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► **To cite this version:**

Léonard Dupont, Staffan Jacob, Hervé Philippe. Scientist engagement and the knowledge-action gap. Nature Ecology & Evolution, 2024, 10.1038/s41559-024-02535-0 . hal-04730178

**HAL Id: hal-04730178**

**<https://hal.science/hal-04730178v1>**

Submitted on 10 Oct 2024

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# 1 **Scientist engagement and the knowledge-action gap**

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7

## 8 **Abstract**

9 The combined gravity of biodiversity loss and climate change keeps increasing. As the approaching  
10 catastrophe has never looked so alarming, the amount of scientific knowledge about the bioclimatic  
11 crisis is still rising exponentially. Here, we reflect on how researchers in ecology or climate science  
12 behave amid this crisis. In face of the disproportionality between how much more scientists know and  
13 how little more they engage, we discuss four barriers which may underlie the decoupling of scientific  
14 awareness from concrete action. We then reflect on the potency of rational thinking to trigger  
15 engagement on its own, and question whether more scientific knowledge can be the tipping point  
16 towards radical changes within society. Our observations challenge the tenet that a better  
17 understanding of what surrounds us is necessary to protect it efficiently. With the environmental cost of  
18 scientific research itself as an additional factor that must be considered, we suggest there is an urgent  
19 need for researchers to collectively reflect on their situation and find how to redirect their actions.

20

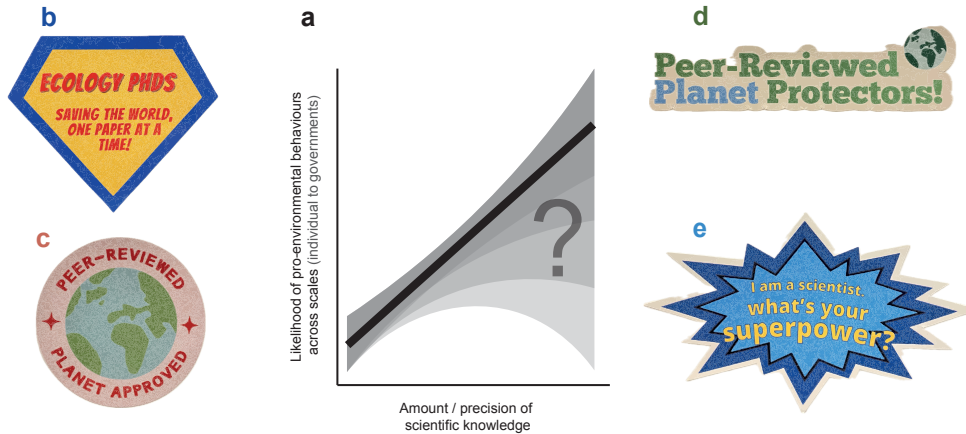
21 Keywords: ecology; climate change; knowledge; action

22           Aside from being the hottest ever recorded<sup>1</sup>, 2023 looked like all previous years, with global  
23 CO<sub>2</sub> emissions increasing again by more than 1.1% compared to 2022<sup>2-4</sup>. 45 years after Charney's  
24 "Carbon Dioxide and Climate" report<sup>5</sup>, 28 Conferences of the Parties (COP) have taken place, while  
25 one global report from the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem  
26 Services (IPBES) and six from the International Panel for Climate Change (IPCC) have been published  
27 <sup>6,7</sup>. Yet, six of the nine planetary boundaries have been crossed<sup>8</sup>, a sign that the Earth system has never  
28 been so unstable for supporting human life durably<sup>9</sup>. While exceeding the 1.5°C warming mark could  
29 trigger a series of irreversible tipping points with grave consequences<sup>10</sup>, the odds of succeeding to stay  
30 below this threshold are quickly narrowing<sup>11</sup> and this goal now appears almost unachievable before  
31 2030<sup>3,12</sup>. Climate is not the only source of worry however, since close to one half of Earth's animal  
32 populations are declining<sup>13</sup>, one of the latest indications of the ongoing mass extinction<sup>14-16</sup>. Each year,  
33 springtime is more silent still<sup>17</sup>, as the buzz of insects<sup>18,19</sup> and birdsongs<sup>20,21</sup> have been smothered with  
34 anthropogenic disruptions.

35

36           Meanwhile, scientists (see Box 1; Glossary) have been taken up in a frenzied quest for more  
37 knowledge<sup>22,23</sup>. In particular, the number of research articles related to climate change has increased  
38 exponentially in the last decades<sup>24,25</sup>, at a rate four to five times higher than in other scientific fields<sup>26</sup>.  
39 Justifying this trend often calls upon a key argument: that better protecting what surrounds us absolutely  
40 demands a better scientific understanding<sup>24,25</sup> (Fig. 1). This knowledge hypothesis is relayed at a  
41 diversity of scales, from the UNESCO<sup>27</sup> or the European Union in funding calls<sup>28</sup>, to research institutes<sup>29</sup>,  
42 publishers designing dedicated stickers (Fig. 1b-d), or scientists themselves in articles or grant  
43 proposals (*e.g.*,<sup>30</sup>). Likewise, we are told that raising scientific awareness is crucial to promote  
44 bioclimate action<sup>31</sup>, as teachers or NGOs have been busy popularising knowledge and drawing  
45 biodiversity or climate frescoes (*e.g.*,<sup>32,33</sup>). The underlying postulate of these discourses is that a high  
46 scientific understanding of the crisis should translate into proportionally-adequate behaviours<sup>34</sup> (*e.g.*,  
47 pro-environmental policies by decisionmakers, sober lifestyle choices by citizens; Fig. 1a). As a  
48 consequence, some researchers have invested a lot of energy into the functioning of the IPCC or the  
49 IPBES in hope of transforming people through rational knowledge.

50



51

52 **Figure 1: The knowledge hypothesis implies a correlation between scientific knowledge and the**

53 **likelihood of pro-environmental behaviours. (a)** Schematics of the knowledge hypothesis (black line), the

54 expected positive correlation between the amount or precision of scientific knowledge and the likelihood of pro-

55 environmental actions. Such trend may be traced across scales, from citizens (scientifically aware vs not aware)

56 to decision-makers within governments or nations. However, this hypothesis is rarely questioned in natural sciences

57 (but see e.g., 88), leaving substantial room for uncertainty (gradient of greys). **(b-d)** Set of stickers handed out by a

58 publisher at the 2023 British Ecological Society conference (Belfast, UK). These graphics are relatively explicit

59 regarding the potency of a better scientific knowledge to trigger positive bioclimate action.

60

61 The relative failure of this endeavour<sup>3</sup> urges to reconsider the principles underpinning the

62 knowledge hypothesis and to question its validity<sup>23</sup>. To do so, looking at the behaviour of researchers

63 in ecology and climate science may be informative. Most ecology researchers believe that nature is

64 intrinsically valuable<sup>35</sup>, appreciate its beauty and believe that we are morally obligated to preserve it<sup>36</sup>.

65 Their scientific education and occupation provide them with tools and figures to grasp the gravity of

66 human-caused disruptions, which they often handle on a daily basis<sup>37,38</sup>. This awareness is reflected

67 by how concerned they claim to be about the future<sup>39,40</sup>, as six in ten climate experts expect at least a

68 3°C warming by the end of the century<sup>40</sup>. Hence, researchers in ecology and climate science are at the

69 apex of rational awareness regarding the gravity of the ongoing bioclimatic crisis. According to the

70 knowledge hypothesis, one would expect them to display the highest level of pro-environmental

71 behaviours: the increase in their engagement<sup>41</sup> should be proportional to how much more they know,

72 thus be radical<sup>42</sup>. In other words, climate and ecology researchers comprise a cohort allowing to

73 question if acute scientific knowledge is key to ignite concrete behavioural changes. In recent years, a

74 body of studies has looked at how scientists behave in this context, which we summarise in Box 2.

75 Despite growing discussions regarding the societal position of researchers and more scientists  
76 speaking up, current evidence suggests that the engagement of ecology and climate researchers is not  
77 proportional to how much more aware they are of the crisis' gravity (Box 2). From means of transport  
78 or lifestyle choices, climate protests to activism, the behaviour of most scientists seems to challenge  
79 the knowledge hypothesis.

80

81           Why then, is the most scientifically-aware social group not at the forefront of bioclimate action?  
82 More importantly, what does this remind us about the power of knowing? In this perspective, we build  
83 upon existing literature in ecology, climate and human sciences to formulate an answer to these  
84 questions. We unfold our argument throughout three sections. First, we go beyond what scientists self-  
85 declare as obstacles to their engagement by detailing a series of levers which could impede more  
86 radical pro-environmental behaviours. Second, since the most acute awareness can be decoupled from  
87 behavioural changes, we dispute the capacity of rational facts to ignite engagement. We discuss what  
88 more knowledge may or may not allow on its own, which questions the meaning of current research.  
89 Finally, we bring forward a series of proposals to redirect energy towards efficient action. As ecology  
90 researchers ourselves, we must specify that our goal is not to condemn scientists for their (or our) lack  
91 of engagement; rather, to encourage discussions and actions on this topic. Our references reflect the  
92 available literature and are biased towards climate-change engagement rather than biodiversity, but we  
93 believe that the mechanisms discussed below apply equally to both contexts.

94

## 95 **Situated hurdles impeding the engagement of researchers**

96           It has been a decade or so since psychology, social and behavioural sciences have started  
97 looking at why inaction persists in spite of climate emergency<sup>43,44</sup>. For example, Gifford devised a  
98 taxonomy of barriers that impede climate change mitigation (see Table 1 in <sup>44</sup>). The specific question of  
99 scientists' engagement is a more recent topic, apart from a few mentions in the late 2000s (e.g., <sup>45-47</sup>).  
100 Most studies discuss the ethics and implications of public engagement as scientists<sup>48-52</sup>, debating if  
101 scientists ought to engage or not, and why<sup>37,50,53-56</sup>. Scientists have also been surveyed to assess what  
102 prevents aspects of their engagement in their view<sup>39,45,57-60</sup>. Yet, a majority of these approaches do not  
103 explicitly discuss the sociological and epistemological factors shaping academical researchers –  
104 although these could likely be classified in a more general framework such as Gifford's<sup>44</sup>. In this first  
105 part, we detail four barriers, some of which may be specific to ecology and climate scientists (Fig 2).  
106 We illustrate how these situated hurdles may impede engagement and question their validity in hope of  
107 collectively debunking them.

108

### 109           *Barrier 1: axiological neutrality*

110           As polls show (e.g., <sup>39</sup>), scientists are imprinted by an ideal of axiological neutrality (Box 1)  
111 preventing them from engaging. Aiming to be objective is an undisputable keystone of the scientific  
112 method. Yet, shared misconceptions can turn this ideal into a stranglehold and hinder action. Indeed,  
113 scientific objectivity is often taken or taught as a duty to produce results without ever going beyond a  
114 cold interpretation of what figures say<sup>61</sup>, while being faithful to supposedly-neutral facts<sup>62</sup>. As such, the  
115 quest for absolute objectivity may put scientists in a position of political apathy regarding their subject  
116 of study, which could favour inaction<sup>63</sup>. Yet, axiological neutrality as originally introduced by Max Weber  
117 acknowledged that scientific facts could never be entirely value-free<sup>64</sup>. For many, objectivity as claimed  
118 by ecologists or climate scientists is thus elusive<sup>65-67</sup>. A noteworthy milestone is Donna Haraway's  
119 famous concept of "situated knowledge" to emphasize the social construction of science<sup>68</sup>. Haraway  
120 showed how biases arising from a "*male gaze*" in primatology had long overshadowed the role of female  
121 primates<sup>69</sup>. She downgraded what was claimed as neutral scientific facts to situated, partial male vision.  
122 In Haraway or Weber's mind, only by being conscious of our stance (see Positionality Statement), by  
123 seeing from whence knowledge is created and by seeking diverging viewpoints can we achieve greater  
124 objectivity as scientists - yet without ever reaching it<sup>64,68,70-72</sup>. Unfortunately, we often lack these trans-

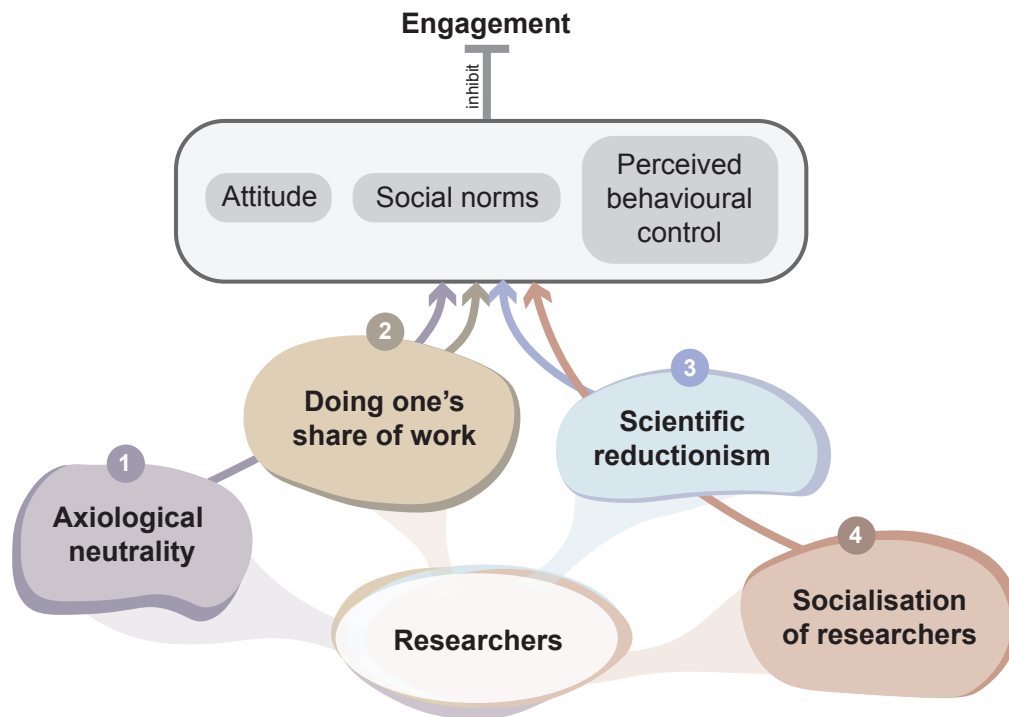
125 disciplinary debates and the divide between epistemology and natural sciences has kept growing. As a  
126 consequence, taking a public stance on scientific findings is often feared to come into conflict with the  
127 ability to “remain neutral”, or with scientific credibility in a social group (Fig. 2). However, several studies  
128 have addressed the credibility issue and sometimes showed that citizens were supporting climate  
129 advocacy by scientists<sup>50,73–75</sup>. Aiming for scientific objectivity should not be incompatible with acting  
130 according to one’s values. We claim that engaging will not make scientists more impure than they are,  
131 for objectivity is learnt rather than innate.

132

133 *Barrier 2: doing one’s share of work*

134 The second barrier impeding the engagement of scientists is their excessive belief in the  
135 goodness and power of knowledge (Fig. 1). Embracing the knowledge hypothesis may lead to the firm  
136 conviction that being a climate or an ecology researcher comprises a great share of the necessary fight.  
137 In a rebound effect dynamics, some scientists may explain that becoming activists or cycling to work is  
138 not their fight, for they already produce knowledge related to the bioclimatic crisis. Indisputably, climate  
139 science and ecology have played a pivotal role in explaining and asserting the links between human  
140 activities and the bioclimatic crisis (e.g.,<sup>19,76–81</sup>). Such history may fuel the desire to keep investing in  
141 more scientific knowledge at all costs. Yet, we argue that the gravity of the situation should incite  
142 scientists to adopt a more critical stance towards their activity. First, why should being ecology or climate  
143 researchers consume any other form of engagement? Second, should more scientific knowledge  
144 always prevail at all costs? Researchers flying thousands of kilometres to a congress may claim that  
145 the benefits of sharing their work will ultimately offset their environmental footprint<sup>82,83</sup> (Box 3). But these  
146 assertions can hardly be quantified and verified, making them more of a belief to withstand cognitive  
147 dissonance than a proven scientific fact. These concerns should weigh all the more in face of the steady  
148 rise in habitat destruction (or species extinction, or CO<sub>2</sub> emissions<sup>2,11</sup>) despite the exponential increase  
149 in the number of research papers<sup>24,37</sup>. Incidentally, it has been proposed in some fields (e.g.,  
150 conservation biology) that more scientific knowledge could be a lesser priority than implementing the  
151 existing one<sup>84–88</sup>, so to fill the knowledge-implementation gap<sup>89</sup>. Scientists could go as far as to question  
152 the increased need for complex research on trophic networks or species interactions<sup>90</sup> in face of  
153 successful conservation cases relying on more traditional knowledge, which had been sustained for  
154 centuries before being rejected in a neo-colonial fashion<sup>91–94</sup>. Finally, a more extreme belief in

155 knowledge is the solving of the bioclimatic crisis through innovation and technology<sup>3</sup> (e.g., CO<sub>2</sub> capture,  
 156 or robotic bees for pollination). We must remind that most of these technologies do not exist yet and  
 157 raise a number of environmental, ethical, legal and equity issues<sup>95-97</sup>. The Promethean belief<sup>98</sup> in the  
 158 power of technique and scientific knowledge to master nature calls upon human *hybris*<sup>99</sup> and the  
 159 naturalist ontology of occidental societies, which should be questioned so to favour engagement (Fig.  
 160 2).



161 **Figure 2: Four scientist-specific hurdles may impede engagement.** The four hurdles add to those  
 162 shared by all citizens, which are further developed in other studies<sup>43,44</sup>. To picture how these barriers may affect  
 163 behaviour, we embed them within a simplified version of the theory of planned behaviour<sup>45,113</sup>, as an example  
 164 among other models. In this classical psychology theory, the impact of the barriers may occur through changes of  
 165 one's attitude (the appreciation of the act of engaging more : it believed good or bad, enjoyable or not, pointless or  
 166 useful?), of the group's social norms (informal rules governing behaviour: do my colleagues engage; will they  
 167 approve of my behaviour if I do?) and of perceived behavioural control (do I feel capable of engaging?). For  
 168 instance, the myth of axiological neutrality reinforces fears of discredit and judgment from scientific peers (social  
 169 norms). It also modifies attitude, as it would seem against scientific ethics to engage and go beyond fact reporting.  
 170 Such analysis also implies that building a critical mass among researchers may act as a tipping point towards a  
 171 new equilibrium, whereby engaged scientists would be socially valued instead of marginalised.

172



173 *Barrier 3: scientific reductionism*

174 A third hurdle may be reductionism<sup>100</sup>: the fact that science segments systems into nested  
175 subparts (e.g., species into populations, individuals, organs, cells) to study them independently and  
176 reassemble knowledge later on<sup>101</sup>. Despite the success of this method, the decomposition of complexity  
177 into isolated problems may complicate seeing the bigger picture or feeling legitimate (e.g., working on  
178 mesoscale eddies under climate change scenarios does not make you aware of planetary boundaries),  
179 which relates to the issue of scientific overspecialisation<sup>102</sup>. However, reductionism may impede action  
180 by other means. In ecology for instance, studying an organism, a population or an ecosystem requires  
181 to reduce its complexity. This may be achieved by studying one or two dimensions (e.g., temperature,  
182 salt) within simplified and controlled environments (e.g., microcosms, models), which pulls researchers  
183 away from natural settings. In addition, animals or cell cultures are seldom called by their vernacular or  
184 Latin name but often using alphanumeric codes. Quantitative measurements are increasingly done  
185 through wireless loggers, mass sequencing methods, automated video recording or cell counting. In  
186 other words, reductionist and quantitative natural sciences probably do not bring researchers closer to  
187 their “*objects*” of study, to their “*model*” organisms; rather, it turns these into abstract entities and fosters  
188 emotional detachment. Combined with the myth of neutrality and the amount of published results  
189 growing exponentially, scientific reductionism may increase emotional numbness<sup>44</sup> and thus change  
190 one’s attitude towards engagement (Fig. 2).

191

192 *Barrier 4: the socialisation of researchers*

193 A final lever decoupling acute rational knowledge from engagement may be the social trajectory  
194 of scientists in the academic system. Initially, researchers are mostly good students who succeed in  
195 academia following a long curriculum in higher education, which tends to positively correlate with a high  
196 socio-economic status<sup>103</sup>. Their curriculum is punctuated with rewards (grades, public recognition  
197 through symbolic ceremonies, citations) distributed by higher-authorities (teachers, supervisors, peers)  
198 on account of regular evaluations (exams, article reviews, defence, activity reports). Academia trades  
199 self-esteem and acknowledgements of one’s intellectual faculties in exchange for abnegation,  
200 obedience and performativity<sup>104</sup>. This positive reinforcement can be a source of powerful operant  
201 conditioning, as it moulds normalised people through “disciplinary power”<sup>105</sup>. As such, questioning a  
202 system that granted you recognition at the expense of sacrifices is likely to be difficult. This social

203 trajectory can thus be expected to hinder engagement in several ways (Fig. 2). First, by producing  
204 agents that lack political awareness: because of their chosen dedication to knowledge leaving little time  
205 in a hypercompetitive academic world; because some may have initially picked “pure research” as a  
206 way to hopefully escape profit-oriented jobs (and politics, see Barrier 1). Second, by selecting for  
207 individualistic and obedient personalities with large egos<sup>106</sup>, who show high degrees of social  
208 conformism<sup>37</sup>, whereas engagement rather calls upon anti-conformism and collective action against the  
209 standing system<sup>39</sup>. Last, because most senior scientists have a high socio-economic status and benefit  
210 from its associated prerogatives. Waiving one’s right to take the plane, to live in a spacious place or  
211 drive to work – in short, living a more sober life – may be a difficult ask for those blessed with privileges.

212 **The behaviour of scientists discredits the existence of a purely rational awakening**

213 In the previous section, we detailed and questioned a series of hurdles which impede the  
214 engagement of climate and ecology researchers. In this second part, we draw conclusions regarding  
215 the capacity of rational knowledge to ignite radical change. We argue that debates about these  
216 questions have been oddly scarce in the scientific community due to overspecialisation.

217

218 The fact that scientists do not display more radical forms of engagement results from a complex  
219 combination of factors (Fig. 2). We must now take a step back. Ecology and climate researchers, the  
220 cohort with the highest scientific awareness of the bioclimatic crisis, have not managed to overcome  
221 their social and psychological barriers<sup>23,53,107</sup>. If the most aware group within society has not taken  
222 drastic action to engage, if the individuals who can best say, read and grasp the gravity of the crisis  
223 have not been moved into action, then what? Then the acuteness of rational thinking will never  
224 overcome the social or psychological barriers of anyone. Climate and ecology researchers are the  
225 social group illustrating that knowing is not sufficient. If these experts have not felt the urge to act,  
226 should decisionmakers skimming through IPBES or IPCC reports be expected to have a rational  
227 epiphany and suddenly become bioclimate activists? Should hopes be placed onto the next generation  
228 just because they now attend compulsory lectures dedicated to raising awareness about the sixth mass  
229 extinction? The empirical answer is: no, this is at least insufficient. This observation undermines the  
230 knowledge hypothesis (Fig. 1a). Such a statement debunks that producing more knowledge and sharing  
231 it downstream will be lifesaving on its own. Knowing, albeit perhaps necessary, is certainly not enough.

232

233 To some degree, this flagrant need to remind that rational knowledge is not enough for societal  
234 change illustrates how partitioned modern research is. Indeed, studies have recurrently shown that  
235 humans do not behave rationally and that a knowledge-action gap often remains (e.g.,<sup>34,44,108-114</sup>).  
236 Arguably, anyone in western societies knew it before Kant's "*Sapere aude!*" ("Dare to know!") paved the  
237 way for a politics of reason<sup>115</sup>. It may hence be symptomatic of overspecialised scientists to think that  
238 raising awareness could be the tipping point<sup>23</sup> (Fig. 1a), or that ignorance is the prime cause for  
239 inaction<sup>116</sup>. Besides, embracing an unproven hypothesis to justify research could be seen as contrary  
240 to the scientific method. Beyond this knowledge-action gap, sociologist J.B. Comby has argued that the  
241 obstinate popularisation of scientific facts about global change (the "*popularisation doxa*"<sup>117</sup>) could lead

242 to a depoliticisation of the climate problem. In his view, overconcentrating on the science of climate  
243 change may conceal its structural causes (*e.g.*, extractivism and capitalism) and focuses too much on  
244 individual actions<sup>117</sup> (Box 2). Journalists and researchers may sometimes prefer popularising scientific  
245 facts without going any further: it could contribute to making themselves feel indispensable, yet without  
246 questioning the privileges of their social class which depend on the system's upholding<sup>117</sup>. Science has  
247 reached a state of such specialisation that few researchers have debated or heard of these studies. As  
248 said above, rational knowledge may not be sufficient to ignite engagement. But just as challenging is  
249 that decoupling scientific results from politics may have impoverished their usefulness in the fight  
250 against the causes of the crisis. Added to the environmental costs of modern research that are  
251 incompatible with Paris' agreement (Box 3), these observations are strong incentives to pause and  
252 ponder on where science is at. As stated by Longuet-Higgins in 1984: "*(...) every scientist should ask*  
253 *him[/her]self, at every level from the most particular to the most general, exactly why he[/she] is doing*  
254 *what he[/she] is doing, and whether he[/she] would not be better advised to do it differently, or even*  
255 *something entirely different.*"<sup>118</sup>

256 **Changing policies: from continuous knowledge accumulation towards reflexive action**

257 We showed how the behaviour of ecology and climate researchers self-questions one of the  
258 claimed reasons to keep accumulating knowledge. Considering the costs associated to modern science  
259 (Box 3) and the gravity of the bioclimatic situation, it is high time to collectively rethink ecology and  
260 climate research before they become satirical. In this last section, we confront activism for more  
261 “research as usual” by thinking about how ecology and climate science could follow a different path  
262 (Fig. 3), without excluding a degrowth of research activities<sup>119</sup>.

263  
264 Scientific research occupies an ambivalent position. On one hand, it has been a pivotal player  
265 to shed light on how grave both climate change and biodiversity loss are. Without it, we would not have  
266 gathered such robust descriptions of the impact humans have had on the Earth’s climate and biosphere.  
267 On the other, modern science has largely contributed to providing the tools that our societies use to  
268 plunder the Earth’s resources<sup>120,121</sup> and is a big CO<sub>2</sub> emitter by itself (Box 3). That is: the science that  
269 characterised the bioclimatic issue can hardly be decoupled from the trajectory of technical progress  
270 which itself lead to the crisis. This report can be painful for many of us, as it shakes a substantial part  
271 of our internal tales of life. After devoting an entire career to scientific research, reassessing and  
272 admitting to have kidded ourselves with preconceptions which do not hold can feel sore. Sore also, is  
273 the event that this dynamic may have partly been orchestrated by decisionmakers. To some degree,  
274 could scientists have been beguiled with an insatiable need for more knowledge, more scenarios, more  
275 certainty before any political action could take place? Nowadays, is more research in ecology or climate  
276 science a sign of resistance, or obedient conformism<sup>122</sup>? We have had fifty years of intensive research  
277 on climate change and the biodiversity crisis. Never has humanity known so much about what is to  
278 come if it does not alter its course. We thus join colleagues claiming that time has come to change  
279 tactics<sup>122</sup> and redirect some, or even all of our energy towards other goals than a sheer increase in  
280 knowledge<sup>37,52,123,124</sup>.

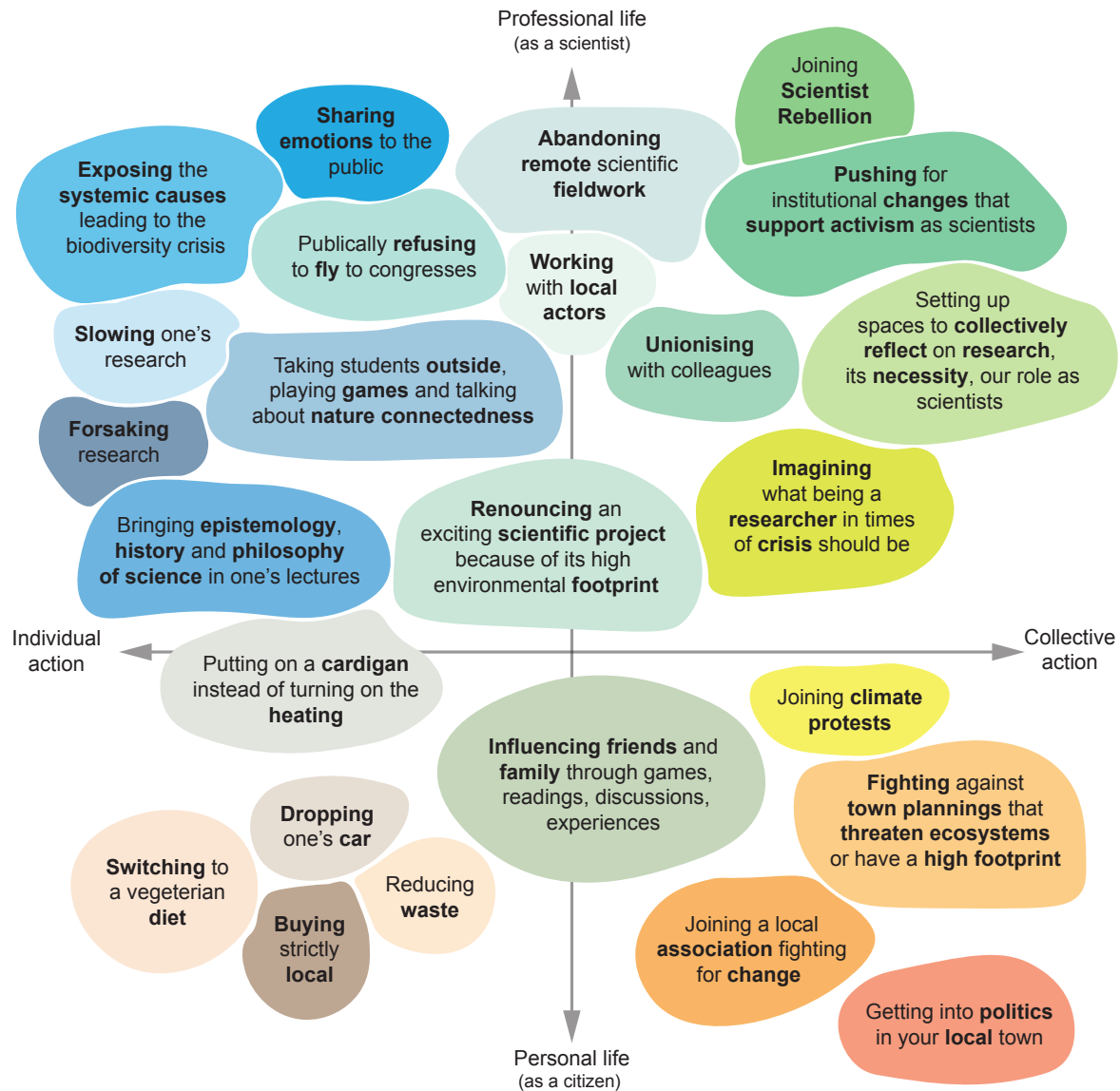
281  
282 We anticipate that the previous sections may seem provocative. Cognitive dissonance<sup>125</sup> shall  
283 be more comfortable; rejecting these interrogations far less costly. To some extent, the fact that  
284 scientists have embraced the knowledge hypothesis may be an attempt to solve a crisis of meaning  
285 impacting academia amid the crisis. Unfortunately, there is little time left to act. For researchers to have

286 a positive impact, they must use their energy to revise their mode of action and collectively question  
287 how to be efficient in their fight for societal change<sup>38,48,122,123</sup> (Fig. 3). How then, to change tactics? We  
288 do not pretend to know what is the single best thing to do. Evolutionary studies have shown how there  
289 may be a multitude of answers to a single problem<sup>126</sup>, and other authors have previously provided  
290 reflexions upon the various ways to engage<sup>122,123,127</sup>. We propose that three interconnected goals be  
291 pursued : (i) reducing the environmental footprint of research<sup>119</sup>, (ii) engaging into actions that  
292 encourage or provoke systemic change and (iii) considering a degrowth of research activities while  
293 aiming at more democratic, meaningful science. To do so, radical changes may be implemented both  
294 within professional and personal spheres<sup>128,129</sup> (Fig. 3). As trusted individuals<sup>130</sup> who know how grave  
295 the situation is, it may be the duty of ecology and climate researchers to embody change as citizens  
296 and scientists<sup>15</sup>.

297

298 For professional aspects, concrete action plans will likely depend on institutions (*e.g.*, urban vs  
299 rural settings regarding *e.g.*, mobility aspects) or career stage. A general, immediate small step could  
300 be to stop acquiring new datasets and focus on analysing the available ones, from previous experiments  
301 or within meta-analyses. In the short to mid-term, scientists could re-anchor their research locally and  
302 involve non-scientific actors<sup>87</sup>. The first outcomes would be a decreased reliance on fossil fuels (*e.g.*,  
303 no remote field work, which would also limit colonial approaches in conservation biology<sup>92,93</sup>) and more  
304 tangible meaning surrounding the addressed scientific questions. In particular, movements such as  
305 action-research aimed at co-building knowledge with local actors around a circumscribed, practical  
306 problem may be a promising breach in the right direction<sup>131,132</sup>. Coupling this constraint with *e.g.*, a  
307 minimum amount of digital technology to acquire simple data (population inventories, photographs)  
308 would also reduce the footprint of research<sup>133</sup>. This decrease in tool complexity could facilitate the  
309 involvement of non-scientists (*e.g.*, local schools) and compel researchers to reclaim skills lost through  
310 technique and specialisation (*e.g.*, naturalist abilities). Another option could be to work on the  
311 knowledge-action gap issue<sup>116,134</sup>. Are nature connectedness<sup>135</sup>, changes in social norms<sup>108,110</sup> or  
312 collective imaginaries of alternative worlds needed to ignite engagement? In this quest, building bridges  
313 with historians, psychologists, social scientists and non-academics will be pivotal<sup>136</sup>. Again, sketching  
314 the diversity of what research could be in times of crisis has yet to be done. Seeing it as an exciting  
315 endeavour more than renunciation will be key to succeed.

316 3) may help us inhabit a liveable Earth for a little longer.



317 **Figure 3: Leads for transformative engagement as scientists and citizens.** This plane summarises a  
 318 series of examples to engage in accordance with one's knowledge of the crisis' gravity. Some of these points were  
 319 taken based on their estimated CO<sub>2</sub> mitigation potential, both for research (e.g., <sup>138,139</sup>) and personal lives (e.g.,  
 320 <sup>140</sup>). Others do not directly impact carbon emissions, but relate more to changes in how research is done, or why  
 321 and what being a researcher could be in such times of crisis. Decoupling the citizen from the scientist self is not  
 322 entirely possible, but we refer to the public stance taken by researchers in either of the two poles<sup>141</sup>. For example,  
 323 mixing with other professions as citizens (e.g., when getting into local politics) may favour more horizontal  
 324 discussions by suppressing the verticality of the expert stance. These primers are not representative of all the  
 325 existing strategies: many more ought to be devised collectively, adapted to the local context while maximising  
 326 social, gender or ethnic diversity so to increase objectivity. Individual actions may be easier to implement for  
 327 academics with a position, but should not be presented as the core of anyone's engagement (Box 2). The option  
 328 of "forsaking research" deserves to be mentioned as a potential political path, rather than as individual failure.



329 **Concluding remarks**

330 “Understanding better to protect better” is a recurrent verse in the scientific community and beyond (Fig.  
331 1). Without further information, it suggests that a better knowledge is sufficient to increase the likelihood  
332 of pro-environmental behaviours. In this article, we highlighted the lack of proportionality in the  
333 engagement of the most scientifically-aware social group: ecology and climate researchers. Several  
334 levers may prevent the emergence of more radicality in their behaviours (Fig. 2). But blaming a minority  
335 of individuals is anything but interesting, even if the social impact of a mass radicalisation of scientists  
336 would likely be great. The point of discussing these hurdles is only to free space for reflexivity upon how  
337 scientists are shaped. Rather, our main goal is to question the validity of the knowledge hypothesis and  
338 its ensuing arguments. At the very most, knowledge may be necessary, but not sufficient to provoke  
339 profound behavioural changes: there is no such thing as rational epiphany or purely rational free-will.  
340 Instead, perhaps we should build upon Morel Darleux’s words: “*We only defend what we have learnt to*  
341 *love*”<sup>137</sup>. Taking these statements into account is necessary if scientists want to have a positive impact.  
342 It entails deep, uneasy questionings about their profession, about internal tales regarding the costs  
343 (Box 3), the benefits and the need for more research. We barely touched upon these complex subjects,  
344 but hope that collectively discussing them more thoroughly and dedicating time to concrete action (Fig.  
345

346 **Box 1. Glossary**

347

348 • **Axiological neutrality:** (from the Greek “*axios*”=value) is the epistemological aim of minimising the  
349 impact of one’s values onto one’s scientific discourse and practices. How to achieve neutrality on a  
350 topic, or if it is achievable at all has long been subject to debate.

351

352 • **Bioclimatic crisis:** refers to the combined crises of climate change and biodiversity loss. These two  
353 crises caused by human activities are intertwined with feedback loops (*e.g.*, climate change impacting  
354 ecosystem functioning, or land use and biodiversity loss leading to greenhouse-gas emissions), making  
355 them inseparable.

356

357 • **Climate scientists:** refers to experts of the Earth’s climate, studying its behaviour and the impact of  
358 climate changes upon abiotic systems (atmosphere and hydrosphere).

359

360 • **Cognitive dissonance:** psychological discomfort caused by an internal conflict between one’s  
361 representations (values, beliefs, knowledge) and behaviours (*e.g.*, knowing that taking the plane is high-  
362 emitting, yet taking it). The subsequent response is a change of representations (*e.g.*, I have no choice  
363 but to fly to this congress) or actions (*e.g.*, I will not fly there) so to minimise dissonance.

364

365 • **Ecology scientists:** refers to scientists studying ecosystems in the widest sense, from applied  
366 conservation science to more theoretical approaches looking at *e.g.*, species interactions or the  
367 biodiversity-function relationship.

368

369 • **Engagement:** in general, describes a trajectory of consistent behavioural choices committed towards  
370 one particular goal. In this case, we specifically refer to engagement to describe to a set of concrete,  
371 pro-environmental behaviours aimed at having a positive impact on the bioclimatic situation. This  
372 includes influencing policies (formal policy work, campaigning or activism), public advocacy and  
373 reducing one’s environmental footprint in both personal and professional spheres.

374

375 • **Knowledge-action gap:** refers to the decoupling between research outputs and concrete actions  
376 taken by individuals. Explaining this gap may call on issues in the transfer of existing knowledge (e.g.,  
377 to the public, to policy-makers) or on psychological and cognitive levers impeding behavioural changes.  
378

379 • **Knowledge hypothesis:** the prevailing hypothesis according to which an increased scientific  
380 understanding of a system should lead to an increase in its protection. Also relates to a belief in the  
381 “goodness of more knowledge”, implying that more scientific knowledge is always beneficial (and at  
382 worse, something neutral), but never detrimental. The underlying postulate of the knowledge hypothesis  
383 is that agents (e.g., citizens, decisionmakers) mostly have rational behaviours. As such, the hypothesis  
384 places the rational free will of agents at the core of bioclimate action and overshadows social norms,  
385 collective dynamics or power imbalances between individuals.  
386

387 • **Naturalist ontology:** an ontology is a formal, explicit specification of a shared representation of the  
388 world. According to Philippe Descola, the naturalist ontology is the belief that “nature” is a separate set  
389 of entities which are not a produce of human will, in contrast to “culture”. Hence, the naturalist ontology  
390 tends to place humans in a dominating position towards non-human entities. It comprises some of the  
391 groundwork which allowed modern science.  
392

393 • **Radical:** (from the Latin “*radix*”=root) refers to behaviours, stances or remarks targeted at the roots  
394 of a problem.  
395

396 • **Situated:** which takes into account the subjectivity of the agent by considering their social, cultural  
397 and material context (e.g., situated knowledge, situated engagement).  
398

399 • **Scientists:** in this paper, we refer to researchers in all fields of science, from non-human “hard”  
400 sciences (e.g., biology, geosciences, mathematics, physics, chemistry) to human sciences (e.g.,  
401 sociology, philosophy, psychology). However, our arguments regarding the knowledge hypothesis and  
402 the intimate relationship with facts describing the gravity of the bioclimatic crisis may be more specific  
403 to ecology and climate scientists.

404 **Box 2. Acute rational knowledge does not translate into acute engagement for scientists**

405           Accurately describing the bioclimate engagement of scientists is a tough task. Things have  
406 been slowly moving in the last few years, with more researchers speaking up in academical and political  
407 arenas (e.g., <sup>142</sup>) or the rise of *Scientist Rebellion*<sup>48,143</sup>. In a recent large-scale poll, climate experts self-  
408 reported higher degrees of engagement than their non-expert scientist fellows<sup>39,57</sup>. However, what  
409 people report can significantly differ from what they actually do (e.g., <sup>144</sup>). In particular, mismatches  
410 between what scientists feel they should do and what they actually take part in have previously been  
411 highlighted<sup>45,58</sup>. Transport-wise, cars are still the go-to option for commuting in French academia <sup>145</sup> and  
412 most scientists extensively rely on flights to travel worldwide<sup>53,54,145–147</sup>. Evidence was even brought for  
413 climate scientists taking the plane more often than non-climate expert researchers<sup>82</sup>. A recent study  
414 showed that discourses of climate delay are found within scientific communities<sup>59</sup>, as in less-aware  
415 social groups<sup>43</sup>. At a more collective scale, only a minority of climate scientists join climate protests  
416 (25% of 200 top-climate experts in 2021<sup>40</sup>), and even fewer partake in activism (e.g., civil  
417 disobedience<sup>37,48</sup>). This all suggests that while experts of the bioclimatic crisis report a greater desire to  
418 engage, the actual process is slow and disproportionately low compared to their rational perception of  
419 the crisis' gravity and rapidity. Graphically, the slope in Fig. 1a seems -at best- far shallower than what  
420 is ubiquitously claimed (or the response is non-linear). More qualitatively, ecology and climate  
421 researchers are not straightforwardly renowned for comprising a radicalised faction in society. The mere  
422 fact that there is room for doubt around their engagement is sufficient to question it. This knowledge vs.  
423 action paradox points at a “*double reality*”<sup>58,123</sup> in the cognition of scientist, whereby they manage to  
424 isolate their sharp awareness of the gravity from their decision-making processes<sup>148</sup>.

425           We must add that the engagement of individuals should not be presented as the single lever  
426 for pro-environmental actions, since the room for manoeuvre is not absolute<sup>140,149</sup>. Our collective fate  
427 strongly depends on structural changes in the hands of higher authorities (industries, governments,  
428 institutions)<sup>150–154</sup>. In addition, overfocusing on individual actions mimics the flaws of meritocratic  
429 discourses by overshadowing the social context: it implies that people are all equal in their capability to  
430 act<sup>155,156</sup>. Still, people with a higher social status (e.g., academics) could be expected to engage more,  
431 as they encounter fewer economic hurdles to changing their behaviour<sup>157</sup> and are responsible for a  
432 greater share of CO<sub>2</sub> emissions (e.g., <sup>158</sup>). Scientists should be all the more interested in being engaged

433 since their credibility regarding climate policies was shown to be negatively correlated to their carbon  
434 footprint<sup>129,159</sup>.

435 **Box 3: The environmental and social costs of modern research**

436 For researchers who did not choose climate science or ecology in hope of positively impacting  
437 the crisis, the previous questions about how rational awareness affects behaviour may seem of  
438 secondary importance. Some may argue that “*pure research*” is what should be defended; that wishing  
439 for a political impact as scientists was a mistake in the first place<sup>160</sup>. Aside from the epistemological  
440 questions raised by such discourses (e.g., about neutrality), another broader issue relates to all  
441 scientists, regardless of their stance: the environmental footprint of research. The carbon footprint of  
442 academia has been extensively documented in recent years; yet strong action from scientists and  
443 institutions is still mostly lacking<sup>53,107,161</sup>. In France for instance, a 2019 survey estimated that members  
444 of the National Centre for Scientific Research (CNRS) emitted an average of 14tCO<sub>2</sub> per year just  
445 through their research activity, in a country where electricity is decarbonised<sup>145</sup>. Despite the huge  
446 variance between fields (e.g., average *per capita* emissions are much higher for astronomers<sup>162</sup>), such  
447 figures are unsettling. First, because they show once again that knowing and quantifying are insufficient  
448 to trigger change. Second, because this carbon footprint questions the sustainability of modern  
449 research and of its future developments. And yet, looking solely at carbon emissions does not even  
450 account for other dimensions of the problem, such as chemical pollutions, or the social and biodiversity  
451 cost of precious metals used in the devices upon which scientists rely to gather or analyse data<sup>133</sup>. If  
452 carbon emissions or environmental destruction cannot even be justified with the knowledge hypothesis  
453 anymore, the tension between the benefits and costs of knowing more is again emphasised. More  
454 concealed perhaps are costs relative to the societal dependencies of institutionalised science and full-  
455 time researchers. The fact that some may devote the entirety of their time to experimenting and  
456 searching is only possible through a highly partitioned society, with other social groups catering for  
457 scientists by producing their energy, base materials or everyday food. That is: the freedom to think  
458 claimed by scientists relies on overshadowed layers of necessity insured by non-academics. Added to  
459 the financial dependency of academia towards society, this aspect may have favoured the adoption of  
460 the knowledge hypothesis to justify a need for more research and create more purpose amid the crisis.  
461 All of these environmental and social considerations constitute a “price for curiosity”, exacerbated by  
462 the current crisis. Acknowledging this price increases the need for more collective discussions about  
463 the “*why*”, the “*how*” and “*what*” scientists are doing day to day, whatever their stance towards the  
464 knowledge hypothesis<sup>53,118,119</sup>.

465 **Competing interests**

466 The authors declare no competing interests.

467

468 **Acknowledgements**

469 This work was supported by the TULIP Laboratory of Excellence (ANR-10-LABX-41) and Staffan Jacob

470 was supported by the Agence Nationale de la Recherche (ANR-19-CE02-0016). We warmly thank all

471 who have accepted to read and discuss this paper in the months preceding its publication.

472 **Positionality statement**

473 Léonard Dupont is a 27yo PhD student in ecology and evolution and intends to depart from academia  
474 afterwards. Staffan Jacob is a 36yo permanent CNRS researcher in ecology and evolution, specialised  
475 in phenotypic plasticity and dispersal. Hervé Philippe is a 59yo permanent CNRS researcher in the field  
476 of phylogenomics, but has been working on the topic of scientific degrowth for 15 years. Both Staffan  
477 and Hervé have children. All three of them identify as males, live in France and do not belong to a  
478 racialised minority. They regularly take part in activism, but do not feel sufficiently engaged. All three of  
479 them deem that tackling the bioclimatic crisis is of greater importance than accumulating more  
480 knowledge. Their research has been funded by public agencies for the last 10 years at least.



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