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Sketching sustainable land use in Europe by 2040: a multi-stakeholder participatory approach to elicit cross-sectoral visions

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Abstract:	<p>The continuously growing global demands on a finite land resource will require better strategic policies and management of trade-offs to avoid conflicts between different land use sectors. Visions of the future can support strategic planning by stimulating dialogue, building a consensus on shared priorities and providing long-term targets. We present a novel approach to elicit stakeholder visions of future desired land use, which was applied with a broad range of experts to develop cross-sectoral visions in Europe. The approach is based on i) combination of software tools and facilitation techniques to stimulate engagement and creativity; ii) methodical selection of stakeholders; iii) use of land attributes to deconstruct the multifaceted sectoral visions into land use changes that can be clustered into few cross-sectoral visions, and iv) a rigorous iterative process. Three cross-sectoral visions of sustainable land use in Europe in 2040 emerged from applying the approach in participatory workshops involving experts in nature conservation, recreation, agriculture, forestry, settlements, energy and water. The three visions - Best Land in Europe, Regional Connected and</p>	

	Local Multifunctional - shared a wish to achieve a land use that is sustainable through multifunctionality, resource use efficiency, controlled urban growth, rural renewal and widespread nature. However, they differ on the scale at which land services are provided - EU-wide, regional or local - reflecting the land sparing versus land sharing debate. We discuss the usefulness of the approach, as well as the challenges posed and solutions offered by the visions to support strategic land use planning.
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1 **Sketching sustainable land use in Europe by 2040: a multi-stakeholder participatory**
2 **approach to elicit cross-sectoral visions**

3
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31 **Abstract (249 words)**

32 The continuously growing global demands on a finite land resource will require better
33 strategic policies and management of trade-offs to avoid conflicts between different land use
34 sectors. Visions of the future can support strategic planning by stimulating dialogue, building
35 a consensus on shared priorities and providing long-term targets. We present a novel
36 approach to elicit stakeholder visions of future desired land use, which was applied with a
37 broad range of experts to develop cross-sectoral visions in Europe. The approach is based on
38 i) combination of software tools and facilitation techniques to stimulate engagement and
39 creativity; ii) methodical selection of stakeholders; iii) use of land attributes to deconstruct
40 the multifaceted sectoral visions into land use changes that can be clustered into few cross-
41 sectoral visions, and iv) a rigorous iterative process. Three cross-sectoral visions of sustainable
42 land use in Europe in 2040 emerged from applying the approach in participatory workshops
43 involving experts in nature conservation, recreation, agriculture, forestry, settlements, energy
44 and water. The three visions - *Best Land in Europe*, *Regional Connected* and *Local*
45 *Multifunctional* - shared a wish to achieve a land use that is sustainable through
46 multifunctionality, resource use efficiency, controlled urban growth, rural renewal and
47 widespread nature. However, they differ on the scale at which land services are provided -
48 EU-wide, regional or local - reflecting the land sparing versus land sharing debate. We discuss
49 the usefulness of the approach, as well as the challenges posed and solutions offered by the
50 visions to support strategic land use planning.

51

52 Keywords: land-use visions, Europe, participatory process, cross-sectoral, multifunctionality,
53 sustainability

54

55

56 **1. Introduction**

57 The world has changed rapidly in the last decades, with profound modifications in the ways
58 we use land to support a growing (United Nations 2015) and increasingly wealthy (Wiedmann
59 et al. 2015) and urban population (Cumming et al. 2014). The successful transition towards a
60 global society that can live within the planet's ecological boundaries is widely seen as the
61 greatest challenge humanity has ever faced (Ellis 2011; Rockstrom et al. 2009; Steffen et al.
62 2015). More people and changing life-style will require more space and more food, timber,
63 clean water and energy, which will have to be provided by a finite land resource, facing added
64 pressures from changing climate (Lambin and Meyfroidt 2011). In this context land

65 multifunctionality, where the same area of land can offer many environmental, social, cultural
66 and economic benefits at the same time, can play a crucial role (Pérez-Soba et al 2008).

67

68 Future land use change is uncertain as it is determined by complex interactions between the
69 biophysical environment and human activity, which in turn are shaped by historical and
70 contemporary cultural and socio-economic processes (Jepsen et al. 2015). Managing its
71 change sustainably is a major challenge (Guerry et al. 2015) and responsibility will need to be
72 shared by governments, the private sector and individual citizens, as emphasized in the new
73 UN Sustainable Development Goals (United Nations 2015). The needed fundamental
74 'sustainability transitions' require a dialogue that engages actors across society and will
75 depend on experimentation, learning and sharing ideas (EEA 2016).

76

77 Scenario analysis is a technique that takes into account the complex land use interactions in a
78 structured manner (van der Heijden 2005) and therefore it is often used in assessments of
79 future land use change (Helming et al. 2011; Verburg et al. 2008) for strategic planning. These
80 assessments frequently relied on business-as-usual scenarios inspired by past trends and
81 processes of change, or on explorative scenarios describing how the future may unfold.
82 Visions (or normative scenarios) represent another scenario technique, which is particularly
83 strong in ensuring saliency and, if developed in a participatory approach, in ensuring
84 legitimacy (Rounsevell and Metzger 2010). Visions of a desired future can stimulate dialogue,
85 help build a consensus on shared priorities, and support planning by providing long-term
86 targets (Howlett 2007; Koomen et al. 2011). Visions describe a pre-specified picture of the
87 world achievable only through certain actions, where the scenario itself becomes an argument
88 for taking those actions (Ogilvy, 1992). As such, developing visions could represent a major
89 step towards achieving a desired future land use through a better understanding what type
90 of world society would like to live in (Buijs et al. 2006, Shipley and Michela 2006).

91

92 However, the translation of scenario narratives into strategic targets remains challenging. To
93 be useful for decision-making, any type of scenario needs to strike a balance between
94 credibility, legitimacy and relevance (Volkery et al 2008; Pérez-Soba and Maas 2015). Using
95 participatory approaches involving sufficiently large groups of stakeholders, and adequate
96 time for the elicitation process and for review and outreach, can enhance credibility,
97 legitimacy and saliency and thereby promote their uptake in land use policies and strategies
98 (Swart et al. 2004). In addition, innovative participatory techniques and computer based tools

99 can help to stimulate the imagination and enhance stakeholders' engagement (Appleton and
100 Lovett 2003; Vervoort et al. 2010; Wang et al. 2016). Imagining a distant future is a difficult
101 exercise for human beings (Bryant and Veroff 2007), because the brain recombines past
102 experiences information to imagine the future (Grant and Suddendorf 2005). A distant future
103 implies a big mental gap from everyday experiences, particularly when we need to extrapolate
104 existing trends into a future without historic precedent.

105

106 In an effort to build a roadmap towards sustainable land resource management in Europe
107 (Pedroli et al. 2015), explorative and normative land use scenarios were linked in a unique
108 approach. Land use scenarios were modelled (Lotze-Campen et al. 2017), and the projections
109 were linked to stakeholder visions of desired future land use (this study) by identifying the
110 pathways reaching the visions (Verkerk et al. 2016). A crowdsourcing exercise to explore
111 young citizens' ideas and desires on their life in 2040 complemented the visions elicitation
112 process (Metzger et al. 2017).

113

114 This paper describes the methodological approach that was developed to elicit cross-sectoral
115 visions, its implementation in a series of participatory workshops involving a broad range of
116 stakeholders on nature conservation, recreation, agriculture, forestry, settlements, energy
117 and water. It depicts as well the three cross-sectoral visions derived from the workshops, and
118 analyses the visions' shared wishes and differences, which largely reflect the land sparing
119 versus land sharing debate. Finally, we discuss the usefulness of the approach for supporting
120 strategic land use planning, as well as the challenges posed and solutions offered by the
121 visions to support transitions towards sustainable land use.

122

123 **2. Methodological approach for eliciting cross-sectoral visions of land use in Europe**

124 The methodological approach to elicit cross-sectoral visions with stakeholders embraces a
125 process involving the workshop design and development of various methods and tools that
126 are applied in the workshops. The process has two consecutive steps. The first step involves
127 the development of visions in *sectoral workshops*. Although the resulting visions include a
128 societal perspective, we call them 'sectoral', as they are intrinsically linked to the sectors
129 represented in the workshops. The second step involves the integration of the sectoral visions
130 into cross-sectoral visions, which comprises the deconstruction of the visions and their
131 unification and consolidation in *feedback stakeholder workshops*. The stepwise approach is

132 depicted in Figure 1. The workshop design and the methods and tools used in the approach
133 are detailed in the next sections.

134 <<Insert Figure 1 about here>>

135 **2.1 Design of the workshops to elicit sectoral visions**

136 The overall objective of the sectoral workshops was to elicit visions for desired future
137 European land use from a broad range of relevant stakeholders. When designing the
138 workshops, we anticipated contrasting visions, and wanted to encourage experts to think ‘out
139 of the box’ and openly about their wishes. Workshops were designed to support this
140 challenging creative process, whilst also providing comparable information on which to base
141 our subsequent analysis.

142 The workshops were structured around four sectoral groupings associated with major
143 European land uses: nature conservation and recreation; food, bio-energy and timber
144 production; settlements and transport infrastructure; and energy and water. This coverage of
145 land uses ensured a broad basis to build cross-sectoral visions. Despite the sectoral focus,
146 stakeholders were invited to participate as individuals, and with the explicit aim to think about
147 broader cross-sectoral (societal) land use visions. The Chatham House Rule
148 (<https://www.chathamhouse.org/about/chatham-house-rule>) was used to encourage
149 openness and the sharing of information. The design should allow the stakeholders to feel
150 engaged, contribute, and have a rewarding individual experience, i.e. the process should not
151 just ‘take’, but also ‘give back’. The workshops would last two full days, a realistic estimation
152 of the time we could ask stakeholders to commit voluntarily, and adequate time for the
153 elicitation process. The two days allowed a progressive development of visions. The first day
154 started with individual reflections about stakeholders’ (land use related) preferences on their
155 life in 2040; followed by taking a perspective from stakeholders’ sector on three aspects of
156 land use in 2040: demand of products, land use change, and impacts; and culminating in
157 broader integrative visions considering societal aspects as life style and global impacts. The
158 workshop structure with the sessions and material produced is presented in Table 1.

159
160 <<Insert Table 1 about here>>

161 162 **2.2 Stakeholder selection**

163 The stakeholders, all professionals representing the main land use sectors, were carefully
164 selected following Gramberger et al (2014) method to ensure a plurality of views that would
165 limit outcomes biases and improve the process legitimacy. Selection features were defined,
166 using land use sector as main feature to group stakeholders in the four sectoral workshops.

167 Additional selection features included: geographical origin (Northern, Western,
168 Central/Eastern or Southern Europe); age (< 30 year-old, 30-50 year-old, or >50 year-old),
169 which was considered an important aspect, given that perspectives on the future may be
170 heavily influenced by generational aspects (Metzger et al. 2017); gender; professional sector
171 (business and economy, government and policy making, research, civil society, practitioners
172 and NGO); and spatial level (European, national, regional or local). A fit for purpose database
173 was built considering the selection features and populated with the help of the project
174 partners. Minimum quotas were set for each feature to ensure a balanced representation and
175 transparency in the selection of participants. For example, we aimed to have 15-20
176 stakeholders participating in each workshop to allow a good balance between personal
177 attention and the chance to be individually heard. Up to 20 individual stakeholders per
178 workshop were therefore identified that matched the quotas. A minimum gender balance of
179 30 % female and 30% male participants was seen as important for the legitimacy and
180 inclusiveness of the exercise. These stakeholders were invited individually and 69 finally
181 attended the workshops. Stakeholders would attend the workshop without prior knowledge
182 or preparation, and with varying degrees of experience in foresight.

183

184 **2.3 Software tools used for building the visions**

185 To enhance 'out of the box' thinking, support discussion, and capture the creative process,
186 two computer-based tools were developed. We called them 'canvas tools' as they enable
187 participants to fill a blank space with elements of their vision, both in images and text. They
188 were designed to improve the vision development process. Firstly, interactive and visually
189 attractive computer-based tools are engaging and may stimulate participants to imagine the
190 future in a creative, vivid and detailed manner. The technique brings out also implicit ideas,
191 supports structuring them and reveals inconsistencies and gaps (Vervoort et al. 2010;
192 Bhowmick 2006). The tools can support discussion between participants by diminishing
193 language barriers, sharing of results, and function as external memory during the two days
194 sessions. The *individual canvas* was designed as graphic novel describing one's future life in
195 four pages - home, work, food and free time -. More details on the features of the individual
196 canvas can be found in Metzger et al. (2017), as they served as basis for the crowdsourcing
197 exercise to explore young citizens' ideas and desires on their life in 2040. Four *sectoral*
198 *canvases* were designed containing questions and images tailored to the sectoral themes.
199 Each sectoral canvas had two pages: the first dealing with the expected demand of goods or
200 services provided by the sector; and the second with impacts of these demands on land use.
201 Each page had a menu on the left side presenting pictures grouped in themes (including land

202 use, agricultural products, modes of transport, environmental pressures); a central area
203 showing an empty space intended for positioning the selected pictures, adding text and
204 showing linkages visualising the group's visions (see Figure 3); and a list of topics on the right
205 side including relevant issues/drivers (socio-economic change, climate change, technological
206 development, etc.).

207

208 **2.4 Use of land attributes**

209 Whilst insightful on their own, creating cross-sectoral land use visions formed part of a larger
210 effort to develop a roadmap towards sustainable land resource management in Europe
211 (Pedroli et al. 2015). The visioning process therefore had to consider a number of land use
212 aspects to enable linking the visions with model-based explorative scenarios of land use
213 (Verkerk et al. 2016), without compromising the creative thinking process. These land use
214 aspects were included in the canvas tools and a range of exercises combining verbal and
215 written descriptions with images, maps, graphs indicating trends, and system diagrams
216 explaining relationships between key aspects (e.g. land uses and drivers of change). They were
217 also used to deconstruct and cluster the sectoral visions (see section 3.2).

218

219 **3. Elicitation of cross-sectoral visions**

220 **3.1 Sectoral workshops**

221 Four sectoral workshops were held in June (18-19 and 21-22) and September (24-25 and 27-
222 28) 2012, attracting 15-19 stakeholders per workshop. Online Resource 1 provides a detailed
223 characterisation of stakeholders for each workshop. During the two-day workshops, the
224 stakeholders participated in several sessions following the workshop design presented in
225 section 2.1.

226 *The first phase* focused on eliciting stakeholders individual desires of their everyday lives in
227 2040 (*individual visions*), as transition towards the sectoral visions. They used the canvas of
228 individual visions and selected images that represented their lives in 2040 (see example in
229 Figure 2). In *the second phase*, stakeholders worked in self-selected groups of like-minded
230 individuals, formed around short statements about future land use for their sector. These
231 groups shared ideas in discussions and exercises supported by different tools (canvas of
232 sectoral visions, maps of Europe, pictures with landscapes and whiteboards). One facilitator
233 that moderated the discussion and operated the sectoral canvas tool assisted each group. The
234 15 resulting *sectoral visions for 2040* were then discussed in plenary. In the *final phase*, the
235 same groups of participants supported by the facilitator expanded the context of their sectoral

236 visions to the wider society. They explicitly discussed other land uses, as well as global impacts
237 of European land use and lifestyles by using images, drawing, photos and text. The resulting
238 broader sectoral visions were presented in plenary during a ‘grand expo’.

239

240 << Insert Figures 2 and 3 >>

241

242 **3.2 Clustering and consolidation of 15 sectoral visions into 3 shared visions across land use** 243 **sectors**

244

245 In order to be meaningful for strategic land use planning, the 15 sectoral visions had to be
246 integrated into a smaller, consistent set of visions across land use sectors. To allow clustering,
247 the 15 sectoral visions were deconstructed using land use types and land use attributes as
248 their building blocks. This was done by a team of researchers participating in the workshops,
249 who consistently completed extensive spreadsheet tables for each of the 15 sectoral visions
250 (included in Online Resource 2) using the material collected in the workshops (see Table 1).
251 The researchers determined for each cell whether the vision expressed a *future change* (i.e.
252 increase, decrease, no change) compared to the present. They also noted a *level of confidence*
253 in their interpretation (high, medium, low), and detailed where *evidence* was found in the
254 workshop materials for the sake of transparency.

255 The land use types considered in the matrix were: built-up areas (separately for cities, towns
256 and villages); agriculture (separately for food, fuel, fibre and fodder); forestry (separately for
257 timber harvesting as main measure, and multifunctional forests); nature conservation;
258 transport (separately for public and private transport); other infrastructure (wind mills,
259 pylons, etc.); and water.

260 The land use attributes included: land cover extent (i.e. the area covered by a land cover type),
261 land-use management (i.e. the intensity by which land is managed), land-use pattern (i.e. the
262 spatial configuration of different land uses), land-use services (i.e. the benefits provided to
263 society by land use), global land impacts (i.e. indirect effects of land use in Europe on land use
264 outside Europe), and lifestyle (i.e. behaviour of people that affects land use). Whilst climate
265 change is crucial for land use, it was considered to have limited impact on land use by 2040
266 and therefore not included in the process to develop cross-sectoral visions.

267

268 The researchers worked with a subset of 20 stakeholders from the original group to elicit a
269 limited set of cross-sectoral visions using as material the former tables. They were selected to
270 allow a good balance between the four sectoral workshops participants, and the chance to
271 contribute individually to the targeted discussions. In an iterative process, over two feedback

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272 workshops (December 2013 and April 2014), stakeholders and researchers clustered the 15
273 sectoral visions and unified them into a set of three shared visions across land use sectors, by
274 unlocking the commonalities in desired transitions (increase, decrease, no change) of key land
275 use attributes (extent of agriculture, forest and urban areas, food and forest production,
276 degree of nature conservation, rural viability and green infrastructure). The key land use
277 attributes were selected based on two criteria: characterising main land uses and their
278 services to enable presence of all sectors in the cross-sectoral visions; and allowing the link of
279 qualitative statements made by stakeholders with quantitative modelling results (Verkerk et
280 al. 2016). The final result was presented and agreed with the stakeholders.

281

282 **4. Description of the resulting visions of future desired land use**

283 **4.1 Sectoral visions**

284 The 15 sectoral visions were each summarised in the form of a narrative (included in Online
285 Resource 3) based on the analysis of the spreadsheets (see section 2.3.1). The names and
286 short descriptions of the visions are presented in Table 2. These visions offer multifaceted,
287 multi-sectoral, multiscale descriptions of sustainable futures in 2040, with a sectoral focus.
288 Despite differences in their underlying concepts and ultimate aspirations, the 15 visions
289 clearly share a common wish of multifunctionality, efficient use of land resources, controlled
290 urban growth, enhanced liveability of rural areas, and nature as the ever-present foundation
291 ensuring an optimal delivery of public goods and ecosystem services. They differ, however, in
292 the scale on which they envision multifunctionality, which ranges from the whole EU territory
293 to the local level.

294

295 <<Insert Table 2 about here>>

296

297 **3.2 Cross-sectoral visions**

298 The three shared visions across land use sectors are named *Best Land in Europe*, *Regional*
299 *Connected* and *Local Multifunctional* to symbolise the main differences in the spatial scale.
300 The visions are outlined in Table 3. On the largest, continental scale, the most appropriate
301 land is matched to the best use, with specialisation as a key principle (*Best Land in Europe*). At
302 the intermediate, regional scale, the matching is between the people in the region and their
303 resources, with energy and transport connectivity as a fundamental premise (*Regional*
304 *Connected*). And on the smallest, local scale, the highly diverse needs of Europeans are mainly
305 met locally by using knowledge of local conditions to achieve better use of land and the supply
306 of goods and services on the spot (*Local Multifunctionality*).

307 An overview of the main differences among the three visions is presented in Table 4.

308

309 <<Insert Tables 3 and 4 about here>>

310

311 **5. Discussion**

312 **5.1 Benefits and weaknesses of the methodological approach**

313 Developing cross-sectoral land use visions at EU scale is still rather unique and few examples
314 can be found in literature (Volkery et al. 2008; Kok et al. 2015). Most of the studies are at local
315 or regional scales, and do not cover all land use sectors (Faysse et al. 2014; Wang et al. 2016).
316 Compared to these previous exercises, our approach covers all Europe and is cross-sectoral.
317 It involves a broad coverage of stakeholders from many regions in Europe, which represent
318 the main land use sectors and bring a rich diversity of cultural contexts. Instead of bringing all
319 experts together in a workshop, as previous studies do, our approach grouped experts in
320 separated sectoral workshops, which makes it easier to develop a consistent set of 'sectoral'
321 visions. Many of the participatory scenario exercises found in literature (Volkery et al. 2008;
322 Brown and Castellazzi 2014; Wang et al. 2016) have used a range of methods and visualization
323 tools separately, but we combined and adapted them in an iterative process to get a greater
324 co-creation and richness in the visions. The use of electronic canvas as visualization tool
325 facilitates the linking of qualitative stakeholder statements with quantitative model
326 simulations, and at the same time enhances the engagement and understanding of the
327 modelling outcomes by stakeholders. Finally, our approach enables the development of
328 plausible policy pathways to reach the visions (Verkerk et al. 2016).

329

330 The approach developed was particularly successful to engage stakeholders, to stimulate their
331 creativity, enhance dialogue among the land use sectors represented, and to help building a
332 common ground of shared priorities. This 'open' process was appreciated by stakeholders,
333 but that implied that it was more difficult to reach an end reconciling their views into few
334 cross-sectoral visions that would be recognized as their own. In fact, several attempts were
335 made by the research team to cluster the 15 visions by using statistical methods and re-
336 grouping them into the four SRES axes (Nakicenovic et al. 2000) until a new clustering method
337 was developed which was found transparent by the stakeholders. It took also substantial time
338 to align the qualitative stakeholder's statements (changes in key land use attributes) with the
339 quantitative model outcomes, as previously found by Volkery et al (2008). All these
340 complications indicate how important it is planning ample time for the elicitation process.

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342 The approach ensured credibility, legitimacy and saliency of the visions. Involving the same
343 group of stakeholders in the full elicitation process enhanced their trust in the vision framing.
344 All this led to shared visions and enhanced their credibility, as the belief in a scenario is much
345 limited to the people involved in their construction (Schoonenboom 2003). Furthermore, the
346 methodical and broad selection of stakeholders helped to enhance not only the legitimacy of
347 the visions among potential users, but also their salience by giving ample room to address
348 sectoral special concerns and therefore convince that results are relevant to support decision-
349 making processes (EEA 2001).

350
351 The combination of different facilitation techniques with the use of computer-based tools (the
352 canvas), contributed to stakeholder's openness, engagement and increased their creativity,
353 as it was evaluated at the end of the workshops. Unwillingness of some stakeholders to reveal
354 their values and stakes can create tensions between participants and prevent creative thinking
355 (Tonn 2003). We used the individual canvases to overcome this issue and to helping the
356 stakeholders in the difficult task to imagine the future at the start of the sectoral workshops.
357 This canvas tool also helped to reveal personal views and beliefs regarding land use related
358 issues of work, travel, food, and free time, that otherwise would have become obscured in
359 the group process. The use of the sectoral canvas in groups helped to understand each other's
360 ideas and discussing openly complex issues related to land use. In conclusion, the canvases
361 proved to be a helpful tool to elicit stakeholder visions in a workshop setting.

362
363 Land-use attributes played a crucial role in the elicitation process and improved the
364 understanding of the complex modelling. They helped to analyse and deconstruct the 15 rich
365 sectoral visions into simple statements, which facilitated the visions clustering and unification
366 into the three-shared cross-sectoral visions. In addition, they enabled to link the qualitative
367 stakeholder statements (visions) with quantitative land use projections in the roadmap
368 construction; this ensured that important aspects of land use would be addressed in both the
369 visioning process and the land use modelling. However, stakeholders included elements in
370 their visions that could not be addressed by land use models, while the land use models could
371 also provide insights in land use not considered by stakeholders when defining their visions
372 (Verkerk et al. 2016). Finally, stakeholders became acquainted with the land use attributes
373 during the vision elicitation process, and this helped them - who are usually wary of 'black
374 box' models - to better understand the modelled outcomes reaching (or not) 'their' desired
375 land use futures; the visions building and the modelling were loosely linked to avoid that
376 stakeholders would be hampered in their creative thinking.

377

1
2 378 **5.2 Policy and societal implications of the cross-sectoral visions**

3 379 The cross-sectoral visions pose important challenges in terms of the policy, strategies and
4
5 380 governance, technological developments and changes in lifestyle needed to achieve them.
6
7 381 However, they also offer solutions, as we discussed below for each of the visions.

8
9 382

10 383 *Best Land in Europe* would supply the largest quantity of goods and services at continental
11
12 384 scale by most efficient use of land resources, but would probably result in a polarisation of
13
14 385 the urban-rural differences and some remote areas would struggle to keep their population
15
16 386 unless land use and economic activities are restructured. Some productive forest and
17
18 387 agricultural land located in less suitable areas would be taken out of conventional use. This
19
20 388 would lead to land sparing (Fischer et al. 2014), with sustainable intensification of agriculture
21
22 389 and forestry. For agriculture, this would occur on the landscapes best suited to supporting
23
24 390 production functions - access to water, fertile soils and proximity to market - but
25
26 391 abandonment of more extensive primary production systems in less favoured areas. For
27
28 392 forestry, this vision implied that forest production would shift from the south of Europe to less
29
30 393 drought-prone areas in the north. This vision would require political collaboration between
31
32 394 the EU Member States (e.g. to decide on the best location for land use and land functions
33
34 395 across scales), at national level (e.g. financial incentives supporting management of
35
36 396 abandoned land or re-structuring in remote rural areas) and regional level (e.g. plans to
37
38 397 reverse urban sprawl and encourage compact city development). It would also require
39
40 398 investment in connectivity and mobility across Europe. Society would need to embrace the
41
42 399 restructuring of Europe's landscapes to obtain maximum efficiency from the land, this may
43
44 400 sometimes conflict with cultural identity issues.

45
46 401

47 402 *Regional Connected* moves away from specialisation to achieve regional self-sufficiency across
48
49 403 multiple services. This implies intensifying agricultural and forestry production across
50
51 404 European regions. This vision would require a strong regional government and a stable
52
53 405 governance structure that promotes collaboration between regions. Whilst stronger
54
55 406 regulatory and incentive-based regional policy would be needed to minimise land use
56
57 407 conflicts, there would be a need to regulate trade between regions and internationally. This
58
59 408 vision also would require large public and private investments in technology, infrastructure
60
61 409 and social cohesion to increase the connectivity within the region, and investments in the EU
62
63 410 energy grid to be self-sufficient. The societal challenges mainly refer to the need to embrace

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411 major lifestyle changes, such as regional food consumption, compact urban living, shift to
412 public transport, and willingness to pay the cost of these changes.

413
414 The vision for the smallest scale is *Local Multifunctionality*, which implies a land-sharing
415 (Fischer et al. 2014) approach with the highest diversification of land use. This vision aims at
416 increasing self-sufficiency and avoiding negative relocation of land use activities overseas,
417 which would lead to a carbon neutral economy. The challenges are multiple and would require
418 a capable, local decision-making and a radical shift in behaviour and a bottom up governance.
419 On the technological side, the vision would imply large investments in new, smart
420 technologies, such as district heating, urban agriculture and EU energy grid. Society would
421 need to embrace major lifestyle changes and would need to reconsider consumption patterns
422 (diet, seasonal food, waste reduction). Society would need to be willing and able to pay for
423 the cost of this local self-sufficiency, e.g. producing food locally may be more expensive under
424 sub-optimal conditions. Altogether, this vision seems the most challenging vision to achieve
425 without a radical transformation in society and decision making processes, underpinned by
426 individual behavioural change. This was confirmed by the absence of the considered policy
427 options that would represent pathways to achieve this vision (Verkerk et al. 2016).
428 Nevertheless, this turned to be the most desired vision by the young generation of Europeans
429 in the crowdsourcing exercise (Metzger et al. 2017).

430

431 **6. Conclusions**

432 We present an innovative methodological approach to elicit visions of land use that increases
433 the body of knowledge about what sustainable land use could look like in Europe in the next
434 decades. The vision elicitation process, with its methods and tools, links and combines
435 effectively the desires of stakeholders from a broad range of sectoral and disciplinary
436 perspectives resulting in rich and robust narratives. These narratives highlight the
437 stakeholder's strong desire for multifunctional land systems, identifying the potential
438 synergies and trade-offs between main land use sectors and the challenges ahead. Achieving
439 the cross-sectoral visions and their goals will crucially depend on paradigmatic changes in
440 national and regional governance, policy strategies, technological developments and changes
441 in lifestyle, in particular those related to urban systems and their links to nature, food and
442 timber, energy, water and transport. The outcomes advance understanding of plausible
443 pathways in the transition towards a sustainable land use in Europe. The next step will be to
444 operationalize these visions into strategic plans by engaging and working close with the
445 appropriate organizations in innovation projects at regional and local level. Most importantly,

446 realize that the land use transitions implied by these cross-sectoral visions require great
447 efforts to reinforce the societal behaviors and create a culture of long-term thinking.

448

449 **Acknowledgements**

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453 Affairs, and carried out by Wageningen Environmental Research. The authors would like to
454 thank the sixty-nine stakeholders who inspired these visions, the professional workshop
455 facilitation team from Prospex bvba for their valuable support, and all partners of the
456 VOLANTE project for their comments on the eliciting visions approach.

457

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460 **Figure captions**

461

462 **Figure 1** Flow chart showing the consecutive steps in the development of the cross-sectoral
463 stakeholder visions.

464

465 **Figure 2** Page of the individual canvas tool showing the visions on future living space empty
466 and completed by one of the stakeholders.

467

468 **Figure 3** Page of the sectoral canvas tool dealing with the question on the expected demand
469 of products, as completed by one of the stakeholder groups. On the left side, a list of themes
470 containing pictures; on the right side a list of issues/drivers.

471

472 **Table captions**

473

474 **Table 1:** Workshop structure: days, sessions and material produced in each session.

475

476 **Table 2:** Names and short descriptions of the 15 stakeholder visions developed in the four
477 workshops.

478

479 **Table 2:** Outline of the three consolidated visions: Best Land in Europe, Regional Connected
480 and Local Multifunctionality.

481

482 **Table 4:** Characterisation of the differences among the three consolidated visions.

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EDITOR'S AND REVIEWERS' COMMENTS

General reply to editor and reviewer #4

Dear Editor and reviewer #4,

We would like to thank you very much for managing our manuscript, and the reviewer for the insightful and constructive comments. We believe that they have helped to improve our manuscript substantially. We hope that you too will find that the manuscript is now ready for its publication in 'Regional Environmental Change'. Below you can find our responses (in green), to all comments and suggestions made by you (in black).

Specific response to reviewer #4 :

I have copied the text as it was in the email received on 20th January 2018.

Reviewer #4: Purpose of the paper is missing. Neighther from the titel or content is not clear wheather paper wants to primarily inform about the method and process and give a hint on content or method and vontent or something else.

We accept the reviewer's suggestion to be more explicit about the objective of the paper. We have changed the title accordingly and modified the last paragraph of the Introduction section.

Some proposal s about the titels structure:

1. Introduction
2. Methodological approach for buolding visions on landuse in Europe
 - 2.1. Design of the process for developing participatory based visions for land use in Europe
 - 2.1.1. Stakeholder selection
 - 2.2. Developing sectoral visions
 - 2.2.1.. Design of the process and workshops for building sectoral visions (131 to 155)
 - 2.2.2. Techniques and tools used for building sectoral visions
 - 2.3. Elicitation of cross sectoral visions of European lan use
 - 2.3.1. Clustering and consolidation of 15 sectoral visions in 3 shared visions . I propose no subtitels.
3. Resulting visions of desired land use in Euroe - description
- 4 the same as proposed only I propose to add 4.3. Policy messages and use un policy making

We appreciate the suggestions to reorganize the sections and sub-sections to help the reader. Therefore, we have modified the structure as follows:

- Introduction
- Methodological approach (including the workshop design, stakeholder selection, software tools and use of land use attributes);
- Elicitation of cross-sectoral visions (including the description of the sectoral workshops and the clustering and consolidation of the visions)
- Description of the resulting visions
- Discussion including policy and societal implications
- Conclusions

1 I also miss in text important for me fact that you analysed also official visions and which and how this
2 was brought in the process. Also how results relates to those official policy visions.

3 This is the topic of other paper that it is not yet published. Whereas relevant, it was not crucial for
4 the participatory approach, and will need to be explained (no reference available) making even
5 longer this already long paper. So we have decided not to include this issue.
6

7 OTHER COMMENTS

8 61 more people and changing life style OK

9 67 to 86 add somewhere the need and challenge of translating scenario analyses into policy messages
10 added a sentence in L92

11 80 and 84 refer to transitions concept. If needed see eea publication on this. Actions towards the future
12 in transitions framework

13 Added a sentence in L73-75 with reference to EEA (2016) publication

14 93 innovation techniques- which?

15 Explained in L98

16 98 and tendencies to extrapolate existing trends into the future of increasing uncertainties

17 Added in L102-104

18 101 unique for LU but exists elsewhere. May be explain more.

19 This is explained in the Discussion.

20 108 i miss here and overall the link to policymaker and politicians, their involvement and communication
21 of messages.

22 Included now in the Discussion and conclusions.

23 133 i think there were not only land use experts

24 The reviewer is right. We have changed land use experts by relevant stakeholders

25 138 no title see proposal above

26 See explanation above about the new structure of the paper.

27 138 to 151 shorten and 152 to 155 expand and concretise

28 We have shorten the first part and included more details in the second part.

29 159 title as above

30 See explanation above about the new structure of the paper.

31 160 start with overall para on which tools and techniques were used and then describe more specifically.
32 .reader is a bit lost here.

33 We have moved the description of the tools to the start of the sub-section and moved the part on
34 land use attributes to other sub-section.

35 170. Add purpose why was decided to use IT

36 This is already explained in the text, e.g. see L 98-104 and L185-194

37 170 to 191 shorten and make concise explicit description

38 we have shorten five lines the description

39 193 see proposal above

40 See explanation above about the new structure of the paper.

41 223 when using word canvas is useful to add word vision, ie. canvas of vision, canvas if individual visions
42 It is in the text confusing use of word canvas for outsider

43 We have changed ' individual canvas' by ' canvas if individual visions'

44 221 to 234 i dont think it is need to be do detaild to specify when participants went in group and
45 conven in plenary etc. Rather paing overall approach and spirit

46 This part has been deleted.

47 279 I think that after that at the end the result was again crosschecked with stakeholders?

48 We agree with the reviewer and added a sentence in L280

49 313 i would put a critical summery statment, delemma, benefit and weakness at the begining and then
50 follow with explanations. Same for Visions and link and use in policymaking
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We have modified the titles of the subsections (L312 and L378) and the content acknowledging the suggestion.

354 replace alternating with combining

We have modified the sentence (L351)

386 see above

See explanation above about the new structure of the paper.

3(1 I would include description of visions in previous chapter...see above and here only discuss feasibility, link to official policy visions, common elements, challenges ie. Multifunctionality meaning etc. See comments above.

This section focuses on the policy and societal consequences of the three visions (as the new title of the subsection indicates)

438 add as commented above. Messaging and policy use

Added in section 5.2

439 conclusions more clear added value in methodological terms, proposals for follow up, proposals for communication and use

We have written a completely new Conclusion section focusing on the issues proposed by the reviewer (L 431-447)

Additionally, please check the following minor points:

All these issues have been approached in the new version.

p. 9 l. 275: characterising

p. 9 l. 276: 2nd time enable should be enabling

p. 10 l. 318: stakeholders' [apostrophe missing]

p. 10 l. 318: stepwise instead of step wise

p. 10 l. 325: Brown & Castellazzi 2014 missing in the list of ref

p. 11 l. 346: led instead of lead

p. 15 l. 489: Table 3 instead of Table 2

p. 29: caption should be Table 2 instead of Table 1

p. 30: caption should be Table 3 instead of Table 1

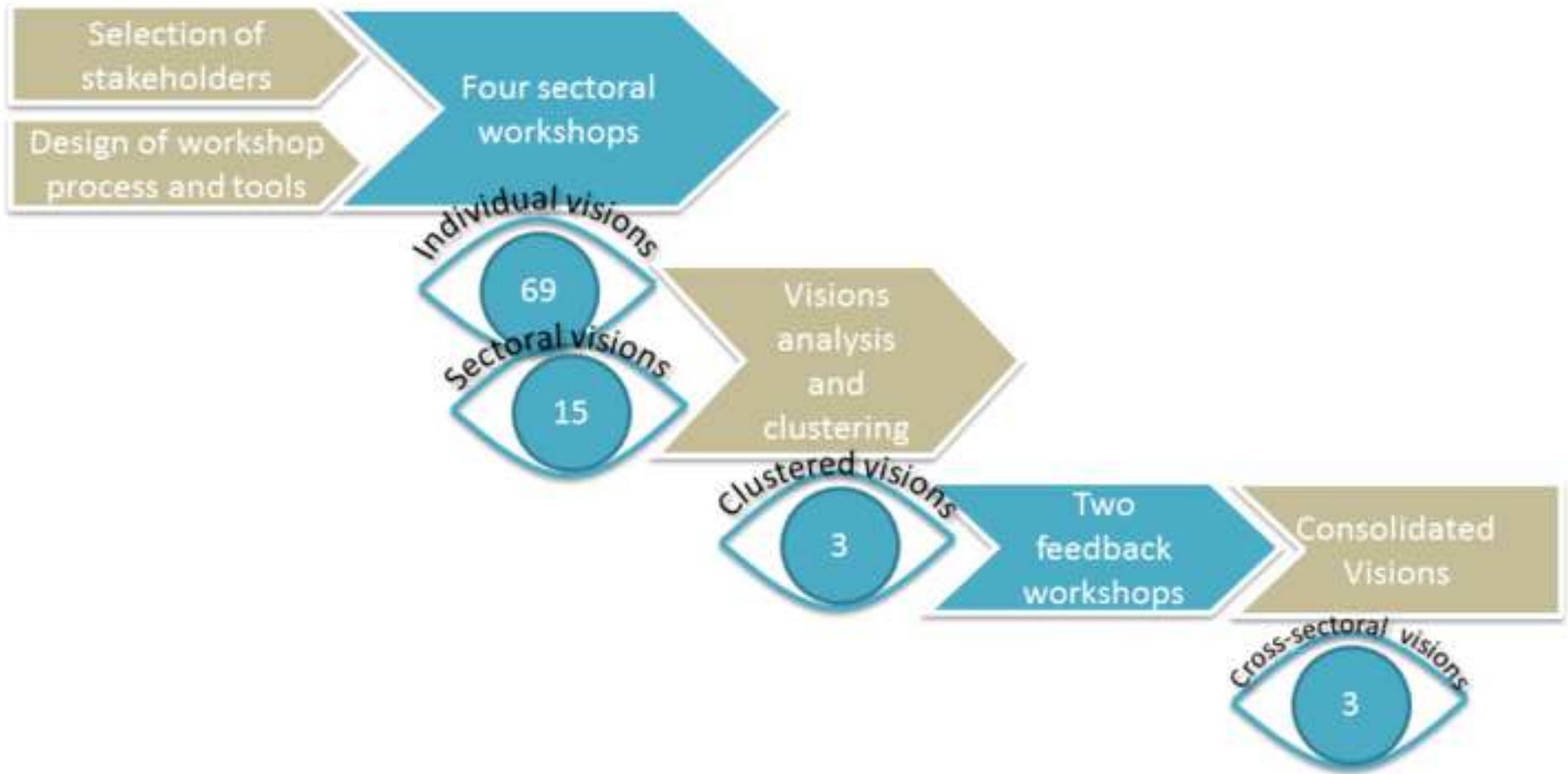


Figure 2

Fill the narrative canvas with photos and text by clicking on the empty boxes.

In 2040, this is how I will live ...

Housing

Click to start typing
(Who is in your household?)

Household

Click to choose a photo

Where will you live?

Click to start typing
(Where will you live?)

Pages


- Welcome
- 1. Home
- 2. Work
- 3. Food
- 4. Leisure

Click to choose a photo

What type of home do you live in? Which building materials are used?


Click to choose a photo

Housing



Technology

Click to start typing
(What technology is in your home?)



And now, off to work.


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In 2040, this is how I will live ...

Household


The household would rather be interpreted as a community level household where different families take care of each other. Not that someone else mother would become your mother, but rather a model




Where will you live?

I will live preferably within a landscape that has multifunctionality and that is open for visitors.

Housing




the building materials are coming from local suppliers. I will need to rely on them since it is too expensive to get them from elsewhere and I appreciate to be inspired from local suppliers that I would like to sustain with my consumption.



Technology

I would make use of circular energy flows in the house that are created through available resources that I would not cause to degrade. I can think of solar and wind energy for example, but also of saving energy usage through moving elements in the house (i.e. the charging of batteries that you also have in hybrid cars)



And now, off to work.

Pictures
per theme

- Forest products
- Agricultural Products
- Other products
- Land cover/land use
- Management intensity
- Ecosystem services and environmental impacts
- Spatial patterns and regions
- Arrows and pie charts

Management intensity

In your vision, what is the societal demand for the products of your sector in 2040?

forest carbon sinks, northern, continental & atlantic Europe

consequence of climate change

linked to higher incomes for forest managers

office paper will increase

internet killed the books

hardwood products and substitution of fossil fuels

open economy, higher profitability

higher profitability

all of these are related to bioenergy

the higher the energy prices, the more the forest will be used for this material

high demands so increase of prices

Issues

Connect the pictures in your canvas to related issues.

- Agricultural prices
- Forest production prices
- Bioenergy
- Energy prices
- Income
- Your issue
Click to type

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Table 1: Workshop structure: days, sessions and material produced in each session.

Day	Session	Material produced
1	Developing individual visions	<ul style="list-style-type: none"> - Individual statements. - Individual canvas showing the individual expectations of desired, future everyday lives of the participants.
	Developing sectoral visions in groups	<ul style="list-style-type: none"> - Flip charts covering the discussion in the groups on how they like land to be used for their sector in 2040. - Two sectoral canvases per group.
2	Developing societal visions in groups	<ul style="list-style-type: none"> - Flip charts summarising the discussion on linkages between land use sectors. - Pie chart with desired future land use cover. - Five maps of land cover (agriculture, forestry, urban, nature and water) in Europe per vision group on which stakeholders could mark areas of expected strong change. - One blank map on Europe on which stakeholders could present an important aspect of their vision. - Pictures of land cover: stakeholders could select a few of them and illustrate significant changes by 2040.
	Final presentation of societal visions in 'Grand expo'	-Sound recordings and videos of the synthesis presentation of each of the vision groups.

Table 1: Names and short descriptions of the 15 sectoral visions developed in the four workshops.

Workshop	Vision name	Short description
Nature conservation and recreation	EURECO	Multifunctionality is central and understood as different land uses within the same plot. Some protected areas are opened to recreation, sustainable production and other functions, but others, including marine areas, are strictly protected.
	Natural Value Landscape (NVL)	Overall theme is multifunctional use of the landscape, being Nature the centre of our society. It is the quality of the land use what changes rather than the land use itself. Green and blue networks ensure interconnectivity.
	Ostrom 2040	Main focus is an open and more accessible landscape for the people with a focus on self-sufficiency, although nature conservation is still needed.
	Past to the Future	Land is multifunctional, respecting the regional context and environmental limitations (energy and water will be major issues). Significant decrease in the land dedicated to agriculture, and increase in forests and nature. Big investments therefore in green corridors in cities.
Food, bioenergy and timber production	Value Land Use	The main aim is to increase the value added production for each piece of land. For example, fertile land can under no circumstance be used for housing.
	Foodscapes	It considers food security as the most important challenge in 2040. This implies a sustainable and substantial increase in food production, that should have high quality, and reduction of the individual consumption of food.
	Forest for Rural Society (FORUS)	The aim is to have sustainable forest management in 2040. The best way to achieve this is through locally controlled forestry and a strong framework at EU level.
	Right place, Right amount, Right functions (3R'S)	In 2040 any spatial area will have to produce a wide range of goods and services. The ideal solution would be to have multiplicity of landscapes with multifunctional land use; food security would require as well to have intensive agriculture.
Urban settlements and transport infrastructure	Challenging suburbia	It is about doing things more efficiently. Suburbia is the epitome of what we do not want Europe to look like. What Europe needs are more diversified, walkable settlements where resources are used in an efficient way.
	EUtopia	EUtopia means a paradigmatic change in Europe. Moving from sectoral towards integrated thinking, from mobility towards accessibility, including services that are accessible without requiring physical movement.
	Neural network	A holistic vision of a sustainable and ecological neural network of settlements with appropriate connectivity. Neural refers to the way it supports the development of urbanization and avoids the unnecessary transport of people.
	Smart density	Density is the key word, meaning that a mixture of functions lead to the most effective use of private and public services. It demands less resources and energy by requiring less built areas expansion.
Energy and water	Insola 2040	It aims to holistically address climate change adaptation and sustainable land use by creating a super grid of integrated renewable energy technologies, used where their potential is best.
	Local matters	The central principles are that local level is important and local resources are used. This can be achieved by having mixed functions on a single plot of land.
	Open Mind, Closed Cycles	We want a closed loop of ecosystem services in Europe. That way we can maximize and reduce waste and live in a carbon-free society based on use of renewable resources.

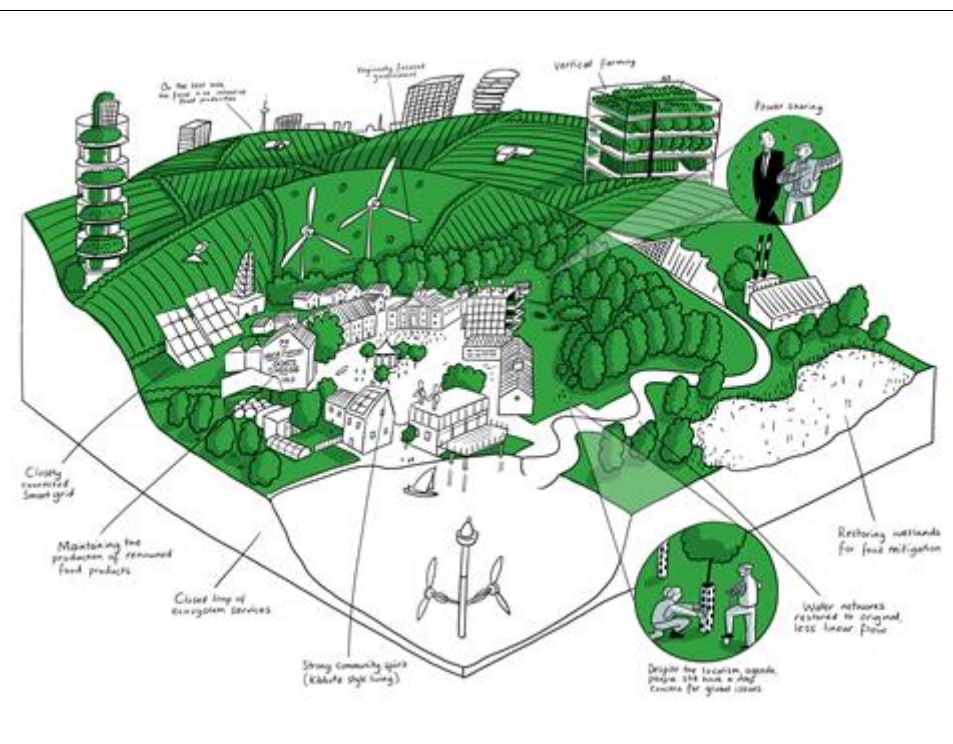
Table 1: Characterisation of the differences among the three cross-sectoral visions.

	Best Land in Europe	Regional connected	Local multifunctional
Main aspiration	<i>To maximise the value of existing land by using the optimal locations in the EU.</i>	<i>To keep a regional coherence by exploiting most land and providing goods and services within a well-connected region</i>	<i>To create local self-sufficiency by optimising the use of land and the supply of goods and services on the spot.</i>
Urban areas	Peri-urban areas disappear, making way for other land functions around the cities, such as urban agriculture, recreation, nature.	Cities are compact, with vertical growth, and very well connected with surrounding towns or villages and nature areas in the region.	New villages emerge in former forests and on abandoned rural land.
Agriculture	The intensity of agricultural production, including biofuels, varies depending on the agro-climatic conditions. For example, in western and central Europe, production is intensive, while Alpine and Mediterranean regions see a decline in agriculture or extensification.	The overall intensity of agriculture decreases with a focus on sustainable production, including a large increase in High Nature Value farming as part of the green network.	Food is produced locally and new practices allow food to be grown everywhere (in cities, forest and nature areas). Consequently, intensity increases in some areas but may decrease in traditional agricultural regions.
Forestry	Industrial highly productive forest dominates in northern and central Europe, whilst regions that are biophysically less suitable or face climate change pressures, such as the Mediterranean, are more extensively managed.	Forest cover increases through the conversion of marginal agricultural land to productive forests supplying the local region. This includes green corridors and forests planted to mitigate carbon emissions.	Forest cover increases through the conversion of marginal land and an increase in agroforestry. Multifunctional mixed wood production is everywhere to cover local demand for all the services delivered by forests.
Nature	Some nature areas with emblematic endangered species become strict conservation areas: isolated and with no human interference. Other areas are managed for recreation.	Nature is encouraged and managed everywhere (in cities, agricultural areas and production forests) with an emphasis on green and blue infrastructure connecting different areas.	Protected areas are open to sustainable food production and forestry where it helps to meet local demand. Management is focused on increasing the number of goods and services delivered.
Green connections	Green connectivity is increased by restoring nature areas with high biodiversity value; there is a special emphasis on wetland rehabilitation.	There are big investments in green and blue corridors.	Nature is pervasive and ubiquitous (even in dense urban areas such as park systems, green rings, green facades and roofs or converted disused transport sites).
Viability in rural areas	Rural areas suffering from severe socio-economic decline do not get further policy support and are abandoned and used for nature.	Rural areas are well connected with big cities, keeping the regional coherence.	Rural viability increases as a result of the strong diversification of activities, creating new opportunities for urbanites who want to start part-time farming. New ways of living appear, such as communal farms.

Best Land in Europe

Optimal use of land is crucial to ensuring maximum production of food and other natural products. Land across the EU is matched to the most appropriate use.

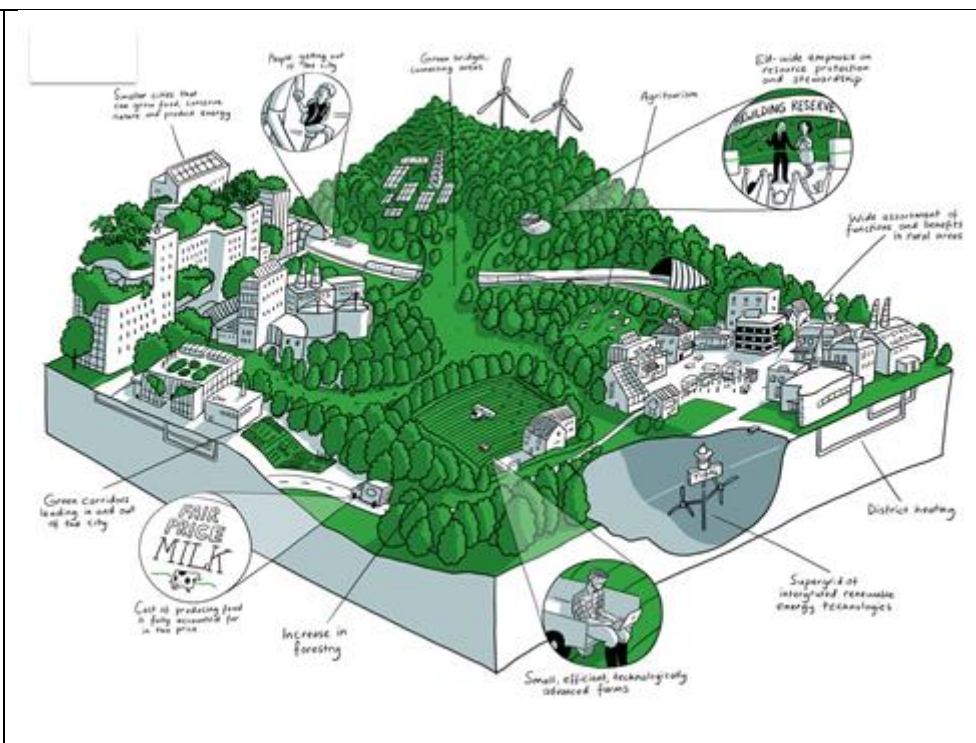
A Europe in a globalised world with intensive movement of products, money and people and good accessibility linking distant urban centres. Political collaboration exists between and beyond the EU Member States. There is intense global competition for resources requiring more efficient land use to meet society's needs. Across the EU, land provides for multiple functions, in a well-planned, well-ordered and zoned use of space. Some land is used for multiple purposes. Other land is better suited to just one function, leading to specialisation.



Regional Connected

Society's needs are met regionally in a coherent relationship between people and their resources. In a non-globalised economy, there is a move away from regional specialisation.

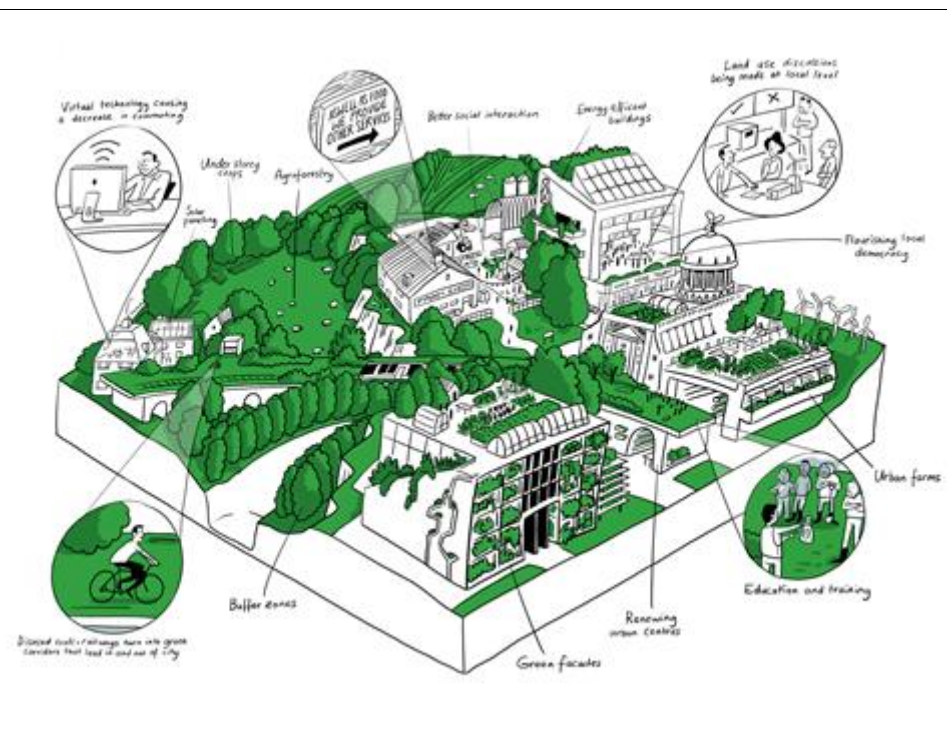
A Europe that has a greater appreciation of the resources that are available regionally and of the value of trying to live without external inputs, with the help of technological developments. Serving the regional population and keeping regional coherence is a key priority. This reduces the need for transportation and its negative effects. Territorial cohesion at the regional scale does not isolate communities or close borders, but creates local autonomy, more resilience, more involvement by the population, and more democracy.



Local Multifunctional

Land functions are localised in small areas based on innovative approaches to living, working and recreation. There is high diversity in goods and services, land use and society.

A Europe that incorporates multi-functionality locally, without distinct sectoral land use areas (for agriculture, settlement, nature conservation, etc.) This generates multiple ecosystem services everywhere. Localised thinking and decision-making is supported by a radical shift in behaviour and 'bottom-up' politics. Rural areas flourish by having a strong green economy where biodiversity is improved through a clean environment and green infrastructure. There is a huge reduction in 'food miles' as products are grown and consumed locally. Technology facilitates the sustainable management of natural resources.





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