



Environmental Evidence for the Future

Summary of Regional Workshops

Contents

Contents	2
1. Introduction.....	3
2. Summary of drivers prioritised and taken forward by workshop participants	6
3. Summary of 100-word challenges.....	12
4. 100-word challenges.....	16
Appendix 1. Mapping drivers from the Scottish workshop to the standard driver list .	37

Summary

This report summarises the results of four regional workshops held in Scotland, Wales, England and Northern Ireland between 24 August and 20 September 2017. The workshops were part of a new initiative paving the way to address the environmental evidence-base for the UK and overseas territories in the future. The participants of the workshops identified cross-cutting policy and practice challenges which, if addressed, they considered would enhance the responsible management of the UK natural environment and its overseas territories in the medium-to-long term.

A standard workshop method was used in all four workshops which resulted in workshop participants co-producing 100-word challenges, in groups of 2-5, which they considered encapsulated the challenge and associated research gap facing the UK and its overseas territories over the next 25 years.

In total 65, 100-word challenges were created by the groups considering a total of 26 single drivers and 13 clusters of drivers. In total 36 unique drivers were considered prioritised and used to create a 100-word challenge by the workshop participants. Multiple 100-word challenges were created for 13 driver.

The driver considered by most participants at the workshops to have significance for the future direction of environmental policy for the UK and its overseas territories was *Climate change will continue to cause increased temperature and increased occurrence of extreme weather and seasonal events*. A 100-word challenge for this driver was created by 7 groups and an 8th group linked it with the driver *The UK and its Overseas Territories will not be immune from rising sea levels, flooding, heatwaves and poor air quality*.

The differences expressed in the multiply 100-word challenges for the same drivers supports the view that all 65 individual 100-word challenges should be taken forward to Phase 3 of the project i.e. remote consultation to collect research ideas to provide evidence associated with the challenge articulated in the workshops.

1. Introduction

The Environmental Evidence for the Future (EEF) initiative has been set up by NERC to

- pave the way to addressing crucial challenges and opportunities for our environment presented by the UK leaving the EU. These include optimising sustainable environmental management, ensuring the resilience of our ecosystems and the quality of our environment
- define, prioritise and address the knowledge gaps in the environmental science evidence base to inform policy and practice in the medium- to long-term (+5, +10, +20 years)
- focus on areas which have the scope to be addressed in the main via the NERC community and NERC's investments

EEF is an independent, co-developed initiative that is designed to complement, not duplicate, parallel initiatives. The initiative is focused on identifying cross-cutting challenges that address multiple needs across organisations and departments from a position of building on and strengthening the longer term environmental science evidence base. It will not answer overly-specific or short-term/current evidence needs and it will not be prescriptive in how prioritised environmental evidence needs are or should be addressed.

To help achieve these aims, NERC held four regional meetings around the UK in August and September 2017 in which participants from government and NDPBs, alongside Civil Society Organisations, academia and business, identify, describe and prioritise future environmental policy challenges and opportunities in the context of the UK's exit from EU Environmental Frameworks.

Four regional workshops:

- Scotland: 24th August 2017
- Wales: 12th September 2017
- England and Overseas Territories: 14th September 2017
- Northern Ireland: 20th September 2017

At each workshop the participants were divided into four breakout groups and considered a set of predefined drivers from a particular perspective:

- Food, Farming, Timber and Forests
- Water, Fisheries and Marine
- Environment, conservation and wildlife
- Climate change, air quality and energy

In addition there was a fifth breakout group at the English workshop

- Overseas Territories

These groups (17 in total) worked through a series of tasks and co-created 100-word challenges facing the UK in the future (full details of the process is described in each of the regional report).

In summary, the workshop was designed around a 5 step process in which participants:

1. Reviewed and discussed a series of drivers that may shape the UK environment over the next 25 years
2. Mapped the drivers according to whether they perceived them
 - To be more or less important for the UK environmental policy in the future
 - To have a certain or an uncertain outcome
3. Identified a series of priority drivers that are
 - More important and have a certain outcome
 - More important and have an uncertain outcome
4. Explored how priority drivers might play out over the next 25 years and, in particular
 - Whether drivers are more likely to create opportunities or threats to the UK environment in a post Brexit world
 - What evidence policy makers will need to capture those opportunities and mitigate the threats
5. Described a number of 100 word challenges that reflect these conversations

The drivers were drawn from the UK National Ecosystem Assessment Technical Report (published in 2011) and updated to reflect more recent geopolitical developments. During the course of the discussion, participants had the opportunity to add to the list of drivers if they felt there were any obvious gaps. The first workshop in Scotland tested 57 drivers and following that process and the feedback from the participants the number was reduced to 47 which were used in all subsequent workshops (termed the standard driver list). For the purposes of this summary the Scottish drives were mapped across to the 47 standard drivers (Appendix 1). The additional drivers created at each workshop are not considered in this report (section 2) as by definition they only occur once and are fully reported in the regional workshop reports; only the drivers which were taken forward to the 100-word challenge are considered in this report.

Most groups found it relatively easy to agree wither a driver was more or less important for the UK environmental policy in the future relative to the other drivers considered but they struggled to agree if the outcomes were more or less certain. Consequently in this report the drivers considered important and located in the certain and uncertain quadrants of the 2x2 matrix have been combined. The exact location of all drivers are fully reported in the regional workshops. This report considers all drivers prioritised as more important for the UK environmental policy in the future regardless if the outcome was considered certain or uncertain.

The purpose of this report is to summarise across all workshops the drivers prioritised by the workshop participants and collate the 100-word challenges.

There are 2 main sections:

- **Section 1** Summary of the priorities drivers and those taken forward by the participants to create a 100-word challenge
- **Section 2** List of all 100-word challenges completed by participants.

2. Summary of drivers prioritised and taken forward by workshop participants

Summation across all groups and all regional workshops (Table 1) revealed that three drivers were prioritised by over 50% of the groups (i.e. 9 or more groups out of a possible 17 groups). These were:

- *Climate change will continue to cause increased temperature and increased occurrence of extreme weather and seasonal events (71%).*
- *The ecosystem approach, landscape-scale approaches, ecosystem services and natural capital frameworks will be significant components of the policy making process (65%)*
- *Patterns of land and marine use will need to change to meet the UK's food and energy needs (53%)*

A further six were prioritised by 8 groups (47%). These were:

- *Agricultural support payments are increasing, focussed on public goods*
- *Citizen engagement is likely to become increasingly important across a range of policy areas*
- *Food security and water security will become significant challenges; perhaps even sources of conflict*
- *The contribution that natural capital makes to UK growth will become more important*
- *The UK and its Overseas Territories will not be immune from rising sea levels, flooding, heatwaves and poor air quality*
- *Waste will continue to increase and is likely to cause significant environmental challenges*

These 9 drivers were all taken forward for further discussion and creation of the 100-word challenges, although sometimes as part of a cluster (see section 2).

One driver, *The contribution that natural capital makes to UK growth will become more important* was prioritised by 8 groups but a 100-word challenge was not created by any group. This driver, however, is similar to another for which 4 groups wrote a 100-word challenge: *The ecosystem approach, landscape-scale approaches, ecosystem services and natural capital frameworks will be significant components of the policy making process*. Consequently it appears that this driver was considered and it is not necessary to take any further action.

Only three of the 47 standard drivers were not prioritised by at least one group. These were

- *Cyber security will be a continuing threat to international security;*
- *International investment in the UK will increase*
- *The sale of petrol and diesel vehicles will be banned in 2040*

Table 1 Number of groups (n=17) prioritising and taking a driver forward to create a 100-word challenge ordered by the most popular drivers taken forward to the 100-word challenge

Driver	List of predefined drivers	Total number challenges	Total drivers prioritised
1	Climate change will continue to cause increased temperature and increased occurrence of extreme weather and seasonal events.	7	12
2	Patterns of land and marine use will need to change to meet the UK's food and energy needs	6	9
3	Agricultural support payments are increasing, focussed on public goods	5	8
4	Lowland/upland land capability and use will face increasing and competing demands	5	7
5	The ecosystem approach, landscape-scale approaches, ecosystem services and natural capital frameworks will be significant components of the policy making process	4	11
6	Food security and water security will become significant challenges; perhaps even sources of conflict	4	8
7	The UK and its Overseas Territories will not be immune from rising sea levels, flooding, heatwaves and poor air quality	4	8
8	Waste will continue to increase and is likely to cause significant environmental challenges	3	8
9	Planning needs to be future proofed and more embedded	3	7
10	Consumption is likely to increase steadily	3	5
11	Governments will seek to achieve a global free trade agreement	3	4
12	The continued decline in vertebrate species populations is part of a complex biodiversity picture creating winners and losers	3	3
13	Improvements in farming techniques and technology will boost productivity and food security	2	7
14	Technology is likely to play an increasing role in regulation, both in monitoring and compliance	2	7
15	The UK will agree more strategic approaches to environmental delivery through legislative reform as a result of Brexit	2	6
16	The world economy will double in size by 2045	2	4
17	The value of the UK's ecotourism markets is likely to increase	2	3
18	Retailer power will drive farming systems	2	2
19	The internet of things will change production processes and practices profoundly	2	2
20	Citizen engagement is likely to become increasingly important across a range of policy areas	1	8
21	Circular economy practices will become more widely used and change what society values	1	7
22	Global resource shortages (metals, nutrients for example) will begin to bite	1	6
23	Data analytics will enable sophisticated mapping of demand and supply	1	5
24	Governments will continue to collaborate to address Climate Change and Sustainable Development	1	4

25	Poverty and social injustice is creating a disconnection between people and the environment	1	4
26	Demand for greater regional and local autonomy will continue	1	3
27	Global population is likely to exceed 8.5 billion by 2030	1	3
28	More than one quarter of the world's population will live with water scarcity on a daily basis by 2040	1	3
29	New technology will continue have an impact on the natural environment	1	3
30	Pests and diseases will be more widely dispersed	1	3
31	GM crops and animals are likely to become culturally accepted in the UK	1	2
32	The average age of the UK population will be 42.9 years in 2045. 1 in 12 will be over 80	1	2
33	The economic centre of gravity will continue to move away from the west towards China and the east	1	2
34	There will be no magic bullet that eases pressure on the natural environment to provide food and energy	1	2
35	Local economic performance around the UK will be uneven, leading to increased regional disparity	1	1
36	The risk of interstate conflict will continue to rise	1	1
37	The contribution that natural capital makes to UK growth will become more important	0	8
38	London and other major UK cities will continue to grow in size and population	0	6
39	Decarbonisation will significantly impact on policy formulation and implementation	0	5
40	Demand for energy will continue to increase	0	3
41	Smart cities and autonomous vehicles will change how we live and travel	0	2
42	People will have increased mobility and job flexibility	0	1
43	The UK will not retain exclusive fishing rights of the 200 mile exclusive economic zone post Brexit	0	1
44	The UK's reputation as a migrant unfriendly country will have an impact on jobs and wealth creation	0	1
45	Cyber security will be a continuing threat to international security	0	0
46	International investment in the UK will increase	0	0
47	The sale of petrol and diesel vehicles will be banned in 2040	0	0

There was a great deal of similarity in the driver's priorities in each of the regional workshops (Table 2) and in each of the four breakout groups' present at all four workshops (i.e. excluding the overseas territories breakout group which was only held at the English workshop). Given the time limitation and the need to priorities in the order of 12 drivers in each breakout group there is no obvious bias in any particular regional workshop. It is relevant to remember that the list of drivers presented to the Scottish participants was different from the other three workshops and some drivers suggested by them were taken forward to the other workshops and prioritised by several of the groups e.g. *Waste will continue to increase and is likely to cause significant environmental challenges* which was suggested by the Food, Farming, Timber and Forests group in the Scottish workshop but not actually prioritised by them. This group did however, incorporate the ideas embodied in this newly created driver in the 100-word challenges they wrote for the driver *Retailer power drives farming systems; Food security and water security becomes significant challenges, perhaps even sources of conflict* and *Consumption will continue to increase*.

Table 2. Number of groups (n=4) prioritising drivers in each of the four regional workshops and in each of the breakout groups (FFTF= Food Farming, Timber and Forest; WFM= Water Marine and Fisheries; ECW= Environment, Conservation and Wildlife; CCAQE= Climate change, Air quality, and Energy). Text for each driver explained in Table 1.

Driver Number	Total Scotland	Total Wales	Total England (ex OT)	Total NI	Total FFTF	Total WFM	Total ECW	Total CCAQE	Total OT
1	3	3	3	2	3	3	2	3	1
2	4	1	2	2	3	1	2	3	0
3	2	4	1	1	2	4	1	1	0
4	1	3	2	1	2	1	3	1	0
5	3	3	2	2	2	2	4	2	1
6	3	1	2	2	2	2	2	2	0
7	1	3	3	0	1	2	2	2	1
8	1	3	2	2	1	2	2	3	1
9	1	2	1	2	0	0	2	4	1
10	4	1	0	0	1	1	1	2	0
11	3	1	0	0	2	0	1	1	0
12	1	1	1	0	0	0	3	0	0
13	1	1	2	3	3	1	1	2	0
14	2	1	1	3	1	1	2	3	0
15	3	0	0	3	0	2	2	2	0
16	1	2	0	1	2	0	1	1	0
17	1	1	0	0	1	1	0	0	1
18	1	0	1	0	2	0	0	0	0
19	1	1	0	0	2	0	0	0	0
20	1	3	2	3	1	1	3	4	0
21	3	1	1	1	1	1	1	3	1
22	1	1	2	2	2	2	1	1	0
23	1	1	2	1	1	1	1	2	0
24	1	0	2	1	1	1	0	2	0
25	1	2	2	0	2	1	1	1	0
26	2	1	0	0	1	0	1	1	0
27	1	1	0	1	2	1	0	0	0
28	0	1	1	0	1	0	0	1	1
29	0	1	1	1	2	0	1	0	0
30	0	1	1	1	0	0	3	0	0
31	0	1	1	0	0	0	2	0	0
32	1	0	0	0	0	0	0	1	1
33	0	1	1	0	1	0	0	1	0
34	1	0	0	1	0	2	0	0	0
35	0	0	1	0	0	0	1	0	0
36	0	1	0	0	1	0	0	0	0
37	1	3	1	3	1	2	2	3	0
38	3	0	2	1	1	1	2	2	0
39	3	1	0	1	0	1	1	3	0
40	1	0	1	1	0	1	1	1	0
41	1	0	1	0	0	0	1	1	0
42	0	0	1	0	0	0	1	0	0
43	1	0	0	0	0	1	0	0	0
44	0	0	0	1	1	0	0	0	0
45	0	0	0	0	0	0	0	0	0
46	0	0	0	0	0	0	0	0	0
47	0	0	0	0	0	0	0	0	0

Some breakout groups clearly priorities drivers relevant to their theme e.g. participants of the Food Farming, Timber and Forest breakout group in all four regional workshops prioritised the driver *Agricultural support payments are increasing, focussed on public goods* but this driver was also prioritised in the 'Environment, Conservation and Wildlife' and 'Climate change, Air quality, and Energy' breakout groups in one of the regional workshops indicating the cross cutting nature of the drivers.

Similarly the focus of the breakout groups can be seen in the prioritisation of the driver *Planning needs to be future proofed and more embedded* which was prioritised by the breakout group focused on Climate change, Air quality, and Energy in all four regional workshops but was also prioritised by at least one other group in all of the regional workshops with the exception of the Water Marine and Fisheries group which never prioritised it.

The Oversea Territories similarly prioritised many of the same drivers as the other groups although four of the top nine were not selected. One of these drivers refer specifically to the UK i.e. *Patterns of land and marine use will need to change to meet the UK's food and energy needs* and another to a UK specific policy i.e. *Agricultural support payments are increasing, focussed on public goods*. The other two drivers *Food security and water security will become significant challenges; perhaps even sources of conflict* and *Lowland/upland land capability and use will face increasing and competing demands* while considered important and relevant to the overseas territories were not prioritised as highly as other drivers. At least one other group in the regional workshops agreed with all the priorities of the overseas territories breakout groups i.e. there was no driver within the standard 47 driver list prioritised by the group focused on the Overseas Territories which was not also prioritised by another group.

The Overseas Territories breakout group created a number of additional drivers and created 100-word challenges for 2 of these (Table 3). They only prioritised nine rather than the 12 recommended indicating that they considered these drivers were indeed the most important in their views for the Overseas Territories in the future.

Table 3 New drivers scored as relatively more important for UK environmental policy by the group focused on Overseas Territories.

Driver	Challenge	Priority	Not ranked
Micro-plastics, waste pollutants and emerging contaminants have increasing impacts on marine ecosystems	●		
Invasive alien species and diseases will be more widely dispersed and arrive more frequently	●		
Ocean acidification and changes to ocean currents will have increasing impacts in marine ecosystems		●	
High seas closed areas/MPAs will increase		●	
UK and OT's will be leaders in research for environmental management			●
The relationship between health and wellbeing and the environment will become more important			●
Aquaculture will be increasingly important to OT's economy			●

A similar pattern to that of the prioritised drivers can be observed in the drivers selected to take forward to create a 100-word challenge, although with fewer entries in the table the patterns are less obvious (Table 4). The wide range of drivers selected to take forward by the workshop participants highlights the diversity of workshop participants.

Table 4 Number of groups (n=4) which took prioritised drivers forward to create a 100-word challenge in each of the four regional workshops and in each of the breakout groups (FFTF= Food Farming, Timber and Forest; WFM= Water Marine and Fisheries; ECW= Environment, Conservation and Wildlife; CCQAE= Climate change, Air quality, and Energy). Driver numbers refer to drivers in Table 1.

Driver Number	Total Scotland	Total Wales	Total England (ex OT)	Total NI	Total FFTF	Total WFM	Total ECW	Total CCAQE	Total OT
1	2	1	2	2	1	1	3	2	0
2	2	1	2	1	1	0	2	3	0
3	1	2	0	2	2	2	1	0	0
4	0	2	2	1	2	1	2	0	0
5	3	0	1	0	1	1	1	1	0
6	2	1	0	1	0	2	1	1	0
7	0	0	2	1	0	0	1	2	1
8	3	0	0	0	1	1	0	1	0
9	2	1	0	0	2	0	0	1	0
10	1	2	0	0	0	0	1	2	0
11	1	0	1	1	0	0	3	0	0
12	0	2	0	0	1	1	0	0	1
13	1	1	0	0	2	0	0	0	0
14	1	0	1	0	2	0	0	0	0
15	0	1	1	0	1	0	0	1	0
16	1	1	0	0	2	0	0	0	0
17	1	0	1	0	0	1	1	0	0
18	0	1	0	0	1	0	0	0	1
19	1	1	0	0	2	0	0	0	0
20	0	1	0	0	1	0	0	0	0
21	0	0	1	0	0	0	0	1	0
22	0	1	0	0	1	0	0	0	0
23	0	0	0	1	0	0	1	0	0
24	0	1	0	0	1	0	0	0	0
25	0	1	0	0	1	0	0	0	0
26	0	1	0	0	0	0	1	0	0
27	0	0	1	0	0	0	0	1	0
28	0	0	1	0	0	0	1	0	0
29	0	1	0	0	1	0	0	0	0
30	0	1	0	0	1	0	0	0	0
31	0	0	1	0	0	0	1	0	0
32	0	0	0	0	0	0	0	0	1
33	0	1	0	0	0	1	0	0	0
34	0	1	0	0	1	0	0	0	0
35	0	1	0	0	1	0	0	0	0
36	1	0	0	0	0	1	0	0	0
37	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0
41	0	0	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0	0	0
43	0	0	0	0	0	0	0	0	0
44	0	0	0	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0	0
46	0	0	0	0	0	0	0	0	0
47	0	0	0	0	0	0	0	0	0

3. Summary of 100-word challenges

In total 65 100-word challenges were created by the groups considering a total of 26 single drivers 13 clusters of drivers (Table 5). In total 36 unique drivers were considered prioritised and used to create a 100-word challenge by the workshop participants.

The driver considered by most participants at the workshops to have significance for the future direction of environmental policy for the UK was *Climate change will continue to cause increased temperature and increased occurrence of extreme weather and seasonal events*. A 100-word

challenge for this driver was created by 7 groups and an 8th linked it with another driver *The UK and its Overseas Territories will not be immune from rising sea levels, flooding, heatwaves and poor air quality*. Although each group was faced by the same driver the 100-word challenge they produced reflect different aspects embodied in the driver. Some groups mentioned *Less predictable weather patterns will make agricultural planning harder* or specifically mentioned *aquatic ecosystems include the consequences of increased sediment and pollutant transport, with likely impacts on aquaculture and benthic quality and potential for eutrophication, and more generally on fresh water quality and availability*. While the specific regional consequences were mentioned in the Welsh workshop *More episodic weather events are likely to lead to increased flooding, pollution and runoff, coastal erosion, changes in dynamics and changes in species range, distribution and diversity. In Wales a high proportion of the population lives in coastal areas. Supporting infrastructure is also concentrated in the coastal area and therefore Wales is especially vulnerable to these impacts*.

The differences expressed in the multiply 100-word challenges for the same drivers supports the view that all 65 individual 100-word challenges should be taken forward to Phase 3 of the project i.e. remote consultation to collect research ideas to provide evidence associated with the challenge articulated in the workshops.

Table 5 Number of 100-word challenges created for each driver by participants at four regional workshops.

Drivers	Number 100-word challenges
Climate change will continue to cause increased temperature and increased occurrence of extreme weather and seasonal events.	7
Agricultural support payments are increasing, focussed on public goods	4
Patterns of land and marine use will need to change to meet the UK's food and energy needs	4
Food security and water security will become significant challenges; perhaps even sources of conflict	3
Lowland/upland land capability and use will face increasing and competing demands	3
The continued decline in vertebrate species populations is part of a complex biodiversity picture creating winners and losers	3
The ecosystem approach, landscape-scale approaches, ecosystem services and natural capital frameworks will be significant components of the policy making process	3
Consumption is likely to increase steadily	2
Demand for greater regional and local autonomy will continue	2
Governments will seek to achieve a global free trade agreement	2
Planning needs to be future proofed and more embedded	2
Poverty and social injustice is creating a disconnection between people and the environment	2
The UK will agree more strategic approaches to environmental delivery through legislative reform as a result of Brexit	2
Citizen engagement is likely to become increasingly important across a range of policy areas	1
Global population is likely to exceed 8.5 billion by 2030	1
GM crops and animals are likely to become culturally accepted in the UK	1

Governments will continue to collaborate to address Climate Change and Sustainable Development	1
Improvements in farming techniques and technology will boost productivity and food security	1
Pests and diseases will be more widely dispersed	1
Retailer power will drive farming systems	1
Technology is likely to play an increasing role in regulation, both in monitoring and compliance	1
The average age of the UK population will be 42.9 years in 2045. 1 in 12 will be over 80	1
The internet of things will change production processes and practices profoundly	1
The UK and its Overseas Territories will not be immune from rising sea levels, flooding, heatwaves and poor air quality	1
The value of the UK's ecotourism markets is likely to increase	1
Waste will continue to increase and is likely to cause significant environmental challenges	1
Circular economy practices will become more widely used and change what society values and Waste will continue to increase and is likely to cause significant environmental challenges	1
Climate change will continue to cause increased temperature and increased occurrence of extreme weather and seasonal events and The UK and its Overseas Territories will not be immune from rising sea levels, flooding, heatwaves and poor air quality	1
Food security and water security will become significant challenges; perhaps even sources of conflict and Patterns of land and marine use will need to change to meet the UK's food and energy needs	1
Improvements in farming techniques and technology will boost productivity and food security and New technology will continue have an impact on the natural environment	1
Local economic performance around the UK will be uneven, leading to increased regional disparity, Lowland/upland land capability and use will face increasing and competing demands, Patterns of land and marine use will need to change to meet the UK's food and energy needs and Patterns of land use will change as a result of competing demands and regional disparity	1
Lowland/upland land capability and use will face increasing and competing demands and 24. Patterns of land and marine use will need to change to meet the UK's food and energy needs	1
Pests and diseases will be more widely dispersed and 54. Invasive alien species and diseases will be more widely dispersed and arrive more frequently	1
Retailer power will drive farming systems and 53. High environmental standards will impact on food and forestry	1
Waste will continue to increase and is likely to cause significant environmental challenges and 48. Micro-plastics, waste pollutants and emerging contaminants have increasing impacts on marine ecosystems	1
Border controls between the North and South are different from now	1
Loss of agricultural soils	1
Antibiotic resistance, pollution and provenance (additional driver suggested by group)	1
Human Health, and its links to environment will increase in importance	1

In total 21 drivers were not considered directly in the creation of the 100 word challenges (Table 6). However, given the interconnected and cross-cutting nature of many of these drivers and the wide range of drivers prioritised by the workshop participants (section2) it is considered that the present

set of 65 challenges focused on 36 drivers (5 new drivers provided by the workshop participants) does embody many of the drivers listed in Table 6.

Table 6 List of drivers not considered directly in the creation of a 100-word challenge.

Drivers
Circular economy practices will become more widely used and change what society values
Cyber security will be a continuing threat to international security
Data analytics will enable sophisticated mapping of demand and supply
Decarbonisation will significantly impact on policy formulation and implementation
Demand for energy will continue to increase
Global resource shortages (metals, nutrients for example) will begin to bite
International investment in the UK will increase
Local economic performance around the UK will be uneven, leading to increased regional disparity
London and other major UK cities will continue to grow in size and population
More than one quarter of the world's population will live with water scarcity on a daily basis by 2040
New technology will continue have an impact on the natural environment
People will have increased mobility and job flexibility
Smart cities and autonomous vehicles will change how we live and travel
The contribution that natural capital makes to UK growth will become more important
The economic centre of gravity will continue to move away from the west towards China and the east
The risk of interstate conflict will continue to rise
The sale of petrol and diesel vehicles will be banned in 2040
The UK will not retain exclusive fishing rights of the 200 mile exclusive economic zone post Brexit
The UK's reputation as a migrant unfriendly country will have an impact on jobs and wealth creation
The world economy will double in size by 2045
There will be no magic bullet that eases pressure on the natural environment to provide food and energy

4. 100-word challenges

The following list is all 65 drivers were produced by participants of at four regional workshops following a process to prioritise drivers of future change.

	England
	Scotland
	Northern Ireland
	Wales

The Driver	1. Agriculture and forestry support payments focused on public goods
The Challenge Wales Food, Farming, Timber and Forests	Farmers and foresters manage their land to deliver economic products and public goods and services. However, pressures on land-use, changing market demands, and changes to CAP funding post-Brexit may have unintended consequences on behaviour, practice and land use. Through better understanding of socio-economic drivers of behaviour and implications on land management practice, and the ecological and environmental interactions we can realise the opportunities to rebalance land use between sectors ie. Agriculture, forestry, recreation and conservation, realise savings and benefits to other sectors (health, energy, tourism) and improve water and air quality, whilst also providing food and forest products.

The Driver	1. Agricultural support payments are increasing, focussed on public goods
The Challenge Wales Water, Fisheries and Marine	<p>The lack of certainty around future subsidies brings risk of agricultural collapse but also opportunities for improved ecosystem services. Risks might include farm abandonment, food security, human and animal welfare. Benefits might include water quality, carbon sequestration, flood mitigation etc. Biodiversity change is likely.</p> <p>To formulate appropriate policy, evidence of the true economic value of ecosystem services in a natural capital/resource accounting format is required. This would include estimation of avoidable costs of agricultural collapse (including societal), and comparison with potential long-term gains to society of using subsidies to support and develop ecosystem services.</p>

The Driver	1. Agricultural support payments are increasing, and focussed on public goods
The Challenge Northern Ireland Food, Farming, Timber and Forests	<p>The UK needs to develop an agricultural support policy which covers the provision of a wide range of public goods [which are] localised and flexible over time.</p> <p>Research is needed to identify the public goods, to develop a framework, to prioritise them in different areas and to determine the best policy delivery mechanisms.</p>

The Driver	1. Agricultural Support payments are increasingly focussed upon public goods
The Challenge Northern Ireland Environment, conservation and wildlife	<p>Sustainable and resilient agricultural systems and practices are an essential part of the future of the UK social and industrial infrastructure. Core to this ambition is maximising the public good opportunities from land use management. Public money for public goods, means payments for goods and services including securing healthy soils, clean water and air, flood management, reversing the decline of biodiversity, and carbon sequestration etc. Research is needed to underpin the development of an index of existing natural resources and land use practices, indicators and modalities for success, and economic implications.</p> <p>A challenge will be how to engage and roll-out such a shift in policy and research will be needed to ensure targeted and appropriate engagement to achieve buy-in from current and future generation farm families.</p>



The Driver	2. Circular economy practices will become more widely used and change what society values And 47. Waste will continue to increase and is likely to cause significant environmental challenges
The Challenge Wales Food, Farming, Timber and Forests	<p>The impact of waste at all stages of our farming, food, forestry and timber sectors has a massive environmental impact. There is an urgent need to embed the principles of the circular economy model in order to ensure sustainable development and lean economic growth which safeguards our natural capital and resources for future generations. Research is needed to identify opportunities and policy levers required to deliver the step changes and interconnectivity across the sectors, in particular in the areas of food and timber supply chain waste, water reuse and recycling, heat recovery and recirculation.</p>



The Driver	3. Citizen engagement is likely to become increasingly important across a range of policy areas
The Challenge	<p>How can we capitalise on increased citizen engagement to improve our environment? In a more interconnected world, how can social media and other types of networking be harnessed as a power for good? How can UK citizens bolster the UK's position as a global leader in environmental protection post-</p>

<p>England</p> <p>Climate change, air quality and energy</p>	<p>Brexit? How can we create the frameworks in which all citizens are able – economically, politically and emotionally – to protect environment? Building a fully enfranchised society through a new form of social contract between the state and society for environmental change in central government will be a vital part of more democratic environmental protection.</p>
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<p>The Driver</p>	<p>4. Climate change will continue to cause increased temperature and increased occurrence of extreme weather and seasonal events.</p>
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<p>The Challenge</p> <p>Northern Ireland</p> <p>Environment, conservation and wildlife</p>	<p>Climate change is inexorable and inevitable over the next 25 years irrespective of current emissions control initiatives and international agreements. It will result in more localised flooding, sea level rise and an acceleration of the invasion of alien species and pests. Less predictable weather patterns will make agricultural planning harder and present significant economic, ecological and social impacts. Research is needed to demonstrate the economic benefits of intervention and appropriate adaptation and mitigation measures. This requires back-casting 25 years to indicate trend, rate of change, and costs incurred. This data, adjusted for world population and economic growth, should be used to test scenarios to minimise risks and maximise opportunities.</p>
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<p>The Driver</p>	<p>4. Climate change is resulting in increased temperature and increased fluctuation in extreme weather and seasonal event</p>
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<p>The Challenge</p> <p>Scotland</p> <p>Environment, conservation and wildlife</p>	<p>We need to remain at the global forefront of climate measurement, modelling and policy response - through, for example, incentives to reduce carbon.</p> <p>A robust and pervasive evidence base, including wildlife trends, is needed to justify the costs and explain the benefits of amelioration.</p> <p>Two outcomes of this could be to</p> <ul style="list-style-type: none"> • Justify investment in green technology and energy-saving • Safeguard biodiversity on land and in our fresh waters and seas
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<p>The Driver</p>	<p>4. Climate change is resulting in increased temperature and increased fluctuation in extreme weather and seasonal events</p>
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<p>The Challenge</p> <p>Scotland</p> <p>Water, Fisheries and Marine</p>	<p>Climate change is highly likely to lead to more extreme events, currently poorly understood and hard to predict. The effects of these events on aquatic ecosystems include the consequences of increased sediment and pollutant transport, with likely impacts on aquaculture and benthic quality and potential for eutrophication, and more generally on fresh water quality and availability.</p> <p>Prediction is likely to become more difficult with Earth system changes consequent on climate change and other anthropogenic pressures.</p>
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Evidence is needed to understand these events and their consequences for ecosystems, and to construct and validate models to confidently predict and mitigate these events.

The Driver	4. Climate change will continue to cause increased temperature and increased occurrence of extreme weather and seasonal events.
The Challenge England Environment, conservation and wildlife	Climate change is a continuing and major threat to UK society, economy and the environment and will impact upon health, well-being and use of resources. This is an issue for the short, medium and long term. A lot of planning and modelling has taken place but this has not always been tested in UK communities and the natural environment. Research is needed into how the application of adaptation and mitigation measures is working, e.g. through pilots, demonstrations and scenario testing. At the acute end of the spectrum, we need knowledge on how systems deal with flooding or heatwaves, but it is also applicable to the loss of species, crop failure, etc. Research also needed on complexity and systems thinking under conditions of uncertainty.

The Driver	4. Climate change will continue to cause increased temperature and increased occurrence of extreme weather and seasonal events + ocean acidification is possible
The Challenge Wales Water, Fisheries and Marine	<p>More episodic weather events are likely to lead to increased flooding, pollution and runoff, coastal erosion, changes in dynamics and changes in species range, distribution and diversity. In Wales a high proportion of the population lives in coastal areas. Supporting infrastructure is also concentrated in the coastal area and therefore Wales is especially vulnerable to these impacts.</p> <p>We need to have better forecasting, an understanding of the scale of impact and local responses. There is a policy need to understand the impact on social, environmental and economic resilience and to embed uncertainty and long term evidence into decision making and future planning processes.</p>

The Driver	<p>4. Climate change will continue to cause increased temperature and increased occurrence of extreme weather and seasonal events.</p> <p>40. The UK and its Overseas Territories will not be immune from rising sea levels, flooding, heatwaves and poor air quality</p>
The Challenge England Climate change, air quality and energy	Recent extreme events have raised public awareness of exposure to risk and expectations that action will be taken. Climate change is likely to increase the frequency and potentially magnitude of extreme events. While climate risks are largely identified, we still need to know how much adaptation we need and what form it should take. Research is needed to work with statutory agencies to understand what works and identify when resilience building ends and a change in practice is needed.

The Driver	4. Climate change is resulting in increased temperature and increased fluctuation in extreme weather and seasonal events
The Challenge Scotland Food, Farming, Timber and Forests	<p>Climate change present risks to producers from increased temperature and more frequent and severe weather events. This leads to an increase in the risks borne by the producer such as crop loss and less productive animals. Climate change and other environmental policies are also limiting producers' tools for managing risk (eg. fertiliser and pesticides).</p> <p>We therefore need to establish more resilient to production systems and appropriate intervention tools to support the land-based industries. Examples include ensuring schemes and futures markets.</p> <p>There is a danger that risk will drive restructuring of businesses across the sector and ancillary support sectors.</p>

The Driver	4. Climate change will continue to cause increased temperature and increased occurrence of extreme weather and seasonal events clustered with 40. The UK and its Overseas Territories will not be immune from rising sea levels, flooding, heatwaves and poor air quality.
The Challenge Northern Ireland Climate change, air quality and energy	<p>The UK faces inexorable challenges at a local level, compounded by severe global pressures as a result of climate disruption. It is important to find an acceptable balance between a sustainable environment and the often competing social, economic and political agendas. Research is needed to target mitigation and adaptation strategies using viable climate, air and water quality models and datasets. This should enable the timely development and application of social and innovative technological solutions that respond to a growing population and its requirements for food security, energy and natural resources.</p>

The Driver	5. Consumption will continue to increase
The Challenge Scotland Water, Fisheries and Marine	<p>Overall consumption will vary and is difficult to predict but some areas of consumption will increase and require control. Threats include constrained resource availability and increased waste. Some resources are finite (rare earth metals, oil and gas) and supplies will decline forcing price increases. There are opportunities for innovation, greater efficiency in resource utilisation, development of novel resources/products, reduction of waste, and developing circular economies. Research can deliver understanding of resource use, consumer patterns and supply chain efficiencies. There is an opportunity to market UK niche products (water, seafood, alcohol).</p>

Education, cultural change and innovative legislative frameworks will be required.

The Driver	5. Consumption will continue to increase
The Challenge Scotland Climate change, air quality and energy	<p>The current rate of consumption increase is unsustainable and is a finite trajectory in terms of resources, energy, waste, space and biodiversity.</p> <p>Impacts are wide ranging, predominantly negative, in many cases irreversible and cumulatively catastrophic. Behavioural change is a fundamental requirement to pull consumption back to a sustainable level.</p> <p>We need a clear, concise definition of the 'breaking point'. We then need to understand consumer choice to bring about policy change that encourages sustainable decisions at an individual and organisational level to ensure this breaking point is not reached</p>

The Driver	10. UK political structures and processes for political decision-making are likely to change
The Challenge Scotland Food, Farming, Timber and Forests	<p>Through Brexit, environmental and other powers become repatriated. The challenge is how and to what extent these powers are devolved; and how the UK maintains and assesses practice against standards – especially against other (Non-EU) international agreements.</p>

The Driver	10. Demand for greater regional and local autonomy will continue
The Challenge Northern Ireland Environment, conservation and wildlife	<p>It is recognised that there is a need for a UK common framework for environmental standards; there is a need for the transboundary relationships to be addressed in environmental policy making. The shared land and sea border in Ireland represents a unique situation both in policy terms and as a single biogeographic unit. Devolved authority will be essential for interoperability on the island, and therefore integration of UK and ROI policy agendas and standards will require sharper focus. Research is needed to fully delineate the shared environmental concerns, boundaries and issues and how these are addressed on a North-South basis. Research is also needed to describe the</p>

extent and success of local arrangements for transboundary operations on key environmental issues, and risk analysis will be needed to identify mitigation measures.

<p>The Driver</p>	<p>11. Food security and water security will become significant challenges; perhaps even sources of conflict</p> <p>24. Patterns of land and marine use will need to change to meet the UK's food and energy needs</p>
<p>The Challenge</p> <p>England</p> <p>Climate change, air quality and energy</p>	<p>The UK relies on home grown and imported food and patterns of production are not optimal, but Brexit presents an opportunity to change this. Because of climate change and competing land use pressures, this situation is likely to be worse without intervention to protect long term sustainability. We need research that explores scenarios and options to provide evidence for decision makers on what best to do where. Management for multiple use is required acknowledging that more people will live in increasing proximity to food and energy production systems. People will have higher expectations of good amenity value, air quality, etc.</p>

<p>The Driver</p>	<p>11. Food security and water security will become significant challenges and perhaps even sources of conflict</p>
<p>The Challenge</p> <p>Scotland</p> <p>Food, Farming, Timber and Forests</p>	<p>Greater demand for food and water and increasing prices alongside climate change and population will change the spatial production of food.</p> <p>Conflicts will therefore arise in the areas of the world where there are adjacent areas of sufficiency and deficiency. We need to ensure affordable sustainable food, conducive to a good diet both in the UK and internationally. We also need to ensure a resilient water supply for people, the environment and business.</p> <p>Brexit is a threat with the UK leaving a bigger club and potential reduction in economic standing of the UK. We need to understand – forecast and monitor – what the demands for food and water in the UK in an international context. We also need to understand implications of this are optimising production and food conducive to a good diet from land without compromising environment</p>

<p>The Driver</p>	<p>11. Food security and water security will become significant challenges within the UK; perhaps even sources of conflict</p>
<p>The Challenge</p> <p>Scotland</p> <p>Environment, conservation and wildlife</p>	<p>The UK is experiencing food and water security challenges. This is causing regional instability, shortages, and conflicts which are having negative effects on society and the environment. To address this we need to understand</p> <ul style="list-style-type: none"> • How can new technology and different approaches to food production and water use – grey water and vertical growing, for example – help alleviate these challenges?

	<ul style="list-style-type: none"> • How can changes in food and water policies help alleviate these challenges? • What are the knock-on effects of these shortages across sectors (environment, healthcare and crime, for example)? • How can we build societal resilience (through, for example, addressing regional insecurities in supply and demand)?
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The Driver	11. Food security and water security becomes significant challenges, perhaps even sources of conflict
The Challenge Scotland Water, Fisheries and Marine	Food and water security will become significant challenges but the impact will be regional. There are direct impacts in the UK but global implications. Consequences include geopolitical instability and migration, impacts on trade and economy, and restricted food imports. There may also be impacts on availability and water quality related to human health and constraining commercial and agricultural production. There are regional opportunities for water-based industry (electronics, paper, tofu) and export of expertise in water efficiency and management. Research in terms of consumption rates (domestic and commercial), new technologies for water recycling, circular industry, reduced waste, and innovative food production;

The Driver	12. Global population is likely to exceed 8.5 billion by 2030
The Challenge Wales Food, Farming, Timber and Forests	Global population will increase with a shift in economic centre of gravity to the east. Resource shortages will lead to increased inter-state conflict (possible shift in global free trade agreement). Threats include increased drive for economic growth at the expense of non-market environmental goods and benefit and increased disparity in access to limited / critical resources. Our response needs to highlight the opportunities of collective solutions to meet UNSDGS (co sustainable development) reviewing what works / where, and why, and trailing new innovative solutions which increase circular economies and reduce global footprints. NERC will need to work cross research councils to achieve this.

The Driver	14. GM crops and animals are likely to become culturally accepted in the UK
The Challenge Wales Environment, conservation and wildlife	Post-Brexit, international trade agreements will come attached with new and possibly lower standards. The risks to the UK of accepting GM crops are potential agricultural intensification; the loss of arable dependent species; and wider impacts for biodiversity and public health. However, with a good evidence base, genetically modified food can lead to opportunities for food security, such as increasing resilience of a plant to environmental stresses or

moving to meat-free diets. If, by 2042, GM food is part of UK policy, it'll need to be based on robust safeguarding and regulatory conditions as the risks to living organisms are significant.

The Driver	15. Governments will continue to collaborate to address Climate Change and Sustainable Development; not just national governments, also cities and regions (para-diplomacy)
The Challenge England Climate change, air quality and energy	<p>Global consensus is thought to be the most effective route to environmental protection. We need evidence that initiatives such as the SDGs and international climate change frameworks are effective. How can multiple agencies deliver more than the sum of their parts at the local level, at pace and cost-effectively?</p> <p>We need an improved understanding of how environmental issues are treated in international institutions, and how these structures and processes could be optimised. This improved understanding of the politics, governance and other elements can help the UK government use its research base to deliver a better global environment.</p>

The Driver	16. Governments will seek to achieve more free trade agreements
The Challenge Scotland Food, Farming, Timber and Forests	<p>The challenge is to understand domestic land-based production sectors in the context of global trading partners.</p> <p>There are a number of factors at play, including quality of production, welfare standards and production support mechanisms. Attitudes to free trade are also changing globally and there is uncertainty about how this will play out for Scotland. It's not clear how agriculture will fare in trade negotiations versus other sectors such as financial services and business services.</p>

The Driver	16. Governments will seek to achieve a global free-trade agreement
The Challenge Scotland Climate change, air quality and energy	<p>In securing a global free trade agreement, the UK will face significant challenges to secure the position of environmental requirements within those negotiations.</p> <p>The key challenge will be to maintain and enhance protections the UK already has. To do so, we will need to understand the environmental implications for climate change, energy and air quality. That understanding will require a clear picture of the regimes of environmental control and protection in the other trading jurisdictions, backed up by a clear scientific rationale for the environmental standards, limits and governance which the UK promulgates.</p>

<p>The Driver</p>	<p>17. Improvements in farming techniques and technology will boost productivity and food security</p> <p>23. New technology will continue have an impact on the natural environment</p>
<p>The Challenge</p> <p>Wales</p> <p>Food, Farming, Timber and Forests</p>	<p>New technology is having an impact on the natural environment and may boost productivity generally and food and fibre security in particular. New technology creates markets in particular new producers, diversifying landscapes and species leading to environmental and industrial resilience. However, technology may also push productivity at the expense of the natural environment. To mitigate this threat and realise the opportunity we need to know more about the business case for their development and the environmental impacts of the new technologies, earlier on in their development and the effect the technologies have on existing markers and supply chains.</p>

<p>The Driver</p>	<p>17. Improvements in farming techniques and technology will boost productivity and increase food security</p>
<p>The Challenge</p> <p>Scotland</p> <p>Food, Farming, Timber and Forests</p>	<p>Improvements in farming techniques and technology <u>will</u> boost productivity and increase food security. This will depend on our ability to have well informed policy built on good public debate and understanding of science; and on an agricultural workforce and structure that can sustainably capitalise on it.</p> <p>This depends on maintaining scientific credibility through ongoing funding [which will have] major impacts on ensuring Scotland’s natural capital is optimised from multiple ecosystem benefits.</p>



<p>The Driver</p>	<p>19. Local economic performance around the UK will be uneven, leading to increased regional disparity,</p> <p>21. Lowland/upland land capability and use will face increasing and competing demands,</p> <p>24. Patterns of land and marine use will need to change to meet the UK’s food and energy needs an (grouped under a Land use cluster)</p> <p>54 : Patterns of land use will change as a result of competing demands and regional disparity</p>
<p>The Challenge</p> <p>England</p> <p>Environment, conservation and wildlife</p>	<p>Brexit provides opportunities to develop new approaches to shaping local and national land use and management policy. There is an opportunity to develop a pattern of land use which optimises multiple benefits for society whilst recognising the sensitivity of regional and local character and needs, and builds resilience for future generations. This requires a better understanding of the dynamics of land use change and associated environmental impacts, and an understanding of decision making by people and organisations. A range of</p>

modelling and support tools are needed to enable evidence based decision making that takes into account competing demands, potential synergies and trade-offs.

The Driver	21. Lowland/upland land capability and use will face increasing and competing demands
The Challenge Northern Ireland Food, Farming, Timber and Forests	<p>The UK needs a joined up policy on food security, the environment and health. Lowland and upland UK will face competing pressures and should be closely linked.</p> <p>Research is needed to identify these pressures, the scale of their impact and the mitigation options. This evidence is essential to formulate a balanced government policy.</p>

The Driver	21. Lowland/upland land capability and use will face increasing and competing demands
The Challenge Wales Environment, conservation and wildlife	<p>Land use will be more politicised post-Brexit as new agricultural policy is created and a public money for public goods system implemented. If food production is prioritised above carbon capture, flooding resilience or nature conservation, then it may be difficult to ensure an ecosystem approach is taken forward. This will be affected by global trade, decarbonisation targets and internal UK markets. In 2042, an effective land use policy would centre around ecosystem services, ecotourism and conservation. Evidence will be needed on the most effective way the land can be managed that increases ecosystem resilience, as well as fits with socioeconomic policy, public health and industrial strategy. Decision making should be based on enhanced monitoring, observation and opportunity mapping.</p>

The Driver	21. Lowland/upland land capability and use will face increasing and competing demands affecting water quantity and quality
The Challenge England Water, fisheries and Marine	<p>Brexit will have impact on UK environmental policy. It is, however, an opportunity to reconfigure our landscape (post CAP and other directives), but calls for a series of legislative controls and a legislative authority with teeth. Water is a critical resource; poor management can increase floods, degrade water quality, cause soil erosion and droughts. We need better joined up models to understand how systems function and what effect changes will have. We need to model the whole water system joined up at all scales supported by comprehensive long term (decadal) monitoring. Research is needed on representative catchments with whole system monitoring and modelling and relevant data analytics and new technologies (middleware).</p>

The Driver	21. Lowland/upland land capability and use will face increasing and competing demands
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	24. Patterns of land and marine use will need to change to meet the UK's food and energy needs
<p>The Challenge</p> <p>Wales</p> <p>Food, Farming, Timber and Forests</p>	<p>Land use is predicted to change in order to meet future food and energy needs. There is a risk that increasing pressures for food and energy results in negative environmental impacts. High level spatial planning with spatially explicit projections of future scenarios can help develop robust policies and support land use change, avoiding land abandonment and damage from higher intensity land management, and the marine and fresh water environments. More search in green energy capacity is needed along with the social and economic [knowledge] of, and drivers of land use change. A more collective understanding of cross-landscape interactions is needed</p>

The Driver	24. Patterns of land and marine use will need to change to meet the UK's food and energy needs
<p>The Challenge</p> <p>Scotland</p> <p>Environment, conservation and wildlife</p>	<p>The UK needs to ensure that food and energy needs are met with an increasing population. With regard to this post-Brexit, it would be desirable to plan sustainable food energy policies by encouraging new technologies and understanding their impacts. This requires the capture of impacts and methods of mitigating unfortunate impacts, which in turn requires cross disciplinary research.</p> <p>Engagement with the farming and fishery establishments will be required to discuss and plan this.</p>

The Driver	24. Patterns of land and marine use will need to change to meet the UK's food and energy needs
<p>The Challenge</p> <p>Northern Ireland</p> <p>Climate change, air quality and energy</p>	<p>A strategy is required to direct changes in land and marine use in order to achieve effective and efficient environmental, economic outcomes for food and energy production. In a post-Brexit scenario the UK will need to explore ways to become more self-sufficient with regards to food and energy production. Evidence is required on the likely need scenarios and to better understand how climate disruption might stop NI environmental policy achieving these.</p>

The Driver	24. Patterns of land use will need to change to meet the UK's food and energy needs
<p>The Challenge</p> <p>Scotland</p> <p>Climate change, air quality and energy</p>	<p>To ensure that, as there is increased pressure from land to produce food and energy, this is not at the expense of (<i>inter alia</i>) environmental and social objectives.</p> <p>We need to understand the current and potential trajectories of land-use change, the values of different benefits of land and the trade-offs that will be required at strategic points.</p>

Emissions from land use will [also] become proportionately more significant for the UK in meeting its climate change targets.

The Driver	24. There is increasing pressure on land and the marine environment to provide food and energy
The Challenge Scotland Water, Fisheries and Marine	There will be increasing pressure on the marine and terrestrial environment to provide food and energy for a growing global population. Policy will need to evolve to allow the sustainable exploitation of natural capital; there is an opportunity for innovative policy beyond the scope of the existing standards and thresholds (regional, national, European, global). Research will be needed to understand the carrying capacity for specific resources under the context of resource demand and the challenges of related issues such as climate change. Solutions should take into account the wider social-ecological-legislative frameworks.

The Driver	26. Pests and diseases will be more widely dispersed
The Challenge England Environment, conservation and wildlife	Pests and diseases will increasingly cause destruction and loss of natural capital and ecosystem services including wildlife, agriculture, fisheries, population and human health, and heritage assets. This may impact public attitudes towards the natural environment. An effective toolkit is needed to identify and respond to emerging pests and diseases. This includes understanding the origins of pests and diseases; modelling pathways and dispersal; a risk based assessment of the potential impacts; and measures to control, mitigate or adapt. This must be supported by an understanding of the role of social attitudes and behaviours and innovative approaches to detection and monitoring.

The Driver	26. Pests and diseases will be more widely dispersed 55. Invasive alien species and diseases will be more widely dispersed and arrive more frequently
The Challenge England Overseas Territories & International	There are frequent and widespread problems with invasive species and diseases threatening and displacing endemic species in the OT's, which potentially leads to loss of ecosystem services, and the reduced productivity of farm animals and crops, destroying farmers' livelihoods and causing socio-economic harm. Baseline research is needed on existing habitats, species and taxonomy and longer-term monitoring to understand the impacts and responses, e.g. to climate change. Some of this may be done using new technology such as drones and satellites imagery to understand environmental change.

The Driver	27. Planning needs to be future proofed and more embedded
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<p>The Challenge</p> <p>Scotland</p> <p>Climate change, air quality and energy</p>	<p>Current decision-making processes take varying consideration of climate change impacts and often happen in isolation. UK and devolved legislation requires different degrees of integration. Providing evidence of the social, economic and environmental benefits of integrated planning for distant horizon scenarios will help make the case for pragmatic and positive policy revision and development post Brexit.</p>
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<p>The Driver</p>	<p>27. Planning needs to be future proofed and more embedded</p>
<p>The Challenge</p> <p>Wales</p> <p>Climate change, air quality and energy</p>	<p>Planning must be future proofed and embedded to ensure an integrated approach: to deliver lower emissions to reduce climate change, protect the environment, improve air quality and ensure sustainable energy production. This will improve quality of life ensuring sustainable management of natural resources, ensure a resilient and protected environment with enhanced health and wellbeing which will improve prosperity and support the economy. To deliver this, policy makers will require a joined up monitoring and modelling assessment. This will provide evidence that supports the integrated planning approach incorporating and impacting on agriculture, land use, population, economics, transport, ecosystems and human health.</p>



<p>The Driver</p>	<p>28. Retailer power drives farming systems</p>
<p>The Challenge</p> <p>Scotland</p> <p>Food, Farming, Timber and Forests</p>	<p>The supply chain is dysfunctional, with asymmetric power and profit for the retailers. This is affecting the sustainability of many farms and processors. If Brexit is to not exacerbate this, there must be an effort to regulate against the worst aspect of this, to develop and implement alternative business models and to educate the public about the true cost of food (production, waste, imports, climate change). More research on this essential.</p>

<p>The Driver</p>	<p>28. Retailer power will drive farming systems 53. High environmental standards will impact on food and forestry</p>
<p>The Challenge</p> <p>England</p> <p>Food, Farming, Timber and Forests</p>	<p>Market forces could drive farming systems in two distinct directions, both of which have consequences for the environment. First, retail power could continue to drive more low cost production with consequences for farm consolidation and land management whereby only the most efficient producers survive. Conversely, high environmental standards could push retailers and other institutional actors to become investors in natural capital throughout the supply chain, or require these standards from producers as the new norm. This raises important questions in terms of impact on the environment - who pays for the environment and who benefits. This challenge requires a range of data covering different disciplines, e.g. economic, cultural, social and environmental and a commitment to long-term data collection and potentially brings new actors into knowledge management, e.g. citizen scientists. Engagement is</p>

required with several other areas of policy, e.g. trade, technology, innovation and consumer protection.

The Driver	30. Technology is likely to play an increasing role in regulation, both in monitoring and compliance
The Challenge	Joined-up policy is increasingly important post-Brexit to work with multiple partners and achieve multiple environmental policy outcomes.
England	Fully joined-up monitoring and modelling from emissions through to impacts, will enable international bodies, governments, regulators, businesses and individuals to work together to improve the environment and quality of life.
Climate change, air quality and energy	The UK needs to understand the strengths and weaknesses of current monitoring and modelling capability. The challenge is to develop robust, trusted technology and tools to develop an end-to-end understanding of emissions and their impacts, reducing climate change, improving air quality and delivering sustainable energy within the context of the sustainable development goals.

The Driver	31. The average age of the OT population is likely to increase and result in an ageing population
The Challenge	An ageing population in UKOTs may have major socio-economic impacts, because the consequence of a declining economy will drive up emigration, shift the focus of public services to social care, and rebalance priorities for environmental stewardship. These factors together increase the risks of loss of sovereignty, public order, and reduced emphasis on environmental care. Improved socio-economic modelling will be required to assess the economic impacts of demographic change and to predict changes in the valuation of natural capital, in addition to modelling the expected reduction in environmental degradation as consumption patterns and energy use fall.
England	
Overseas Territories & International	

The Driver	32. The continued decline in vertebrate species populations is part of a complex biodiversity picture creating winners and losers.
The Challenge	Continued decline in higher level species will lead to a reduction in control of habitat and food chains. This is not a simple loss but one which impacts across the board because of the fine balance of ecosystems. It will be a progressive distortion leading to a significant ecological imbalance and the creation of new potential for pests and invasive species. However, there is also potential opportunities for eco-tourism centred on rare and vulnerable species. Research
Northern Ireland	

Environment, conservation and wildlife	is required to assess how the public values conservation and to examine the complexity of ecological networks e.g. impacts of raptor loss. Measurement of the probability and consequence of decline will provide evidence of consequential loss of representative vertebrate species.
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The Driver	32. The continued decline in vertebrate and other species populations is part of a complex biodiversity picture creating winners and losers
The Challenge Scotland Environment, conservation and wildlife	<p>With the removal of European safeguards, we need to frame our national policies around resilient ecosystems that are valued by society. We should utilise and develop our evidence base, with creative use of technology and stakeholder engagement to inform policy and action.</p> <p>Our objective is more integrated and strategic environmental policy for</p> <ul style="list-style-type: none"> • Best use of scarce resources • Increased well-being and security • Rich and healthy biodiversity

The Driver	32. The continued decline in vertebrate species populations is part of a complex biodiversity picture creating winners and losers
The Challenge England Environment, conservation and wildlife	Tackling declines in biodiversity species and populations requires innovative approaches to asset management and conservation at a range of scales, recognising the importance of ecosystem functions and ecological networks, and the role of people. The development of a coherent ecological network ensuring resilience of our biodiversity and ecosystem services is needed, which can be supported by an interdisciplinary evidence of what works where, and how good practice can be implemented at scale.



The Driver	34. Poverty and social injustice in Scotland is resulting in a disconnection between people and the environment
The Challenge Scotland Food, Farming, Timber and Forests	Poverty and social injustice in Scotland consume very significant resources and political space, which results in a gap in provision of support for environmental services. This large sector of society is disconnected from the environment with adverse effects on health, wellbeing and economic contribution. Research on social science aspects of early life interventions and the economic benefits of this should be increased.

The Driver	34. Poverty and social injustice is creating a disconnection between people and the environment
The Challenge	<p>Poverty and social injustice is creating a disconnection between people and the environment.</p> <p>Lack of awareness and appreciation of the natural environment leads to a society disenfranchised from environmental policy, feeding a vicious circle of reduced political emphasis upon nature. Economic downturn post-Brexit could increase poverty, which combined with lack of political will could lead to increasing environmental harm.</p> <p>To reconnect people of all social classes with the environment and the essential ecosystem services it provides we need to understand the barriers to access and appreciation of nature. Research should focus on public attitudes, understanding, awareness and valuation of the environment, to establish whether this disconnect is driven by time, resources or accessibility.</p> <p>Policy links are to health and wellbeing, community engagement and education policy</p>
Wales Water, Fisheries and Marine	

The Driver	36. The ecosystem approach, landscape-scale approaches, ecosystem services and natural capital frameworks will be significant components of the policy making process
The Challenge	<p>The challenges/opportunities are the need: for monitoring evidence to understand the condition of the ecosystem and how it changes with adaptive management; to understand the natural capital of Scotland/UK, have a shared view of what it means, how we value it, the value of each component, and its use in decision-making (for example: using the tourist and other value of beavers v. the land use challenges; comparing the benefit of increased farm land from removing hedges v. wildlife costs); to understand how to balance tick-box with holistic regulation; to demonstrate that the EA/ES approach, when properly implemented, leads to a more efficient, equitable and sustainable aquatic environment.</p>
Scotland Water, Fisheries and Marine	

The Driver	36. The ecosystem approach, landscape-scale approaches, ecosystem services and natural capital frameworks will be significant components of the policy making process
The Challenge	<p>The UK needs to adopt a whole system approach to policy-making to provide a more holistic policy landscape. This approach provides greater opportunities for improved environmental management with greater community and stakeholder involvement. Brexit provides an opportunity to build on European frameworks to create a world-class, sustainable system of environmental management and conservation.</p> <p>Research is needed on ecosystems, using a cross disciplinary approach to include the historic environment. Greater opportunities for designing research across the environment – both natural and cultural - are required to support the implementation of these approaches.</p>
Scotland Environment, conservation and wildlife	

The Driver	36. The ecosystem approach (and) natural capital frameworks will be significant components of the policy making progress
The Challenge Northern Ireland Water, fisheries and Marine	The UK needs a natural capital framework and ecosystem approach to avoid focusing on single agenda items and consider the overall value of ecosystems. Policy needs to become more applied to how ecosystems function and consider their overall value (long term vision). Post Brexit, implementing an ecosystem approach will help promote the economic value of ecosystem services. If this is not successfully demonstrated, there is a risk that environmental protection is weakened because loss of European control. If the outcome is successful, the impact should be more resilient ecosystems. To develop an effective response, policy makers need ecosystem models to support decision making. This will benefit from more modern data analytics, big data and include concepts such as cumulative effects. The approach needs to link with international agreements such as OSPAR, climate policy and land based policy.

The Driver	37. The internet of things will change production processes and practices profoundly
The Challenge Scotland Food, Farming, Timber and Forests	Digital technology provides the opportunity to gather information in new ways and link it together. This is the internet of things. We could use this intelligence to provide new services - such as ecosystem services - and link them to new methods of payment. Examples include animal health, trade (provenance) and carbon sequestration. The challenge is to provide evidence through real-life demonstrations all the range of possible benefits. This may require public/private partnerships to address market failures.

The Driver	40. The UK and its Overseas Territories will not be immune from rising sea levels, flooding, heatwaves and poor air quality
The Challenge England Overseas Territories & International	Many of the UKOTs will be very seriously impacted by predicted climate change effects, leading to reduced environmental quality for terrestrial, marine and human life. These effects will likely be more serious than in mainland UK, requiring innovative and robust mitigation and adaptation technologies/strategies. Innovation in adaptation will be critical, as well as integrating climate models with socioeconomic understanding, research into cumulative impacts and risks, and a full range of associated understanding of epidemiology and habitat envelope modelling. The resulting outputs will have relevance to the UKOTs, but also to other nations in tropical and subtropical locations.

The Driver	41. The UK will agree more strategic approaches to environmental delivery through legislative reform as a result of Brexit
The Challenge England Water, fisheries and Marine	There is an opportunity enshrined within the EU exit for the UK to become a world leader in terrestrial and marine environmental management and technology and to derive significant economic, social and environmental public benefits. In order to achieve this in the short term, policy must remain effective and robust. To support long term growth, we must retain exemplar policies and build upon them, through clear targeting of outcomes. This also requires an effective system to measure ecosystem benefits and to communicate and embed both of these clearly across all policy areas. All of the above requires long term strategic planning and resourcing in order to reap the full benefits which can clearly deliver net economic, environmental and social gains.

The Driver	41. The UK is likely to agree more strategic approaches to environmental delivery through legislative reform as a result of Brexit
The Challenge Scotland Environment, conservation and wildlife	On leaving the EU, the UK has the chance to redesign environmental delivery through legislative reform. This is an opportunity to be much more strategic, effective and efficient in our approach to improving ecosystem health and human wellbeing. To achieve this, we need better understanding of <ul style="list-style-type: none"> (a) Clarity of desired outcomes (b) Which actions would achieve those outcomes (c) Direct and indirect effects (environmental/social/economic) of those actions within and across different sectors (transport, health, housing) (d) How emerging technologies can be used to improve implementation and compliance

The Driver	44. The value of the UK's ecotourism markets is likely to increase
The Challenge England Overseas Territories & International	The UKOT's economies rely increasingly on ecotourism. The impacts of Brexit include loss of EU funding for infrastructure projects and advice on sustainable tourism. To improve living standards new sources of funding and expertise are needed to maximise potential ecotourism benefits and protect and maintain the fragile habitats and species on which this depends. Research is needed to quantify the existing natural environment baseline and the possible impacts of increased visitor numbers by modelling the potential economic, social and environmental effects. Research may also be needed to see if the existing designations will still be fit for purpose.

The Driver	47. Waste will continue to increase and is likely to cause significant environmental challenges (links with environmental pollution)
The Challenge Wales Water, Fisheries and Marine	Waste is defined as a risings, process inefficiencies and pollution (transient /persistent). Increased contamination will ultimately lead to health and wellbeing impacts. Potential threats post Brexit include reduction in effectiveness of regulatory framework, reduced funding to incentivise behavioural change. A lack of funding may lead to reactive action rather than a strategic focus on chronic system failures. Opportunities include increased flexibility to consider circular economy integrating waste, land management etc. To capitalise on the opportunities policy makers need to be aware of how to harness innovative technology, any lags in deployment and need targeted Information about source pathways and apportionment.

The Driver	47. Waste will continue to increase and is likely to cause significant environmental challenges 48. Micro-plastics, waste pollutants and emerging contaminants have increasing impacts on marine ecosystems
The Challenge England Overseas Territories & International	Waste disposal will need to diversify and scale up to cope with both domestic- and externally-driven increases in waste production. The impacts of uncontrolled increases in waste pose a number of risks to environmental and public health, prosperity and the local economy. The UK's commitments to meeting its biodiversity targets require a greater focus on assisting its overseas territories in their transition towards more environmentally sustainable practices and green economic development. Further research and innovation in supply chain analysis, industrial production, disposal systems, and ecotoxicology is needed to examine and implement forward-looking solutions. These steps will both reduce consumption and support moves towards a more circular economy.

The Driver	49. Border controls between the North and South are different from now
The Challenge Northern Ireland Water, fisheries and Marine	Brexit will lead to a change in border controls for Northern Ireland and Republic of Ireland for environment and agriculture. This could lead to an increase in pollution, divergence in regulation and standards, and less cooperation. However, there may be more flexibility to refine controls and policy to suit the Northern Ireland climate and landscapes. Research is required to understand the strengths and weaknesses, and opportunities and threats of current cross border arrangements, and how these can adapt to optimise trans boundary environmental management. This should include monitoring and data.

The Driver	50. Loss of agricultural soils
The Challenge England Environment, conservation and wildlife	Soils have a fundamental role in our environment with extensive dependencies on other goods and services. Despite this, soils are not valued in our society and economy. We do not have enough knowledge about our soil and its diversity, quality and health, and policy around soil is currently weak or non-existent. Are we losing our soils? What are problems are there and what are we storing up for the future? Is this an issue that requires policy attention and interventions?

The Driver	51. Antibiotic resistance, pollution and provenance (additional driver suggested by group)
The Challenge Wales Water, Fisheries and Marine	<p>An increasing and ageing human population is driving increased risk of chemical contamination of the environment. The fate of these in the environment and their impact upon ecosystems is poorly understood. Impacts on human, wildlife and environmental health can be severe (e.g. antimicrobial resistance, cancers, mental health).</p> <p>To formulate appropriate policy, we need to understand sources, pathways and persistence in environmental systems, and links to human food security. Improved public health and wellbeing would reduce demand for pharmaceuticals. Costs of source control, reduction in demand and effective clean up, must be contrasted with the societal and economic losses associated with a contaminated environment.</p>

The Driver	52. Human Health, and its links to environment will increase in importance
The Challenge Wales Food, Farming, Timber and Forests	Rising cost of health care is unsustainable. We want to understand the links or prevent pushes to increase GDP which may cause a decline in environmental quality and health. There needs to be more understanding of the opportunities the natural environment presents for health (e.g. linking payments to agriculture with diet and environmental impacts). In general we need better evidence of links between physical, mental health and natural resources (air quality & lung health, green space & mental health, water pathogens & diseases). Better understanding of links to other policies in education, health and recreation.

Appendix 1. Mapping drivers from the Scottish workshop to the standard driver list

The first workshop in Scotland tested 57 drivers and following that process and the feedback from the participants the number was reduced to 47 which were used in all subsequent workshops (termed the standard driver list). The following table maps the Scottish drives prioritised by the participants of the Scottish workshop to the 47 standard drivers.

Agricultural support payments are increasing, focussed on public goods	<i>Agricultural support payments are increasing, focussed on public goods</i>
Circular economy practices will become more widely used and change what society values	Circular economy practices will change what society values
Citizen engagement is likely to become increasingly important across a range of policy areas	Citizen engagement is likely to become increasingly important across a range of policy areas
Climate change will continue to cause increased temperature and increased occurrence of extreme weather and seasonal events.	Climate change is resulting in increased temperature and increased fluctuation in extreme weather and seasonal events.
Consumption is likely to increase steadily	Consumption will continue to increase
Cyber security will be a continuing threat to international security	Cyber security is an increasing threat to international security
Data analytics will enable sophisticated mapping of demand and supply	Data analytics will be used to understand changing demand and supply patterns for a range of goods and services
Decarbonisation will significantly impact on policy formulation and implementation	Decarbonisation will significantly impact on policy formulation and implementation
Demand for energy will continue to increase	Demand for energy is increasing, with potential impacts on the environment from new technology.
	Demand for greater regional autonomy will remain a political issue
	UK political structures and processes for political decision making are likely to change
	Devolution of decision making down to local/metropolitan actors
Food security and water security will become significant challenges; perhaps even sources of conflict	Food security and water security will become significant challenges; perhaps even sources of conflict
Global population is likely to exceed 8.5 billion by 2030	Global population will exceed 8.5 billion by 2030
Global resource shortages (metals, nutrients for example) will begin to bite	Global resource shortages (metals, nutrients) will begin to bite
GM crops and animals are likely to become culturally accepted in the UK	GM crops and animals will become culturally accepted in the UK

Governments will continue to collaborate to address Climate Change and Sustainable Development	Governments will continue to collaborate to achieve the Paris Agreement on Climate Change
	Governments will continue to collaborate to achieve the UN Sustainable Development Goals
Governments will seek to achieve a global free trade agreement	Governments will seek to achieve a global free trade agreement
Improvements in farming techniques and technology will boost productivity and food security	Improvements in farming techniques and technology will boost productivity and increase food security
International investment in the UK will increase	Increasing international investment in local and regional economies and resources
Local economic performance around the UK will be uneven, leading to increased regional disparity	Local economic performance around the UK will be uneven, leading to increased regional disparity
	Increasing concentration of population in urban centres
	Current levels of growth in London and other major UK cities cannot be sustained without significant investment to protect the natural environment
	Societal and political pressures on London and the South East may result in resources and population being moved to the rest of the UK
Lowland/upland land capability and use will face increasing and competing demands	Patterns of land use will need to change to meet the UK's food and energy needs
More than one quarter of the world's population will live with water scarcity on a daily basis by 2040	More than one quarter of the world's population may live with water scarcity on a daily basis by 2040
New technology will continue have an impact on the natural environment	Demand for energy is increasing, with potential impacts on the environment from new technology.
Patterns of land and marine use will need to change to meet the UK's food and energy needs	There is increasing pressure on land to provide food and energy
People will have increased mobility and job flexibility	People will enjoy increased mobility and job flexibility
Pests and diseases will be more widely dispersed	<i>Pests and diseases are more widely dispersed</i>
Planning needs to be future proofed and more embedded	<i>Future proof planning needs to be more embedded</i>
Retailer power will drive farming systems	Retailer power drives farming systems
Smart cities and autonomous vehicles will change how we live and travel	Smart cities and autonomous vehicles may change how we live and travel
Technology is likely to play an increasing role in regulation, both in monitoring and compliance	Technology may play an increasing role in regulation, both in monitoring and compliance

<p>The average age of the UK population will be 42.9 years in 2045. 1 in 12 will be over 80</p>	<p>The average age of the UK population will be 42.9 years in 2045. 1 in 12 will be over 80.</p> <p>The ageing population will place significant pressure on public services</p>
<p>The continued decline in vertebrate species populations is part of a complex biodiversity picture creating winners and losers</p>	<p>The continued decline in vertebrate species populations is part of a complex biodiversity picture creating winners and losers.</p>
<p>The contribution that natural capital makes to UK growth will become more important</p>	<p>The contribution that natural capital makes to UK growth will become more important</p>
<p>Poverty and social injustice is creating a disconnection between people and the environment</p>	<p>Poverty and social injustice is creating a disconnection between people and the environment</p>
<p>The economic centre of gravity will continue to move away from the west towards China and the east</p>	<p>The economic centre of gravity is shifting away from the west towards China and the east</p>
<p>The ecosystem approach, landscape-scale approaches, ecosystem services and natural capital frameworks will be significant components of the policy making process</p>	<p>The ecosystem approach, landscape-scale approaches, ecosystem services and natural capital frameworks will be significant components of the policy making process</p>
<p>The internet of things will change production processes and practices profoundly</p>	<p>The internet of things will change production processes and practices profoundly</p>
<p>The risk of interstate conflict will continue to rise</p>	<p>The risk of interstate conflict will continue to rise</p>
<p>The sale of petrol and diesel vehicles will be banned in 2040</p>	<p>The sale of petrol and diesel vehicles will be banned in 2040</p>
<p>The UK and its Overseas Territories will not be immune from rising sea levels, flooding, heatwaves and poor air quality</p>	<p>The UK and its Overseas Territories will not be immune from rising sea levels, flooding, heatwaves and poor air quality.</p>
<p>The UK will agree more strategic approaches to environmental delivery through legislative reform as a result of Brexit</p>	<p>The UK is likely to agree more strategic approaches to environmental delivery through legislative reform as a result of Brexit</p>
<p>The UK will not retain exclusive fishing rights of the 200 mile exclusive economic zone post Brexit</p>	<p>The UK will not retain exclusive fishing rights of the 200 mile exclusive economic zone post Brexit</p>
<p>The UK's reputation as a migrant unfriendly country will have an impact on jobs and wealth creation</p>	<p>The UK's reputation as a migrant unfriendly country will have an impact on jobs and wealth creation</p>
<p>The value of the UK's ecotourism markets is likely to increase</p>	<p>Increasing value of the UK's cultural ecosystem services (landscapes/open green space, market towns, heritage sites) to global tourism markets</p>
<p>The world economy will double in size by 2045</p>	<p>The world economy is expected to double in size by 2045</p>
<p>There will be no magic bullet that eases pressure on the natural environment to provide food and energy</p>	<p>There is increasing pressure on the marine environment to provide food and energy (the blue economy).</p>
<p>Waste will continue to increase and is likely to cause significant environmental challenges</p>	<p>Waste will continue to increase and is likely to cause significant environmental challenges</p>

