinary collaborative laboratory: O-LiFE](#)

312 A historical reconstitution demarche: The study here is an a posteriori analysis of the rationalities of
 313 the project: firstly on the choice of the country and the institutional approach. Collective and informal
 314 discussions regarding these rationalities were settled during several seminars of the project or other
 315 collaborative ones, such as the ones described above, from 2018 to 2022 so before, during after the
 316 COVID episode to extract the institutional, diplomatic but also practical, logistic and financial
 317 rationalities affecting the project construction and purposes. The second and longer step was a
 318 reconstruction of the history of the program and its various institutional forms across time, including
 319 the different constraints, obstacles and reorganizations the project had to face and construct for
 320 adapting itself to the evolving socio-academic context of Lebanon.

321 [Results of the studied cases](#)

322 [Multi-issues SICMED Seminar](#)

323 WG outcomes were first combined for generating thematic sustainability indicators common to a
 324 majority of sites. After this step, in order to evaluate each site-specific sustainability, the generated
 325 indicators were assimilated to each investigated area. The restitution phase resulted in the obtainment
 326 of sustainability indicators common to different sites (Table 1):

327

| Table 1. The 10 indicators sorted out as necessary during restitutions of the four Hammamet sessions | | | | | | | | | | |
|--|-------------------------|---------------|--------------------|--------|--------------------------------|-------------------------|----------------------|--|--------------|-----------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Indicator | Water exploitation rate | Water quality | Water social value | Health | Water governance & Information | Ecosystem vulnerability | Water economic value | Anthropogenic Pressure/Human Impact on Water | Biodiversity | Landscape |

328 The multiplicity of disciplines involved in each site-investigation on previous or ongoing projects,
 329 pushed the participants to subdivide the indicators into more specific sub-indicators. As these were
 330 defined during country-specific sessions, they can be either specific to locations hence implying
 331 different ratios and measurements according to the site or else be common to several sites. The sub-
 332 indicators were then evaluated in agreement with their usefulness, their social relevance and the
 333 multiplicity of target groups for which the sub-indicator would be particularly useful. In the interest of
 334 building a common measurement system following Porter *et al.* (2006) and Hamel (2010), a very basic
 335 score assignment was proposed during the sessions in order to evaluate all indicators and sub-
 336 indicators according to three sub-criteria (0: indifferent, 1: good, -1: bad). During the restitution
 337 phase of the workshop, seminar animators and managers presented an example of a score assignment
 338 on one indicator (Table 2).

| Table 2 Example of one indicator of one Action: Indicator 1. Water resources exploitation rate for AMETHYST project for both sites of Tensift (Morocco) and Merguellil (Tunisia) | | | | |
|--|------------|------------------|------------------------|-------------------------------|
| Sub-Indicator type | Usefulness | Social relevance | Sensitivity/Robustness | Multiplicity of target groups |
| | | | | |

| | | | | | |
|--------------------------------------|--------------------------------------|-----------------------------------|-------------------------|------------------|------------------------------|
| Surface Water that can be mobilized | Hydro-climatic data | (1,1,1,1,1,1) ³ | (1,1,1,1) ⁴ | (1) ⁵ | (1,1,1,1,1,1,0) ⁶ |
| | Evapotranspiration by remote sensing | (1,1,1,1,1,1) | (1,1,1,1) | (1) | (1,1,1,1,1,1,0) |
| | Dams siltation | (1,1,1,1,1,1) | (1,1,1,1) | (1) | (1,1,1,1,1,1,0) |
| | Models (e.g. WEAP) | (1,1,1,1,1,1) | (1,1,1,1) | (1) | (1,1,1,1,1,1,0) |
| Ground Water that can be mobilized | Hydro-climatic data | (1,1,1,1,1,1) | (1,1,1,1) | (1) | (1,1,1,1,1,1,0) |
| | Evapotranspiration by remote sensing | (1,1,1,1,1,1) | (1,1,1,1) | (1) | (1,1,1,1,1,1,0) |
| | Groundwater recharge | (1,1,1,1,1,1) | (1,1,1,1) | (1) | (1,1,1,1,1,1,0) |
| | Models (e.g. MODFLOW) | (1,1,1,1,1,1) | (1,1,1,1) | (1) | (1,1,1,1,1,1,0) |
| Mobilized surface Water | Agriculture surveys | (-1,1,1,0,0,1) | (1,1,1,1) | (1) | (1,0,0,0,0,0,0) |
| Mobilized Ground Water | Agriculture surveys | (-1,1,1,0,0,1) | (1,1,1,1) | (1) | (1,0,0,0,0,0,0) |
| | Illegal boreholes | (-1,1,1,-1,-1,1) | (1,1,1,1) | | (1,0,0,0,0,0,0) |
| Partial Scores of Indicator 1 | | (5,11,11,7,7,11) Σ = 52 | (11,11,11,11) Σ = 44 | (11) Σ = 11 | (11,8,8,8,8,0) Σ = 43 |
| Total Score of Indicator 1 | | (52+44+11+43)/(66+44+11+77) = 76% | | | |

339

340 The example exposed in Table 2 illustrates a simple method to determine an overall score for a given
341 indicator. Participative research as a principle should be positioned at the bottom of the Arnstein
342 ladder (Arnstein, 1969) following van Asselt & Rijkens-Klomp (2002). This will be useful to target the
343 indicators to be developed or monitored in priority.

- 344 • A post-seminar follow-up was assessed by sending to all participants a long Excel table which covers
345 all the covered disciplines that were included as part of the SICMED socio-environmental issues
346 through indicators with the hope of combining them into multidisciplinary ones. Nevertheless, very
347 few answers were obtained during the first two months since some respondents clearly stated a
348 short time frame to meet all the planned objectives.
- 349 • Global results of the seminar raised the issue of the equitable/equal representativeness of the
350 scientific community since for instance hydrology were the dominant field in term of thematic
351 proposed and of number of researchers/experts. Water thematic were therefore dominant and
352 described as a main biophysical issue during the workshop due to the fact that scientist tend to
353 stick to their discipline (hydrologist among themselves and sometimes soil scientists and
354 climatologists, agriculture and economics, etc.).
- 355 • The animation team noticed the difficulty encountered by the participants during the session to
356 distinguish between a socio-environmental indicator and a variable that may be directly
357 measurable or not on the field. A socio-environmental indicator is a result which provide an insight
358 of the state and dynamics of a socio-environmental issue clearly understandable by the general
359 audience (for instance the water availability per capita and per day) and /or an environmental
360 measurement (water depth obtained for a piezometer) and a variable can be measured or not
361 (water of a local groundwater layer). On a more epistemological point of view, the attempt to
362 propose an analytical way (i.e. distinguishing variables of an issue) for apprehending a systemic
363 issue is not easy. Indeed, some variables are well-characterized but difficult to establish in a
364 quantitative way, such as subterranean or nival contributions to many Mediterranean watersheds.
365 Some elements may be known as separated but one may find covariances or mutual influences

³ Usefulness: Practicality = 1, Measurability = 1, Coverage = 1, Accuracy = 1, Synthetic = 1

⁴ Social relevance: Understandable = 1, Practical = 1, Generic = 1, Illustrative = 1

⁵ Sensitivity/Robustness = 1

⁶ Multiplicity of target groups: Public Services = 1, Associations = 1, Foundations = 1, NGOs = 1, Agencies = 1, Specific Programs = 1, General public = 1

366 such as the demography-resources nexus. Some parameters may be hidden or blurred or
367 inductively defined such as the hypothesis of “religion” or “culture” for explaining what is seems
368 irrational behaviors or only not understood (Hofstede, 1983; Bredillet et al. 2010; Rees-Caldwell &
369 Pinnington, 2013). And so on for even more fuzzy and hard-to-distinguish variables.

- 370 • Finally, the outcome was hardly of a concern for the overall community, mostly because the
371 combination of many indicators, intended to be exhaustive as a goal was somehow difficult to
372 apprehend for the community. Indeed, most environments assessed in Maghreb and Lebanon are
373 facing very different risks, nuisances and environmental threats complicate the construction of
374 indicators and the process of priority hierarchisation.

375 As a partial conclusion, such a seminar might be considered as a failure but however, because of the
376 involvement of many researchers of different disciplines, it can also be considered as a success in a
377 sociological perspective. Indeed, one of the main challenges was the mental burden mainly due to
378 “results” obligations in a research context of data-scarcity and lack of administrative and logistic
379 supports, added to the fact that, for the educational context, the structures rarely meet the needs of
380 the growing number of students. In the light of that, the working groups had coordinated their efforts
381 to overcome the issues enhancing the scientific collaborative aspects in their works.

382 [PSI: using a call for small projects to investigate academic perceptions](#)

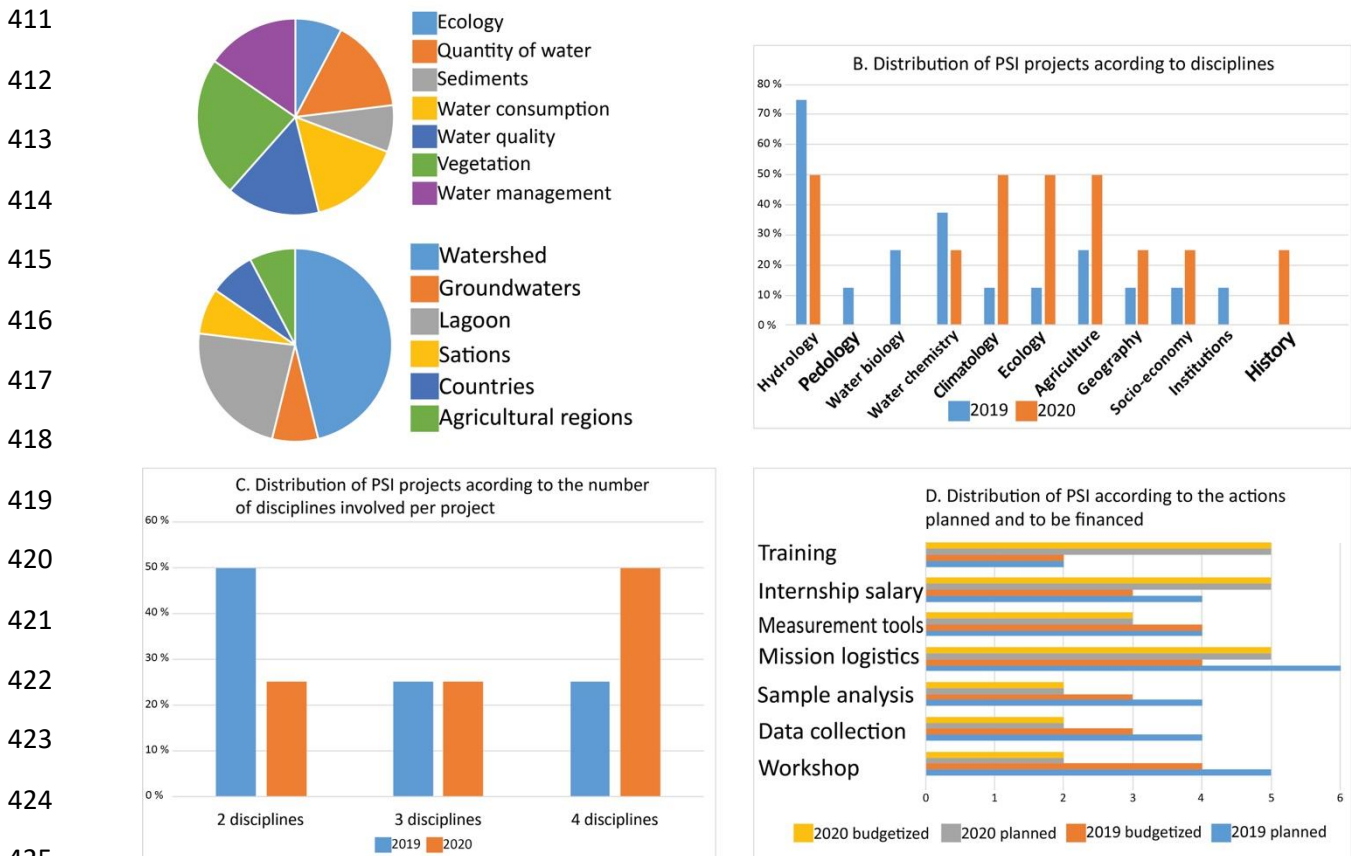
383 Over the two calls (2019 and 2020), 13 projects have been submitted of which 8 projects have been
384 selected, meaning 61.5% ratio of success. We here consider all the submitted projects to be
385 representative of the above-described community on multidisciplinary methodologies. Nevertheless,
386 were all the projects have been apprehended and considered therefore useful? The figure 1 shows an
387 overall representation of the projects according to three criteria:

- 388 a. The scientific disciplines involved
- 389 b. The number of disciplines involved per project
- 390 c. The distribution of planned and funded tasks

391 Five countries were involved by this program: France (Island of Corsica), Tunisia, Morocco, Algeria and
392 Lebanon. Figure 1a exposes the fact that the program mainly concerned hydrological issues. Indeed,
393 due to the fact that serious ecological crises related to water had occurred since the independence of
394 Maghreb countries and Lebanon (for instance the 1973-1983 drought period in Maghreb), water issues
395 were quickly acknowledged as serious and even vital at all levels and sectors of the society and the
396 state, from public infrastructures to scientists (Taleb, 2006; Kuper *et al.* 2009; Hamrita *et al.* 2017).
397 Furthermore, demographic growth, great and progressive changes in consumption and habits along
398 with an average increase of incomes as well as urban transition had also impacted the environment
399 (Sebti *et al.* 2009). Thereby, the most used spatial scale of study was the watershed.

400 This situation has directly impacted the involved disciplines (figure 1b) leading to an
401 overrepresentation of themes related to hydrology in the projects submitted in both years 2019 and
402 2020. The call procedure did consider this tendency and promote a formal balance between
403 disciplines. Finally, actions tasked and applying for funding were mostly operational elements,
404 especially student internships, logistics, materials for field measurements, etc. This statement is
405 directly related to two major challenges in academic research: the overall lack of funds which
406 characterizes less-endowed research budgets and also the specific lack of recurrent and easy-to-get
407 small funds, i.e. funds that does not need long and very random selection procedures. These two points
408 are frequently used to justify long-term and community-based research programs which can last over
409 10 years. It allows at last research to be planned in stages over several years, which in practice becomes
410 extremely difficult around the Mediterranean Sea and especially on its southern shores.

Figure 1: Distribution of PSI projects according to issues and scales, disciplines involved, number of disciplines and tasks.



428 In the same time, the whole research follows a very stable methodological framework which includes
 429 measurements campaigns and debates among experts before the diffusion of the work. It is important
 430 to notice that paradoxically, all projects were settled from academics and cities towards rural areas.
 431 Except one project, cities are seen as not concerned by projects perceived as mostly dedicated to rural
 432 areas and issues, as if there is no direct connection between them. All the issues raised in the projects
 433 mainly concern rural areas and one project planned a workshop ex ante in order to identify the
 434 environmental issues which need to be studied according to the rural stakeholders. The rest of the
 435 projects (6) had workshops planned ex post because of time constraints. Finally, 9 projects over 13 did
 436 plan biophysical investigations along the dominant watershed perspective, and only two projects were
 437 defined according to (partially) socially-defined units, i.e. agricultural regions.

438 In practice, the action was wronged or/and lost a part of its credibility because of both the COVID-19
 439 period and the accelerated end of the program funding by MISTRALS SICMED, 2 years after the launch
 440 of the program. However, the researchers of the different countries involved in the SICMED program
 441 were well aware of the program funding issues because of their good knowledge of the institutional
 442 and organizational aspects of research policies. One researcher stated that, the Indicators initiative
 443 was considered as a comet tail which means an attempt at the end of the program to try out innovative
 444 or original approaches.

445 The Bouregreg: understanding of the impact of dam structures on dam shores

446 Results

- 447 1. The first step was effective: all expert teams did agree to involve themselves into this not-so-
448 obvious participatory process and exchanged descriptions on how they read and analyzed the
449 environment according to their disciplines, which also helped the whole team to better know one
450 another on a personal plan. It was a key moment for the whole program as all the experts had the
451 opportunity to learn of different point of views on things they were used to study according to the
452 perspective and criteria of their own discipline;
- 453 2. The second step provided several compromises: a cross-assessment of multiple sources of data
454 (meteorological data) allowed Goussot *et al.* (2014) to explain the discrepancies between remote
455 sensing land-cover analysis and cereal production variability over time. Another example concerns
456 the acceleration of the gully erosion phenomenon on the banks of the dam. For some decades the
457 issues were poorly understood by physicists until geographers and historians exposed the fact that
458 by pushing out local population after 1920, the French colonial power strongly influenced the
459 industrialization of local agricultural and pastoral practices thus enhancing the vulnerability of the
460 land surfaces to gullying. The major changes in land cover led to the amplification of surface runoff
461 which ultimately triggered the gullying of the banks, without any major changes after the
462 independence in 1956 (Goussot *et al.* 2014). As a result, on a local scale, the kinetic of local
463 processes was undoubtedly much higher in this area in comparison to the rest of the basin (Laouina
464 *et al.* 2010). This common reflection helped the team to identify the main origin of sediments in the
465 dam reservoir.
- 466 3. In the third and more intertwined step, sediments sampling campaign along the river banks
467 between the dam and in the coastal zone (under the sub-tidal zone) combined with bathymetric
468 surveys and a new UAV and LIDAR technologies (Hout *et al.* 2020), allowed to document sediment
469 fluxes and surface erosion all along the watershed. Results were counter-intuitive: 80% of the dam
470 sediments come from the erosion of the dam's banks and micro basins associated and not from the
471 river watershed as initially expected (Ezzaouini *et al.* 2020). Sediment discharges downstream were
472 reduced by 80% after the construction of the dam in 1974, to the point where no more sand reaches
473 the sea. Therefore, this implies focusing future efforts on the local erosion of the banks of the dam
474 and on the understanding of the environmental consequences of the strong decrease of sediment
475 supply from the Bouregreg over the coastal zone.

476 Discussion

477 At the origin, the research question was very downward covering large spatial areas and involving only
478 two disciplines, physic and hydrology. After the first year, the problematic evolves and the approach
479 becomes upward, more focused on a local spatial scale and encompassing further scientific disciplines
480 in addition to hydrology and physic. This evolution was possible through the combination of factors:

- 481 1. Institutional support: Long-term institutional support was mandatory. This support was provided
482 by international agencies through the 35-years partnership between UNESCO and IHP through the
483 FRIEND-Water program (support and development of regional capacities through workshops and
484 training (Mahé *et al.* 2021), as well as the watershed basin agency in Morocco and the CNRS in
485 France (INSU MISTRALS research program (Mahé *et al.* 2020). This common longstanding effort
486 helps to envision reflections and paradoxically support radical and meaningful changes in scientific
487 orientations, as opposed to the usual norms involving short-term projects mainly.
- 488 2. Time: As mentioned above, the temporality is a crucial notion in the implementation of projects.
489 Agendas must include and manage field campaigns, workshops and seminars, which may appear
490 time consuming but however help to adjust visions on main issues and eventually clarify how each
491 team will contribute in the solving of the main problematic of the program (however it can lead to

492 slight differences in the speed of production of results between different teams and fields of
493 investigation, depending on the success of different calls, but it is also a source of motivation for
494 the involved research teams).

495 3. Inclusion: Reporting, meetings and field campaigns were crucial in order to open the debate within
496 the research community. In addition, another key point was also to keep the research team open
497 to newcomers. In practice, the 10-years program was developed according to this line of thinking,
498 15 workshops and 10 training sessions in the three countries (France, Algeria and Morocco),
499 accelerating therefore the sharing of knowledge and expertise between involved teams. Inclusion
500 therefore is a main factor in accordance with the formal assumption of a multidisciplinary research
501 program based on debate and multidisciplinary approaches of the problematic. Inclusion however
502 is a major challenge for most research programs by the fact that newcomers are often assigned to
503 undefined actions which are poorly integrated into the general schedule.

504 4. Generalization: The share of a multidisciplinary visions over the watershed is not relevant enough
505 for validating the approach. The extension of the debate to similar issues increases its value through
506 parallel actions in Algeria and Tunisia. For instance, results in Algeria (Hadour et al. 2021) were
507 enhanced by data of surface sediment fluxes (time series) from the National Hydraulic Agency
508 (Algeria is the only country in Africa performing this type of survey) allowing therefore a calibration
509 between sediment cores and surface fluxes. In Tunisia (Kotti et al. 2017), the combination of studied
510 samples from estuary and near shore areas with a remote sensing study of the coastal erosion
511 exposed the same reduction in sedimentation after 1981 and the building of the dam of the
512 Mejerda River in northern Tunisia (Ben Moussa et al. 2019; Amrouni et al. 2019; Hzami et al. 2021).
513 The results showed also that beach sand dunes were in a process of intense erosion in this area due
514 to the combined effect of the littoral dynamics and the stopping of the arrival of new sedimentary
515 materials (Amrouni et al. 2019).

516 By the fact that similar causes produce similar effects in equivalent situations/contexts, characteristics
517 and physical dynamic of one site may be interpreted as reliable proxies for the studies of other sites.

518 The working environment was however not characterized by a complete social harmony therefore
519 leading to several oppositions due to inherent structural constraints within the academic community:

- 520 • The first point was the necessity to share an important amount of data within the group and
521 without any formal recognition and/or clarification of property or acknowledgement rights. This
522 issue was solved by convincing several teams to simultaneously share their data (meteorology,
523 hydrology, geographic GIS maps), leading therefore to new collaborations;
- 524 • This differences within research groups highlighted also some hidden drawbacks. As a matter of
525 fact, the average number of co-authors varies considerably from a discipline to another (from
526 geosciences with usually more than 10 co-authors to social sciences with rarely more than three),
527 constraining mutual co-authorship invitations for common publications;
- 528 • Another major but quite usual issue was the timeline of the project: all teams were not following
529 the same chronogram, adding therefore difficulties and delays in the general timeline of the project
530 slowing some teams for instance some teams which had to wait for data to continue their program.
531 At the end, respecting the project timeline frame was very challenging.

532 It is important to state out that one of the main financers, the AUF (Agence Universitaire de la
533 Francophonie) greatly helped in the success of this multidisciplinary cooperation program. Indeed, not
534 only they allowed to redistribute credits from different lines to others with great flexibility (allowing
535 integration of new partners within the run of the program), but they also extended of one year the
536 duration of the program which induce many collaborations and made this period the most productive
537 time of the program (with all teams having enough results to discuss). Moreover, this has allowed to
538 rapidly formalize the main lines of a new program, more focused on some specific topics and areas,
539 quickly funded and extended to Algeria and Morocco. Finally, a few years later, this project became
540 one of the major research axes of the CNRS INSU MISTRALS Mediterranean program.

541 [Against all odds: The Franco-Lebanese multidisciplinary collaborative laboratory: O-LiFE,](#)
542 [an over-ambitious project with some successes](#)

543 A first component-based mandate

544 Initiated in 2012, the “Observatoire Libano-Français de l’Environnement (O-LiFE)”, is a research
545 observatory and platform based in Lebanon with the aim to experiment the establishment of a
546 multidisciplinary observatory in a multiple challenging context such as Lebanon. Indeed, this country
547 was chosen because it aggregates most if not all the socio-environmental issues and challenges
548 encountered along Mediterranean shores but also because one-century-long institutional connection
549 and cooperation between French and Lebanese research and academic institutions do help for further
550 researches, through common languages and research traditions, already settled conventions for
551 students and academic exchanges and easier visa procedures. Furthermore, the size of the country
552 (10452 km²) enable the possibility to directly observe the results and make spatial extrapolation but
553 also reduce the costs of field missions and measurement campaigns. Finally, the environmental,
554 economic and political contexts of Lebanon are highly sensitive to climate changes allowing therefore
555 the ecological and societal vulnerability of the country to increase further in the near future (Füssel,
556 2007).

557 Given the inevitability of global changes and their (already) devastating impacts over the citizens, the
558 corresponding research communities (considering that observation is etymologically and thematically
559 essential to understand environmental and anthropic changes) see as urgent the need to collect,
560 perpetuate, share and enhance the value of environmental information. Moreover, the synergy
561 between systematic observation of the environment and modelling, allows the possibility to analyze
562 such mechanisms. However, it requires long-term spatialized data covering a wide variety of features
563 and structured in databases coupled with spatial modelling. As a result, some researchers from French
564 and Lebanese institutions wished to lay the foundations of a shared observatory as a first step towards
565 a future network of circum-Mediterranean observatories. This initiative was conducted in partnership
566 with the CNRS MISTRALS program, IRD⁷ and CNRS-Lebanon and supported by several universities in
567 France (Montpellier, Toulouse, Grenoble, Aix-Marseille and Avignon) and Lebanon (UL, USJ, AUB, USEK
568 and Balamand⁸). The approach was based on a pragmatic mean to associate actors in a common action
569 allowing to federate a great diversity of actors across the collection and preservation of environmental
570 data in addition to the definition of a common body of variables.

571 After its initiation in 2012, O-Life network was validated as LIA⁹ for the 2014-2018 period, then as a
572 GDRI¹⁰ for the 2018-2022 period. Its missions were progressively defined firstly to face the (lack of)
573 data availability and connection between scientists in different disciplines. During the establishment
574 phase, three priorities were enhanced: conducting observation services, build databases and model to
575 understand and prevent. Thematic priorities were first biodiversity, water and environmental
576 management before the highlighting of issues involving air and sea pollution and seismic risks over the
577 country. Therefore, during the 2014-2018 period, O-Life was structured around 4 thematic axes:

- 578 • Water-LiFE: Issues related to water resources were quickly pointed out as a connection between
579 biophysical and social disciplines (including political and geostrategic).

⁷ Institut de Recherche pour le Développement

⁸ Université Libanaise, Université Saint Joseph, Université Américaine de Beyrouth, Université de Saint Esprit Kaslik, Université de Balamand

⁹ Laboratoire International Associé

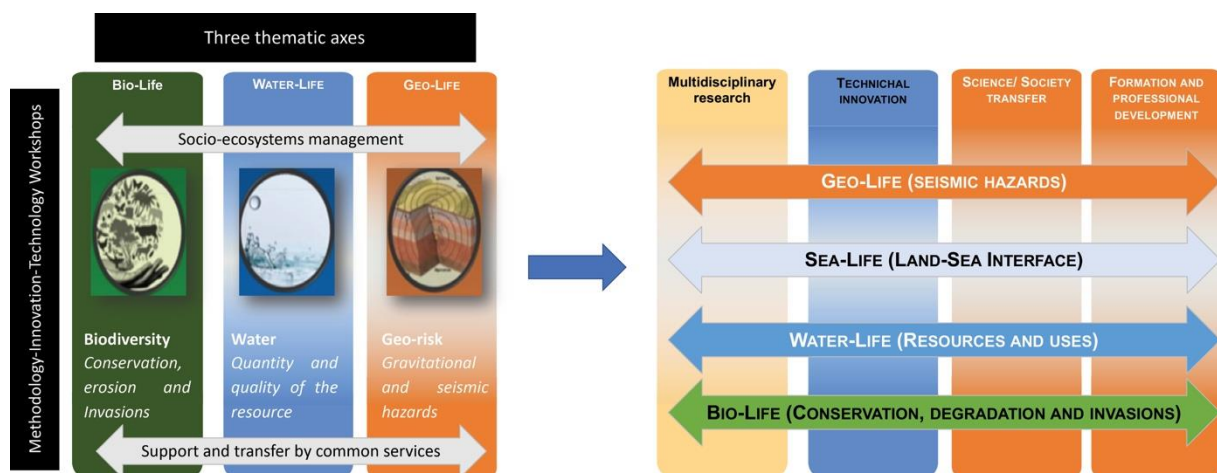
¹⁰ GDRI-Sud/IRN (Groupe De Recherche International/ International Research Network), initially settled for the 2018-2021 period, extended to 2022 due to COVID-19 and Lebanese events affecting all the research actions: researchers' salaries melting pushing them to leave or to find secondary jobs, students leaving the country, riots, etc. all terrible constraints that should not be obliterated.

- 580 • Bio-LiFE: Biodiversity on the contrary was highlighted to expose the fact that it is hardly taken in
581 consideration in Lebanon despite the knowledge that the country is part of the 10 mini biodiversity
582 hotspots of the Mediterranean Sea.
- 583 • Geo-LiFE: The forecasting and management of seismic risk was addressed as Lebanon is subject to
584 a number of natural earthquakes and the fact that scientific work around this thematic had already
585 be executed but with the majority of the information had stayed within academic circles and poorly
586 communicated to the population.
- 587 • Sea-LiFE: This component was added afterwards in order to highlight the importance of marine
588 environment and address issues of pollution and other anthropogenic degradations.

589 During this phase of the program, 40 researchers representing the 17 partner institutions (from which
590 14 Lebanese) were involved in O-LiFE. The institutional organization and funding process did reflect
591 this organization along the different thematic (Figure 2a):

- 592 • The network constituted a place of debate, orientation and consensus in which actors with various
593 thematic and methodological tools determined together the priorities and the harmonization of
594 the means and resources available or to be sought. Indeed, the fragmented research context
595 pushed all partners to build its own financial and research network with foreign and/or local
596 partners. Building a place of debate was not an obvious process and we had to avoid any social
597 competition among members and formalize all the decision processes to reassure all the partners
598 of the network;
- 599 • Affirming external and valuable standards throughout the network: Scientific such as the
600 Sustainable Development Objectives; Participatory with a support to multidisciplinary
601 collaborations and environmental ones with the inclusion of the socio-ecosystem concept, thereby
602 fighting both conservationist and liberal postulates (van Asselt & Rijkens-Klomp, 2002; Cornwall &
603 Jewkes, 2006), and bringing together all the emblematic pressures (coastline, mountains, cities,
604 etc).

605 Figure 2. Institutional organization of O-LiFE: a. 1st version of 2014-2018 then 2018-2022. b. 2022-...
606



- 607
- 608 • By labelling/supporting actions abroad and at national and regional levels, O-LiFE federated some
609 of the requests made to international donors (large European global programs, etc.). At last, O-LiFE
610 was asked to extend its experience to the Mediterranean region, based in particular on

611 observatories as "frontier" objects, between cultures, themes, methodologies and organizations
612 along a Euro-Mediterranean research network of observatories¹¹.

613 Further mandates towards transversal components

614 Although initially effective for its first objectives pushing scientists from the same discipline but
615 scattered across a lot of institutions and programs, this organization faced progressively a threshold
616 beyond of which the institution itself became an obstacle. Hence the fact that the organization is
617 strongly based on "projects orientated structuration", the global project was managed in silos to
618 address disciplinary related issues, themes and research actions. The main obstacles were the
619 difficulties to go beyond this framework of thematic divisions and also to think in a more sustainable
620 way regarding research teams although they came from different institutions, implying therefore a
621 more perennial establishment of the research in Lebanon. The second proposal for the 2018-2022
622 mandate (Figure 2a) was envisioned as carrying on the effort and facilitating these interactions by
623 adding:

- 624 • A transversal axis, dedicated to experimental observations (Tool-LiFe with the objective to develop
625 methods and tools) was proposed to facilitate the transition from a research-equipped structure to
626 an equipment-based but issues-oriented structure. Practically, it is a support for instrumentation,
627 data and information collection, storage and sharing;
- 628 • Formal support to increase the effect of the O-LiFe label through continuous review of appropriate
629 tenders with a focus on multidisciplinary tenders and connection between partners for drafting
630 responses;
- 631 • A new axis: Socio-LiFe to include social issues as well as to answer the needs of preparing scientists
632 to communicate with the public and decision-makers which should be a component of every project
633 when needed.

634 This intermediate phase is reconsidered in the latest mandate proposed in 2022 for supporting a more
635 transdisciplinary and mutual integration. All the components are to be defined and justified according
636 to the actions to overpass the environmental component/silo approach (Figure 2b). This may be seen
637 as a 90° shift in the diagram of the program, however in practice it implies that the sub-managers of
638 the program are focusing on the actions and not the environmental components therefore
639 encouraging future projects to be organized from an action perspective.

640 Questioning the efficiency of the project

641 After 8 years, O-LiFE was able to:

- 642 • Successfully gather a pool of multidisciplinary experts in the various fields of biodiversity, water
643 science, geo risk management, sea-based research, air quality and social sciences. However, the
644 main limitation of this action is that these experts are rarely consulted by Lebanese national and
645 local actors and stakeholders;
- 646 • Develop transdisciplinary research. One of the main success of O-LIFE is that thematic researchers
647 involved in the project have proposed and coordinated multidisciplinary research topics;
- 648 • Have included social science and integrated human impacts and retroactions. It also included a
649 connection with national extension services and by then transferring scientific research results to
650 the general audience through various media. This actually helped to be recognized as a reliable and
651 visible research institution in environmental sciences⁹;
- 652 • Act as a funding and labelling support to multilateral groups with a power of more than 300% (more
653 than 3 US\$ raised for each US\$ provided by O-LiFE);

¹¹ Consequently, each observatory site of O-LIFE and partners in Lebanon has been the object of several monitoring campaigns from several thematic priorities (e.g. The Nahr Ibrahim watershed with Water-LiFe, Bio-LiFe and then others, etc.), allowing thereby different disciplines to meet on the ground.

- 654 • Build a solid network of back-up, storage and transferring tools dedicated to equipping and
655 supporting data collection in a wide variety of areas;
- 656 • Conducts researches based on approaches requesting little and often low-cost means, support the
657 deployment of sensor networks and facilitate studies in complex environments (either because of
658 physical inaccessibility or because of the social and political situations in Lebanon). O-LiFE has
659 therefore progressed toward the needs of investing into “frugal science”.

660 Nevertheless, despite the considerable improvement in research and the building of trust within the
661 O-LiFE team and among the partner institutions, O-LiFE failed to:

- 662 • Build a data collection system on physical and social attributes which involve the various researches
663 and teams and also to constitute a unique multi-thematic and multi institutions database which it
664 has first aimed to implement. Data sharing remains therefore as one of the major obstacles to the
665 objectives of O-LiFE;
- 666 • One of the hypotheses behind the reluctance for data sharing could be related to extremely tight
667 competition on time and resources where researchers do not invest time to format their data in a
668 sharable form and where no financial, publication and institutional advantages could support this
669 action in addition as well of the risk of data theft after being shared. Data sharing remains therefore
670 as one of the major obstacles to the objectives of O-LiFE, due both to the inner research
671 competition and to the lack of financial and institutional support for the researchers;
- 672 • Go beyond the network level as for instance becoming progressively the first network/institution
673 to be considered by the community to joint formal and successful responses to largely-funded
674 international calls for tenders but also for common publications. This action faces the difficulty to
675 obtain such funds in countries considered as “risky”, the existence of other national and
676 international networks that can provide equivalent supports with other obedience and legitimacies
677 (such as common languages or beliefs), the fact that monodisciplinary calls are much better funded
678 especially in biophysical sciences, and finally, the effective unavailability of the French and
679 Lebanese researchers who must respond to various responsibilities of management and publication
680 and in addition for some of the Lebanese members, responsibilities also in remunerative expertise
681 missions.

682 At present, O-LiFe is also associated with a team spirit to be considered as a specific resource in the
683 face of calamities that befall Lebanon (the 2019 economic breakdown, the 2020-2021 Covid-19
684 pandemic containment and the 2020 Beirut explosion). The vanishing of technical means (gas, data
685 recorders) is aggravated by the huge decrease of the value of financial incomes and the blocking of
686 banks. Solidarity between O-LiFe members allows to find temporary resources and means, small
687 financial supports, job transfers or job offers in French laboratories to limit the brain drain.

688 Discussion & conclusion

689 Representativeness of the proposed experiments

690 These multidisciplinary research programs were clearly not the only ones to be evaluated on the shores
691 of the Mediterranean, and it must be recognized that there is an institutional bias as well. Even within
692 the framework of cooperation between France and the other Mediterranean members of the AUF,
693 several other projects were evaluated for the interweaving of disciplines in action:

- 694 • The ANR¹²-funded TRANSMED-call AMETHYST project (2013-2017) “Assessment of changes in
695 MEdiTerranean HYdro-resources in the South: river basin Trajectories” in Morocco and Tunisia,
696 largely connected to SICMED and integrating socio-economic trajectories into watershed futures;

¹² ANR : Agence Nationale de la Recherche

697 • The Almira project ¹³ from the same ANR TRANSMED-call (2013-2017) “Adapting Landscape
698 Mosaics of Mediterranean Rainfed Agrosystems for a sustainable management of crop production,
699 water and soil resources”
700 • MISTRALS-SICMED ReSAMed (2010-2012)¹⁴ & METASIM (2011-2013)¹⁵, or even CNES¹⁶ EVA2IRT
701 (2013-2014), all programs orientated toward remote sensing-based hydrology modelling on the
702 same sites in Morocco and Tunisia ;
703 At the same time, the biggest weakness of these actions is related to their project structure: how to
704 capitalize on the experiences and networks once the projects are completed? This is where the value
705 of perennial structures such as observatories and long-term joint programs becomes clear.

706 Formalization of multidisciplinary knowledge

707 Actually, many scientific problematics do not require an multidisciplinary approach (Alvargonzález,
708 2011; Lélé & Norgaard, 2005; Nicolescu, 2014; Schroeder, 2022) and dividing the research themes into
709 various pieces each attributed to a specify discipline along the analytical method is an easier mean to
710 acquire information. Academic literature and research institutions has promoted more and more
711 detailed structures for too complex and sometimes (even often) contradictory objectives: (i)
712 understanding complex issues such as SES ones and (ii) a more socially-orientated research for better
713 advising stakeholders (Brewer, 1999; Jacobs & Frickel, 2009; Lam *et al.* 2014). The related
714 contradictions have been described, acknowledged and largely debated in several publications (Olivier
715 de Sardan, 1990; Albaladejo & Casabianca, 1997; Montmain & Penalva, 2003; Cornwall & Jewkes, 2006;
716 Bousquet *et al.* 2009; Lavigne-Delville, 2011). Indeed, some institutional elements are quite often
717 observed to exacerbate these trends (Hamad, 1982; Jerneck *et al.* 2011; Lyall *et al.* 2013). There are
718 several reasons for this, which are clear but sometimes not-so-obvious:

719 • The first argument is honesty: Various conceptual & methodological constraints but also the sole
720 habit induces a low use of systemic approach. Scholars and researchers often prefer a more
721 analytical analysis which are poorly suited for the study and understand complex systems such as
722 SES. In this case, methods such as multi-criteria analysis, relying on the combination of factors
723 governing a given socio-environmental context are therefore favored (Lélé & Norgaard, 2005;
724 Hajkowicz & Collins, 2007). However, being able to break down an SES issue into its components is
725 a prerequisite for such an analytical demarche: components should have been defined and
726 classified within the system. It is therefore hidden multidisciplinary, without assuming it. Most of
727 the time, unfortunately, hierarchizing elements to be investigated is not explicated, formalized nor
728 justified¹⁷, helping one specialist to focus on its own specialty with the traditional and falsely honest
729 “I focus on my domain”. However, formally linking pieces together for solving socio-environmental
730 issues is the necessary step of research after accumulating data: the establishment of theories from
731 data and information previously collected. This approach (or modality of inference) is commonly
732 called "inductive" and is functioning along a hypothetico-deductive research approach (deduction
733 vs. induction vs. abduction) (Blecic & Cecchini, 2008, pp. 539-540), involves combining together
734 "elements", pieces of science, according to a plan that can shed light on a question. Therefore,
735 dealing with socio-environmental issues implies necessarily to organize and hierarchize its
736 components therefore multidisciplinary cannot be avoided for understanding the structure of a
737 socio-ecosystem;

¹³ <https://www.umr-lisah.fr/?q=fr/content/projet-almira>

¹⁴ Recharge des Systèmes Aquifères en Méditerranée

¹⁵ Modélisation de l'Evapotranspiration ET Assimilation de données Satellitaires pour la gestion de l'Irrigation en Méditerranée

¹⁶CNES : Centre National d'Etudes Spatiales

¹⁷ Justified implies avoiding truisms such as « it is well known...”, “since the beginning of times...” or “this point is important”

- 738 • The second point is exhaustivity: these components are in trophic, energetic, spatial, social, political
739 or economic interaction/interdependency and constitutes a coherent system: each element moves
740 in relation with another and all the components form a system. It means that results from an
741 analytical demarche, for instance prospective and/or predictive results are intrinsically false and/or
742 reductive. Multidisciplinarity is by then necessary for understanding the functioning of a socio-
743 ecosystem. However, the large debate between multi, inter and transdisciplinarity is flawed:
744 definitions are not always mutually exclusive¹⁸, with not a common agreement on the terminology
745 even after a debate starting in the 90's. It is not practically operative as no one can see the
746 differences on the field. As a response, we consider however that these concepts matter because
747 it is the way humans rationalize and act, and humans are the most powerful force in SES¹⁹. Defining
748 the borders, the limits of a system is far more important and implies always simplifications (as there
749 is no closed systems on earth in the present-time). One should order disciplines, issues and stakes
750 and separate what is important for the study of the system and what is not. This is the fundamental
751 element in our neologism: holodisciplinarity (Saqalli, 2020), the methodological process of building
752 and providing arguments to establish the criteria/criterion able to establish the exhaustivity
753 regarding disciplines and processes for the study of the system, the stake or the issue we
754 considered;
- 755 • The third point could be formal balance: Indeed, biophysical sciences having enough funds having
756 more funds and more legitimacy from stakeholder audiences do have very little incentives to
757 cooperate. Social sciences do face opposite contexts. Actually, one may consider the first two points
758 as the methodological bedrock for acknowledging the primordial position of social sciences (with
759 primordial in its etymological meaning: first to consider), solely because humans, the main natural
760 force activating and transforming territories especially along Mediterranean mostly urbanized
761 shores, are driven by social factors. One should then point out that not considering this main natural
762 force is a bias and there is already methodological tools, such as socio-anthropological agent-based
763 modelling (Saqalli, 2020) to combine altogether social information, including from qualitative socio-
764 anthropological methods, and biophysical data and dynamics, each one in its rank and with its
765 weight. Not considering social sciences because "we do not have enough data" is not a scientific
766 argument (Saqalli, 2020);
- 767 • The last point is efficiency: As pointed out by Bachelard (1938), the need for a change such as
768 multidisciplinarity arises while facing an "epistemological obstacle". However, this is a necessary
769 but not sufficient condition. It only means that a researcher from one discipline is confronted with
770 a problem that goes beyond the "normal" science to which he or she belongs. In practice, going
771 beyond is not rewarding as stated above for the reason that institutional and financial rewards are
772 by far higher and safer for a researcher if he stays into its field of competence. This explains the
773 overall difficulty for promoting multidisciplinarity: this obstacle here implies either a constraint
774 within each community or from outside as stakeholders encourage a more operational research:
- 775 ○ The inner "pull" may appear only when the first two points are not only acknowledged but also
776 considered as mandatory for getting research funds which is far from a reality. Unfortunately,
777 the evolution of funds in the southern Mediterranean region did follow an opposite way, where
778 it remains structurally low in terms of absolute values and in proportion to the economies of the
779 Mediterranean countries (Pouloudi et al. 2012; El-Jardali et al. 2012; Ismail et al. 2013; Mandil
780 et al. 2018). Even worse, the orientation towards "excellency" as quantified by publication and
781 funding metrics did discourage promotion of challenging researches regarding these criteria
782 (Laraus, 2004; Porter et al. 2006; El-Jardali et al. 2012);

¹⁸ apart from the difference between multi- and interdisciplinarity based on the fact that the hypothesis-testing process, whatever it can be, is assessed within the discipline and the mental process of one methodologically consistent group of scientific practices (for instance social sciences) in the first term, or it is assessed across such groups in the second one.

¹⁹ The problem is that humans do not order things and act accordingly in the same way, thereby justifying with this sole argument the value of social sciences as the only ones able to define in which the various motors of a SES push.

- 783 ○ The external “push” for orientating projects towards advising stakeholders is counterbalanced
784 by the non-transparency wall in the choices of decision-makers, i.e. the reluctance of
785 stakeholders to justify their actions reducing thereby their contacts with scientists in most of
786 the countries of the Mediterranean basin. This is even intensified by French *Napoleonic*
787 technocratic traditions, where engineer traditions are dominant. Facing “doubt-providers” is
788 more disturbing and seems less efficient than solutions-providers, amplified recently by the use
789 of consulting firms for everything (Barthel & Verdeil, 2008);
- 790 ○ Risks and risk information: Since the book of Ulrich Beck in 1986 (Beck, “The society of risks”,
791 1986), environmental research started to be more interested in risks, hazards and
792 vulnerabilities, mostly on an analytical point of view. In a society where risks and crises occupy
793 a central position in the development, the establishment of a comparing, hierarchizing and
794 prioritizing risk procedure has become crucial. However, such a process is mainly based on
795 environmental data and their analysis and interpretations. Consequently, data acquisitions and
796 treatments methodology should be considered as important as the decision making itself during
797 a crisis event because of the uncertainties in link with data collection and analysis.

798 Public policy limitations and priorities:

- 799 a. Lack of operational procedures in the public sector to be applied over threats, risks and nuisances.
800 On the contrary, one may see the multiplication of technical reports provided by dedicated
801 consulting companies focusing on one point and by then having difficulties to also envision the local
802 SES context but also the various uncertainties regarding both the quality of the measurements and
803 the conceptualization of the issue. Managing environmental threats, risks or nuisances need
804 figures, numbers for already-characterized-as-important parameters, which means that the
805 parameters’ selection criteria are already settled as well as their measurement procedures and
806 analysis. Indeed, diagnosis should be separated to management to avoid dealing with issues you
807 have little clues on. Admittedly, during the last decade, many project calls on the Mediterranean
808 region encouraging multidisciplinary researches have also supported their pragmatic
809 implementations and more involvement of concerned stakeholders, NGOs, public services and
810 other institutions.
- 811 b. Information in and out of crises: As a consequence of the previous point, even if crisis prevention
812 is more efficient than crisis management but implies long and well-structured data collection
813 campaigns, crisis times urge the need for rapid measures and procedures. Practically, it means that
814 prevention increases connections between stakeholders while crises reduces them drastically to
815 minimize interferences. Nevertheless, crisis management is even more obviously depending on
816 diagnoses, at the very least to check what emergency do we deal with.
- 817 c. Communication problems between public operators and scientific community which lead to
818 motivation issues in the scientific community. However, some public structures as hydraulic
819 services in Algeria, partly in Morocco, Tunisia and Lebanon, are on the contrary well connected to
820 the national scientific sector following a technocratic model of development. Nevertheless, the
821 other environmental issues are far less valued compared to the water sector.
- 822 d. Professional competition within different scientific communities. Combining and analyzing a large
823 set of parameters from distinct disciplines implies to consider them on the same level of importance
824 after a selection in accordance to a series of criteria based on the environmental context of the
825 studied area. The problem here come by the fact that in most cases, the academic financial context
826 is composed by scattered public funding which rarely cover at the same level all the needs in each
827 different domain. In the light of that fact, public governmental funding priorities should be
828 reconsidered regarding each different environmental context (Heberlein, 1988; Van Dusseldorp &
829 Wigboldus, 1994; Stojanovic *et al.* 2016);

- 830 e. Institutional instabilities, especially in southern Mediterranean countries, represent another main
831 constraint to setting-up multidisciplinary research structures. Although scientific research has
832 allowed the growth of a solid network between many academic institutes (privates and publics) on
833 the area of interest, the sector is extremely vulnerable to socio-political contexts and academic
834 institutions thus scientific capacity, strongly relates on the political and economic country
835 situations. In the four considered countries by this paper (Algeria, Lebanon, Morocco and Tunisia)
836 for instance, scientific works relies mainly on foreign funding because of the severe socio-economic
837 and political instabilities. In general, the most resilient local universities (the best-funded) are
838 dedicated to technical and applied knowledge linked to an essential resource for the development
839 (engineering schools: oil, mines, energy, agriculture, water, sea) or on hazard studies
840 (desertification, drought, geologic and geomorphologic hazards, human health and demography)
841 (Hamad, 1982; Van Dusseldorp & Wigboldus, 1994; Lyall *et al.* 2013; Bark *et al.* 2016);
- 842 f. In the continuation of the previous idea, some fields are therefore considered as strategic by the
843 public authorities and thus may polarize the majority of local funds allowed for the research.
844 Nevertheless, despite investments by public authorities on scientific research, the impact on the
845 actors directly in link with the main environmental issues is weak (Steele & Stier, 2000; Bredillet *et*
846 *al.* 2010; Hassenteufel, 2010; Santamaría *et al.* 2010; Lyall *et al.* 2013).

847 [Specific situations from case studies](#)

848 The point that can be inferred from the experiences described above is that these obstacles are
849 exacerbated in MENA¹⁵ countries located along the shores of the Mediterranean Sea:

- 850 • First and above all, the absence of stable and consequent funding and the support of traditional
851 approaches instead of multidisciplinary framework;
- 852 • Second and because the first point implies that networks quality are the main stable source of funds
853 and even income for Lebanon, the risk of rejection within disciplinary communities with hidden
854 social sanctions in case of “betrayals” and protective competence shelters;
- 855 • The third point is that scientists are seen by public offices not as researchers, meaning providers of
856 doubts and questions, but rather available (and cheap) experts (Barthel & Verdeil, 2008) providing
857 deliverables into international projects and by then sometimes national prestige and providing
858 solutions or at least confirmations to ministries and public offices: they are not seen as needing
859 support but on the contrary are to bring support to action.
- 860 • These three points are actually the strongest ones by far, meaning that scholars and academics are
861 de facto adaptable to trends and dynamics unless it is a threat to their social position. As a matter
862 of fact, the following points are supportive arguments for a position regarding multidisciplinary
863 firstly defined by the first three points above:
 - 864 ○ A mutual misunderstanding between disciplines based on reciprocal clichés
 - 865 ○ A conflict of agenda between tasks, duties and objectives for all researchers
 - 866 ○ Misconceptions between variables, data, objectives, measurements & indicators
 - 867 ○ A fear of losing the decision power from stakeholders
 - 868 ○ The non-consideration of the transdisciplinary research in academic evaluations of researches.

869 More specifically, the four experiences illustrate several specific elements (El Kenz, 2005):

- 870 1. Money: Stable budget is fundamental despite the “Simpler, Better, Cheaper” ideology. Even more,
871 instability distorts the balance between disciplines as social sciences are often the first to be
872 sacrificed to the austerity principle. The countries considered in these studies (Algeria, Lebanon,
873 Morocco, Tunisia) suffer from versatile and low budgets but some countries expose a more solid
874 and resulting scientific production and the international implications are in direct correlation
875 (World Bank, 2018; UNESCO Statistics Institute, 2022);

- 876 2. Time: Building metrics collectively such as in the SICMED experiment and the Bouregreg collective
877 work requires a progressive impregnation and time cannot be avoided. Past colonial tensions,
878 political internal struggles and conflicts or competition for funds are not confidence-building
879 elements. As a result, the more a country does face such elements and others that structurally and
880 regularly create issues (such as in Algeria or Lebanon), the less multidisciplinary is acknowledged;
- 881 3. Winner-take-it-all: Hydrology, seen as essential, benefits in all MENA countries from both a long
882 tradition of national expertise and a very strong legitimacy among governmental administrations,
883 research institutions and other stakeholders as the result of the strong dependency of these
884 countries towards water in this arid environment. It is then by far the most developed discipline in
885 socio-ecological systems in addition of being the discipline where most of the efforts towards
886 multidisciplinary were assessed: SICMED, Bouregreg, PSI and O-LIFE are all dominated by
887 hydrology related issues and projects and the self-recognition of this constraint is primarily due to
888 the fact that "pull" and "push" incentives for hydrology have been actively effective for a long time.
889 Hydrology is the domain where applied research and complementary actions with public policies
890 are the strongest, as in the watershed-defined ORMVA²⁰ in Morocco for instance (El-Alaoui, 1999).
891 But the richer a discipline is, the less orientated towards multidisciplinary they are, and most of the
892 cases we studied are hydrology-based that is trying to integrate other components of the SES. This
893 simple qualitative correlation assertion could be of course justified and does not imply a causality;
- 894 4. Measuring is nice: while focusing on combining methodologies, the PSI program did actually fund
895 mostly measurement campaigns, field missions, training and internships. Water parameters are the
896 most characterized one in the SICMED experiment. The Bouregreg program is defined by a series
897 of measurement campaigns and innovations related to water. It is then useful to ask about the
898 threshold criteria of completeness beyond which the measurement is sufficient: when can we say
899 that the measurements are sufficient to go further?
- 900 5. Decentralization and concentration of power: all these countries are very centralized, with the
901 exception of Lebanon. This statement means that, apart from government defined but local
902 structures such as the ORMVA in Morocco, all decisions remain in ministries and other local powers
903 are rarely acknowledged. For instance, the well-considered hydrology related issues are well
904 considered among state-defined stakeholders however, there are still no areas where local actors
905 are involved, as if the strategic importance of water limited its management to higher government
906 levels. Biodiversity and land use/land cover are only considered politically interesting when ancient
907 customs allow local authorities to be part of the negotiation, as in the case of the pastoral
908 management of Moroccan Agdals (Dominguez, 2017). Therefore, multidisciplinary and
909 development-oriented research are depending on a very small number of interlocutors;
- 910 6. Culture: we previously stated that, along religion, culture is most of the time the default explanation
911 when no obvious explanations were not found. Indeed, some be. The issue with "culture" is that it
912 provides a permanent and structural "explanation" ("they are like that") without having to explore
913 it, while going after hidden, blurred or inductively defined and most importantly temporary factors
914 such as more institutional, political or economic parameters is far more complicate but more open
915 to analysis (Hofstede, 1983; Bredillet et al. 2010; Rees-Caldwell & Pinnington, 2013). As a response,
916 we propose to use the culture point only when all other factors have been exhaustively explored.

917 [Suggestion proposals for promoting inter- and holodisciplinary](#)

918 As a conclusion, one should acknowledge that the two components, logistical and epistemological, are
919 both effectively acting:

²⁰ Office Régional de Mise en Valeur : Regional Development Authority

- 920 • Acknowledging the structural and logistical reasons, including balance of power based on fund
 921 availability and recognition from the society and public services, domination relationships,
 922 institutional instability and other points we stated above. As a matter of fact, a tradition of long-
 923 term public service exists in these countries, including the maintenance of long-term and
 924 intertwined public- environmental infrastructures such as dams (Mahé et al. 2021). Scientific
 925 research efficiency is directly linked to the stability of national institutions which draw organigrams
 926 and funding. International partnerships encourage more global approaches regarding population
 927 and environment nexuses. Such partnerships are essential on a short term for keeping research
 928 infrastructures when it is the most needed as during crisis and/or shortage times. They also ensure
 929 the stability and often the funds necessary to provide the time and means required by a more
 930 multidisciplinary understanding of natural phenomena, economy and population. It is also the
 931 occasion to acknowledge some common cultural trends from both sides of the Mediterranean area
 932 and not only the southern one²¹;
- 933 • Holodisciplinary: The epistemological principles we deduced from the various projects and
 934 experiments tend to build a demarche for (i) listing variables, (ii) formalizing and clarifying
 935 corresponding parameters, (iii) evaluating them according to clear criteria, (iv) building indicators
 936 from these parameters to facilitate the comparison, (v) hierarchizing and prioritizing socio-
 937 ecological issues and stakes according to these indicators (Saqalli, 2020). In any cases, we plea here
 938 for a first apprehension of an issue and the circumscription of it through what should overcome the
 939 whole debate on the fuzzy notions of multidisciplinary, multidisciplinary and transdisciplinarity:
 940 holodisciplinary, the idea that we should reach exhaustivity of the dynamics and disciplines
 941 regarding an issue, whatever the criterion for establishing it (Saqalli, 2020). Formalizing, applying,
 942 diffusing such approaches in agreement with legitimate stakeholders, public officers and political
 943 actors are a satisfying pattern to follow for the following years and decades. Nevertheless, it is
 944 unclear if the race between these positive approaches and the coming environmental changes is
 945 still attainable.

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21 The success of this approach can be illustrated by the recent distinction obtained by Tunisian colleagues for their study of the coastal Ghar el Melh lagoon in the North of Tunis, in collaboration with local populations and associations, and national and international NGOs including WWF. Thus the national institution for marine studies (INSTM in Tunis) officially launched in December 2022 an observatory of the Ghar le Melh lagoon, which obtained the UNESCO “Ecohydrology” program label, as the first African/Mediterranean coastal Ecohydrology demosite of UNESCO. Among the criteria to fulfill to get this label, there are clear scientific questions, environmental challenges linked to ecology/hydrology related questions, operational survey means, scheduled mitigation/remediation measures, strong connection with local/regional communities, and high level of capacity for local/regional/international sharing of experience, for instance through international networks like UNESCO programs –FRIEND-Water, Ecohydrology, G-WADI, etc.).

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